KONFERENZBAND | PROCEEDINGS

EVA BERLIN 2023

Elektronische Medien & Kunst, Kultur und Historie

27. Berliner Veranstaltung der internationalen EVA-Serie
Electronic Media and Visual Arts

29. November 2023 – 01. Dezember 2023
Kunstgewerbemuseum am Kulturforum Potsdamer Platz, Berlin
Eine Kooperation zwischen der BTU Brandenburgische Technische Universität Cottbus-Senftenberg, den Staatlichen Museen zu Berlin - Preußischer Kulturbesitz und dem Deutschen Zentrum für Luft- und Raumfahrt e.V. – Institut für Optische Sensorsysteme

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KONFERENZBAND | CONFERENCE PROCEEDINGS

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INHALTSVERZEICHNIS | CONTENT

TRANSFORM

Game-changing Technologies stehen im Mittelpunkt der Konferenz EVA-Berlin 2023. Machine Learning, Künstliche Intelligenz, Blockchain und XReality-Anwendungen sind die innovativen Treiber in den Ökosystemen der Kultur- und Kreativwirtschaft sowie der künstlerischen Produktion. Haptische Komponenten eines Werkes werden greifbar gemacht und bildliche Darstellungen in passende Worte gefasst. Ein Landschaftsgemälde erhält als Klanglandschaft einen neuen akustischen Erlebnishorizont oder wird als animierte Wetterkulisse in ein Gaming-Setting integriert.

Digitale Kompetenz und der Erwerb technologischer Souveränität erweisen sich damit als Voraussetzungen, um die Transformation der Kultur zu gestalten und die neu gewonnenen virtuellen Räume angemessen zu möblieren. Die Vermittlungsarbeit in den Kultureinrichtungen profitiert von diesen Möglichkeiten. Es bieten sich neue Wege an, mit dem Publikum zu interagieren und eine breitere Öffentlichkeit zu adressieren. Multimodale Zugänge und personalisierte Interaktionsangebote unterstützen die inklusiven Ansprüche eines partizipativen Kulturverständnisses und öffnen die Angebote für eine barrierefreie Wahrnehmung durch benachteiligte oder beeinträchtigte Publika. Zugleich etablieren sich innovative technologische Werkzeuge in den ewigkeitsfesten Arbeitsfeldern der Dokumentation, der Konservierung und der Rekonstruktion. Maschine Learning Tools, von der linguistischen Analyse historischer Aufzeichnungen bis zum OCR handschriftlicher Texte, liefern bereits heute wertvolle Metadaten für die Dokumentation. Digitale Repräsentanten werden in der Konservierung und Restaurierung von Kunstwerken eingesetzt, um Schäden zu analysieren, Restaurierungsmethoden vorzuschlagen oder die Farben und Texturen zerstörter Artefakte plausibel zu rekonstruieren.

Das 'Kunstwerk im Zeitalter seiner technischen Generierbarkeit' birgt aber auch Risiken. Im neuen Miteinander von Mensch, Maschine und Objekten lösen sich vertraute Bindungen an das Faktische, an die materielle Zeugenschaft der Objekte und an die physische Präsenz vor dem Original. Das wirft nicht zuletzt Fragen der Glaubwürdigkeit auf. Mit wem sprechen wir eigentlich, wenn wir mit einem algorithmischen Gegenüber in Dialog treten? Und welcher Intentionalität ist das KI-basierte Kunstwerk verpflichtet?

Die 27. Berliner EVA-Konferenz lädt dazu ein, aktuelle Positionen und praktische Anwendungsbeispiele zu diesen Themen kennen zu lernen. Es werden innovative Beiträge zu den Schwerpunktthemen der Konferenz vorgestellt und in Workshops können Kooperationsprojekte verfolgt oder grundlegend neue Arbeitsweisen kennengelernt werden. Konkrete Verfahren, Projekte und Produkte werden parallel zur Konferenz in einer Ausstellung und in der Postersession präsentiert.

Als Teil des internationalen EVA-Konferenzen-Netzwerks ist die Berliner Veranstaltung eine Plattform länderübergreifenden Austauschs und der europäischen Kooperation.

Andreas Bienert,
Eva Emenlauer-Blömers,
Dominik Lengyel

TRANSFORM

Game-changing technologies are at the centre of the EVA-Berlin 2023 conference. Machine learning, artificial intelligence, blockchain and XReality applications are the innovative drivers in the ecosystems of the cultural and creative industries and artistic production. Haptic components of a work are made tangible and visual representations are put into words. A landscape painting is given a new acoustic experience horizon as a soundscape or is integrated into a gaming setting as an animated weather backdrop.

Digital expertise and the acquisition of technological sovereignty are thus proving to be prerequisites for shaping the transformation of culture and appropriately furnishing the newly acquired virtual spaces. Educational work in cultural institutions benefits from these opportunities. New ways of interacting with the public and addressing a broader public are opening up. Multimodal access and personalised interaction offerings support the inclusive demands of a participatory understanding of culture and encouraging innovative offerings for barrier-free perception by disadvantaged or impaired audiences. At the same time, innovative technological tools are establishing themselves in the everlasting fields of documentation, conservation and reconstruction. Machine learning tools, from the linguistic analysis of historical records to the OCR of handwritten texts, are already delivering valuable metadata for documentation. Digital representatives are used in the conservation and restoration of works of art to analyse damage, suggest restoration methods or plausibly reconstruct the colours and textures of destroyed artefacts. However, the 'artwork in the age of its technical generability' also harbours risks. In the new coexistence of man, machine and objects, familiar ties to the factual, to the material testimony of the objects and to the physical presence in front of the original are loosened. Not least, this raises questions of credibility. Who are we actually talking to when we enter into a dialogue with an algorithmic counterpart? And to what intentionality is the AI-based artwork committed?

The 27th Berlin EVA Conference invites you to discover current positions and practical application examples on these topics. Innovative contributions to the main topics of the conference will be presented. Workshops and co-operation projects can be pursued to learn about fundamentally new ways of working. Practical processes, projects and products will be presented in an exhibition and in the poster session alongside the conference.
As part of the international EVA conference network, the Berlin event is a platform for transnational exchange and European co-operation.

Andreas Bienert,
Eva Emenlauer-Blömers,
Dominik Lengyel

EVA BERLIN 2023

29. NOVEMBER – 01. DEZEMBER 2023

Eröffnung: Keynote
Digital aufgelöste Demokratie:
Von der Unabhängigkeitserklärung des Cyberspace zur neuen Unmündigkeit

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EVA BERLIN Konferenz 2023

Zum ersten Mal in der Entwicklung der Menschheit steht eine Universaltechnologie zur Verfügung, die als global vernetzte Infrastruktur eine ungeahnte Komplexität erzeugt und zur zentralen Herausforderung für soziale Systeme geworden ist. Gleichzeitig sehen sich Gesellschaftsformationen aller Art mit vielfältigen Problemlagen konfrontiert, die häufig miteinander verknüpft und verwoben sind. An dieser Komplexität müssen über kurz oder lang alle reduktionistischen Verfahren sozialer Organisation scheitern, was die Frage nach adäquaten Methoden im Umgang dringlich werden lässt. Mit aller Vorsicht kann Demokratie als hilfreiche Methode angeführt werden, erlaubt sie doch ein Denken zweiter Ordnung, das eine Generationen von Menschen überschreitende Entwicklung und Nutzung unterschiedlicher Ressourcen, Dinge und Interessen erlaubt und diese zugleich zur Grundlage neuer Nutzungsweisen und Entwicklungen machen kann. Demokratie wäre, so gedacht - zumindest im Ideal -, ein Modus menschlicher Selbstorganisation, der auf die evolutionären Veränderungen reagieren kann, mit denen Leben gegenwärtig konfrontiert ist. Aus dieser Perspektive lässt sich die Verbindung von digital-binären Infrastrukturen und Demokratie als enormes Spannungsfeld verstehen, das sich unmöglich auf technische Fragestellungen beschränken lässt.

Während die multiplen Krisen als Ausdruck eines Kontrollverlustes interpretiert werden können, verspricht die Sammlung, Speicherung und Vernetzung aller datenfähigen Ereignisse einen besseren Umgang mit der Komplexität, was de facto die Transformation von sozialen Systemen beschleunigt. Die ‚smarten' Problem-Solving-Anwendungen lassen sich eben nicht auf die Verknüpfungen von Menschen, Geräten und Dingen aller Art, von Wohn-, Büro-, Verwaltungsräumen reduzieren, sondern stehen für eine ko-evolutionäre Systemveränderung, die historisch keinen Vorläufer kennt. Will man den Gedanken von Demokratie als hilfreiche Methode im Umgang mit diesen Veränderungen ernst nehmen, kann man sich nicht mit Fragen nach Nutzungsmöglichkeiten und -bedingungen digitaler Technologien zufriedengeben. Auch die Idee, Demokratie müsse sich an die neuen Verhältnisse anpassen, greift zu kurz. Denn was sich mit den vernetzenden Technologien tatsächlich verändert, sind die Bezugsgrößen von Sozialräumen und -zeiten, von Geographien und ihren Populationen. Gelingt es nicht, das Verhältnis von Demokratie und Technologie neu zu denken, ist die Gefahr groß, dass Demokratie in den Geschäftsfeldern digitaler Infrastrukturen aufgelöst wird.

Hier ist es hilfreich, sich an die „Unabhängigkeitserklärung des Cyberspace" von 1996 zu erinnern, die eine gerechtere, diskriminierungsfreie und geistreichere Welt versprach, indem der Cyberspace einer analogen und materiellen Welt aus „Fleisch und Stahl" gegenübergestellt wurde (vgl. Barlow 1996). Diese Gegenüberstellung spiegelt eine fundamentale Fehleinschätzung wider, die ihr Gegenüber in der ebenso grundsätzlichen Fehleinschätzung analog organisierter sozialer Systeme wiederfindet: In der folgenschweren Trennung von Digitalem und Analogem, von Materiellem und Immateriellem, von Biologischem und Technologischem. In seiner „Anthropologie des Cyberspace" schreibt Pierre Levy, dass man Demokratie nicht anderen Regierungsformen vorzieht, „weil sie die Herrschaft einer Mehrheit über eine Minderheit festschreibt", sondern weil sie „die Macht der Regierenden einschränkt und Rechtsnormen gegen Willkür vorsieht (…), weil sie partikulare Regeln, Privilegien und Monopole durch generelle Regulierungsmechanismen ersetzt" (Levy

1997: 98). Versteht man unter „generellen Regulierungsmechanismen“ die Einladung, Demokratie auch über die Systemgrenzen repräsentativer Demokratien hinaus zu denken, ohne dabei einem naiven Cyberspace-Mythos aufzusitzen, lässt sich Demokratie als wichtige Methode im Umgang mit Krisen und Transformationen skizzieren. Diese Methode setzt nicht einfach auf Partizipation an bereits bestehenden Systemen, sondern lässt sich aus einer evolutionsgeschichtlichen Perspektive als konsequente und notwendige Weiterführung ko-evolutionärer Prozesse menschlicher Selbstorganisation definieren.

Dass diese Betrachtung von Belang ist, lässt sich daran, dass die Praxis partizipativer Prozesse durch die Einbettung in digitale Infrastrukturen zunehmend darauf hinausläuft, Menschen auf die Rolle von User:innen zu reduzieren. Plattform-Unternehmen haben in partizipativen Prozessen ein lukratives Geschäftsmodell entdeckt und entwickelt, das ohne Demokratieverständnis und -angebot auskommt (vgl. Faßler 2020). Die Verschränkung von Alltagsleben mit privatwirtschaftlich produzierten und organisierten Infrastrukturen provoziert in Folge eine schwierige und schwache Verteidigungshaltung repräsentativer Demokratien, weil Nutzer:innen eben keine Bürger:innen mehr sind. Hinzu kommt, dass die ohnehin schon fragwürdige Fiktion eines „eigenen Volkes“ als Trägerschaft demokratischer Verhältnisse zum zentralen Bezugspunkt für rechts-populistische Bewegungen geworden ist und damit jede Legitimationskraft verliert. Deshalb ist die Notwendigkeit, Demokratie neu zu entwerfen dringlich und sollte die ko-evolutionären Entwicklungszusammenhänge von Mensch-Geräte-Netzwerken als Ausgangslage für neue Gedanken und Praxen ernsthaft in Betracht ziehen. Ich stimme Geert Lovink zu, wenn er schreibt: „Was wir nicht brauchen, ist eine weitere Realpolitik oder einen noch gewalttätigeren globalistisch-neoliberalen Konsens. Unsere zerbröckelnde Welt braucht dringend neue Vokabularien und Visionen“ (Lovink 2022: 187). In diesem Sinne gilt es, auch Demokratie als Methode des Fiktionalen zu verstehen, als Ort entwicklungsoffener Vorstellungswelten, die sich schon immer einer eindimensionalen Deutung entziehen konnten. Gelingt dies nicht, laufen repräsentative Demokratien Gefahr, eine neue Unmündigkeit dort zu produzieren, wo sie glauben, Freiheit und Rechte zu verteidigen.

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KONFERENZ I | CONFERENCE I

TRANSFORM I

SESSION I

Inklusion und Partizipation | Inclusion and Participation

Moderation: Eva Emenlauer-Blömers
(ehem. Berliner Senatsverwaltung für Wirtschaft, Technologie und Forschung, Projekt Zukunft)

Kurzfristig vertreten durch | Briefly represented by:
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Social Flow: Social connectedness and flow in participatory art

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ABSTRACT: Zeitgeist - a participatory artwork developed by the researcher/artists Dr. Shama Rahman and Dr. Olive Gingrich, uses deep-learning algorithms to indicate creative 'Flow' mental states visualised on a holographic Pepper's ghost display. Based on real-time analysis of physiological brainwave data through deep-learning algorithms, participants visually experience the probability of being in Flow - a mental state of creative peak performance (Nakamura & Csikszentmihalyi, 2002). Forming part of the AHRC-funded p_ART_icipate research project, this research looks at the effect of participatory arts on social connectedness and mental well-being. Two small-scale pilot user studies (N=12 and N=16), point to a significant effect of the intervention on social connectedness, mood and varying levels of Flow - with facilitation and environmental conditions being a potential confounding factor. This paper presents the findings of this initial pilot study, as well as a discussion around co-factors of social flow.

Keywords: Inclusion - Visualisation - Artificial Intelligence

Image 1: Zeitgeist at the Royal Society

1. INTRODUCTION

Zeitgeist is a participatory artwork which measures whether audiences are in a Flow mental state - a state of increased creative engagement, and improved mood - using deep-learning algorithms for Flow state detection from brainwaves as measured via EEG – an electroencephalogram which monitors brain activity. Zeitgeist analyses this data and represents Flow states as visual cues on a holographic display. These visual cues are additionally designed to encourage Flow states a process called 'nudging'. Lighter colours and more complex forms represent a heightened state of Flow. Darker colours and simpler forms represent lower states of Flow. In her PhD, Rahman found a biomarker for the creative Flow state within experimental paradigms of creative performance (Rahman et al., 2021). Trained on this biomarker data, deep-learning algorithms classify new brainwave data from wearables as real-time correlates of Flow (Adnan et al., 2020). Previous research suggests a direct link between participatory art and social connectedness (Gingrich et al. 2019). Zeitgeist builds upon this research, using creative engagement to enable 'Social Flow' -a Flow state involving more than one person. Our hypothesis is that 'Social Flow' can result in increased social connection, improved mood, and thus altogether result in a greater sense of wellbeing.

Zeitgeist has previously been shown at Ars Electronica, EVA London Conference, and Poole Museum. Two initial pilot studies are presented here, with the first one having taken place at Somerset House in August 2023, engaging pairs of users (n=12), and the second the Royal Society in September 2023 (n=16) *(see Image 1)*. Both user studies followed the same design but involved different cohorts and environmental settings. User studies included a series of facilitated creative activities while visualising Flow states in real-time. Pre- and post-intervention surveys, as well as interviews and observation point to insights into key factors of flow. Exercises include humming, wordplay and improvisation. Joy and a degree of cognitive challenge including speed seem to be contributing factors to Flow. While people appear to respond differently to different types of participatory engagement, Flow states seem to be easier reached by participants with a degree of knowledge of meditative practices which have a cross-over in open monitoring. Participants reported deeper social connectedness post-intervention, as compared to normal (non-intervention) social ice-breaker activities.

2. RESEARCH CONTEXT

The AHRC-funded p_ART_icipate research project led by the University of Greenwich, with partners CNWL NHS Foundation Trust and Brunel University, examines a set of research questions on the impact of participatory art interventions on social connectedness among the UK public. User groups include vulnerable populations disproportionately affected by social distance. In the Zeitgeist case study, primary user groups within the pilots included creative professionals (Somerset House) and knowledge workers (Royal Society). The objective of the study is to provide new insights into design and facilitation of participatory art within an online context:

Over the last decade, artistic practitioners (M. Abramovic, P. Sermon), policy-making bodies (UK Parliament, local councils), health organisations (NHS Foundation Trust, PHE), cultural organisations (Southbank, Tate) and academics (MIT's Co-Creation Studio, Centre for Performance Science) investigated means to improve societal wellbeing through creative engagement. Whereas the effect of participatory art on health and wellbeing is widely researched (AHRC Connected Communities, Evidence Review Mental Health Foundation), important questions remain about best practices for art facilitation online. Post-Covid-19, we face an urgent need to understand the potential of technology-facilitated art to alleviate the effects of social isolation in remote working and living conditions. Recent research points to an increase in loneliness, isolation and sensory deprivation during COVID-19 (Fancourt 2020, Venkatesh 2020). The Office for National Statistics estimates that 14.3% or 7,4 million people across the UK felt their wellbeing being affected due to loneliness ("lockdown-lonely") during lockdown (ONS 2020). Health issues associated with social isolation and loneliness frequently include depression, anxiety, chronic stress, and insomnia (Wilson et al. 2007, Stickley & Koyanagi 2016, Sepulveda-Loyola et al. 2020). While the effects of participatory engagement on social connectedness within quality relationships are well supported, there remains a significant knowledge gap on the role participatory tools play in an arts and health context *online* (n.b.), particularly in combatting sensory deprivation resulting from isolated living and remote working conditions.

Remote working conditions pose a major challenge for UK employers and employees post-Covid-19 with an immediate need to improve tools for collaborative work processes to combat social isolation and sensory deprivation. Equally, psychological side-effects of working from home are largely unexplored, despite the number of people working from home across the UK more than doubling from 4.7 million to 9.9 million between 2019 and 2022 (Office for National Statistics 2023). The populations studied within the two user groups (pilot and control) are - knowledge workers and creative professionals belong to populations with high work-from-home rates: A report by Gartner (2021) estimates 51% of knowledge workers work from home; with the UK government report of the same year suggesting only 26.8% visited their workplace in a week. These numbers have improved since the pandemic. As working-from-home (WFH) conditions are rapidly increasing, new tools are needed to mitigate potential side effects of remote working such as sensory deprivation and feelings of disconnection and loneliness, with social isolation being linked to a higher risk of heart attacks, mental disorders and mortality (Holt-Lunstad et al. 2015, Hakulinen et al. 2019).

There is clear evidence of the impact of participatory arts providing opportunities for meaningful social contact, as a means of alleviating social isolation and loneliness (Mental Health Foundation's Evidence Review on Participatory Art 2011). Greater social connectedness has been linked to a lower risk of cancer recurrence, higher survival rates following a heart attack, lower blood pressure, better immune responses, and better psychological wellbeing (Cohen 2004, Stansfeld 2006, Uchino et al. 1996). Recent research suggests that the effects of social isolation and sensory deprivation can be mitigated through participatory media arts experiences (Tymoszuk, Fancourt, et al. 2020, All-Party Parliamentary Report 2017). p_ART_icipate estimates the effect of participatory art on social connectedness within the UK population, engaging with four discrete, vulnerable groups. The artwork Zeitgeist forms part of this research, focusing on creative practitioners, knowledge workers (pilot) and healthcare workers (upcoming).

The potential for participatory arts to contribute to mental health and wellbeing has been the subject of parliamentary debates, all-party parliamentary reports, research by the Arts Council of England and academic research (Fancourt 2019, Billington et al. 2013). According to the All-Party Parliamentary Report on the Arts, Health and Wellbeing (2017), 82% of people living in deprived communities engaging in participatory art practices enjoyed greater wellbeing. The report calls for increased interdisciplinary, cross-council research by Research Councils UK and individual research councils in the areas of participatory arts, health and wellbeing. The AHRC report 'Connected Communities' (2022) on participatory arts and wellbeing singles out the importance of facilitation practices for beneficial outcomes. While a large body of evidence points to a strong causal relationship between participatory arts, mental health, and perceived social connectedness (Dadswell et al. 2020, Mansfield & Daykin 2020, Perkins & Williamon 2014, Fancourt & Perkins 2018), little research exists on the potential for participatory arts to contribute to social connectedness online, a knowledge gap that needs to be filled in the context of social distancing and WFH. Research supports the importance of sensory experiences in facilitating social connectedness and preventing feelings of loneliness (Heatley Tejada et al. 2020); however, in societies already affected by loneliness before the pandemic, the role of social and sensory deprivation remains understudied post-Covid. This case study investigates the effect of digital participatory arts on wellbeing and mood, social connectedness and Flow.

2.1 FLOW, CREATIVE ENGAGEMENT, PARTICIPATORY ART

Flow increases intrinsic motivation (Veenhoven 1984), meaningful engagement and absorption (Csikszentmihalyi, 1990), and importantly, improves mood and happiness (Diener, 2000; Diener & Diener, 1996). 'Flow' mental training is proposed to enhance cognitive performance, creativity and productivity. Previously, Flow cognitive training has been shown to improve cognitive abilities in those with traumatic brain injury (Yoshida et al., 2018). However, the relationship between Flow and social connectedness remains understudied, and Zeitgeist's pilot study addresses this.

The first use of the term 'participatory arts' can be traced to an art review by Richard Ross for the Los Angeles Institute of Contemporary Art (Ross 1980). The relationship between participatory arts and mental health has been the subject of a range of studies pointing to a direct effect of participatory arts engagements on self-esteem and confidence (Marmot 2004, Wilkinson 1996), on dignity (Horton 2003) and psycho-social notions of identity following illness (Clift et al. 2008, Daykin et al. 2008). A meta-analysis review of the impact of arts on dementia and cognitive processes by Young et al. highlights the potential for creative activities to raise attention, aid the stimulation of memories, and enhance communication (Young, Camic & Tischler 2015). Yet this diverse field of interdisciplinary research is facing a different set of challenges in a post-COVID context: The focus now lies on questions into design, facilitation and accessibility within mediated, digital participatory arts - in both physical and online settings - as well as the need for new evidence of the effect of participatory arts on social connectedness.

2.2 ZEITGEIST INTERFACE

The Zeitgeist case study focuses on the effect of a participatory arts intervention on Flow- states, mood and social connectedness. Incoming raw EEG data is received via bluetooth and then analysed via a Python script through NeuroCreate's proprietary deep-learning algorithm (Adnan et al., 2020) to calculate the continuous probability of Flow states in real-time. This probability measure is a floating points value between 0 and 1 which is then parsed using an Open Sound Control (OSC) protocol, and sent to a Touchdesigner (http://www.derivate.ca) patch. This visual coding software allows for real-time representation of these incoming values, which are mapped onto two 3-dimensional Moebius strips (FBX files) - one for each participant in a given pair. The colour of the Moebius strips responds to the participants' probability of being in Flow, with warmer colours (golden and warm teal/blue tones) indicating a likely Flow state and cooler colours (purple/violet tones) the potential absence of Flow. The scale and visual complexity of the resulting shape are influenced by a shared Flow factor, computed by adding both participants' Flow states such that the larger the combined Moebius strips appear, the higher the probability of Flow states in both participants. Participants can observe their respective Flow state, as well as one of their interlocutors in real-time.

Image 2: Zeitgeist Hologram

2.3 PARTICIPATORY ARTS FACILITATION

Across two pilot user studies at Somerset House and the Royal Society (both London, UK) participants were invited to take part in three facilitated exercises which included an onboarding activity (5 minutes average) consisting of humming, followed by wordplay improvisations of single word associations (5 minutes) and longer phrase associations (5 mins). The humming activity serves as a way of allowing participants to 'arrive and ground' both individually and with their partners. They are prompted to hum along with the facilitator and are free to match their note or to harmonise. Participants can equally treat the facilitator's note as a base (or drone), such that there are no leaders but rather more collectively they can choose to explore accompanying melodies and harmonies. This practice is a form of Deep Listening (Oliveros, 2005), and requires active engagement from participants. This humming exercise encourages participants to 'blend' notes and serves as a way of synchronising breathing, which may have a knock-on beneficial impact on their ability to achieve Flow states and to connect with each other. The second exercise begins with an associative wordplay. Participants are prompted to respond to their partner's suggested word with their own association. As they are asked to respond quickly, they may begin with associations that may be considered 'obvious', however, the facilitator pre-empted the intervention by proposing that participants may wish to challenge each other as they go on, with an aim to 'surprise' and make each other laugh. From single-word associations, the facilitator then encouraged the movement to full phrases of association and dialogue. The overall facilitation duration typically lasted between 15 - 20 minutes and was framed by a pre- and post-

survey. Participants were also invited to write free-flowing thoughts and comments following the post-surveys and intervention.

2.4 EVALUATION

Throughout the interventions, data was collected pertaining to 5 main areas. Incorporating existing models of Flow assessments, participants were provided with pre- and post-questionnaires: the former exploring flow propensity (linked to their trait of being able to enter a Flow state in general), social connectedness (specifically, their perceived closeness to their partner-participant prior to the intervention), and mood; the latter exploring their flow reflection/self-analysis during the intervention, and social connectedness and mood post the intervention. Building upon Csikszentmihalyi's Flow Questionnaire (FQ) (1975), flow propensity was determined by asking participants key questions regarding their historic experience of common flow states. Using a multiple choice Likert scale (never, sometimes, often, always), participants were asked about 3 key components of flow, in the form of the following questions:

When I get really involved in my work my concentration becomes like my breathing … I never think of it.
Sometimes when I am working I become so absorbed that I am less aware of myself and my problems.
When I am working I am so involved in it that I don't see myself as separate from what I am doing.

By assessing participants' capacity for, and relationship to, concentration, temporality and self-awareness, it was posited that we could determine their overall likelihood of entering a Flow mental state of heightened creativity, lowered stress and peak performance (Figs 1,2&3). This information – alongside their mood (measured on a 7-point Likert scale, across 4 categories: alert/drowsy, happy/sad, active/passive, involved/detached), and social connectedness (measured on a 7-point Likert scale, in response to the question 'how close do you feel to the other participant?') – allowed us to contextualise the EEG data in order to determine whether engagement with the intervention had had a tangible effect on their mental-state.

Finally, the post-questionnaire incorporated further questions reflecting on the participants' experience during the intervention. These questions were consistent with Csikszentmihalyi's componential view of Flow (Jackson & Csikszentmihalyi 1999), wherein the Flow state is characterised by nine main components: focused concentration on the present activity (concentration), sense of control over one's actions (control), merging of action and awareness (merging), autotelic experience (autotelic), loss of self-consciousness (self-consciousness), loss of time awareness or time acceleration (time), clear proximal goals (goals), unambiguous feedback (feedback), and dynamic balance between challenge and skill (balance). The post questionnaire presented 8 questions that engaged with each of these topics in the form of a simple yes/no response, as follows: *'I had complete concentration on the task*', *'I had clarity of goals and reward in mind'*, '*I had a feeling of control over the task', 'I had a balance between challenge and skills*', ' *I had a transformation of time'*, '*I had an intrinsically rewarding experience which was the end in itself'*, '*I had an effortlessness and ease of experience'*, ' *I had a merging of action* and *awareness losing self-conscious rumination';*

3. RESULTS

Although working with a limited number of participants (N=12 at Somerset House and N=16 at the Royal Society), results nonetheless suggest a meaningful correlation between participation in the installation, social connectedness, and Flow. In the first instance, at Somerset House the participants demonstrated a high propensity for flow, with similar results across all 3 categories (concentration, temporality, self-awareness). In each instance, a total of 83-84% of participants reported sometimes or often experiencing Flow characteristics *(Fig.1,2, and 3)*.

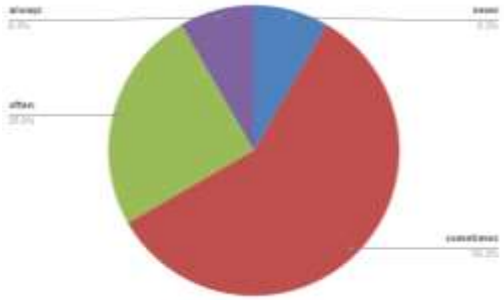

Fig 1: *When I get really involved in my work my concentration becomes like my breathing … I never think of it.*

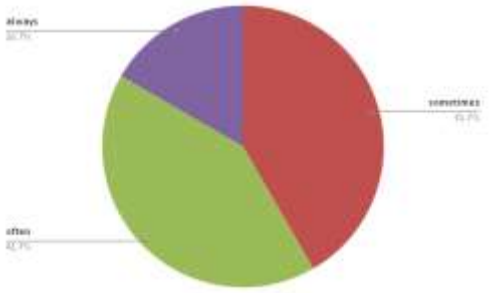

Fig 2: *Sometimes when I am working I become so absorbed that I am less aware of myself and my problems.*

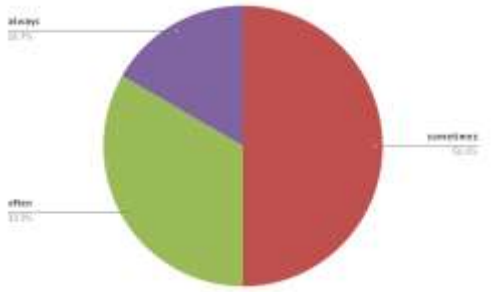

Fig 3: *When I am working I am so involved in it that I don't see myself as separate from what I am doing.*

At the control (Royal Society, N=16), the propensity to be in flow was comparable to cohort 1 *(Fig. 4, 5 and 6).*

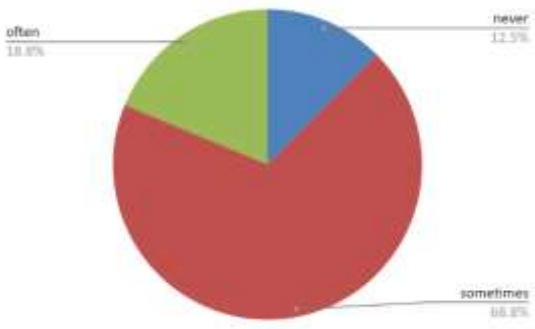

Fig. 4: *When I get really involved in my work my concentration becomes like my breathing … I never think of it. - Royal Society*

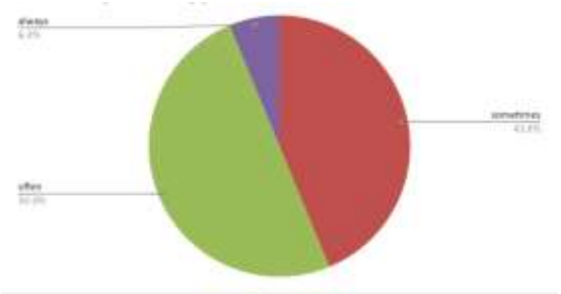

Fig. 5: *Sometimes when I am working I become so absorbed that I am less aware of myself and my problems.*

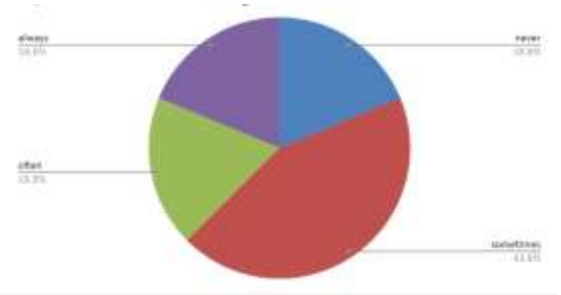

Fig. 6: *When I am working I am so involved in it that I don't see myself as separate from what I am doing.*

At Somerset House, the post-intervention self-analysis suggested a high experience of Flow within the intervention amongst the participants. Using their yes/no answers to the 8 questions, participants were assigned an overall flow score, between 0 (all no's) and 8 (all yes's). 9 out of 12 participants scored 6 or above, with an average rating of 6.33. Of the 8 criteria, 'I had a rewarding experience' rated the highest (91.7%), followed by 'I had a transformation of time' (83.3%), 'I had a balance between challenge and skill' (83.3%), and 'I had an effortlessness and ease of experience' (83.3%). In contrast, 'I had a feeling of control' scored the lowest (58.3%). It is perhaps worth noting that the language of such questions, though drawn from Csikszentmihalyi's research, is not entirely neutral. The nuance between challenge/skill and effortlessness, for instance, might require further unpicking to be truly meaningful, whereas a question regarding a 'rewarding' experience risks eliciting platitudes: although they were answered anonymously, there may still be a risk if it is perceived the researchers are in presence.

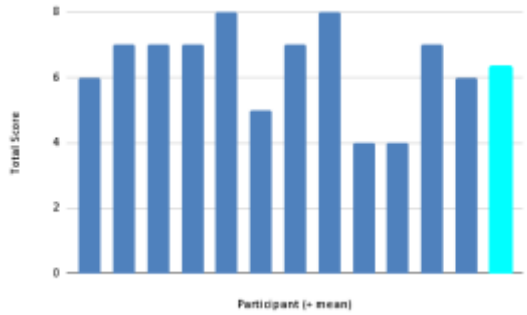

Fig. 7: *Participants total flow scores - Pilot 1 - Somerset House*

At the Royal Society, the Flow factor was lower with an average of 5.37/8 which could be related to a number of factors including - the different cohort group (academics as opposed to creatives), external factors such as a noisy background environment at the Royal Society where participants were not separated from the general public within a Neural Interfaces conference (and were sometimes observed or disturbed in contrast to Somerset House) and/or a different Flow propensity in the cohort overall. As such, the Royal Society cohort constitutes a control group for conditions conducive to Flow.

Comparisons between the pre- and post-intervention mood scales suggested significant changes in the participants' wellbeing and engagement. Whilst only half of the participants reported feeling more alert afterwards, the increase in alertness was pronounced, and only a quarter of participants reported being less alert *(Fig. 8).* All participants reported feeling as happy or happier after the intervention, though by less dramatic margins. A third of participants reported feeling more active, though a quarter reported a significant drop in activeness *(Fig. 9).* At Somerset House, the most pronounced results were found in the involved/detached category *(Fig. 10):* 7 out of 12 participants reported significant increases in involvement, with only 1 participant reporting any increase of detachment .

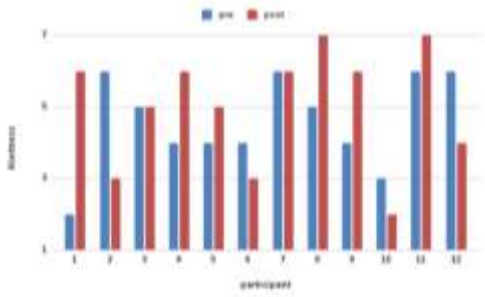

Fig. 8: *Mood scale, Alertness, Somerset House*

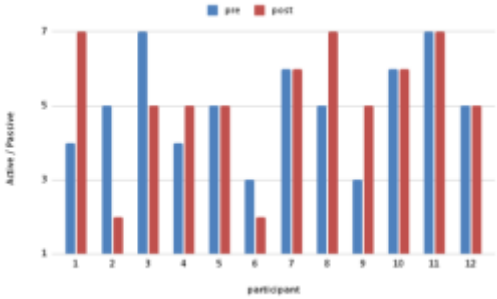

Fig. 9: *Mood scale, Active/Passive, Somerset House*

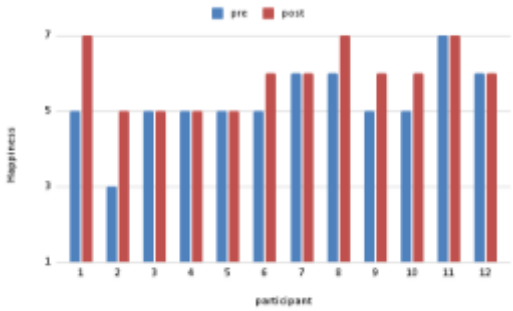

Fig. 10: *Mood scale, Happiness, Somerset House*

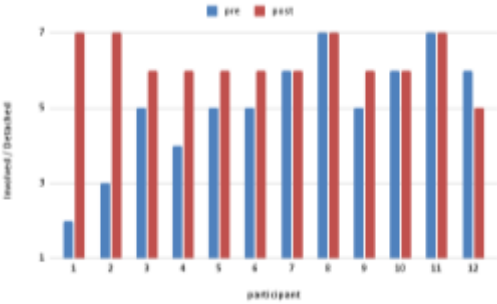

Fig. 11: *Mood scale, Involvement (Somerset House)*

Taken as a whole, at Somerset House, the cohort participants reported an average positive increase across all categories, with the most pronounced increases in involvement (*Fig. 11*) and happiness *(Fig. 10)*. Performing a two-tailed Paired T-test showed significant p-values of .04129022 for involvement and 0.01282582 for happiness for the Somerset House cohort, as well as significance for involvement p=0.004734 *(Fig. 12)*

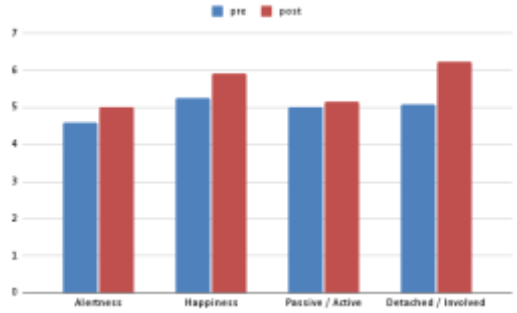

Fig. 12: *Mood scale, Mean - pilot 1 - Somerset House*

For the second cohort at the Royal Society (N=16), an effect of the intervention on feeling of involvement was significant with a p-value of p=0.00473, but not for the other mood factors (Fig.10); While happiness increased, the link between intervention and happiness was not significant with p=0.09515;

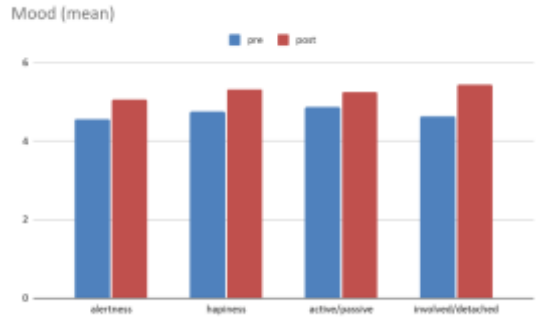

Fig. 13: *Mood scale, Mean - pilot 2- Royal Society*

Lastly, among both cohorts (pilot 1 & pilot 2/control) participants self-reported a significant increase in social connectedness post-intervention in both cohorts. Although no differentiation was made, for instance at the Royal Society, between participants with an already established social bond and those meeting for the first time during the intervention, these results suggest the intervention did have a positive effect on how close participants felt to one another. At Somerset House, half of the participants reported feeling closer to their partners after the intervention, with half feeling the same level of closeness as before. All of the participants who reported no increase in closeness, were already close to begin with as recorded in their pre-questionnaire. In contrast, there were significant increases in closeness for those who felt distanced at the start – perhaps suggesting the intervention was more effective in forging social bonds amongst strangers than increasing connectivity amongst associates.

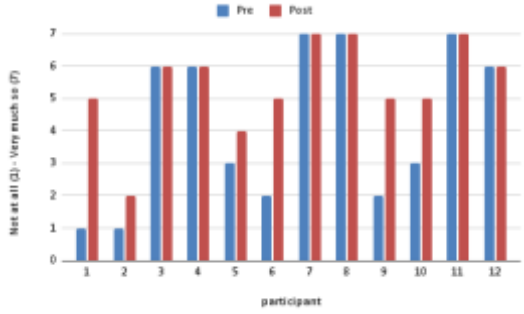

Fig. 14: *Perceived closeness to partner participant, pre and post intervention. - Somerset House*

Fig 15: *Perceived connectedness to partner participant, pre and post intervention, mean. - pilot 1 Somerset House*

Overall, among the Somerset House cohort (pilot 1, N=12) there was significant increase in social connectedness, rising from an average of 3.9 (on the 7-point Likert scale) to 4.9. Performing a two-tailed Paired T-test showed significant p values 0.03227 for social connectedness shown by graphical means through the IOS survey (Aron, Aron & Smollan, 1992) and p=0.00004386 for social connectedness when asked the question '*How close do you feel to other participants?'*

The control / second cohort (Royal Society, N=16) also showed a significant correlation between facilitated participatory engagement and social connectedness for both the IOS survey p=0.003573 and closeness to the other participant p=0.042421 *(Fig. 14, 15, 16 & 17).*

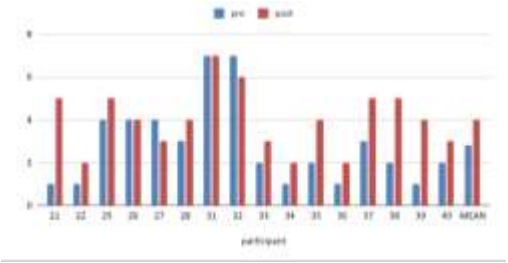

Fig 16: *Perceived social connectedness to partner participant, pre and post intervention. - Royal Society*

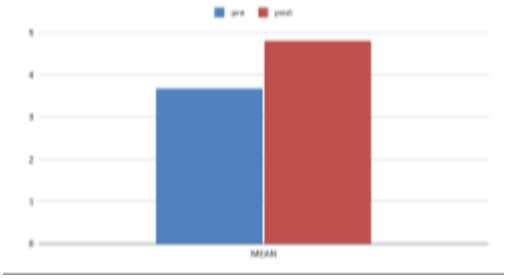

Fig 17: *Perceived connectedness to partner participant, pre and post intervention, mean. - pilot 2, Royal Society*

What is less clear, however, is the role facilitation played in the pursuit of social connection. Whilst participants broadly responded positively to the facilitation (both as observed by the researchers and rated in the post-questionnaire), there was no obvious correlation to their overall flow score. Whilst it felt clear to the researchers that the facilitation was helping participants to engage more deeply with the intervention, it's precise effects were no doubt mitigated by a range of exterior factors (how well the participants knew each already, the environment in which the intervention took place, noise, or potential influence of alcohol etc.).

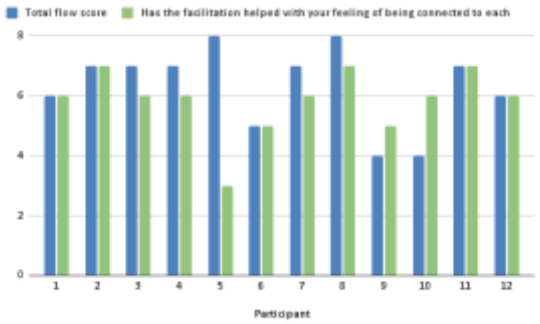

Fig 18: *Total flow score in relation to facilitation - Somerset House*

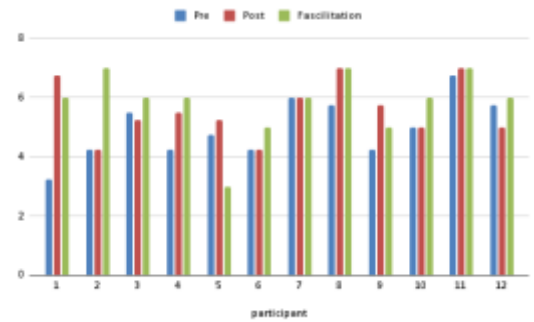

Fig. 19: *Post mood in relation to facilitation - Somerset House*

Comparing the pre- and post-mood analysis to the facilitation rating for the Somerset House cohort - which had a more controlled setting due to the absence of background noise within a dedicated room for the intervention, we can see that although a higher post-mood average correlated to a higher facilitation score, high facilitation scores were given regardless of the size of the increase in mood. Again, whilst observationally the facilitation had a positive effect on both mood and social connection – participants seemed more at ease as the facilitation progressed, resulting in more playful and creative responses to their structured conversations – a more nuanced investigation is required to determine exactly how facilitation can be best used for this purpose.

3. CONCLUSION

The concept of 'Social Flow' as a shared, synergetic variation of Flow mental states postulates a link between social connectedness, and individual Flow experience. While the presented study is currently only a pilot with a limited sample size, results point to a significant relationship between participatory art intervention and mood, and importantly a link with perceived social connectedness.

These findings support existing evidence on the effect of participatory arts engagements and social connectedness and wellbeing. However, the link between Flow and Social Connectedness has not been studied in detail and prompts intriguing questions about the nature of Flow as a complex and multifaceted phenomenon. Future research involving the research partners CNWL NHS Foundation Trust, NeuroCreate and the University of Greenwich will investigate potential dependencies between social connectedness and Flow - as either interrelated or distinct co-factors of wellbeing. Further research will focus on the effect of participatory art engagement on healthcare workers, and measures of social connectedness in an online context; Participatory arts are based on the ideas of communalities, shared experiences, and social collaborative experiences. As a participatory interface the Zeitgeist project offers new insights into the complex relationship between design, facilitated experience, and their effect on wellbeing and points to a potential link between social connectedness and Flow.

4. ACKNOWLEDGMENT

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Image 3: Zeitgeist at Royal Society

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Zwischen Absenz des Objekts und Präsenz für Alle
Zur virtuellen Erfahrung von Kunst und ihrer Vermittlung

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Unter Beachtung aktueller Entwicklungen der Vermittlung kann eine publikumsorientierte und an epistemischem Interesse orientierte museale Vermittlungsarbeit auch ohne das physisch präsente Objekt gelingen: Kunstvermittlung im virtuellen Raum bietet durch personalisierte Interaktion neue Zugänge zu Wissen und Kultur. Die ästhetische Erfahrung mag im virtuellen Raum wohl eine andere sein, für eine zeitgenössische teilhabe- und vor allem publikumsorientierte Vermittlung sowie ein erfolgreiches museales Audience Development, ist die Diskussion um diese jedoch nur zweitrangig.

1. EINFÜHRUNG

Zum virtuellen Surrogat degradiert, als Instrument zur Zielgruppenerweiterung gefeiert bewegt sich das digital reproduzierte Objekt in Kunst- und Museumslandschaft im kontroversen Zwischenfeld aktueller Diskussionen um Kunst- und Kulturvermittlung im digitalen Raum. Geprägt von der Absenz des originalen (Kunst-)Objekts kann das Kunstwerk digital reproduziert im virtuellen Raum nun nicht mehr den Ausgangspunkt der musealen Vermittlung darstellen. Doch ist das (meist) analoge „Original"-Kunstwerk in Zeiten einer tendenziell ohnehin eher publikumsorientierten statt objektorientierten Vermittlungsarbeit [1] überhaupt noch notwendig? Können Potenziale einer in den digitalen Raum übertragenen Vermittlung für eine teilhabeorientierte Musemsarbeit nicht ohnehin ohne das Objekt genutzt werden?

Im folgenden Beitrag, der den gleichnamigen Vortrag am 29.11.2023 in Berlin verschriftlicht thematisiert Methoden digitaler Kunstvermittlung, um im Anschluss mögliche Potenziale, aber auch kunstphilosophische

Gedanken zu Grenzen der Kunstvermittlung im virtuellen Raum am digitalen (Kunst-)Objekt darzustellen. Braucht der/die Rezipient:in den taktilen Zugang zur ästhetischen Erfahrung des Objekts? Ist eine ästhetische Erfahrung im virtuellen Raum überhaupt möglich?

2. DIGITALE KUNSTVERMITTLUNG IM ANALOGEN UND DIGITALEN RAUM

Nicht erst seit den pandemiebedingten kurzzeitigen Museumsschließungen ist ein erhöhtes Aufkommen an Vermittlungsangeboten im virtuellen Raum in der internationalen Kulturlandschaft zu beobachten. Immer mehr Museen machten im letzten Jahrzehnt ihre Sammlung in Online-Sammlungen digital zugänglich und versuchen seitdem ihre Objekte virtuell inszeniert auf Social Media, webbasiert oder gar in eigenen Apps zu vermitteln. Doch was gehört alles zu dem breit gefächerten, viel thematisierten, in der Wissenschaft doch erst rückhaltend behandelten Feld der digitalen Kunstvermittlung?

Zunächst einmal lassen sich digitale Umsetzungen der musealen Kunstvermittlung nach ihrer Kontaktebene unterscheiden: Grundlegend gilt es, digitale Kunstvermittlung im analogen Ausstellungsraum bzw. öffentlichen Raum in Abgrenzung von Kunstvermittlung im digitalen Raum zu differenzieren [2]. Letztere kann in verschiedenen Arten von virtuellen Räumen erfahrbar sein: Zu den virtuellen Orten, in denen Kunstvermittlung im digitalen Raum geschehen kann, zählen klassische webbasierte Sammlungspräsentationen („Sammlung online“), Social Media-Plattformen und Apps. Vermittlungsangebote lassen sich dabei in verschiedene, nach Grad der Interaktivität gestaffelten Stufen unterscheiden:

Stufe 0: Visuelle Präsentation der Objekte ohne inhaltliche zusätzliche Informationen.
Stufe 1: Textbasierte Vermittlung
Stufe 2: Multimediale Vermittlung
Stufe 3: Multimediale interaktive Vermittlung [3].

Vermittlungsangebote der dritten Stufe können den User/die Userin auch durch luditive Elemente bis hin zu partizipativen Angeboten, die User-Generated-Content generieren, aktivieren. Bei der Interaktion mit dem Objekt gibt es dabei einen sicherlichn offensichtlichen Unterschied: Der/die Rezipient:in agiert nicht mit dem originär analogen Objekt, sondern einer digitalen Reproduktion.

Sowohl im analogen als auch im virtuellen Raum bewegt sich das Ausstellungsobjekt dabei im Spannungsfeld zwischen epistemischen Interesse und Ausgangspunkt zum Genuss der ästhetischen Erfahrung. Schon in den 70ern wurde diese zunächst konträr erscheinenden Wirkweisen musealer Ausstellungsstücke diskutiert [4], bei der das Kunstwerk sowohl als Schöpfung des inspirierten Künstlers, das die Rezipierenden in einen Zustand der Ergriffenheit versetzt versus die Darstellung desgleichen Objekts, das ein Zeitzeugnis ist und Ausgangspunkt eines Lernprozesses sein kann, inszeniert und erfahren werden kann [5].

Sicherlich ist dabei der individuelle Zugang sowie Nutzungsmotivation und Erwartungshaltung der Rezipient:innen entscheidend: Denken wir an die hierbei oft zitierten nach Motivationstypus segmentierten Besucher:innentypen nach John H. Falk, die sich in Facilitators, Experience Seekers, Explorers, Rechargers und Hobbyists gliedern. Im Zentrum steht dabei das ebenfalls von Falk geprägte „Free Choice Learning“, das vor allem bei den interessierten Hobbyists zu beobachten ist und die Besuchsmotivation beschreibt, nicht nur ästhetischen Genuss erleben zu wollen, sondern sich vor allem im Rahmen eines Museumsbesuchs weiterbilden zu wollen [6]. Dass sich die Besuchsmotivationen nicht 1:1 auf die Nutzung virtueller Angebote übertragen lassen, steht hierbei außer Frage. Sowohl soziale Aspekte, als auch die des „Erlebnisses“ im Ausstellungsraum können nicht unverändert auf ein Nutzungsverhalten und -motivation bei virtuellen Vermittlungsangeboten übertragen werden. Nutzer:innen von virtuellen Museumsangeboten sind dabei nicht nur einer digitalen Reproduktion des Werks ausgesetzt, auch die situative, soziale und ästhetische Kontextualisierung des Werks erfährt im virtuellen Raum eine Änderung, dessen Sigifikanz es noch näher zu bestimmen gilt.

3. ZWISCHEN DEMATERIALISIERUNG UND HYPERMATERIALITÄT: ZUR PRÄSENZ IM VIRTUELLEN RAUM

Auch im analogen Museumsraum ist der multisensorische Zugang zum Kunstobjekt meist durch konservatorisch bedingte Restriktionen beschränkt: Während im Ausstellungsraum das Anfassen der Objekte meist nicht erlaubt ist, ist er im virtuellen Raum gar nicht erst möglich. Doch ist das zum Erfahren des Kunstwerks als epistemisches Objekts überhaupt notwendig? Stellt die

Erfahrung des digital reproduzierten Objekts tatsächlich eine eingeschränkte dar, obgleich der mediatisierte Zugang in einer digital geprägten Informationsgesellschaft nicht ohnehin die vorherrschende ist [7][8]?
Überlegungen zu einer veränderten, surrogierten Erfahrung von virtuell reproduzierten Objekten führen in ihrer Diskussion dabei natürlich stets zurück auf Walter Benjamin, der schon in den 30er Jahren über den möglichen Verlust der „Aura" bei technisch reproduzierten Kunstwerken klagt [9]. Jüngere Positionen finden sich beispielsweise in Bruno Latour und Adam Lowe, die die unterschiedliche Erfahrung von ursprünglich analoger Kunst und deren Reproduktion untersuchen, nach denen die vielfache Reproduktion sogar der Auratisierung des Originals positiv beisteuern kann [10]. Doch wie steht es um die Aura des virtuellen Bildes selbst?
Neben dem physisch präsenten Objekte ist es dabei auch das Publikum selbst, das den Ausstellungsraum zum sozialen Raum macht [11] und somit die ästhetische Erfahrung in diesem maßgeblich mitprägt. So ist es auch der Ausstellungsraum selbst, der als „Erfahrungsraum" [12] die künstlerischen Positionen und deren Wahrnehmung durch den Rezipienten prägt.
Wo findet sich in der Diskussion rund um die Erfahrung von digital reproduzierter Kunst die digitale Kunstvermittlung wieder?
Nach Werner Schweibenz wird das digitale Bild zu einer eigenständigen, neuen Quelle der Erfahrung, das „Digitalifakt" [13].
Das Digitalisat, bzw. Digitalifakt wird zu einem neuen Artefakt, das auf ein Medium angewiesen ist: Abhängig von technischen Mitteln, das das Objekt digital reproduziert und virtuell darstellt, wird das Objekt vermittelt dargestellt und lädt auf Museumswebseiten, Online-Sammlungen und Apps mit Informationen, interaktiven Anwendungen bis hin zu Gamifikationumsetzungen zur Interaktion mit dem Objekt ein.
Nach Bill Brown und seiner Dematerialität-Hypothese verschiebt sich die Materialität bei der Reproduktion ins Digitale: Auch wenn nach ihm alles einen materiellen Ursprung hat (in unserem Falle auch das Museumsobjekt) beobachtet er durch zunehme Digitalisierungsprozesse in unserer Gesellschaft eine „Entmaterialisierung" der Welt [14]. Sandra Dudley überträgt ähnliche Gedankengänge in die museale Praxis und fordert mehr taktilen und multisensorischen Zugang zu Museumsobjekten [15].
Doch braucht es wirklich taktilen Zugang zum musealen Objekt, um eine ästhetische Erfahrung zu machen? Der Diskurs um die genaue phänomenologische Erfassung der ästhetischen Erfahrung scheint endlos und wird an dieser Stelle kaum in Kürze wiedergeben zu sein. Was erfahren wir, wenn wir Kunst sehen? Um nur einen kurzen Überblick zu möglichen Auffassungen einer Erfahrungsdefinition von Kunst zu geben: Von John Dewey, der in seiner eher rezipient:innenaktiven Auffassung von Erfahrung für weniger Trennung von ästhetischer und Alltagserfahrung plädiert [16] bis hin zu Nelson Goodman mit seinem eher objektzentrierten Erfahrungsbegriff, bei dem Kunst als Symbolbild nach Zeichen ausgelegt ist [17] gibt es seit Jahrzehnten die unterschiedlichsten Auffassungen was eine ästhetische Erfahrung prägt und überhaupt *ist*. Verstünde man Kunst nach den auf Symbolprozessen basierenden Erfahrungsbegriff nach Goodman, so stellt sich die Frage, inwiefern die Angst um die verlorene Aura des Digitalisats sinnvoll ist: Möchte das Publikum digitaler Vermittlungsangebote *erfahren* oder *verstehen*?
Benötigen wir das Spüren einer Aura überhaupt für die nach Falk definierten *Hobbyists*, die im Sinne des Free-Choice-Learnings vor allem nach neuem Wissen streben?

4. ANFASSEN NICHT ~~ERLAUBT~~ MÖGLICH: SCHAUEN ABER SCHON!

Betrachten wir mit George E. Hein Lernprozesse im Museum, so schreibt auch er Ende der 90er, dass es gerade das Objekt ist, von dem der vermittlungsgesteuerte Lernprozess ausgeht [18]. Doch wie der Erfahrungsbegriff selbst, ist es auch der der Vermittlung, der sich innerhalb der letzten Jahrzehnten weiterentwickelt hat. Trotz unterschiedlicher definitorischen Auffassungen von Vermittlung, herrscht für die aktuelle Museumspraxis ein Konsens: Vermittlung ist nicht länger objekt-, sondern publikumszentriert. Das weisen nicht nur jüngste Publikationen innerhalb der Vermittlungstheorie auf, sondern auch Positionierungen der deutschsprachigen Museumslandschaft wie unter anderem der aktuelle Leitfaden für Bildung und Vermittlung des Deutschen Museumsbundes, der nich eindeutiger für publikumsorientierte Vermittlungsarbeit plädoieren könnte [19].

Die Vermittlung ist im Wandel, geht nicht länger vom Objekt, sondern von seinen Rezipierenden aus: Ist es dann auch nicht zeitgemäß, die Diskussion um eine Erfahrung am digital reproduzierten Objekt im musealen virtuellem Vermittlungskontext zu verschieben?

Während der physische Zugang zum Werk eingeschränkt scheint, öffnen sich – trotz möglicher Verschiebung der ästhetischen Erfahrung am Objekt durch Ent-Materialisierung oder gar Ent-Auratisierung – Wege der Zugänglichkeit allein durch die Veröffentlichung und Vermittlung des Objekts im virtuellen Raum: Der Zugang zum Werk Online-Sammlungen und andere Vermittlungsformate gewähren, wie schon frühzeitig erkannt und vielfach plädiert wurde, einen ort- und zeitunabhängigen Zugriff auf museale Bestände. Durch zusätzliche virtuelle Vermittlungsangebote mit interaktivem bis zu ludischem Charakter können Besucher:innen/User:innen aktiviert werden und auf Sammlungsbestände aufmerksam gemacht werden. In einer digitalisierten Gesellschaft sind nun mal digitale Vermittlungsangebote von Museen ein relevanter Faktor kultureller Teilhabe.

Digitale Vermittlungsmethoden bedeuten eine weitere Ebene der Zugänglichkeit. Die Auseinandersetzung mit dem musealen Objekt wird dabei nicht ersetzt, sondern auf einer weiteren (virtuellen) Ebene fortgeführt.

Während Falks zuvor zitierte Arten an Besucher:innen alle bereits die jeweilige Kulturinstitution besuchen, können unter Online-Nutzenden sowohl Nichtbesucher:innen als auch Besucher:innen sein. [20][21].

Besucher:innen können dabei durch virtuelle Vermittlungsangebote ihren Museumsbesuch vor- oder nachbereiten, Nichtbesucher:innen können das Haus zeit- und ortsunabhängig besuchen. Auch Hürden, die den klassischen Besuch eines Hauses verhindern können können im digitalen Raum möglicherweise überbrückt werden: Finanzielle Barrieren (nicht nur durch Eintritts-, sondern auch Anreisekosten),

Zeitbarrieren (aufgrund von Öffnungszeiten abhängigem Zugang), Barrieren körperlicher oder psychischer Einschränkungen oder ortsbezogene Barrieren.

Blicken wir auf die Geschichte von (Kunst-)Sammlungen zurück, so hatte der Großteil der Bevölkerung im 17. und 18. Jahrhundert keinen Zugang zu den Objekten, die nur für Eigentümer sowie Angehörige eines bestimmten Mileus sichtbar waren. [22].

Heute stehen museale Sammlungen theoretisch allen offen. Und doch sind analoge Objekte nun einmal ortsgebunden und an die zuvor genannten Bedingungen gebunden: Virtuelle Zugänglichkeite bedeutet ortsunabhängige Zugänglichkeit. Auch wenn der multisensorische Zugang bei digitalen Vermittlungsangeboten eingeschränkt sein mag, so wird das Werk dennoch *überhaupt* sichtbar.

5. PARTIZIPATION ODER VERLUST DER ATMOSPHÄRE?

Die das Objekt präsentierende Vermittlung im digitalen Raum wird zu einem neuen Medium: Ein Medium, das sowohl eine (neue) ästhetische Erfahrung ermöglicht, als auch das epistemische Interesse des Besuchenden stillt.

Doch braucht es tatsächlich einen authentischen Transfer der Wirkmächtigkeit des analogen Originals zur Erfüllung der eigenen Bildungsziele und der Erfahrung des Objekts?

Unter Beachtung aktueller Entwicklungen der Vermittlung kann eine publikumsorientierte museale Vermittlungsarbeit auch ohne das physisch präsente Objekt gelingen: Kunstvermittlung im virtuellen Raum bietet durch ihre mannigfachen Umsetzungsmöglichkeiten neue Zugänge zu Wissen und Kultur. Die ästhetische Erfahrung mag im virtuellen Raum wohl eine andere sein, für eine zeitgenössische teilhabeorientierte Vermittlung sowie ein erfolgreiches museales Audience Development mit Outreach Impact, ist die Diskussion um diese jedoch nur zweitrangig.

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"Concrete Sculptures" in Hong Kong – Erkundungen in erweiterter Fotografie

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KURZDARSTELLUNG: Mit ihrer Begeisterung für übersehene Details im urbanen Raum erforscht die Autorin eine Vielzahl von Methoden und Strategien, um die unverwechselbare Ästhetik des Hongkonger Stadtmobiliars zu erfassen, darzustellen und zu erhalten. Diese Objekte werden möglicherweise bald abgerissen oder neugestaltet. Die Sammlung wird die Grundlage für ein immersives VR-Erlebnis bilden, das die retro-futuristische Ästhetik der Betonskulpturen präsentiert und utopische sowie dystopische Erzählelemente miteinander verbindet. Durch die Erprobung verschiedener innovativer Bildgebungsverfahren, darunter Photogrammetrie, 3D-Scanning und NeRF, zielt das Projekt darauf ab, nicht nur zweidimensionale Bilder zu erfassen, sondern räumliche Darstellungen zu schaffen, deren Beleuchtung und Textur nachträglich angepasst werden können. Mit diesem Projekt sollen die technischen Möglichkeiten der Fotografie ausgelotet und gleichzeitig ein tieferes Verständnis für das architektonische Erbe und die kulturelle Identität der Stadt gefördert werden.

1. EINFÜHRUNG

Nur wenige Metropolen der Welt beeindrucken wie die Skyline von Hongkong mit ihrem sublimen Pomp. Doch im Schatten der markanten Wahrzeichen werden kleinere Details wie die einzigartige Straßenmöblierung meist übersehen und ignoriert, obwohl sie eine wichtige Rolle im Stadtgefüge spielt. Mehrere dieser Bauten aus den vergangenen Jahrzehnten wurden bereits abgerissen, neu dekoriert oder mit anderen Mitteln umgestaltet. Das vorliegende Projekt nutzt diese Bauwerke, um das künstlerische Potenzial räumlicher Darstellungen mit bildgebenden Verfahren zu untersuchen. Es erforscht die Möglichkeiten, reale Objekte in eine stereoskopische Visualisierung und darüber hinaus in 3D-Modelle zu übertragen, die nachträgliche Anpassung der Kameraeinstellungen und Beleuchtungssituation ermöglichen.

Die Fotografie städtischer Räume hat sich trotz zahlreicher Versuche, andere Methoden einzusetzen, in erster Linie auf ihre zweidimensionale Darstellung beschränkt. Es bietet sich jedoch an, die räumliche Dimension dieser Gebiete zu erfassen, da sie die Dokumentation von Architektur und die Bewahrung des kulturellen Erbes neu begreift, übersehene Objekte wie Pavillons, Brunnen oder Fußgängerbrücken einschließend, die trotz ihrer umstrittenen ästhetischen Qualität einen bedeutenden Teil des städtischen Gefüges bilden und höchstwahrscheinlich vermisst werden, sobald sie verloren sind.

Heutzutage werden Bilder von neuen Gebäuden in der Regel gerendert, so dass eine nachträgliche Anpassung ihrer Darstellungen eine Selbstverständlichkeit ist. Das Sammeln und Kombinieren von Visualisierungen bestehender Objekte erfordert eine andere Herangehensweise, vor allem, wenn man die

Abnutzungserscheinungen mit einbeziehen möchte.

Der Einsatz von stereoskopischen Aufnahmen und Darstellungen, Photogrammetrie oder NeRF (Neural Radiance Fields) [1] und anderen aktuellen Techniken bieten neuartige Möglichkeiten für die Erfassung und Darstellung städtischer Räume in 3D und ermöglichen gleichzeitig die nachträgliche Anpassung von Perspektive, Licht und Textur.

Darüber hinaus ist es von entscheidender Bedeutung, Publikationsformen zu definieren, die diese räumlichen Darstellungen global zugänglich machen, wie z. B. die Repräsentation des Objekts in VR, und somit auch archivierbar wird. Dies ermöglicht eine größere Verbreitung und Erhaltung des potentiellen kulturellen Erbes, insbesondere auch für Bildungszwecke.

Nachdem ich über die ästhetische Qualität der retrofuturistischen Architektur Singapurs arbeitete, wie sie in meinem preisgekrönten stereoskopischen Video *Venomenon* vorgestellt wird, zog ich nach Hongkong und fand dort einige vergleichbare, dennoch ganz spezifische Erscheinungsformen dieser architektonischen Ära. Mir fiel die besondere Liebe zum architektonischen Detail auf, und deshalb konzentrierte ich mich auf das so genannte Stadtmobiliar. [4]

Die Eingliederung in den Stadtraum und ihre Alltäglichkeit führt dazu, dass sie kaum wahrgenommen werden: Bushaltestellen, Sonnenschirme, Stege, Brunnen, Laternen, Verkaufsstände, Litfaßsäulen, Feuermelder, Schaltkästen, Reklametafeln, Abfallbehälter, Blumenkübel, Bänke und Lüftungsschächte erfüllen wichtige Funktionen im Gefüge der Stadt, verschwinden aber in der Belanglosigkeit ihrer Aufgaben. Mit ihren unscheinbaren Pastellfarben fügen sie sich einfach ins Stadtgefüge ein. Als Einzelobjekte auf zweidimensionalen Fotografien mit entsprechender Beleuchtung festgehalten, lässt sich die skulpturale Qualität bereits erahnen – allerdings ist es mit den heutigen Möglichkeiten keine große Herausforderung mehr, ihre Plastizität zu erfassen – oder sie mit synthografischen Techniken zu rekonstruieren. Auf diese Weise sind wir in der Lage, die Charakteristik von Gegenständen zu bewahren, um sie aus jedem Blickwinkel zu betrachten und sogar verschiedene Phasen der Renovierungen wiederzubeleben. Neben dem erwarteten Nutzen, die Erinnerung an die besondere Ästhetik aufrechtzuerhalten, werden die erfassten Objekte die Grundlage für ein retrofuturistisches Szenario in einer immersiven VR-Erfahrung bilden [7].

Völlig unbeeindruckt vom filigranen chinesischen Renaissancestil wurde in der historischen Architekturepoche des Brutalismus [9] – zeitgleich mit dem ‘Tropicalismo’ und dem japanischen Metabolismus-Stil – Hongkongs städtebauliche Grundausstattung mit viel Beton und zahlreichen Kanten gestaltet, was Städteplaner heute so sehr beunruhigt, dass sie die unscheinbaren Funktionselemente nur mit Farbe oder der Abrissbirne in den Griff bekommen wollen. Diese scheinbar unbedeutenden Elemente tragen zum Gesamtcharakter und zur Funktionalität der Metropole bei. Sie verdeutlichen auch das Spannungsverhältnis zwischen Bewahrung und Fortschritt in den Städten, da die Stadtplaner ein Gleichgewicht zwischen dem Bedürfnis nach Aktualisierung und Modernisierung und dem Wunsch, die Vergangenheit zu bewahren, finden müssen.

Obwohl ein Eindruck dieser Strukturen durch die Fotografie erhalten werden kann, können nur Methoden zur Erfassung der räumlichen Dimension diesen übersehenen mehr oder weniger funktionalen Skulpturen im öffentlichen Raum gerecht werden.

Abb. 1: *Beton-Pavillons in Causeway Bay vor der Renovierung*

2. HERANGEHENSWEISE

Die laufende Forschungsarbeit evaluiert eine Reihe von Methoden zur Erfassung der räumlichen Komplexität und der Möglichkeiten des fotografischen und synthetischen Bildes. Da sich die besagten Objekte oft an unerwarteten Orten befinden und auf Google Streetview kaum sichtbar sind (sie befinden sich hauptsächlich in Wohnkomplexen, Parks oder Fußgängerzonen und sind oft von Pflanzen verdeckt), dient ein Schnappschuss mit einem Mobiltelefon zur Erinnerung, vor allem um den

Standort festzuhalten, und dann für einen gründlichen Erfassungsprozess zurückkehren zu können.
Die folgenden Techniken wurden angewandt, um die Möglichkeiten für die Erfassung zu erproben. Die Praktikabilität hängt jedoch weitgehend von der jeweiligen Struktur ab.

2.1 STEREOSKOPISCHE FOTOGRAFIE

Eine grundlegende Methode, um die räumliche Dimension dieser Objekte zu erfassen, ist das klassische Verfahren, ein Bild für das linke Auge und – mit entsprechendem Versatz – ein Bild für das rechte Auge aufzunehmen. In der gesamten Fotogeschichte wurde diese Strategie angewandt und immer wieder an neue Formate angepasst.
a.) Eines der neuesten Geräte für diese Technik ist das Dual Fisheye-Objektiv von Canon, das gleichzeitig zwei parallele Kreise nebeneinander aufnimmt (Abb. 2). Obwohl der Abstand der Linsen fixiert ist, ist das Ergebnis durch die extreme Perspektive überzeugend, vor allem, wenn man es mit einem VR-Headset betrachtet, das einen vollständigen 180°-Blick auf das Objekt und seine Umgebung ermöglicht.

Abb. 2: *Brunnen im Shek-Kip-Mei-Park, aufgenommen mit einem Dual-Fisheye-Objektiv*

b.) Ein geeigneter und realisierbarer Ansatz ist die Verwendung eines modernen Smartphones mit mehreren integrierten Objektiven und der 3D-Foto-Einstellung in einer App wie beispielsweise ProCam. Diese Methode eignet sich gut für die schnelle Aufnahme mittelgroßer Objekte und liefert sofort zwei parallele Bilder, die allerdings als JPEG komprimiert sind.
c.) Eine komplexere, aber dennoch überzeugende Methode, vor allem wenn eine hohe Auflösung für ein gedrucktes Bild das endgültige Ziel ist, ist die Verwendung einer Großformatkamera mit digitalem Rückteil und die horizontale Verschiebung der Objektivstandarte. Das Resultat kann dann als hochaufgelöstes Anaglyphbild gedruckt werden. Für Lentikulardrucke mit mehreren Phasen sollte eine Reihe von Bildern mit unterschiedlichen Abständen aufgenommen werden. Eine bessere Beleuchtung und eine größere Brennweite steigern die Tiefenwahrnehmung.
Diese Technik führt jedoch nur zu einer subjektiven, vom Fotografen definierten Ansicht und ermöglicht keine nachträglichen Anpassungen, die über die Möglichkeiten einer unkomprimierten Bilddatei im Rohdatenformat hinausgehen. Außerdem ist diese Technik im Gegensatz zu den oben erwähnten Methoden mit dem Dual-Fisheye-Objektiv oder einem Smartphone aufgrund der Zeitdifferenz zwischen den einzelnen Bildphasen auf stationäre Objekte beschränkt.

2.2 3D-SCANNEN

Abb. 3a und b: *Aufnahme des Brunnen im Shek-Kip-Mei-Park als texturiertes Polygonnetz (a) und als Punktewolke (b)*

a.) LiDAR (Light Detection and Ranging) ist eine Distanzmessungstechnologie, bei der Entfernungen durch das Aussenden von Laserimpulsen und die Dauer gemessen werden, die das reflektierte Licht benötigt, um zurückzukehren. Sie erstellt 3D-Modelle von Objekten und Umgebungen durch die Erfassung von Millionen von Datenpunkten. Für diese Untersuchung wurde ein Leica BLK360 Scanner verwendet. Das Ergebnis war weder für kleinere Objekte aufgrund der fehlenden Einzelheiten und der unzureichenden Textur überzeugend, noch für die größere Fläche des Brunnens. Hier führten die feinen

Details der Fliesen und des Geländers sowie die Wasserreflexionen und die Bewegung der umliegenden Pflanzen zu einem unbefriedigenden Ergebnis.
b.) Der eingebaute Lidar eines iPhone 12 Pro Max sowie die True-Depth-Kamera auf der Geräterückseite führten dagegen bei kleineren Objekten zu überraschend zufriedenstellenden Ergebnissen, insbesondere durch die deutlich bessere Erfassung der Oberflächentextur.

2.3 3D-MODELLIERUNG AUF DER GRUNDLAGE ERFASSTER DATEN

a.) Bei Verwendung der aufgezeichneten Rohdaten aus dem 3D-Scan ist das Ergebnis in vielen Fällen nicht überzeugend, die Grundformen lassen sich besser in einer Anwendung wie Maya oder Blender modellieren. Um das Aussehen und die Anmutung des realen Objekts zu erhalten, sollte die erfasste Textur auf die Oberfläche abgebildet werden. Dieser Ansatz bietet Möglichkeiten zur nachträglichen Beleuchtung und zu Anpassungen wie der Änderung der Brennweite.
b.) Beim Texture Mapping werden realistische Texturen auf die 3D-Modelle aufgebracht, um das Aussehen und die Oberflächendetails der erfassten Objekte nachzubilden. Die Texturierung bereichert die geometrischen Körper um Einzelheiten, um eine immersive und realistische virtuelle Erfahrung zu erreichen.

2.4 SYNTHOGRAFIE

Die Möglichkeiten, die maschinelles Lernen (KI) und neuronale Netze bieten, wachsen derzeit sprunghaft an und müssen erst noch genauer ausgelotet werden. Facebook hat bereits vor mehreren Jahren die Möglichkeit eingeführt, ein zweidimensionales Bild auf die dritte Dimension zu erweitern, Personen oder einfache Objekte zu extrahieren und den Hintergrund inhaltssensitiv zu füllen [8]. Bei diesem Projekt wird die Anwendung vorerst in der Extraktion des Hintergrunds liegen, um die Objekte freizustellen. Sobald eine entsprechende Menge an Darstellungen von Stadtmobiliar gesammelt wurde, kann eine KI darauf trainiert werden, neue Objekte im Stil der vorhandenen zu generieren. Dies wird vor allem als Methode zur Identifizierung, Klassifizierung und Unterscheidung der besonderen Merkmale dienen, die dem Stil innewohnen. Im weiteren Verlauf des Projekts wird die Erstellung von 3D-Modellen aus einer kleinen Menge von Bildern mit NerFs und der kürzlich eingeführten Methode des Gaussian Splatting erprobt.

2.5 STRUKTURIERTES LICHT

Strukturiertes Licht ist eine Technik der Bildverarbeitung und des 3D-Scannens, bei der ein Lichtmuster, in der Regel Gitter, Streifen oder zufällige Punkte, auf ein Objekt oder eine Szene projiziert wird. Durch die Analyse der Verformung oder Verschiebung des projizierten Musters in Bildern, die aus verschiedenen Blickwinkeln aufgenommen wurden, nutzen Systeme mit strukturiertem Licht Triangulationsprinzipien, um die Tiefe und Geometrie der Oberfläche des Objekts genau zu bestimmen. Diese Technik ermöglicht die Erfassung und Messung von 3D-Formen, was Anwendungen wie die Rekonstruktion von Objekten und die Oberflächeninspektion ermöglicht. Systeme mit strukturiertem Licht werden häufig in der Denkmalpflege für Artefakte und Gebäude eingesetzt. Der an unserer Institution verfügbare Shining 3D EinScan Pro HD Scanner bietet eine hohe Präzision für kleine Objekte, wurde aber für dieses Projekt nicht eingesetzt, lediglich die mit dieser Methode operierende TrueDepth Kamera eines iPhones.

2.6 PRÄSENTATION

Die verschiedenen Aufnahmetechniken bieten eine große Bandbreite an Präsentationsmöglichkeiten, die vom Anaglyph- oder Lentikulardruck bis zu raumfüllenden VR-Erlebnissen in einem Headset reichen. Das Hauptziel besteht darin, die Kombination verschiedener Objekte in einem Szenario zu ermöglichen, indem die Beleuchtung und der Stil trotz der Aufnahme unter verschiedenen Bedingungen angepasst werden.
Derzeit erforschen wir dreidimensionale Projektionen – unter Verwendung von Punktewolken, die mit einem 3D-Laserscanner Leica BLK360 erfasst und dann in Blender verarbeitet werden, um sie auf ephemeren Oberflächen darzustellen.
Die hier beschriebenen bildgebenden Verfahren werden eingesetzt, um ihre Stärken und Schwächen zu erproben, mittels der Erfassung verschiedener Objekte in unterschiedlichen Größen und Komplexitätsgraden.

3. FALLSTUDIEN

Um einen optimalen Investigationsansatz zu bestimmen, wurden verschiedene Arten von Strukturen für Fallstudien ausgewählt. Zwei

Bauwerke im Shek-Kip-Mei-Park und im Kent-Road-Park in Kowloon sowie zwei Fußgängerbrücken, eine in Kowloon Bay und die andere in Causeway Bay in Hongkong. Aufgrund ihrer Merkmale und Größen bieten sie eine gute Grundlage für den Vergleich und die Bewertung entsprechender Aufnahmetechniken.

3.1 PAVILLON IM KENT-ROAD-PARK

Aufgrund seiner freistehenden Struktur kann der Pavillon von allen Seiten betreten und betrachtet werden, was eine umfassende Erfassung seiner architektonischen Details und Merkmale ermöglicht. Darüber hinaus weisen die zusätzlich ausgewählten Pavillons einzigartige Stile und Formen auf, die für die Analyse und Dokumentation interessant sein können. Die Patina der Oberfläche zeigt Schichten von Renovierungen im Verlauf der Zeit, was ihn zu einem idealen Objekt für diese Fallstudie macht. Allerdings ist die Höhe der Pavillons eine Herausforderung für fotografische Aufnahmen, insbesondere wenn es darum geht, sie aus einem höheren Winkel zu fotografieren – daher werden für komplexere Versionen Drohnenaufnahmen eingesetzt. Da die Struktur der Pavillons in dieser Untersuchung eher schlicht ist, erwies sich die Modellierung in einer 3D-Anwendung unter Berücksichtigung der erfassten Textur als der beste Ansatz, um eine Vorstellung für die Oberfläche mit ihren Zeichen der Zeit zu vermitteln.

Abb. 4a-c: *Pavillon im Kent-Road-Park in der 3D Darstellung von Google und während des Scanvorgangs in verschiedenen Apps*

3.2 PFLANZKÜBEL IM SHEK-KIP-MEI-PARK

Der Pflanzbehälter hat eine ideale Größe für Aufnahmen einer Bildserie für photogrammetrische Erfassung, einschließlich der Oberfläche mit ihren Gebrauchsspuren und Farbschichten. Man kann leicht um das Objekt herumgehen, um es von allen Seiten zu erfassen. Mit einzelnen Standbildern oder aus einer Videosequenz extrahiert und kombiniert in Agisoft Metashape oder Autodesk Photo ReCap liefert diese Herangehensweise überzeugende Resultate. Aufgrund der gebogenen und unebenen Form ist die Modellierung in 3D aus Geometrien heraus komplexer als beim Pavillon. Bei diesem Objekt führte die einfachste Art der Erfassung zum besten Ergebnis: mit einer TrueDepth-Kamera im Smartphone und der *3d Scanner App* (Abb. 5a-c).
Diese Technologie eignet sich besonders gut für die Erfassung mittelgroßer Objekte, da sie dank ihrer Präzision die komplizierten Details, Texturen und die einzigartige Patina, wie sie bei den Pflanzkübeln zu sehen ist, genau wiedergeben kann.

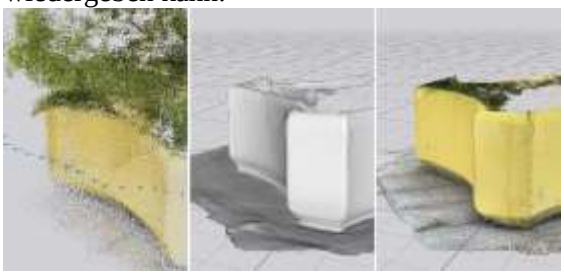

Abb. 5a-c: *Pflanzkübel, aufgenommen mit iPhone 12Pro Max und 3d Scanner App, als Pointcloud mit Kamerapositionen, 3D Modell mit und ohne Textur*

Für diese eher kleinen Objekte ist die Darstellung in Google Earth unbefriedigend. Die Ansicht von oben ist teilweise durch das Dach oder die Anlage verdeckt, und aufgrund der Lage im Park ist keine Straßenansicht verfügbar (Abb. 4a). Außerdem müssen die Details der relativ kleinen Konstruktionen aus der Nähe aufgenommen werden, um sichtbar zu sein. Für andere architektonische Elemente besteht die Möglichkeit, Bilder für die 3D-Modellierung oder sogar für Photogrammetrie aus Google Earth zu nutzen.

3.3 BRUNNEN IM SHEK-KIP-MEI-PARK

Die Aufnahme des Brunnens im Shek-Kip-Mei-Park erwies sich aufgrund seiner Größe, der architektonischen Überlagerungen, sowie von umgebenden Pflanzen und den Spiegelungen auf dem Wasser als schwierig. Die Versuche

mit dem Leica-Laserscanner waren unbefriedigend, da zu viele feine Details die Erfassung und Modellierung erschweren. Der derzeitige Einsatz des Laserscans resultiert in einer abstrakten Ansicht als Punktewolke, die ästhetisch überzeugend wirkt, aber keine Details liefert (Abb. 3b). Daher dienen vorhandene Bilder aus Streetview und Bilder vor Ort als Grundlage für die Modellierung und weitere Versuche, 3D-Dateien aus Einzelbildern zu erzeugen.

3.4 FUSSGÄNGERÜBERWEGE – "JIMMY BRIDGE" WAI YIP STREET & YEE WO STREET

Zwei ausgewählte Fußgängerbrücken, die sich in Größe und Form stark voneinander unterscheiden (Abb. 6a und b), haben aufgrund ihres Erscheinens in lokalen und internationalen Filmen (zum Beispiel "Love in a Puff" und "Ghost in the Shell") Kultstatus, zeitgenössisch ausgedrückt zählen sie zu den 'instagrammable' Orten Hong Kongs. Beide sind aufgrund ihrer Größe und Lage, die mehrere Straßen überbrückt, mit den zuvor genannten Methoden schwer zu erfassen. Sie sind auf Google Streetview gut dargestellt, sowohl von der Innenseite als auch von außen. Daher werden diese Bilder als Grundlage für die 3D-Modellierung dienen.

Abb. 6a und b: *Beispiel für einen Fußgängerüberweg in Wai Yip Street*

Nachdem wir die beste Vorgehensweise für die Aufnahme mehrerer Objekte unterschiedlicher Größe, Form und Qualität festgelegt haben, wird eine Reihe von ihnen mit der entsprechenden Technik erfasst, während einige modelliert und die Patina ihrer Oberfläche durch die Textur hinzugefügt wird. Auf diese Weise lassen sich auch bereits abgerissene Bauten wiederbeleben. Letztendlich werden sie in ihrer Perspektive und Beleuchtung visuell angepasst, um dann in einem VR-Erlebnis kombiniert zu werden.

4. SCHLUSSBEMERKUNG

Ziel des Projekts ist es, nicht nur die bekannten Strukturen zu betrachten, sondern auch übersehene architektonische Idiosynkrasien, besondere Details und verborgene Konstruktionen hervorzuheben. Ich betrachte das spezifische tropische Hybrid, das für den Architekturstil der 1970er Jahre typisch ist, als eine Praxis, die im Begriff "Retrofuturismus" zusammengefasst werden kann, da sie gleichzeitig modern, wenn nicht sogar zukunftsweisend und historisch zu sein scheint. Heute scheint diese zeitgeschichtlich bedeutsame Epoche der Vergangenheit anzugehören, eine ferne Erinnerung, begraben unter den vielfältigen Erscheinungsformen internationaler und postmoderner Bauten.

Abschließend befasst sich diese fortlaufende künstlerische Forschung mit den unzähligen Techniken, die für die Erhaltung und Darstellung des Stadtmobiliars in Hongkong zur Verfügung stehen, einer wertvollen, aber übersehenen Komponente des architektonischen Gefüges der Stadt. Durch den Einsatz verschiedener Methoden, darunter stereoskopische Aufnahmen, 3D-Scans und 3D Modellierung, rückt das Projekt diese oft vernachlässigten städtischen Elemente in den Mittelpunkt und unterstreicht ihren besonderen ästhetischen Reiz und ihre kulturelle Bedeutung. Die Erforschung dieser Techniken verdeutlicht nicht nur ihr Potenzial für die Dokumentation und Erhaltung architektonischer Besonderheiten, sondern ebnet auch den Weg für künftige Untersuchungen in diesem Bereich. Die Fähigkeit, diese Objekte dreidimensional zu erfassen und wiederzugeben, eröffnet spannende Perspektiven für die erweiterte Fotografie, die Erfassung des kulturellen Erbes und die Schaffung immersiver Virtual-Reality-Erlebnisse. Im Zuge der weiteren Entwicklung des Projekts könnten die Ergebnisse als Referenz dienen, die den Weg für künftige Untersuchungen in diesen Bereichen weist und bei der Erforschung und dem Verständnis städtischer architektonischer Landschaften

sowie neuer Wege zur Erfassung und Darstellung der Dreidimensionalität hilft.

5. DANKSAGUNG

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SESSION II

Erweiterte Umgebung | Extended Environments

Moderation: Eva Emenlauer-Blömers
(ehem. Berliner Senatsverwaltung für Wirtschaft, Technologie und Forschung, Projekt Zukunft)

Kurzfristig vertreten durch | Briefly represented by:
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Digital Exhibitions vs Real Exhibitions or Curator vs AI driven Curator

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ABSTRACT: The advent of AI seems to undermine the role of the curator as the creator of an exhibition. But perhaps to reflect on this theme it is necessary to go back to considering the reasons for an exhibition. What is the reason for an exhibition? If you will allow us the pun, the answer is not to show, but to communicate new visions, new research, new readings and to give the physical experience of a cultural journey. The exhibition is the result of a research project and wants to communicate the results to the public. In this a curator differs from an AI: it is not a matter of presenting at best what is there, but of showing what is not there, what is not yet known or has just come to discover. It is not a question of reworking, but of elaborating and elaborating not knowing what to find, but what to look for. Research is not only an operation on content, but obviously also on exhibition methods, on exhibition design. Some great exhibitions of the Italian exhibition tradition are brought as case studies.

1. DIGITAL EXHIBITION VS REAL EXHIBITION

In the now long debate between digital and real, which the solution of the phygital seems to have only temporarily dormant, the issue of Artificial Intelligence has now been inserted. With the speed that distinguishes our era, we have been seized during the pandemic by the temptation to eliminate the physical dimension of an exhibition in favor of a totally web-based existence. These have also been strengthened by a growing influence of technological means on narration and on the choral demand for interactivity, on the one hand, and immersiveness on the other. As often happens, we have moved from the use of technology as a means, to bringing technology as an end for a narrative that seemed unable to do without it. The deprivation of freedom and sociality during pandemic made many believe that we were entering a new era

Figure 1: *The Magic Box. Salone del Mobile.Milano Sala delle Cariatidi, Palazzo Reale, Milan 2022. Exhibition Design Alessandro Colombo and Paola Garbuglio. Photo courtesy Salone del Mobile.Milano*

where everything, school, culture, commerce, could be moved to a virtual platform.
Now, having recovered with dramatic and salvific speed the importance of experience in space and shared sociality, a new deus ex machina fills our horizons with thought and action. In fact, generative artificial intelligence seems to be able to fill all that professionalism carried out by man in order to be able to provide us, ready in the catalog, with solutions for our problems of communication, including exhibitions and museums. If Artificial Intelligence can do everything for us, and we would only be called upon to indicate the directions of research and then reap the benefits, why shouldn't we also entrust the machine with the task of conceiving and producing exhibitions? The advent of AI seems, in fact, to undermine the role of the curator as the creator of an exhibition. But perhaps in order to reflect on this theme it is necessary to return to consider the reasons for an exhibition.

Figure 2: *Pier Luigi Nervi_Architecture as Challenge. MAXXI, Rome, 2012. Exhibition Design Alessandro Colombo and Paola Garbuglio. Photo courtesy Fondazione PLNP.*

2. WHY AN EXHIBITION?

What is the reason for an exhibition? If you will allow us the pun, the answer is not to showcase, but to communicate new visions, new research, new readings and to give the physical experience of a cultural journey. The exhibition is the result of a research project and aims to communicate the results to the public. It is also true that, unfortunately, many exhibitions and even museums are conceived and offered to the public as unique exercises in collecting, cataloguing and displaying works of art, objects, artifacts concerning this or that theme, this or that period, this or that movement.
The exhibition would thus be a more or less rich, more or less beautiful, more or less immersive and interactive resumé,

Figure 3: *The Magic Box. Salone del Mobile.Milano. Sala delle Cariatidi, Palazzo Reale Milan, 2022. Exhibition Design Alessandro Colombo Studio Cerri & Associati. Photo Archivio A. Colombo*

which allows us to approach a certain theme. In this sense, we have, in fact, seen the birth of completely virtual exhibitions, without the presence of real pieces and the narration, entrusted to technology, becoming predominant over the physical object. The suspicion that this type of exhibition would be better conceived by an artificial intelligence is legitimate.
But the exhibition is something else, as we mentioned: the exhibition is the physical and communicative culmination of a research project. In this respect, a curator differs from an AI: it is not a matter of presenting what is there in the best possible way, but of showing what is not there, what is not yet known or has just come to be discovered.

Figure 4: *TAKE YOUR SEAT. Salone del Mobile.Milano Milan, 2022. Exhibition Design Alessandro Colombo and Paola Garbuglio. Photo courtesy Salone del Mobile.Milano*

It is not a question of reworking, but of elaborating, and it is elaborated not knowing what to find, but what to look for. Taking the theme to the extreme, the contents are the basis of the idea of the exhibition and do not constitute the filling of the exhibition container.

Figure 5: *Artemisia Gentileschi. A materpiece for Milan. Diocesan Museum, Milan, 2017. Exhibition Design Alessandro Colombo. Photo Amendolagine Barracchia.*

Figure 6: *Paolo Veronese_Adorazione dei Magi. A materpiece for Milan. Diocesan Museum, Milan, 2019. Exhibition Design Alessandro Colombo adn Paola Garbuglio. Photo Amendolagine Barracchia.*

3. CURATOR VS AI DRIVEN CURATOR

The research is not only an operation on content, but obviously also on exhibition methods, on exhibition design. Juxtaposing, dialoguing, decontextualizing, or contextualizing are an integral part of the research process. Exposing an altarpiece at a human height instead of the usual one in relation to ecclesiastical architecture, is an operation of perceptual communication that puts us in a completely new relationship with the work of art, just to give a simple example. But this is justified by the new reading that has been given to the work, and in the details that we want to bring to eye level, transforming a critical and scientific operation into a physical experience.

Figure 7-8*: Bruno Morassutti 100+1! ADI Design Museum, Milan, 2021. Curator Alessandro Colombo e Francesco Scullica. Exhibition Design Alessandro Colombo and Paola Garbuglio. Photo Amendolagine Barracchia.*

4. CASE STUDIES

To deepen what has been said above and to reiterate the importance of the intrinsic link between curatorship and installation, between ordering and spatial experience, some major exhibitions of the Italian exhibition tradition are brought as case studies.

Figure 9: *Picasso at Palazzo Reale in Milan, September – November 1953, curated by Fernanda Wittgens and Franco Russoli with the exhibition of Guernica in the Sala delle Cariatidi.*

Pablo Picasso agrees to exhibit Guernica, convinced by the state of the room, half-destroyed by the war and the neglect that followed the bombings. The quality of the space, the link with the violence of weapons, makes the exhibition unique and the experience offered to visitors who, for a long time, sat in front of the painting. Art, space, and history become here an unrepeatable unicum that gives substance and reason to the exhibition.

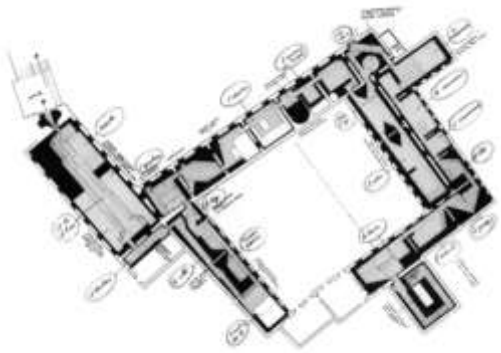

Figure 10: *Achille and Pier Giacomo Castiglioni, Vie d'acqua da Milano al mare, Palazzo Reale, Milan, 1963. Courtesy Plotini Allestimenti*

Figure 11: *Achille and Pier Giacomo Castiglioni, Vie d'acqua da Milano al mare, Palazzo Reale, Milan, 1963. Courtesy CSAC – Centro Studi e Archivio della Comunicazione, Università di Parma, Fondo Castiglioni, Achille e Pier Giacomo*

Achille and Pier Giacomo Castiglioni, Vie d'acqua da Milano al mare, Palazzo Reale, Milan, 1963. The exhibition Waterways from Milan to the sea proposed an inventive solution to the serious problems of traffic on the Lombard territory through the creation of a navigation system in Northern Italy. Both the walls and the floor, the entire installation, was made with wooden bridge boards to recreate the atmosphere and the spatial feeling of the river world. The final part of the project was set up in the Caryatid Hall, where a passage with a linear development was defined by sloping walls which, scenographically, evoked a sort of navigable canal. Also in this case, the message and design of the space, and the experience of the space it offers as it is traversed by the public, offers an unrepeatable whole that remains one of the milestones in the history of the exhibition. The total lack of technology, at the time, is not a brake on the quality of the human/space/content interaction, although or precisely because it is a totally analog interaction.

Figure 12: *Harald Szeeman, Le Macchine Celibi, Electa, Milan, 1989*

The propositional power of the exhibition as a provocation to reflection and the "clash" between opposing objects finds a magnificent example in the exhibition Le machine celibataires by Arald Szemann. In 1975 Harald Szeemann curated an exhibition that provoked controversy, to the point of scandal, at the Kunsthalle in Bern entitled 'The Celibate Machines', which would also land at the Venice Biennale attracting great interest. In the same year, 1975, Szeemann edited the book of the same name for Electa, which talks about absurd machines with no purpose, except to transform love into an element of death. The celibate machine transforms something into something else, just as the curator transforms his knowledge and the works he chooses and exhibits into something else, in an exhibition that did not exist before and that finds its reality in the exhibition.

Figure 13: *La Biennale di Venezia, Le macchine celibi. Les machines celibataires, Venezia, 1975.*

Figure 14-15*: Skyscraper Stories: 60 years of the Pirellone, from industrial culture to the institutional activities of Lombardy Region, curated by Pirelli Foundation and Alessandro Colombo, Pirelli skyscraper, Milan, June/December 2021.*
Photo Amendolagine Barracchia.

The exhibition Skyscraper Stories: 60 years of the Pirellone, from industrial culture to the institutional activities of Lombardy Region, June/December 2021, curated by the Pirelli Foundation with the architect Alessandro Colombo, tells the story of the building, which began as the Pirelli headquarters and then became the headquarters and symbol of Lombardy Region, with video installations with exclusive testimonies, photographs, illustrations, and archive footage. The exhibition celebrates the modernity of technology and industry in Lombardy, the institution of the regional government, and the urban avant-garde of the *città che sale*,"the city rises", as expressed by the city of Milan. In this sense, the story narrated, that of the skyscraper, and the skyscraper itself that houses the exhibition, become an indissoluble unity that allows the public to know and experience at the same time, to travel through time and to touch the importance and beauty of an architecture more than sixty years after its inauguration. The digital dimension of the exhibition, always accessible from the web, remains over time as does the building it narrates.

3. CONCLUSION

To conclude, it is now a matter, in the face of the overwhelming advancement of technology, to reflect on the constructive clash between man-machine and machine-man, AI, a clash that takes place on the battlefield of the exhibition, which is a real, physical, and not a digital, virtual field. We believe that, with this framework in mind, we can innovate the field of exhibitions and exhibition design also by using artificial intelligence, which can become a useful tool when it is enlisted in man's curatorial and exhibition research.

Figure 16: *Sergio Polano, Mostrare. L'allestimento in Italia dagli anni Venti agli anni Ottanta, Lybra Immagine, Milano, 1988*

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The Prompt Wrangler: AI text-to-image generation as curatorial practice

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ABSTRACT: The *Slow Down Time* project is an aesthetic and technical investigation of the procedural outcomes of generative AI routines as both standalone works of visual culture and mechanical biproducts of large language models (LLM). As an exercise in new media curation, the assemblage operates as both a performative and conceptual response to LLM black-box processes in the form of a slow-media / slow-synthesis art intervention.

The archive documents the dialogue between the text-to-image service Midjourney, a network of twenty-three prompt authors and the curator, Mitch Goodwin (aka The Prompt Wrangler). An intentionally meditative process that catalogues fragments of data and dialogue – via email, the written word and printed copies (sent by global postal systems) – enabling contemplation within latent diffusion spaces.

The curatorial process for *Slow Down Time* archive was also an exercise in transparency, with the inclusion of the Discord data for the original instance of every image. This openness not only exposes each image's genealogy, but also makes possible the "creation" of further generations beyond the archive. Capturing and preserving the stylistic and technical developments of the Midjourney "house style" over a specific period of time (August 2022 - May 2023) was also an important goal of the project.

1. INTRODUCTION

Slow Down Time is a collaborative art intervention that seeks to cursively deconstruct the procedural aesthetics and compositional tendencies of latent diffusion models, in this case the text-text-to-image service Midjourney. The philosphical nature of this procedural inquiry has four curatorial elements:

- *Contemplation* - Do contemplative practices make the opaque operations of LLMs more relatable?
- *Deconstruction* – How does adopting literary devices impact production and reception of text-image generative AI?
- *Documentation* – What is actually being preserved by curating human-machine dialogues within a finite period of a technology's rapid development?
- *Presentation* - By framing the machine compositions in exhibition and symposia contexts important questions emerge around creative authorship, cultural heritage, data integrity and the means of (media) production in the age of AI

1.1 THE PROPOSAL

My invitation to potential prompt authors was to compose a simple line of text. In many ways this request was akin to a techno-futurist thought experiment: *What would you like the machine to dream?*

Both an aesthetic and technical investigation, the project seeks to examine the procedural outcomes of generative AI routines as both standalone works of visual culture and mechanical bi-products of large language models (LLM). These models are trained on gigabytes of text-image pairs, a form of annotated archive scraped from the Internet and dutifully, if not slavishly, labelled by humans.

Slow Down Time is an attempt – using curatorial and literary methods – at a conceptual response to that archive. The majority of text prompts are not the calculated compositions of a typical prompt engineer. Instead, they are mostly contemplative – quotations, throw away comments, existential questions, melancholic observations, whimsical thoughts and the occasional literary flourish.

> *The Loneliness Room*
>
> A single boat floats
> Blue ripples surround the oars
> Loneliness can be so still
>
> - Sean Redmond

Figure 1 - *Edition 03-A2DB from the "Loneliness Room" series by Midjourney, Redmond & Goodwin (2022-10-04)*

1.2 TEXT-TO-IMAGE POETICS

The most fascinating aspect of these emregent forms generative "art" production are the poetics of both the textual prompt and the final outcome. [1] It begins and ends as a text. Within that loop various modes of receivership and re-contexualisation take place.

For me, while the outcome is inherently visual, the process feels like a literary one. Therefore, I was keen from the outset to work with former colleagues who possess a literary-minded creative instinct – or at least, loiter around those who do.

Although the process is ultimately a technological one, there was no need for participants to be familiar with A.I. or generative art making. Having said that, given the current period of emergent A.I., machinic and data-centric logics are perhaps more widely understood across the Arts and Humanities - especially since the arrival of ChatGPT.

1.3 SLOW A.I.

> *The reason I'm painting this way is that I want to be a machine, and I feel that whatever I do and do machine-like is what I want to do.* – Andy Warhol [2]

Generative A.I. systems perform image requests in a matter of seconds, representing a new machine operation of hyper-seduction. *Slow Down Time* is a response to this manufactured desire for instantaneity and gratification in a time of near ubiquitous modes of digital media production and consumption.

Figure 2 - *Handwritten response from artist Ron McBurrnie to images from his series, "Newton". See: https://slowdowntime.com/ron-mcburnie/*

Contemplation then becomes a key feature of the design process, occurring at numerous stages of the project's life:

i. *Crafting* of the prompt by the authors
ii. *Production* of image variations (often over many hundreds of generations)

iii. *Curation* of the final collection of thity-three image series

iv. *Printing* of the selected images as a set of photographic prints

v. *Receivership* by the authors of their image series in the post

vi. *Response* by the authors to the generated images as tactile media objects

vii. *Archiving* of the images, meta data and the dialogue exchange with the authors

Each step in the journey a deliberate measure to slow down time.

This iterative "slow-A.I." method seeks to discern the character and the intention of the algorithm when responding to text prompts by authors who assume – however misguided they may be – that the algorithm is cognizant of the world beyond the network, and that there is 'human-like' intention in the stylistic and compositional choices it makes. To which one is tempted to ask, is there some form of contemplation or sub-text at work within the algorithmic black-box as it blitzes through its trove of cultural fragments?

1.4 ALGORITHMIC THERAPY

When the invite to participate in the MidJourney Beta arrived in my inbox in June of 2022, it had been a particularly crappy time in my life. The playful interaction with the "creative process" of a generative A.I. was a welcome tonic, gradualÿ restoring of my sense of creative energy and mental well-being. I immersed myself, in the cascade of images on the Newbie Discord servers, a mash-up of cultural and historical forms fluttering before my eyes like cheap knock-offs of masterpieces blinking in a slot machine. Suddenly, I was back in the salty pipes as it were, messing about with a new software tool, reclaiming my geekdom and - as always - contemplating its implications. This time however, the software dance feels like a partnership, my creative instincts augmented by an algorithm.

I can appreciate now the observation by Midjourney founder David Holz, that users find their text-to-image interactions to be a "deeply emotional experience" with the potential for it to be therapeutic, as he reflected at the time, "there's a lot of beautiful stuff happening." [3]

Figure 3 - *Early test image,'A rose is a rose is a rose' by Midjourney & Goodwin (2022-07-26).*

2. A CONTEST OF PERCEPTION

Up until recently generative AI outputs have been lacking definition and perspective, like the face on Mars or the puffs of dust on 9/11, they were suggestive images observed at a distance construed by the limitations of image capture. This is similar to the "surrealist charm" that Raphaél Milliére observed in earlier generative A.I. efforts like Craiyon and Wombo. [4]

We can trace the recent pop-cultural inflection of generative A.I. back to early face swapping apps like FaceApp (2017) which made the technology accessible on IOS and Android. The emergence of early #deepfakes online, featuring infamous synths, such as Barack Obama (2018) and Tom Cruise (2021). To the contested spaces we have today, between chat-based transformers like ChatGPT and Bard and the generative text-to-image services like Midjourney and DALL.E. As *Time* magazine recently declared, we have found ourselves in an "A.I. arms race" of competing vision machines. [5]

David Holz has suggested the Midjourney model's purpose is to "augment our imagination". [3] Like the emergence of expanded cinema, Midjourney plays with genre and form, using existing principles that have long informed media arts practice such as non-linearity, repetition and remix to exploit the archive. What is emerging are rhizomatic possibilities for cultural (re)production and exchange.

2.1 THE NEW REMIXOLOGY

In *Art as Information Ecology*, Jason Hoelscher writes that "art's difference is sustained over time and reveals itself differently with each encounter, because art is information's free play of difference." [6] MidJourney as algorithm is conducting this free play, there are rules, but each interaction is different, each outcome unique. In reality, this is nothing new:

> *Blues and jazz musicians have long been enabled by a kind of "open source" culture, in which pre-existing melodic fragments and larger musical frameworks are freely reworked. Technology has only multiplied the possibilities.* – Jonathan Lethem [7]

How should we describe these outcomes if we are indeed experiencing an entirely new genre of electronic image production and perception? Networked images, database images, algorithmic images are all useful terms, reflective as they are of the procedures within. They are certainly products of algorithmic processes, so we might understand the operant as a text-to image service, or an image synthesiser, or a kind of auto-photography.

Magic lurks within the algorithm too. Eryk Salvaggio – from the quite magnificent blog, Cybernetic Forests – has described the technology of the more photo-realistic aspirations of the DALL.E platform as "a kind of spirit photography". [8] Conjuring images replete with the ghosts and markings of past technologies: the fading image, the decaying medium and the corrosive chemical reaction.

Ilya Sutskever, cofounder and chief scientist at OpenAI, describes the process as "transcendent beauty as a service" [9], while artist and theorist Lev Manovich has poetically described his interactions with MidJourney as akin to working with a "memory machine". [10] The recognition that it is a service but also a metaphysical experience, is a new way of thinking about tools of automation.

2.2 SPIRIT VOICES

> *The lesson I have learned the most is that words are spells. If I didn't know it before, I know it now for sure.* – Tess Parks [11]

My initial experience of the psychedelic drift of the host platform Discord, was certainly reflective of an other-worldly exchange. My first image requests were whimsical queries, nocturnal flights of fancy, gentle tentative casts into the virtual spirit world - unnervingly well-suited to the algorithm's default aesthetic:

Figure 4 – *Early test image 'Johnny & Mary' by Midjourney & Goodwin (2022-07-18) Lyric from Palmer (1980)*

When entering the "/imagine" prompt into a text field and receiving back a wholly new image generated by an A.I., I am reminded of Arthur C. Clarke's often quoted axiom that "any sufficiently advanced technology is indistinguishable from magic". [12] Nevr has that statement felt more true. MidJourney is no different. It might also be an enchanted object, as Mario Klingermann has observed, "a magic incantation that turns words into gold." [13]

That art of prompt crafting is definitely the secret sauce of text-to-image synthesis services. Wired magazine has noted the impact this will have in a range of creative practices, not least the curation of digital media and generative art in a gallery context, "prompt curation offers an alternative way of developing a personal artistic style. Interestingly, it also places images in dialog with text, as traditional museum curation does, although in a less academic and often more poetic format". [4]

2.3 THE STORY PITCH ANOLOGY

Having taught film production for many years, the signifier-laden text to visualisation pipeline of Midjourney closely reflects the industry staple of the story pitch. A skill in which it is routine to cite previous works, name-drop actors, directors and other films to give the folks with the purse strings a taste of what might end up on screen. A sharp well-crafted pitch in an

elevator or across a bar or in the back of a cab can set in motion a multi-million-dollar project.

In my screen writing courses, I would routinely quote a scene from Robert Altman's *The Player* as an explainer for the vagaries and elasticity of the commercial story pitch. In one exchange between a writing team and the studio's producer played by Tim Robbins, we can see how the crafting and condensing of a story pitch is akin to designing a text prompt for an A.I., the clarity only emerging when the writers cite specific examples:

Scriptwriter #1
It's a story about a bad-guy senator.

Scriptwriter #2
He's traveling around the country on the country's dime …

Producer
It's a cynical, political thriller comedy?

Scriptwriter #2
But it's got heart in the right spot. Anyway, he has an accident ...

Scriptwriter #1
- and he becomes clairvoyant, like a psychic.

Producer
So, it's a psychic, political, thriller comedy with a heart?

Scriptwriter #2
With a heart, not unlike *Ghost* meets *Manchurian Candidate*. [14]

3 TOWARDS AN ARCHIVE

After several weeks of fevered exploration of the technology, recurring anomalous patterns began to emerge: surface textures, inferences of data-noise in the form of hair-like wires and machinic glitches. Historical and genre abstractions were present too: luminous acrylics and garish neon, moody pink skies and deep shadows, while silhouetted strangers, always facing away from the viewer, give scale and hint at sub-text, but their melancholic presence haunts the canvas.

What was also observable were the spaces in between objects and forms that were not describable in human terms, these machinic utterances were clearly the product of an algorithmic loose end. Stephen Wolfram has described this tension as an "inter-concept space" at the edge of human understanding somewhere beyond Euclid optics and Wolfram's own description of the limits of computational entanglement – the ruliad – where "things look familiar but mostly what we will see are things we humans do not have words for." [15]

Moreover, when things went well, when images managed resolve themselves successfully, certain compositional and stylistic tendencies became evident. This suggested that a default aesthetic was at play. This was the poetics I referred to in my September '22 article in *The Conversation* that documented my initial flirtations with Midjourney. [16]

Figure 5 - *Edition 03B-A3GC from the "Bots"series by Midjourney, Gardner & Goodwin (2022-12-30) See: https://slowdowntime.com/ruth-gardner/*

3.1 GLITCHES AND ANOMALIES

These tendencies were especially evident when the going got tough for the Natural Language Processor (NLP) with regards to negotiating the conceptual or linguistic intent of the prompt. Typically, this occurred when a prompt was too open or vague, or the scenic elements were to complex, or the genre parameters not so easily resolved. Depending on the context, Midjourney would improvise to achieve, what it "supposed" was a coherent image and an adequate response to the given prompt.

It was these textures, anomalies and improvisations that became interesting to me, and influenced my decision to share my prompt writing adventures with my creative and academic colleagues. Giving rise to numerous questions:

- What if we intentionally prompted Midjourney with abstractions, with lyrical compositions or existential riddles?

- What if I did this in a controlled manner, remaining true to the prompt and generating not one but many hundred images following the same thread?
- How might a mediated dialogue between authors and algorithm tease out stylistic tendencies or subtext?
- How might one curate over time, these text-to-image interactions – both the successes and the failures – in a format that might reveal the potential discursive poetics of the machine?
- What would such a collection reveal about the algorithm's coded sensibilities – what embedded biases and imported "world views" might we detect?

These questions formed the basis of my curatorial design of the *Slow Down Time* (SDT) project. A deliberate effort to work against the emergent practice of "prompt engineering" at a time when such descriptors were only beginning to emerge, and see what – if any – compositional intentionality we could collectively ascertain. Further to this was the question as to whether there was any evidence of an aesthetic "hand" at work, or as Lev Manovich would perceptively observe in his own extensive interactions with Midjourney – a "house style". [17]

3.2 ARCHIVE ALEMENTS

At the time of the archive's conception, I was on extended personal leave without pay from my academic institution due to an accumulation of factors that those familiar with post-COVID neo-liberal enterprises may recognise. So, I needed an affordable and accessible platform to host a net-art experiment that was also a form of art therapy. For better or worse I settled on a Word Press blog site. A familiar platform with sufficiently flexible templated options to organise the required text and image data. After all, despite this being a very visual exercise, it was inherently data and link driven. A future ambition would be to move to a database model like Omeka.

Without getting too prescriptive with regards to the Midjourney image generation process, there were several parameters and data points from a curatorial perspective that I considered important elements to track in the organisation of the *Slow Down Time* archive. My aim was to make the cataloguing system as transparent as possible:

Title and edition number – a classification system to track the evolution of image variations and/or prompt manipulation (aka "prompt wrangling").

Text prompt – the original prompt supplied by the authors.

Image prompt – some prompt authors were artists themselves and I invited a few of them to also submit an image to complement their text prompt.

Prompt parameter/s – in some cases it became necessary to include additional prompt parameters to direct Midjourney towards a coherent outcome.

The parent grid – the first response to any prompt provides four image variations in a 512x512 pixel grid.

Midjourney Job ID – the original Midjourney job number used to identify the generated image.

Discord message link – the exact location of the generated image on my Discord server

Commencement date – the period of Midjourney's development in which the image series were "created".

Contact sheets – all the images from each series to reveal the genealogy of the images.

Figure 6 – *The parent grid from the first response to the prompt "How do I know if this is real?" by Midjourney, Perkin and Goodwin (2022-10-06)*

4 VIDEO INTERPOLATION TESTS

An unplanned component of the project were the video interpolation experiments. These were produced for a selection of prompts that displayed what I would describe as expanded

modes of "compositional desire". In these cases, I pursued compositional threads just one or two grid variations, often generating hundreds of images as a result. I discovered that when these images were compiled in a linear sequence, they more clearly revealed the evolution of the generative process. The linear sequencing of image variations on a timeline was done using Runway ML's frame interpolation process.

4.1 SAD BY DESIGN

Beginning with a curious sequence of images from a prompt by Geert Lovink – "sad by design" – I could more clearly demonstrate the algorithm's seeming determination to find coherence from compositional abstractions through multiple re-generations. These emergent patterns demonstrate how the algorithm seeks out formal references from the chaos and abstraction – the latent instinct of the diffusion model. In turn through our witnessing of the sequential playback, we are able to attribute meaning and mediated symbolism upon the ghostly visage.

Figure 7 – *09-A4EE & 09-A4GB from "Sad by design" by Midjourney, Lovink & Goodwin (2023-01-23) See: https://vimeo.com/800727356*

Through veils of abstraction, we can also see how this process reveals the narrow bandwidth within the labelling method used to train the Midjourney algorithm as it seeks out visual stereotypes: the horror film poster featuring a blood red silhouette, the traumatized Asian/Middle Eastern figure in a scarf, the forlorn female model disappearing into advertorial collateral and is that Picasso's *Weeping Woman*? Perhaps.

The prompt mentioned neither gender or any form of embodiment. What is being designed here? Are women inherently sad – or just rendered that way by men and their algorithms?

4.2 REALITY CHECK

> *What is a face, really? Its own photo? Its make-up? Or is it a face as painted by such or such painter? That which is in front? Inside? Behind? And the rest? Doesn't everyone look at himself in his own particular way? Deformations simply do not exist.* – Pablo Picasso [18]

In another example worth noting is the series of images produced by Jennifer Perkin's prompt, "How do I know if any of this is real?" which initially produced the silhouetted outline of a young woman in portraiture. Although her face is obscured her ghostly presence will be familiar to anyone who was playing around with Midjourney back in those halcyon days of late 2022. The neatly fitted shirt, the bob of black hair are signatures of a default female character known as Ms Midjourney who haunts "the blank spaces between parameter weights and engrams." [19]

Figure 8 *– Edition 01-D2CE from "Reality Check" by Midjourney, Perkin and Goodwin (2022-10-06) See: https://vimeo.com/805075965*

During the course of generating over 260 images from the Perkin prompt the abstract orb, reminiscent of an inverted tear drop, underwent many variations: landscapes, sunsets, cracked earth, bleached valleys and occasionally hints of a baking cityscape, even a stack of old newspapers signpost the urban decay. A concurrent narrative appeared to express a synergy between these two "minds" – roots, branches, valleys, stars, and finally in the last frame where I stopped the process – tears. A

sadness had emerged. Was reality no longer shared? Or was it mourning the fact that the two could not really be as one, permanently staring off in separate directions?

5 THE DIGITAL GOTHIC

Have you ever tried to describe a dream? And yet try as you might, you cannot recall how it started, or how it arrived at its fevered resolution? You're left clutching at fragments, a disjointed burst of images flicker back at you like some form of rear-projection technique or a glimpse of the upside down. What lingers is a staccato conversation between language and memory and history, an awkward fumble in the dark, a psychohistory of image fractals falling in and out of time. Late nights with the Midjourney Bot are like that – gothic portals through liquid time.

Despite its futurist and often disorientating tendencies the text-to-image process has a distinctly nostalgic feel to it. This reflexive dance recalls the notes I read recently for Bill Callahan's new album, *Reality*. An interaction with an AI image service is like the circling back of a song lyric, the algorithm "pitting dreams of dreams against dreams of reality." The future jacked-up on the past in a recursive cyber-coil. [20]

Figure 9 - *Edition 04-C2B from the "Future Imperfect" series by Midjourney, Brown & Goodwin (2022-09-22).*

My own personal experience of wrestling with a seemingly innocuous Midjourney prompt – "the future of architecture" – was of being horrified that such a simple unadorned request of an AI could produce image after image of crumbling cityscapes and barren wastelands. Each variation rendered in deep reds and oranges with hot hazy disappearing horizon lines of infinite destruction. While in the centre of the image rose a shiny abstract tower, all glass and steel and aqua blue accents, impossible architectural forms that reached pleasingly into the temperate cooling air of the stratosphere. There will always be inequality, I suppose. Winners and losers, algorithms and keystrokes, the Cloudalists and the Earth hardened data clones toiling away in the sun.

5.1 TECHNO-FUTURIST REDUX

Generative AI text-to-image services represent a major shift in the gothic techno-futurist tendencies of digital media. They look exclusively and mindlessly back into the past before portending their dark melancholic scenarios and thereby stoking our anxieties of what might be imminent – that which comes for us in the dark. Machine learning algorithms diligently seek out corollary information from vast archives of training data consisting of billions of image and text pairs scraped from the web that recalls a somewhat skewed rendition of humanity's cultural history.

What they find of course is that the darkness is embedded in our past and it *is* horrific. From epic biblical tales of destruction to the horrific photographs of the holocaust, from movie stills of slasher films to the paintings by Goya and Etienne Sandorfi and the illustrations of HR Giger and Zdzisław Beksiński. From photojournalism of fallen towers and gruesome mechanical wreckages to screenshots of marauding zombie hordes. The algorithms of Midjourney and DALL-E are merely appropriating what is already there, dutifully recycling back to us the dark and ominous retrograde landscapes of the human mind.

Figure 10 - *Edition 10-A4CD from the "El Agua" series by Midjourney, Posse & Goodwin (2023-10-31)*

6. BUT AT WHAT COST?

It should be made very clear that this project does not operate in a vacuum and is very aware of persistent and unresolved issues pertaining to the development and rapid proliferation of generative AI.

Via the likes of danah boyd, Edward Snowden, Yuval Harari, Trevor Paglen, Tristan Harris and Shoshana Züboff, we know very well that algorithms of surveillance and analysis are not in any way passive. Nor should we expect generative A.I. to be a docile entity once fully formed and embedded on the networks of commerce, governance, and information production. They will mature rapidly to become core components of an increasingly artificial lived experience. Virtual constructs to be sure, however in-tandem with existing modes of data mining and analysis, generative AI constitute powerful operationalised forces of calculation, prediction and influence.

These are the emergent signatures Frank Pasqual describes in *The Black Box Society* [21] and Züboff picks up on in *Surveillance Capitalism*. [22] Invisible infrastructures and opaque operations that churn through the data stacks rapaciously farming the artificial crowds of our synthetic psychic doubles. These are the ungoverned and the time-poor netizens of Stiegler's *Automatic Society* [23] and Jonathan Crary's waking dreamscape, *24/7: Late Capitalism and the Ends of Sleep*. [24]

6.1 INVERT THE NARRATIVE

We might only ever notice their presence when our number comes up. This is because, machine learning tools and automated systems are increasingly deployed across a range of industry sectors to evaluate risk, pre-empt crime, monitor workers and to make moral judgements often splintering along racial and cultural lines.

All these methods have been criticised for further marginalising the poorest and most vulnerable members of society and negatively profiling already marginalised communities. Virginia Eubanks has argued in her important book, *Automating Inequality*, that we must resist by exploiting these same technologies to tell our own stories and to advocate for the poor and the marginalised and lift the lid on opaque unethical practices.

6.2 THE TROUBLE WITH GEN-A.I.

> *In principle a work of art has always been reproducible. Man-made artifacts could always be imitated by men. Replicas were made by pupils in practice of their craft, by masters for diffusing their works, and, finally, by third parties in the pursuit of gain.* – Walter Benjamin [25]

While it is not the focus of this paper, I think it is important to flag some of the key ethical concerns particular to generative AI technologies at this critical moment in their foundational development:

Embedded biases - the embedded inequality, cultural stereotypes and gender biases within training data and their generative outputs.

Worker safety - the psychological cost of labelling training data and monitoring violent, abusive and explicit content.

Worker rights - the exploitation of vulnerable workers in the labelling and vetting of text-image pairs.

Digital rights - the unsolicited acquisition of copyrighted work by living artists for training data purposes as well as the discernible "presence" of style and technique in the output.

Environmental costs - the energy impact of algorithmic calculations / the mining of rare minerals to construct chips and components.

Some of these signatures are certainly evident in the *Slow Down Time* archive. For an of how problematic this can be in practice, see Wajeehah Aayeshah's *ID* series and Jack Latimore's series *The Cliff*. Both expose the limitations of the Midjourney corpus in depicting (and describing) cultural diversity.

Figure 11 - *Edition 05-A1C from "The Cliff" series by Midjourney, Latimore & Goodwin (2022-10-16).*

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Open Justice Transformations Impacting Extended Reality (XR) Environments

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ABSTRACT:

This paper continues the discussion on advanced jurisprudence, outlined in Algorithms, Ethics and Justice (Hadzi, 2022), where restorative justice was proposed for the mitigation of artificial intelligence (AI) crimes. Algorithms, Ethics and Justice proposed an alternative approach to the current legal system by looking into restorative justice for AI crimes, and how the ethics of care could be applied to AI technologies. This paper will expand the notion of cyber crimes from AI crimes to extended reality (XR) crimes, given the rise of the metaverse (Anderson & Rainie, 2022; Chohan, 2022), and the future scenario of bio-metrical data of EEG capable headsets (Graham, 2022) being misused by rogue companies and/or criminals (Jaber, 2022; Nair et al., 2022; Zhao et al., 2022). The paper will do so first by discussing Mill's text On Liberty (Mill, 1978), as a context to explore open justice in extended realities (XR), and then by continuing the discussion around the right to be forgotten and the freedom of the press versus privacy, through a comparative analysis between the legal situation in the EU and that of the USA. The paper concludes by reviewing possible international open justice scenarios for XR criminals.

1. INTRODUCTION

This paper continues the discussion on advanced jurisprudence, outlined in Algorithms, Ethics and Justice (Hadzi, 2022), where restorative justice was proposed for the mitigation of artificial intelligence (AI) crimes. Algorithms, Ethics and Justice proposed an alternative approach to the current legal system by looking into restorative justice for AI crimes, and how the ethics of care could be applied to AI technologies. This paper signifies an edited version of Hadzi's contribution to the Digital Research in Humanities and Art Conference (Hadzi, 2023), focusing on the notion of cyber offenses in extended reality (XR), given the rise of the metaverse (Anderson & Rainie, 2022; Chohan, 2022), and the future scenario of bio-metrical data of EEG capable headsets (Graham, 2022) being misused by rogue companies and/or criminals (Jaber, 2022; Nair et al., 2022; Zhao et al., 2022). The paper will do so first by discussing Mill's text On Liberty (Mill, 1978), as a context to explore open justice in extended realities (XR), and then by continuing the discussion around the right to be

forgotten and the freedom of the press versus privacy, through a comparative analysis between the legal situation in the EU and that of the USA. The paper concludes by reviewing possible international open justice scenarios for XR criminals.

A legally well-regulated metaverse (Ravenscraft, 2022; Warin & Reinhardt, 2022), and in a wider sense a well-regulated social media environment, could be seen as a potential democratic tool allowing metaverse users freedom of expression (UNESCO, 2011) and freedom of information access (Wagner, 2022), through an advanced form of jurisprudence. Nevertheless, social media users, including metaverse users, should also consider that those rights come with responsibilities, namely legal restrictions on infringing other users' privacy rights (Hartshorne, 2010, p. 69).

One can discuss Mill's consequentialist utilitarianism, outlined in On Liberty (Mill, 1978), in a contemporary context juxtaposing social media users' freedoms against other users' right to privacy. On Liberty can be used in the metaverse context where there is the potential for "super users", such as influencers, or a "tyranny of the masses", to harm the rights of individual users. Mill followed Bentham in his discussion on utilitarianism (Capaldi, 2004). The protection of minorities' and individuals' rights is central to Mill's On Liberty (Crisp, 1997). Bentham discussed jurisprudence in regard to the happiness of such minorities or individuals (Brink, 2007). Bentham writes that "publicity is the very soul of justice. It is the keenest spur to exertion and the surest of all guards against improbity. It keeps the judge himself while trying under trial" (in Smartt, 2014, p. 19). Bentham defended open justice in order for the public to be able to follow court trials and to check if judgments are enforced in a fair manner. One might say that in the past, court hearings were the social media of society. Many people attended court hearings, sometimes also only for entertainment (Rodrick, 2014, p. 131). Nowadays the public can still attend court hearings, though interest has vanished, and the public relies today on social media posts and news to be informed about ongoing trials.

This paper will also discuss Mill's notion of preventing "harm to others" (Mill, 1978, p. 9)—basically, the concept of a protection of the individual user against harmful action(s) of the masses and/or of other users, grounded on the claim that "the individual is sovereign" (Mill, 1978, p. 9). As there is a whole range of harm, this paper focuses on the protection of individual users' privacy rights, the users' sovereignty over mind and body, as also discussed by Berlin (2002), especially in light of the planned use of EEG headsets on the metaverse (Graham, 2022).

2. ON LIBERTY

Mill's argumentation for the social benefits of the freedom of an individual can be translated into the contemporary context of social media and metaverse users—basically freedom of speech (Barendt, 2005) and the protection of an individual user against bullying and "mobbing". Applying Mill's line of thought in On Liberty to modern conditions, the public sphere offers judgments about social media influencers' posts and metaverse users' behaviours (Wang et al., 2022). The general public will judge behaviours and social media publications as being "fake" or true. Following Mill, in the case of true social media posts, a public discussion would offer a sound judgment. Furthermore Mill's position would be strongly against majorities' pre-conceptions and biases being intrusive on individual users' "social graces" (i.e. aspects of personal and social identity such as gender, religion, ability, class, ethnicity or sexuality (Burnham, 2018)). It is in the public interest to establish truth. In case of a false, or uncertain, social media post a position following Mill would be that there should still be a discourse within public space, as the truth will prevail, allowing for democracy to flourish. Of course reading On Liberty today one needs to be clear that Mill did not have the social media users (and today's concept of "shit storms") versus individual users in mind. Nevertheless On Liberty can be referred to when discussing theories of "social media" freedom of expression (Donner, 1992). One can then go on to discuss the violence and abuse certain social media posts can inflict on parties with the metaverse.

But how to deal with today's flood of fake social media posts? In a metaverse, a social media environment dominated and molded by powerful companies (Wieshofer, 2022), e.g. the metaverse by Meta (formerly known as Facebook)? Mill's reply might not be in the

realm of jurisprudence, but, confronted with false social media posts Mill might argue that it is free and open social media which will allow for the establishing of truth through fact finding and public discourse, analysing the false social media posts in question (Parialò, 2022). Mill probably would argue for an open public social media environment, allowing for an analytical, judicious public discourse, as we, as social media users:

„have a right, also, in various ways, to act upon our unfavourable opinion of anyone, not to the oppression of his individuality, but in the exercise of ours. We are not bound, for example, to seek his society; we have a right to avoid it (though not to parade the avoidance), for we have a right to choose the society most acceptable to us. We have a right, and it may be our duty, to caution others against him if we think his example or conversation likely to have a pernicious effect on those with whom he associates. We may give others a preference over him in optional good offices, except those which tend to his improvement. In these various modes a person may suffer very severe penalties at the hands of others for faults which directly concern only himself; but he suffers these penalties only in so far as they are the natural and, as it were, the spontaneous consequences of the faults themselves, not because they are purposely inflicted on him for the sake of punishment.“ (Mill, 1978, p. 57)

3. THE RIGHT TO BE FORGOTTEN

Nevertheless, a retrospective reading of Mill's On Liberty concerning social media platforms, XR environments, and metaverse users' right to freedom of expression versus individual metaverse users' right to privacy cannot be fully investigated within Mill's historical context. We shall thus move on to contemporary case studies around freedom of expression, the right to privacy, and the right to be forgotten, in order to discuss the notion of open justice within XR environments such as the metaverse, starting with discussing the concept of "habeas data" (Farivar, 2018), Latin for "you have the data", the right to collect data (Corrales Compagnucci et al., 2022) and the freedom to delete it. Within digital networks and data centres data of individual users is being stored, possibly forever, making it difficult for XR crime offenders to ever rehabilitate their image. This right was entrenched in EU legislation by the European Union Court of Justice as the "right to be forgotten" in May 2014 (Google Inc. v Agencia Española de Protección de Datos (AEPD), 2014). The Court of Justice of the European Union press release states that "if, following a search made on the basis of a person's name, the list of results displays a link to a web page which contains information on the person in question, that data subject may approach the operator directly and, where the operator does not grant his request, bring the matter before the competent authorities in order to obtain, under certain conditions, the removal of that link from the list of results" (Court of Justice of the European Union, 2014a).

The "right to be forgotten" (Court of Justice of the European Union, 2014b) is a significant right for metaverse users, and not only a "get away" right for XR criminals, considering the vast amount of data which is separated by data processors from the users, and especially the amount of data created, often unwillingly, by users, having to share updates about their private affairs on these platforms. Basically the company Meta, running the metaverse (Lee et al., 2022), under the "right to be forgotten", is regarded as both a controller of data and a processor of data, and thus has to give metaverse users the right for their data to be removed from the metaverse, as already established in the EU 1995 Data Protection Directive (European Data Protection Supervisor, 1995), due to Meta's recording of personal data, as well as making it available to other (public) metaverse users. The legislation applies to any company or data processing operator that "[has] a branch or subsidiary in a Member State which promotes the selling of advertising space" (Venice Commission, 2014, p. 3). In article twelve, the European Court of Justice instructs every member state to secure users' rights to obtain from the data processor "as appropriate the rectification, erasure or blocking of data the processing of which does not comply with the provisions of this Directive, in particular because of the incomplete or inaccurate nature of the data" (European Data Protection Supervisor, 1995). Through the General Data Protection Regulation (GDPR) the "right to be forgotten" now also applies to XR environments, such as the metaverse, though now referred to as "right to erasure" in article 17 of the GDPR (Logemann, 2018). One also needs to highlight that the GDPR changed from the notion that

data belongs to the data processors (and users have to opt-out of data sharing) to data belonging to the users (and users can opt-in to data sharing), meaning that Meta now has to ask for the permission of its users to store personal data of its users in the metaverse.

3. DATA ETHICS

Thus metaverse users should consider what it means to preserve and manage fair ethical treatment with "data ethics" (Fernandez & Hui, 2022) and information sharing. The public interest and freedom of expression, key to "open justice" with respect to XR crimes, are balanced against the right to privacy, and other human rights (Bayer, 2022), in European Union member states' courts. The Human Rights Act (European Convention on Human Rights, 1998), powerfully impacted European Union jurisdiction, notably in the above mentioned balancing act between the right to privacy (article eight of the Human Rights Act) and freedom of expression (article ten of the Human Rights Act), as well as the right to life (article two of the Human Rights Act). The Parliamentary Assembly of the Council of Europe reaffirmed (Tugendhat & Christie, 2002, pp. 619–620) "the importance of every person's right to privacy, and of the right to freedom of expression, as fundamental to a democratic society. These rights are neither absolute nor in any hierarchical order, since they are of equal value" (Parliamentary Assembly, 1998). Freedom of expression, on the other hand, allows for an open justice system, through which public interest is safeguarded and fair XR crime trials can be conducted. Nevertheless certain XR criminals may need protection from extrajudicial attacks, due to the nature of their XR crime. It has been argued that the balancing act of European Courts has led to a decline of open justice, due to freedom of expression being "pitched" against privacy rights and the right to a fair trial (Goodale et al., 1993), as well as the right to life. In this connection, a famous case, which upheld the right to privacy (Hall & Dyer, 2002), serving as a reference for privacy rights for XR crimes in the metaverse, was Naomi Campbell's court case against the Daily Mirror (Campbell (Apellant) v. MGN Limited (Respondents), 2004), who pictured her in front of a drug rehabilitation facility. The court granted Campbell right to privacy overriding the newspaper's right to freedom of expression.

The court's ruling meant that freedom of expression was circumscribed. Lord Steyn, in a case relating to restrictions on publication, stated, referring to articles 8 and 10 of the Human Rights Act, that "first, neither article has precedence as such over the other. Secondly, where the values under the two articles are in conflict, an intense focus on the comparative importance of the specific rights being claimed in the individual case is necessary. Thirdly, the justification for interfering with each right must be taken into account. Finally, the proportionality test must be applied to each. For convenience I will call this the ultimate balance test." (Re S (A Child), 2005). Lord Nicholls continued the argumentation in the Campbell case, stating that "freedom of expression has been stressed often and eloquently, the importance of privacy less so. But it, too, lies at the heart of liberty in a modern state. A proper degree of privacy is essential for the well-being and development of an individual. And restraints imposed on government to pry into the lives of the citizen go to the essence of a democratic state" (Campbell (Apellant) v. MGN Limited (Respondents), 2004).

In the case of an XR crime (Ewulum & Bede Chigbogu, 2022) metaverse users could claim "public interest" in order to report on private matters. Nevertheless, Foster points out that "between a judge and the general public there is little common ground over what public interest actually means—and any publication will be wise to look hard at the differences" (Foster, 2007). Likewise what right to privacy actually means in the metaverse is also not clear cut. In the case Von Hannover v Germany the European Court of Justice ruled that privacy includes "a person's name, photo or physical and moral integrity" (Global Freedom of Expression, 2004). Moreover the European Court of Human Rights, referencing article eight, stated "the Court considers that the notion of personal autonomy is an important principle underlying the interpretation of its guarantees" (Pretty v. the United Kingdom, 2002). Interestingly for metaverse users, the notion of reputation was included in article eight of the European Convention on Human Rights (Feldman, 1997), as according to Zelezny "reputation is what a person is seen to be in the eyes of others—the individual's projection of self within a society" (Zelezny, 2010, p. 116). According to Justice Stewart "The right of a

man to the protection of his own reputation from unjustified invasion and wrongful hurt reflects no more than the basic concept of the essential dignity and worth of every human being; a concept at the root of any decent system of ordered liberty" (Henry 2021), to which Justice Erickson adds "Defamatory statements are so egregious and intolerable because the statement destroys an individual's reputation; a characteristic which cannot be bought, and one that, once lost, is extremely difficult to restore" (Henry 2021).

4. FREEDOM OF EXPRESSION VS. PRIVACY

In order to limit freedom of expression in the metaverse there must be concrete proof for a damage of reputation of a single user. Metaverse users, e.g. influencers, often publish without thinking, mainly motivated by likes and profit, and generally not by finding the truth. Metaverse users can harm other users, in the form of XR crimes, attacking one's privacy and reputation. However Judge Hoffmann argues that "no freedom is without cost and … the judiciary should not whittle away freedom of speech with ad hoc exceptions. The principle that the press is free from both government and judicial control is more important than the particular case" (R (Mrs) v Central Independent Television Plc, 1994).

Following articles 8 and 10 of the Human Rights Act requires courts subject to this legislation to strike a balance between the rights to privacy and to self expression respectively. The decision of the Court of Appeal in A v B Plc and Another in 2002 reflected on this state of affairs:

„The manner in which the two articles operate is entirely different. Article 8 operates so as to extend the areas in which an action for breach of confidence can provide protection for privacy. It requires a generous approach to the situations in which privacy is to be protected. Article 10 operates in the opposite direction. This is because it protects freedom of expression and to achieve this it is necessary to restrict the area in which remedies are available for breaches of confidence. There is a tension between the two articles which requires the court to hold the balance between the conflicting interests they are designed to protect. This is not an easy task but it can be achieved by the courts if, when holding the balance, they attach proper weight to the important rights both articles are designed to protect. Each article is qualified expressly in a way which allows the interests under the other article to be taken into account." (A v B Plc and Another, 2002)

Such a "balancing act" would be required for XR criminals who, once they have served their "punishment", ideally should be rehabilitated. This rehabilitation, however, may involve certain limitations, for example by curtailing freedom of expression, especially if mental health issues are involved, as metaverse users may be disseminating hate speech, causing harm to individual users. Undoubtedly metaverse users have the right to discuss any matter of public interest in the public sphere; however when the right to freedom of expression is misused to spread hate and false stories (Ricardo, 2022) in the pursuit of likes and subscriptions, that right should be restricted and regulated. An example for such need of protection is that of the Maxine Carr "witch hunt" (Carr v News Group Newspapers Ltd & Others, 2004), documented in the First Cut TV series entitled Being Maxine Carr (Ginnane, 2008). The film shows how women who have been mistaken for Maxine Carr were attacked violently, with some women even having to abandon their homes and neighbourhoods. For XR criminals, once they have served their penalty, they should be allowed to return back to society, where, under the rule of law, they have the right to privacy and to be left alone. If this proves to be impossible, due to attacks from the public, a controversial "contra mundum" injunction may be enacted, giving the XR criminal a new identity, undermining open justice principles. Understandably the public may be afraid of anonymous XR criminals moving into their communities. Those communities may turn to vigilante self-defence justice, taking the law into their own hands, committing a crime themselves.

Compared with the EU, the situation in the USA is very different for the company Meta, and the metaverse. In the USA freedom of expression is a constitutional right that overwrites all other rights. There is no balancing act to be performed between the right to privacy and the right to freedom of expression, of the kind faced by judges in the EU. Thus public interest, and the content published on the metaverse, is defined

by users themselves, as manifested in the case Richmond Newspapers, Inc v Virginia (Richmond Newspapers, Inc. v. Virginia, 1980). The First Amendment in the USA protects freedom of speech, and with it guarantees an open justice system in the USA for XR users. With social media turning towards extended realities (XR) by creating platforms such as the metaverse, a pseudo public space is being created offering a platform for public discourse (Balkin, 2005).

Freedom of expression and open justice are crucial tools for a healthy democracy (Huq, 2022). If freedom of speech/freedom of the press is curtailed societies risk developing into autocracies. Following this line of argumentation it is notable that already in 1787, the third president of the USA, Thomas Jefferson stated that:

„The people are the only censors of their governors; and even their errors will tend to keep those to the true principles of their institution … The way to prevent these irregular interpositions of the people, is to give them full information of their affairs through the channel of the public papers, and to contrive that those papers should penetrate the whole mass of the people. The basis of our government being the opinion of the people the very first object should be to keep that right; and were it left to me to decide whether we should have a government without newspapers, or newspapers without a government, I should not hesitate to prefer the latter“ (in: Bajracharya, 2018; Cole, 1982).

After the Second World War Meiklejohn continued the line of argumentation, in regard to self-governance, that the First Amendment "is not, primarily, a device for the winning of new truth, though that is very important. It is a device for the sharing of whatever truth has been won. Its purpose is to give to every voting member of the body politic the fullest possible participation in the understanding of those problems with which the citizens of a self-governing society must deal" (Meiklejohn, 1948). Freedom of speech is an essential tool for investigative reporting, as well as strengthening the liberty of individuals in society. For Siebert this "theory of sovereignty, freedom of the press, became one of the natural rights of man" (Siebert, 1952). Judge Black also defended freedom of speech against the security interests of a government, arguing for "security" to be a broad, "vague generality whose contours should not be invoked to abrogate the fundamental law embodied in the First Amendment. The guarding of military and diplomatic secrets at the expense of informed representative government provides no real security for our Republic" (New York Times v USA, 1971). In the age of social media (Rodríguez-Vázquez et al., 2022) it will be very easy to humiliate users in the metaverse in the pursuit of attention or profit, although the lines are blurred within the metaverse as to what may constitute a for-profit dissemination and what may be a news update. In the USA judges in the case Yath v. Fairview Clinics ruled that the posting of private medical information on social media "is sufficient for the 'publicity' prong of the invasion of privacy test, no matter how limited the site or webpage may be" (Yath v. Fairview Clinics, N.P., 2009), and Kulesza states in International Internet Law that "it is most certainly because of the global phenomenon of the Internet that such concepts as freedom of speech or protection of privacy have taken on a whole new dimension and created the urge for a new, international consensus on the cyber-arena" (Kulesza, 2012, p. 45). Kulesza goes on to highlight the issue of censorship:

„The current approach to regulating electronic content is filtering. Since practically no state allows freedom of speech to be exercised without any limitations, state authorities attempt to exercise their legislative restrictions also over online forms of expression. Therefore, most of them perform some sort of censorship ("Internet filtering") for different social, political or security reasons, which results in limiting access to certain Internet content. The list of "filtering" countries is growing day-by-day ... However, next to the filtering policies that clearly violate the present human rights standards of free speech by excessively restricting access to certain content, there are those forms of filtering that leave much more room for controversy. The scope of Internet censorship is growing not only in countries recognized as autocratic, but also in model democracies.“ (Kulesza, 2012, pp. 45–46)

5. OPEN JUSTICE TRANSFORMATIONS

In order to counter such censorship open justice principle need strengthening, as democracies rely on fair criminal justice systems. In this

respect social media has strengthened free speech, and the right of public interest, by allowing for instant updates on XR criminal proceedings. The Judicial Studies Board, established in the UK, in order to protect judicial independence, advises, as a general rule on reporting, which could include social media posts, that "the administration of justice must be done in public. If the court is asked to exclude the media or prevent them from reporting anything, however informally, do not agree to do so without first checking whether the law permits the court to do so … [T]he prime concern is the interests of justice" (Judicial Studies Board, 2009, p. 18). The courts may consider not allowing social media reporters to report about the proceedings, deciding on a case-to-case basis, according to the balancing act (article eight vs. article ten) as set out by the European Convention on Human Rights. Bohlander opines that "open court proceedings and the publicity given to criminal trials are vital to the deterrent purpose behind criminal justice. Any departure from the open justice principle must be necessary in order to be justified" (Bohlander, 2010, p. 322), as anonymity might allow for XR criminals, especially given the Metaverse environment, to "use anonymity to act scandalously or perpetuate skull duggery, and yet others are drawn to the light of celebrity-hood" (Berryman, 2014, p. 26), even, according to Rodgers, allowing for XR criminals to "[cast] a shadow over entire communities" (Whitehead & Gardham, 2010). The practising of open justice becomes more and more cumbersome in the contemporary world of social media influencers, who are often not clear on whether they are posting for profit, or with a genuine motivation in supporting open justice. For Bohlander "the debate has been too much about terminological facades in many judicial fora, up to the European Court of Human Rights, for far too long" (Bohlander, 2010, p. 327), and for Crook "reporting of trials inevitably involves an exploitation of the infotainment dimension of journalistic narrative" (Crook, 2009, pp. 263–264). This is where XR criminals are protected through article six of the Human Rights Act, the right to a fair trail, in order to avoid trial by social media. For Abromovsky it "is ironic … that while a jury is repeatedly admonished in all cases to consider only the evidence and exhibits which emanate from the witness stand, they are subjected to a barrage of often inflammatory and irrelevant information prior to their impanelment" (Goodale et al., 1993, p. 293), while Feintuck argues that the centrality "of the media to democracy, as the primary information source, cannot be overemphasised, and the very fact that democracy (Cheng, 2022) requires citizens to be informed if they are to act effectively as citizens, serves as a prima facie justification for regulation within a democratic context" (Feintuck & Varney, 2006, p. 5).

Public interest, according to McQuail, can be understood as conventions, "laws and evaluative claims which surface in public debate according to local circumstance" (in Peruško, 2009, p. 7). The balancing act between the different rights proves to be difficult, as an XR criminal might be exposed to "significant risk of injury or death … and that failure to protect her from that risk would amount to a breach of Article 2 of the European Convention on Human Rights (protection of right to life)" (Dougan, 2005, p. 302). European Union courts, due to focusing more and more on the right to privacy, are limiting open justice, compared to the USA, which implies limiting what one is allowed to publish on social media, in our case the metaverse. This can lead to a censoring, or even self-censoring, of metaverse users, who do not take up their right to freedom of speech, despite being protected through article ten (freedom of expression) in the European Convention for the Protection of Human Rights and Fundamental Freedoms (Council of Europe, 2022), as discussed above. One can ask why "contra mundum" anonymity is being granted at all? And how this will impact on open justice in the EU (compared to the USA where freedom of speech trumps privacy rights)? By discussing these questions this paper will conclude that there is indeed an impact, some may say a negative impact, on open justice, but that freedom of speech remains significantly protected through the EU.

US Supreme Court Judge Brennan referred to (social) media to support courts in practising open justice. Social media posts do not cover all court hearings, but select what is in the public interest. Here often courts and (social) media reporters clash on what counts as "public interest". Social media user feel entitled to report on what they deem to be of importance, while judges have the duty to protect XR criminals to guarantee a fair trial, which for social media users represents a form of censorship and a curtailing of open justice

principles. According to Roderick "Research in the United Kingdom and the United States suggests that, more often than not, the [social] media report extraordinary, newsworthy proceedings and tend to ignore ordinary, routine cases that may have educative value" (Rodrick, 2014, p. 135). Social media users are under pressure to gain subscribers for their feeds against their competitors, and thus chase the more sensationalist court hearings, often neglecting rigorous fact checking, meaning that the process of justice is often neglected in favour of reporting on thrilling situations instead. It seems that social media users are solely focusing on seeking attention and profits. Through the Human Rights Act 1998, European Union courts, and Strasbourg jurisprudence, have become inclined to favour the right to privacy over the right to freedom of expression. Naomi Campbell, as discussed above, was photographed in public space, when leaving the rehabilitation centre, still the judge decided in her favour, overriding the Daily Mail's right to freedom of expression with Campbell's right to privacy. This ruling is unique to the European Union, because in the USA freedom of speech would triumph, and a judge would never rule against freedom of expression. In the USA social media users can choose what to report on, and what is in the public interest. It becomes more of an ethical decision for social media users in the USA what to report on. Likewise the above discussed "contra mundum" injunctions for XR criminals, due to potential attacks of members of the general public against XR criminals, hinder the general public in forgiving those convicted XR criminals. If the public does not accept XR criminals, once having served their punishment, society becomes stymied with an archaic criminal justice system. Thus open justice is an important tool allowing for society to have certainty that XR criminals are being successfully punished and, more importantly, rehabilitated and re-integrated into society. Freedom of expression and freedom of speech allow for this to happen in a democratic civilisation, which can only happen in a progressive society. Freedom of speech also allows for harmful speech, which often infringes on the individual users' right to privacy and the right to be left alone. Deloire, from Reporters Without Borders, states that "any movement towards state control would be seen as detrimental to a ... free press and would send out the wrong message to authoritarian governments" (Deloire, 2012). It is plausible to restrain abuse of power through the public interest defence. Nevertheless if the definition of such public interest is in the hands of state powers, and the jurisdiction itself, then society moves towards diminishing open justice systems.

In an ideal world, XR users would have a balanced discussion on political issues in the public sphere, such as the metaverse. Rather than following such an idealistic vision it might be more compelling and adequate to create a media plurality within the metaverse. That said, there are certainly also metaverse users who will never breach an ethical code, but those same users might also never risk sharing controversial views, basically conducting self-censorship. This might very well be the new tendency metaverse users see themselves following through future XR criminal court proceedings.

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SESSION III

Generative Erzählungen | Generative Storytelling

Moderation: Prof. Dr. Dorothee Haffner
(HTW Berlin)

Data Spaces // Data Worlds: Perspektivwechsel mit künstlerischer Unterstützung. Eine erste Einordnung

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KURZDARSTELLUNG: Mit der Ausstellung Data Spaces // Data Worlds möchte das Interactive Science Lab (ISL) einen Ort schaffen, der vielfältige Möglichkeiten bietet: Wissenschaftler:innen untereinander und die interessierte Öffentlichkeit können in angenehmer, anregender Atmosphäre miteinander über die aktuelle Forschung am Center for Interdisciplinary Digital Sciences (CIDS) ins Gespräch kommen. Durch die aktive Beschäftigung mit den Ausstellungsmodulen und durch das Betrachten sowie teilweise (Mit-)Gestalten der künstlerischen Darstellungen soll Interesse geweckt, Verständnis und Offenheit erzeugt, interdisziplinäre Forschung sowie die Öffnung der Wissenschaft nach außen unterstützt werden. Das ISL stellt folgende Hypothesen auf: 1. Objekte mit attraction / niedriger Einstiegsschwelle erzeugen Aufmerksamkeit und animieren zum Ausprobieren. 2. Interaktive Objekte vermitteln komplexe Sachverhalte durch eine spielerische Herangehensweise. 3. Interaktive / partizipative Objekte ermöglichen Perspektivwechsel, da Besuchende eine Vermittler:innenrolle und / oder die Perspektive eines:r Forschenden oder Gestaltenden einnehmen können. 4. Interaktive / partizipative Objekte schaffen als boundary objects Raum zum Dialogisieren.

1. DIE AUSSTELLUNG

Mit CIDS entsteht an der TU Dresden ein Zentrum für Digitale Wissenschaften. Die Forschenden befassen sich interdisziplinär mit Themen wie Digitalisierung, Hochleistungsrechnen, Daten, Modellierung und Simulation, Künstlicher Intelligenz oder Wissensextraktion sowie Visualisierung von Wissen.

Das ISL plant eine interaktive Ausstellung, die Prototypen und Demonstratoren zu aktueller Forschung aus dem CIDS in Kombination mit historischen Objekten aus den universitären Sammlungen sowie aus künstlerischer Forschung zeigen soll (Abb. 1). Ziel der Ausstellung ist es, die Besuchenden auf einer Reise in die Welt der Daten zu begleiten: An etwa 10 dialogorientierten Stationen sollen neben den grundlegenden Prinzipien von Data Science und digitaler Transformation die konkrete Forschung vor Ort sowie die historische Rechen- und Computertechnik der Sammlung der TU Dresden erfahr- und erlebbar gemacht werden. Die Besuchenden können gemeinsam und / oder allein Kontinuitäten verfolgen und Brüche aufspüren. Künstlerische Darstellungen und digitale Visualisierungen öffnen den Blick und bieten andere Perspektiven. Die Exponate für die Ausstellung werden nicht nur mit den Forschenden co-entwickelt, sondern sollen auch mit weiteren Zielgruppen in partizipativen Workshops, sogenannten Labs, entstehen.

***Abb. 1**: Blick ins Foyer des CIDS: Die Visualisierung zeigt beispielhaft die Trias aus (Forschungs-)Objekt, historischem Objekt und künstlerischer Darstellung.*

Die Basisausstellung zielt auf das intuitive Erfahren und Verstehen der Besucher:innen ab. Um dabei die vielfältigen Zielgruppen zu adressieren, sind drei Verständnisebenen geplant: Verstehen – Diskutieren – Partizipieren (Abb. 2).

Diese Verständnisebenen sollen durch die Ausstellungsobjekte selbst, durch variabel abgestufte Interfaces und durch ein Begleitprogramm erreicht werden. Führungen durch Wissenschaftler:innen und öffentlichkeitswirksame Veranstaltungen unter anderem in Zusammenarbeit mit dem COSMO Wissenschaftsforum unterstützen das Vorhaben. Im Besonderen sollen Schüler:innen die Ausstellung besuchen und für MINT-Themen begeistert werden. Das ISL plant im Sinne der Inklusion möglichst viele Stationen umfassend zugänglich zu machen und damit wiederum einen Mehrwert für alle Besuchenden zu erreichen.

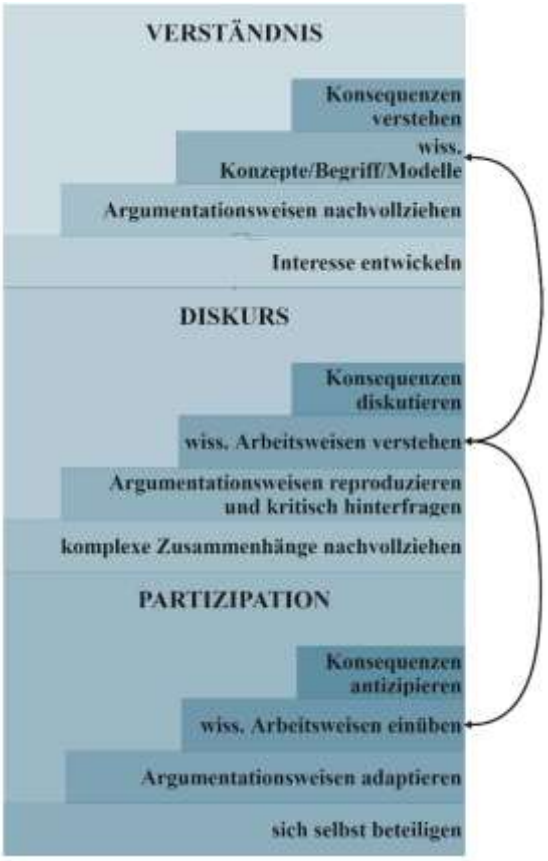

***Abb. 2:** Übersicht der Verständnisebenen*

2. VIELE PERSPEKTIVEN, VIELE ERKENNTNISE

In der Ausstellung können die Besuchenden mehrfach die Perspektive wechseln und immer wieder anders auf die Objekte schauen. Das beginnt schon mit dem Ort, an dem die Ausstellung zu sehen sein wird: Sie entsteht nicht in einem Museum oder Science Center, sondern wird integrativer Teil des Forschungsgebäudes auf dem Universitäts-Campus. Einerseits schmückt sie das Gebäude, andererseits ermöglicht die Ausstellung einen außergewöhnlichen Zugang, den direkten Blick in Themen und Methoden der Forschung des CIDS. Dieser erste Perspektivwechsel funktioniert sowohl für die Besuchenden als auch für die Forschenden anderer Fachrichtungen.

Durch die aktive Nutzung und das Erleben der vorgestellten Forschungsprojekte ändert sich die Perspektive auch inhaltlich: Der Wechsel von außen nach innen. Mit der Forscher:innen-Brille schauen die Besuchenden ins Backend und erfahren mehr über die im Hintergrund

laufenden technischen / methodischen Prozesse und Verflechtungen im Wissenschaftsbetrieb. Hier helfen MINKT-Ansätze (Vgl. engl. STEAM) zum einen konzeptionell, aber auch methodisch beim Verstehen. [1]

Der dritte Wechsel findet im Rahmen der Partizipation und der intensiven kreativen Beschäftigung mit den Themen und Objekten statt. Die Besucher:innen kommen von der Rezeption zur Produktion von Wissen und werden zu Teilnehmenden. Das soll durch das Zusammendenken der verschiedenen Erkenntnis- und Wissensformen aus Wissenschaft und Kunst erreicht werden. [2]

Das Ziel ist die Produktion von boundary objects, welche zum einen aufgrund ihrer Plastizität einen inklusiven Charakter haben aber zum anderen mit Blick auf ihre Integrität einen robusten Inhalt transportieren können und somit einen geteilten Raum für unterschiedliche Perspektiven schaffen sowie zwischen verschiedenen Gruppen übersetzen können.[3] Künstlerische Darstellungen sowie (partizipative) Workshops mit Künstler:innen helfen beim Verständnis und beim Zugang zum Thema, bauen Hürden ab und nehmen Ängste.

2.1 DIE ROLLE DER KUNST IM NATURWISSENSCHAFTLICHEN, TECHNISCHEN KONTEXT

Kunst bzw. der Perspektivwechsel durch eine alternative, kreative Herangehensweise kann für die MINT-Fächer sehr befruchtend sein. Kunst meint in diesem Zusammenhang die Geistes- und Sprachwissenschaften, Musik, Tanz, Theater, Design, Bildende Kunst und neue Medien. Die Erweiterung von MINT zu MINKT eröffnet nicht nur eine größere Methodenvielfalt, sondern erreicht zudem einen größeren Personenkreis. Es entstehen beispielsweise völlig neuartige Ansätze und Verbindungen, um Probleme zu lösen. Nicht die wissenschaftlichen Konzepte allein führen zum Ziel. Es ist vielmehr der kreative Prozess mit explorierenden, problem- sowie frageorientierten Methoden, der zum Ziel führt.

Julian Klein stellt das so dar: “Zu welchen Zeiten, in welchen Phasen kann Forschung künstlerisch sein? Zunächst in den Methoden (wie Recherche, Archiv, Erhebung, Interpretation und Deutung, Modellbildung, Experiment, Eingriff, Petition); aber genauso auch in der Motivation, der Inspiration, in der Reflexion, der Diskussion, in der Formulierung der Forschungsfragen, in Konzeption und Komposition, in der Durchführung, in der Publikation, in der Evaluation, in der Art und Weise des Diskurses […].” [4]

Julia Bee und Gerko Egert fragen: „was gilt als Wissen, was als Forschung, was als Erkenntnis, als Methode? Und was scheint überhaupt würdig genug, um für Forschung interessant zu sein? Wenn gerade das scheinbar Nebensächliche betrachtet wird oder das, was sich schwer oder gar nicht mit analytischen Blicken fassen lässt, erweitern wir die Möglichkeiten des Forschens immens: Wiederholbarkeit, Falsifizierbarkeit, Kausalität, Universalisierbarkeit – aber auch lineare Schreibweisen, logische Argumentation und Nachvollziehbarkeit sind nur die Spitze des Eisbergs, der auch andere Aggregatzustände annehmen könnte.“ [5] Das will sich das ISL zunutze machen.

2.2 MACHINE LEARNING MADE PARTICIPATORY – DAS ORIENTIERUNG-MODUL MASCHINELLES LERNEN

Das Verständnis von grundlegenden Prinzipien und Begrifflichkeiten ist gerade in Bezug auf den Themenkomplex Künstliche Intelligenz von entscheidender Bedeutung. Im Rahmen der Ausstellungsvorbereitung soll mit Schüler:innen ab Klassenstufe 9 / Gymnasium eine Workshop-Reihe durchgeführt werden, an deren Ende eine partizipativ gestaltete kreative Anleitung für die KI-Anwendung „asan.AI“ [6] des Orientation-Moduls Maschinelles Lernen stehen soll.

Es zielt ab auf “Verstehen” und entsteht vor allem in Zusammenarbeit mit einem Department des CIDS, dem Center for Scalable Data Analytics and Artificial Intelligence (ScaDS.AI). In der Ausstellung gezeigt werden sollen unter anderem zwei Anwendungen des ScaDS.AI Living Labs: „asan.AI. Machine Learning made easy“ und „Multicut“. Zu den konkreten Anwendungen aus der Forschung, die von den Besuchenden ausprobiert und genutzt werden können, kommen Infografiken, Visualisierungen und der historische Computer

D4a mitsamt interessanten Einzelteilen wie z.B. einem Handlocher.

Die verschiedenen Einzelelemente bilden zusammen mit einem raumbildenden Möbel ein sogenanntes Orientation-Modul, das Überblickswissen bietet und grundlegende Fragen, Konzepte und Begriffe zum Thema Maschinelles Lernen vorstellt. Dieser Überblick bildet die Basis für eine tiefere Auseinandersetzung mit einem Thema oder unterstützt beim Verständnis der weiteren in der Ausstellung gezeigten Themen.

Die Schüler:innen lernen im Verlauf der Workshopreihe „asan.AI“ zu verwenden. Die Anwendung ermöglicht es, mit maschinellem Lernen zu experimentieren, ohne Vorkenntnisse darüber zu haben, wie es funktioniert. „asan.AI“ kann mit eigenen Bildern oder Webcam-Daten trainiert werden. Ebenen lassen sich hinzufügen, löschen oder verändern. Im Umgang mit der Anwendung erarbeiten sich die Teilnehmenden Grundlagen des Machine Learnings und nutzen sie als Werkzeug, um eigene Probleme zu lösen.

Mit diesem selbst erworbenen Verständnis erarbeiten die Schüler:innen zusammen mit einem:r Grafiker:in / Illustrator:in eine großformatige Illustration bzw. Infografik, die die Grundlagen des Machine Learnings für das gesamte Publikum der Ausstellung verständlich erklärt.

Als weiteres Ergebnis können die im Workshop untersuchten Aufgabenstellungen an das System als Fallbeispiele bzw. Tutorials für „asan.AI“ dienen. Darüber hinaus erlernen die Teilnehmenden Sketchnotes / Graphic Recordings anzufertigen und erwerben die Fähigkeit, diese kreative Methode einzusetzen.

Neben der Darstellung komplexer Sachverhalte in einer künstlerisch gestalteten Infografik steht bei einem zweiten Workshop die Visualisierung komplexer Themen im Mittelpunkt. Die „Genetic Sandbox“ [7] ist ein weiterer Teil des Orientierung-Moduls zum Maschinellen Lernen.

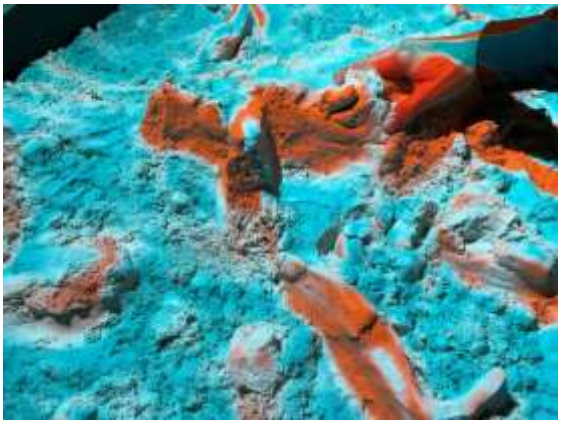

Abb. 3: *Erster Blick auf die „Genetic Sandbox“*

Auch die „Sandbox“ soll das Publikum zu dem weiter oben beschriebenen Wechsel der Perspektive sowie zum kreativen, divergenten Denken einladen. Im Rahmen eines Workshops, der es den Schüler:innen ermöglicht, mit genetischen Algorithmen zu experimentieren, soll es um die Anwendungsmöglichkeiten für das KI-System gehen, das der „Sandbox“ zugrunde liegt. Die Teilnehmenden werden in die Lage versetzt, die Anwendung mit allen Sinnen zu erfahren und die dahinter liegenden Mechanismen explorativ-kreativ zu begreifen. Es geht um das Beispiel der Wegfindung mithilfe genetischer Algorithmen. Die Teilnehmenden sollen durch die Beschäftigung mit der „Sandbox“ in die Lage versetzt werden, über Abhängigkeiten, Veränderungen von Handlungsweisen und Setzen von Zielen zu diskutieren. Der Hands-On-Ansatz ermöglicht es, ein eigenes Projekt mitzubringen oder zu entwickeln und mit dem interaktiven Projektionssystem zu experimentieren.

Mit den die Ausstellung vorbereitenden und begleitenden interdisziplinären Workshops und dem fächerverbindenden Angebot werden neben den technisch-mathematisch interessierten jungen Menschen auch jene mit eher künstlerisch-kreativem Profil angesprochen.

Die Schüler:innen stärken ihre Fähigkeiten bei der Überprüfung, Verarbeitung und Aufarbeitung von Informationen und erlernen neue Visualisierungs- und Präsentationstechniken. Zudem wird die kooperative Arbeit (in Kleingruppen) sowie die Kommunikation und der Erfahrungsaustausch untereinander im konkreten Anwendungsfall

trainiert. Bei der Beschäftigung mit „asan.AI“ erwerben oder verbessern die Teilnehmenden außerdem ihre Fähigkeiten bei Problemlösungsprozessen, bei der Modellierung von Zuständen und Abläufen oder dem Umgang mit Informationen.[8]

Zudem reflektieren die Schüler:innen ihr eigenes Verhalten und diskutieren die gesellschaftlichen Aspekte der Informatik. Bei der Ausgestaltung der Infografik kommen die Gestaltungsdimensionen, in denen Kunst in Erscheinung tritt (Fläche, Körper/Raum und Prozess) zum Einsatz. Durch den Werkstattcharakter der Workshops werden alle Sinne der Jugendlichen angesprochen und sie lernen Kunst als Problemlösungsprozess kennen.[9]

Sie setzen digitale und analoge Werkzeuge kreativ und phantasievoll ein. Alle Teilnehmenden können von den ganz unterschiedlichen Ansätzen profitieren und durch das Einnehmen der jeweils anderen Perspektive zu neuen Erkenntnissen kommen. Mit der Anfertigung der Infografik lösen sie das Problem gemeinsam mit sämtlichen zur Verfügung stehenden Mitteln und Werkzeugen.

2.3 EVALUATION – IMPACT DER AUSSTELLUNG

Die Ergebnisse aus der Zusammenarbeit des ISL mit den Wissenschaftler:innen zur Produktion der Prototypen / Demonstratoren und mit den Schüler:innen (gemeinsam mit den Wissenschaftler:innen) bspw. zur Produktion der Infografik sollen in einem kontinuierlichen Prozess evaluiert werden. Das ISL stützt sich dabei auf die Forschung zu Learning Experiences in der Wissenschaftskommunikation.[10] Auf Basis dessen entstehen standardisierte Umfragen, die für einzelne Objekten oder ganze Module angewandt werden. Deren Analyse wiederum mündet umgehend in die Überarbeitung der Objekte in einem permanent beta Prozess. Die Ausstellung macht sich somit die Arbeitsweisen der Wissenschaft zu eigen und sieht sich in einem ständigen Prozess des Wandels und der Verbesserung der eigenen Ausstellungselemente – sowohl auf inhaltlicher als auch auf methodisch-didaktischer Weise. Im Fokus stehen dabei sowohl Aspekte, die Aufmerksamkeit aufgrund von inhaltlichen oder gestalterischen Elementen erzeugen, als auch Punkte, die vor allem die Auseinandersetzung mit dem Objekt im Detail bedeuten, hier sowohl auf Basis der Kognition als auch der Interaktion. Als Ziel soll hervorgehen, welchen Einfluss das Objekt als wissenskommunikatives Element auf die Besucher:innen in Bezug auf auf Wissen, Einstellung und schlussendlich dem eigenen Verhalten hat.

3. ZUSAMMENFASSUNG

Die Besuchenden erfahren in den Workshops und bei der Benutzung der verschiedenen Anwendungen, auf welche unterschiedlichen Arten Wissen produziert werden kann. Das Orientierung-Modul wird damit zum Artefakt, um Dinge auszuprobieren und zu evaluieren sowie die Ausstellungsentwicklung in Teilen partizipativ zu gestalten. Bei der Arbeit mit den Besuchenden / Teilnehmenden kann überprüft werden, wie interaktive Ausstellungsobjekte zum Diskurs bzw. zur Partizipation anregen.

Beide Elemente Infografik und „Sandbox“ liefern nicht nur einen niedrigschwelligen Zugang zum Ausstellungsmodul, sondern gestalten gleichzeitig den Raum. Im Sinne des MINKT-Ansatzes arbeiten Gruppen von Lernenden / Besuchenden zusammen, um ein visuell ansprechendes Produkt oder Objekt zu schaffen, das auf dem Verständnis eines MINT-Konzepts basiert, wie in diesem Beispiel das Maschinelle Lernen.

Mithilfe der Kunst bzw. der künstlerischen Forschung entsteht ein neues Beziehungsgefüge zwischen Wissenschaft und Öffentlichkeit.[11] Sie unterstützen Besuchende und Forschende beim Verständnis anderer Positionen und bei der Einnahme neuer Blickwinkel, indem sie die Grenzen der Disziplinen verschieben.[12] Dadurch werden die gesellschaftlichen Auswirkungen von Wissenschaft, Forschung und Technologie für beide Seiten fassbarer und nachvollziehbarer.

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A symbolic homecoming. 3D digital imaging of Greek vases from the MHNC-UP

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ABSTRACT: One of the most interesting Portuguese-German diplomatic relations is associated with the imprisonment of a ship in Lisbon during World War I. Bringing this centenary story, which took place between 1914 and 1927, back to light seemed appropriate due to its strong symbolic charge: some of the pieces contemplated in the events we will soon be remembering are symbolically returning home. The subject is not new, however, as it has already been the subject of a number of publications, including by one of the proponents of this study. But the approach presented here is naturally different, as it falls within one of the themes under discussion at this meeting, 3D digital analysis methods and techniques. This approach has already been considered several times by another of the proponents of this study, one of which included four Greek vases from different productions and periods from the Museum of Natural History and Science of the University of Porto (MHNC-UP) that we will be discussing.

1. INTRODUCTION

One of the most interesting Portuguese-German diplomatic relations is associated with the imprisonment of a ship in Lisbon during World War I. Bringing this centenary story, which took place between 1914 and 1927, back to light seemed appropriate due to its strong symbolic charge: some of the pieces contemplated in the events we will soon be remembering are symbolically returning home. The subject is not new, however, as it has already been the subject of a number of publications [1][2][3], including by one of the proponents of this study [4][5][6][7]. But the approach presented here is naturally different, as it falls within one of the themes under discussion at this meeting, 3D digital imaging and analysis methods and techniques. This approach has already been considered several times by another of the proponents of this study [8][9][10], one of which [11] included four Greek vases from different productions and periods from the Museum of Natural History and Science of the University of Porto (Museu de História Natural e da Ciência da Universidade do Porto – MHNC-UP) that we will be discussing.

Hence, the main objective of this article is to highlight how 3D imaging and computational methods in archaeological and conservation studies can contribute to a better comprehension

of ancient pottery. Furthermore, we aim to understand production and filling standards, the potter's skills, and trading issues, as well as to demonstrate if a vessel has the ability to perform certain functions, as exemplified next.

1.1 A FATE OF HISTORY

Let's briefly return to a fascinating story that frames the presence of the pieces under study. It was the result of the historical upheavals at the beginning of the past, which led to Portugal's participation in World War I, due to economic problems and pressure from England. In this context, on 24 February 1916, Portugal seized all the German and Austrian merchant ships that had sought refuge at the beginning of the conflict, and on 9 March formally entered the conflict. Among the six or seven dozen vessels seized was a 3245 tonne steamer registered in Hamburg and owned by Hapag, the Cheruskia. This was no ordinary seizure. This vessel was transporting valuable cargo to the Berlin museums: 412 boxes containing materials from the excavations in Assur by the well-known German archaeologist Walter Andrae (1875-1956). By decision of the Commercial Court, these goods were put on the list of prisoners of war and deposited at the Lisbon Customs House until the end of the conflict. From that date onwards and after José Leite de Vasconcelos refused to house the collection in the Portuguese Ethnological Museum (now the National Archaeological Museum), due to an alleged lack of space, Augusto Pereira Nobre, rector of the University of Porto between 1919 and 1926, and who had been appointed Minister of Instruction in 1920, had the collection transferred to the University. The importance of the collection did not go unnoticed and it was offered for study to renowned French Assyriologists François Thureau-Dangin and George Conteneau. According to Andrae, in his memoirs, this study yielded no results because the 412 or so boxes containing the materials were not accompanied by inventory lists [12].

The diplomatic adventures and misadventures that involved tough negotiations with advances and setbacks to get the material back are well known. In his memoirs, Andrae recalls an episode that particularly moved him: in a private conversation he had with the Kaiser, informing him of the retention of the Assur finds in Portugal, the latter, unrealistically and without any sense of reality at the time, angrily replied that he would send a warship to Porto and bomb the city!

In 1925, in the context of Andrae's second stay in Portugal, accompanied by the German minister plenipotentiary in Lisbon, E. A. Voretzsch, an agreement was reached for the return of Assur's possessions in exchange for other objects selected and offered by the Berlin museums (Staatliche Museen Preußischer Kulturbesitz). This second stay would bring back good memories and some pleasant experiences, in particular a friendly relationship with the Berlin family living in Portugal, Michaëlis de Vasconcellos [12]. In June 1926, eight years after the war, the objects were finally returned, and the following month the crates arrived by sea and river in Berlin, having been unloaded at Kupfergraben, directly in the south wing of the new building, where the excavation diaries were kept [12]. Soon, in January 1927, a selection of objects from the Berlin museums with archaeological and ethnographic collections from Europe, Africa, South America, Central America and Oceania arrived in Portugal.

It is in this context that the MHNC-UP has a small archaeological collection of Greek vases, distinguished, however, by the great variety of productions and decorative styles, namely Mycenaean, Beotian, Corinthian, Attic Black and Red Figure Attic, Lucanian, Apulian and the so-called gnathia technique. In a letter to Carlos J. Michaëlis de Vasconcellos, dated 21 October 1925, he expressly mentioned his concern for careful selection for teaching purposes.

2. MATERIALS AND METHODS

From this small group of twelve specimens from the MHNC-UP, we will focus on four Greek fine-wear vessels that were the object of 3D imaging and analysis, dating from 6th to 4th c. BCE and representing different productions (unknown archaeological site provenance) (Table 1): a Corinthian globular *aryballos* (MHNC-UP-020052), an Attic black-figure shoulder *lekythos*, Group of Vatican G 52 (MHNC-UP-020053), an Apulian red-figure *lekanis*, Circle of the Patera Painter and the Baltimore Painter (MHNC-UP-020058, lid and vessel; probable production area: Taranto / Daunia) and a Gnathian cup-*skyphos*, (Morel, Shape F-4242) Laurel Spray Group (MHNC-UP-020060).

Inv.ID	MHNC-UP-020052		MHNC-UP-020053	MHNC-UP-020058 (vessel)	(lid)	MHNC-UP-020060
Shape/style	Corinthian globular *aryballos*		Attic black-figure shoulder *lekythos*, Group of Vatican G 52	Apulian red-figure *lekanis*, Circle of the Patera Painter and the Baltimore Painter		Gnathian cup-*skyphos*, (Morel, Shape F-4242) Laurel Spray Group
Period (BCE)	c. 575-550		c. 550-500	c. 330-320		c. 330-300
Provenance (before 1925)	Berlin State Museums			Berlin State Museums		Berlin State Museums
References	[4][11][20][24]		[4][11][21][24] [25]	[4][11][22][24]		[4][11] [23][24]
3D system	SL	CT	SL	SL	SL	SL
Scans/slices	23	560	35	41	44	24
KB	3,661	10,999	8,038	47,927	28,121	23,692
Vertices	91,426 [a]	295,215	200,766 [a]	1,196,641	702,267	591,146
Faces	182,78 [a]	590,430	401,456 [a]	2,393,286	1,404,530	1,182,296
Weight (g)	82.3		130	587.4	502.65	148.7
Width (mm)	61.7		66.85	293.5 209.2 [b]	209.78	156.2 96.5 [b]
Height (mm)	67.1		141.29	104.8 98.5 [b]	100.1	68.5 61 [b]
Length (mm)	61.4		66.32	207.4	211.4	95.8
Mesh volume (mm^3)	45,279.3 [c]		- [d]	330,490.9	292,038.4	82,812.1
Density (g/cm^3)	1.8 [c]		- [d]	1.8	1.7	1.8
Max. filling height (mm)	62.8		140.5	88.6	94.3	58.4
Max. filling vol. (cm^3)	64.4 [c]		- [d]	1,006.2	754.3	211.9
Centre mass [xyz] (mm)	-1.5 [c] 29.2 [c] 0.3 [c]		- [d] - [d] - [d]	1.9 55.9 2.7	1 57.3 -0.3	-1.1 30.9 0.3

Table 1: *Short description and main measurements of the 3D models of the vessels. (a) mesh is not watertight, (b) excluding handles, (c) from CT-derived 3D model, (d) not computed because the mesh is not watertight. Values are rounded to one decimal place.*

2.1 3D IMAGING

Different imaging methods, techniques, and resolutions may reveal, distort, or conceal specific features of the object. This issue is of great importance when analysing, namely, forming and painting techniques, or even natural, animal, and anthropic surface alterations that have occurred over the centuries.

The four vessels were digitised at MHNC-UP, with a portable structured white light scanner (SL), Breukmann smartSCAN3D-HE: with two colour cameras, 250 mm stereo field of view (FOV), 129 µm lateral resolution, 1024 mm operating distance, 211 x 159 mm^2 maximum FOV, and 120 mm depth of measuring volume. The system has values according to standard procedures for estimation of accuracy [13]. Within this study, these settings represent an optimal compromise between time available, required level of detail, and computational resources. The Corinthian globular *aryballos* was also digitised with a helical computed tomography (CT) scanner, at the Veterinary Hospital of Porto, specifically to assess its inner structure and morphology and to visualise significant technological and functional features.

2.2 ANALYSIS FROM 3D DATA

A brief morphological description and analysis of the vessels is presented, making the most of a small set of analytical tools to (i) compute and

characterise global and local features of each 3D digital model (e.g. topological and basic linear and volume measurements, centre of mass, contact surface of the base, capacity, and wall thickness; curvature analysis is also used to differentiate surface texture regions by detecting and characterising subtle technological, functional, and conservation marks); (ii) generate automatically scientific illustrations. For further technical and methodological details see [11]. As earlier mentioned, these parameters can provide clues about the production, transportation, trade, and use of the vessels.

2.3 DIGITAL DATA LIFECYCLE

Following the research data management plan, several relevant attributes were documented in detail during the entire data lifecyle and added as descriptive, administrative, and structural metadata to every collection and vessel, while the standard operating procedure was added as technical metadata to each vessel. Linked Open Data (LOD) [14] and FAIR data principles [15] were applied whenever possible [16]. In the spirit of Open Science [17][18], selected data generated during this study was deposited in Zenodo [19], an online repository, with unique and persistent identifiers assigned to the digital resources and under a CC usage license [20][21][22][23].

3. RESULTS AND DISCUSSION

Table 1 shows a few basic descriptions and main measurements of the SL- and CT-derived 3D models of the vessels. Within this study, mesh holes were filled in order to generate watertight meshes and enable to compute the volumes and capacities of the vessels – except for MHNC-UP-020053, whose interior could not be completely digitised by the SL scanner due to occlusion. The material density was calculated by the ratio of its mass per unit volume; an offset plane parallel to the base plane of the vessel was used to calculate the filling height, inner volume, and maximum filling volume without dropping; the centre of the coordinate system was set at the centre of the 3D model's base.

Figure 1 displays the isometric and orthographic views of the SL-derived 3D digital surface models of the vessels. The image texture/colour of the vessel's painted decoration is not displayed in order to make the geometric features highly readable. Whereas Figure 2 shows automatic illustrations from the same 3D digital models – except for the profile of MHNC-UP-020052, which was generated from the CT-derived model. The first reflective symmetry is orthogonal to the most distinctive geometric feature, such as handles. The contact surface between the bases of the vessels and a horizontal plane is indicated in Figure 3, which enables to assert the consistency with the overall shape of each vessel while helping to maintain its stability when standing up. Both MHNC-UP-020052 and MHNC-UP-020053 are stable when standing up, but a closer examination revealed that the lid from the Apulian red-figure *lekanis* when used as a container and the Gnathian cup-*skyphos* are not entirely stable, as some areas of the base are not in contact with the horizontal plane.

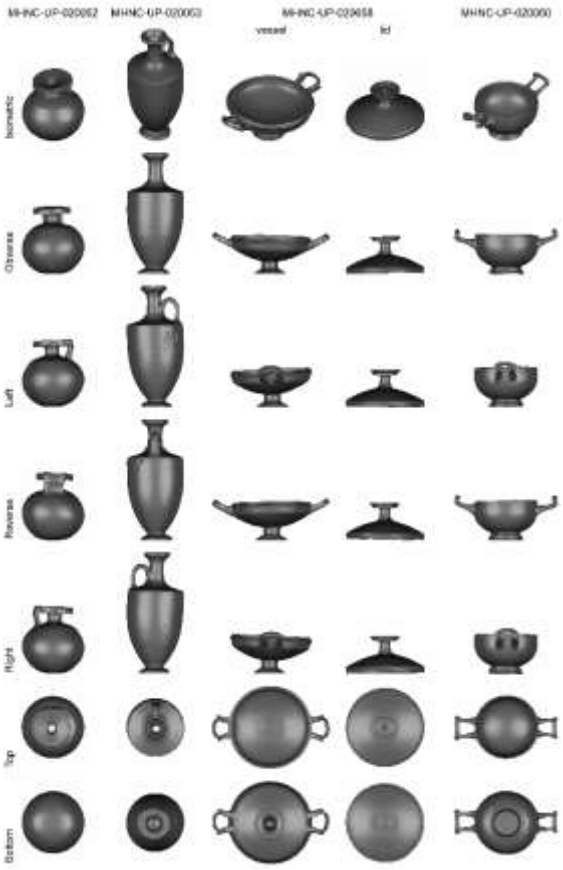

Figure 1: *Isometric and orthographic views of the SL-derived 3D digital surface models of MHNC-UP-020052, MHNC-UP-020053, MHNC-UP-020058, and MHNC-UP-020060. Note that the vessels do not share the same scale in this figure.*

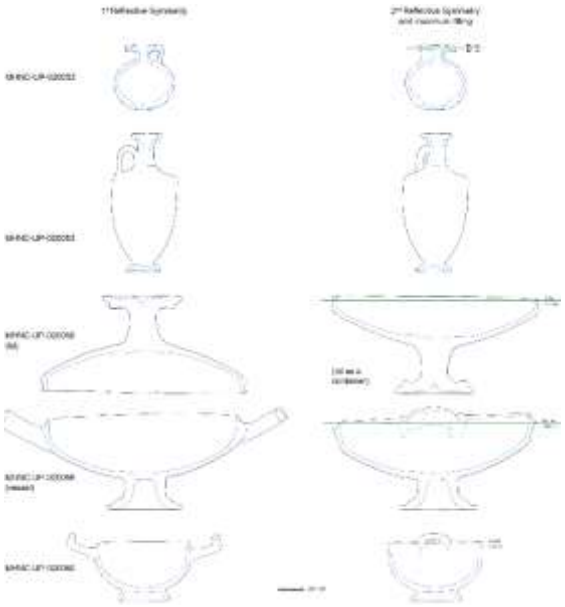

Figure 2: *Automatic illustrations of the 3D digital models of the vessels. All profiles were generated from SL scan, except for MHNC-UP-020052, which was generated from CT scan. The 1st reflective symmetry is orthogonal to the most distinctive geometric feature, such as handles. Silhouette (black line), inner cross-section (blue line), and maximum filling height/volume (horizontal green line). Every vessel shares the same scale.*

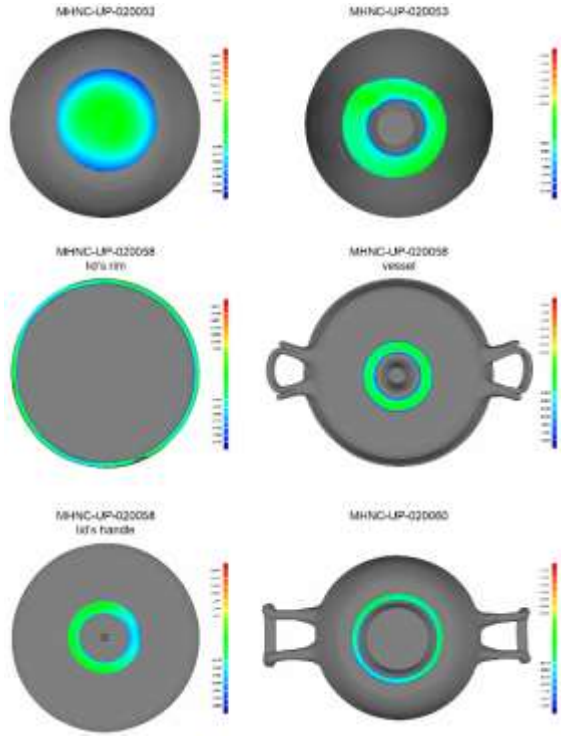

Figure 3: *Colour map showing the contact surface between the bases of the vessels and a horizontal plane (bottom views): a) MHNC-UP-020052; b) MHNC-UP-020053; c) MHNC-UP-020058, vessel; d) MHNC-UP-020058, lid's rim; e) MHNC-UP-020058, lid's flat knob handle (i.e., lid working as a container); f) MHNC-UP-020060. Contact (green), far (light blue), and farthest (dark blue) surface areas. The horizontal plane is set as invisible for higher readability of the colour map.*

3.1 CORINTHIAN GLOBULAR *ARYBALLOS* (MHNC-UP-020052)

The *aryballoi* were typically produced to contain perfume or oil, for athletes at the baths. The MHNC-UP-020052 has a globular wall decorated with three warriors (or hoplites) to right, with spears, helmets, and round shields (Fig. 4). Tongues on the upper part near the handle; dotted line on the rim. Short handle runs from the rim to the shoulder, externally decorated with a zigzag motif.

Figure 4: *Corinthian globular aryballos (MHNC-UP-020052).*

The CT imaging of this vessel makes visible significant technological and functional features, besides revealing hidden details – the most significant of which is shown in Figure 5. Wheel-throwing was confirmed as the primary forming technique by: (a-d) the spiral pattern of ridges and grooves up and around the walls, formed as the potter's fingers pulled the clay on the wheel; (a, e-f) the oblique orientation of elongated inclusions and voids in the clay paste/matrix (characteristic of pulling the clay on a fast wheel), and the orientation of inclusions and voids parallel to the walls. The cavity (c) almost reaches the outer surface of the vessel, making this area particularly fragile, which is a concern for conservators. The protuberance at the centre of the inner surface of the vessel's base was rather unexpected, giving rise to some hypotheses, e.g., to serve as a structural function by strengthening the thin base of the vessel or by making the *aryballos* more stable; help consolidate sediment deposits at the bottom of the container in order to prevent sediment mixing into the perfume/oil when poured; make the container easier to clean prior, by facilitating the removal of sediments; decrease its capacity (with possible trade implications). Or was it simply formed as the potter's fingers pulled the clay on the wheel, "with the two elongated hollows representing

the impressions of fingers", thus suggesting a "hasty and/or inexpert execution" [26]?

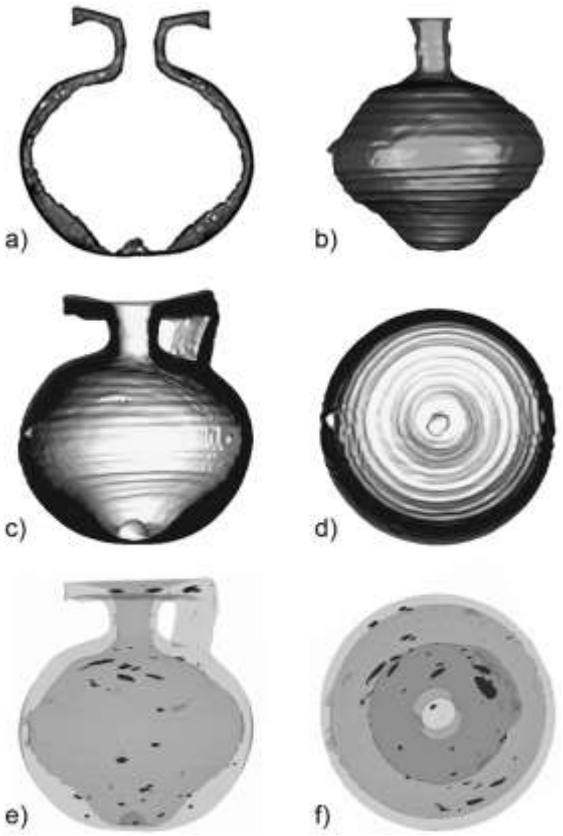

Figure 5: *CT scan of MHNC-UP-020052. a) Frontal tomographic negative image from the original vessel; b) filling volume; c, d) lateral and horizontal sections from the generated 3D digital model; e, f) lateral and top views (with transparency) from the generated 3D digital model, exhibiting voids in dark grey. External and internal structures and features: examples of spiral ridges and grooves, voids, cavity, protuberance.*

3.2 ATTIC BLACK-FIGURE SHOULDER LEKYTHOS, GROUP OF VATICAN G 52 (MHNC-UP-020053)

Shoulder *lekythoi* were usually designed to hold oil or perfume. The MHNC-UP-020053 has a curved wall with a naked young man running to the left, flanked by two young men standing, dressed in a himation; the one on the right holds a spear (Fig. 6). A piece of clothing hangs on the wall next to the young man on the left. On the shoulder, a three-leaved plant element, flanked by four ornamental dots; an ivy leaf on each side. Added red on the hair, on the pieces of clothing hanging from the hands of the young men, on the lower part of the scene and on the neck. The rim, the handle, the lower part of the wall and the base of the vase are in black. Small semi-circular handle that runs from the neck to the shoulder.

Figure 6: *Attic black-figure shoulder lekythos, Group of Vatican G 52 (MHNC-UP-020053).*

3.3 APULIAN RED-FIGURE *LEKANIS*, CIRCLE OF THE PATERA PAINTER AND THE BALTIMORE PAINTER (MHNC-UP-020058)

Originally, a *lekanis* could have had a wide variety of utilitarian and symbolic functions, such as being a container for cosmetics or small items of adornment, or being offered as a dowry or grave goods. It consists of two parts: a low vessel with two handles (arranged horizontally and upright that run from the lower part of the vessel) and one foot, and a lid with a flat knob handle. Both parts of this Apulian red-figure *lekanis* have survived. The MHNC-UP-020058 has two handles, a stem and a foot, and its lid has a stem and a flat knob handle (Fig. 7). This *lekanis* has a curved wall, with the lid decorated on one of its sides with an effeminate winged Eros sitting naked on a rock with outstretched legs, holding a phiale with fruits in his right hand. On the other side, a female figure sitting on rocks with a sakkos, dressed in a peplos and a himation that rests on her left shoulder and holding a phiale with fruits in her right hand. Flanking both scenes, palmettes motifs and beneath the handles laurel leaves and rays; wave motifs on the rim and radial motifs on the lid handle. Added white on the fruit and on the rock.

When turned over, the lid can also act as a container, i.e. a secondary function. As expected, the maximum volume of the vessel is larger than that of the lid (Table 1). Interestingly, the vessel and the lid have different densities, which may suggest that different types of clays were used, or were prepared in a different manner, or that the material is non-homogeneous (e.g. natural or

intentional admixture of distinct types, amount, volume, and distribution of mineral/organic matrix, or inclusions, to improve the structure of the fabric), or it may just indicate the presence of voids – further archaeometric techniques would be needed to characterise their fabric and perhaps infer their provenance. The wall thickness of the vessel and the lid increases consistently from top to bottom (Fig. 8), demonstrating the potter's skills on the wheel (i.e. wheel-throwing as the primary forming technique). Curvature analysis was set to ±0.4 and revealed that the finishing texture (fine-grained fabric) of the inner surface of the vessel is different to that of the lid. The inner surface, more likely exposed to people's gaze, displays a smoother surface and the lid shows a light rough pattern (Fig. 9). This parameter is relevant as it may help to confirm the primary intentional uses of each part of this specific vessel.

Figure 7: *Apulian red-figure lekanis, Circle of the Patera Painter and the Baltimore Painter (MHNC-UP-020058).*

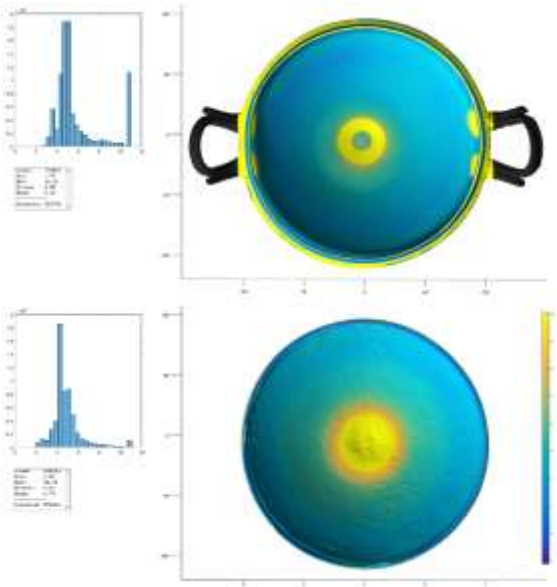

Figure 8: *MHNC-UP-020058: top view of the vessel (top) and bottom view of the lid (bottom). Colour map showing a detail of the variability of the wall thickness of the body – from blue (thin) to yellow (thick), corresponding to low to high values of the thickness; grey tone indicates unselected areas. Automatic quantitative and qualitative data of the wall thickness: the joining of the handles and stem to the body of the vessel and the lid are indicated in yellow.*

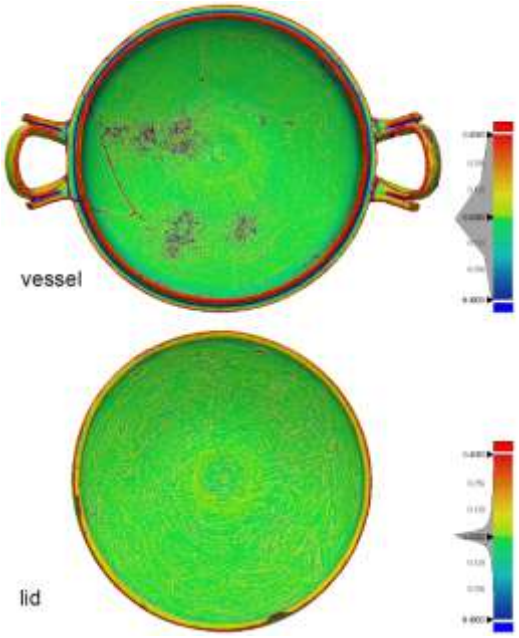

Figure 9: *MHNC-UP-020058: top view of the vessel (top) and bottom view of the lid (bottom). Curvature analysis of the inner surfaces: lines revealing previously fragmented areas; rough pattern suggesting anthropic use-wear (possibly worn), although one should not discard natural wear. The colour map is from red (convex) to blue (concave), corresponding to high to low values of the curvedness, whereas green colour indicates planar patches.*

3.4 GNATHIAN CUP-*SKYPHOS*, (MOREL, SHAPE F-4242) LAUREL SPRAY GROUP (MHNC-UP-020060)

Typically, Gnathian cups were small drinking cups. The MHNC-UP-020060 consists of a small hemispherical vessel with two handles and a foot (Fig. 10). It has a curved wall decorated with two bands outlined by two concentric lines beneath the rim. The first line is decorated with an egg pattern and the second one with red bands flanked by two yellow ones. The body is decorated with grape bunches between three vertical ivy branches, all in added white. On the other side, double line, above and below, with ivy leaves. There is a reserved space between the cup and the foot. Upright handles that run from the mid-wall.

Figure 10: *Gnathian cup-skyphos, (Morel, Shape F-4242) Laurel Spray Group (MHNC-UP-020060).*

Once again, the wall thickness of the body increases consistently from top to bottom (Fig. 11), revealing the potter's skills on the wheel. It is also possible to detect underdrawing traces from the use of a pointed tool, such as a cane or a stiletto.

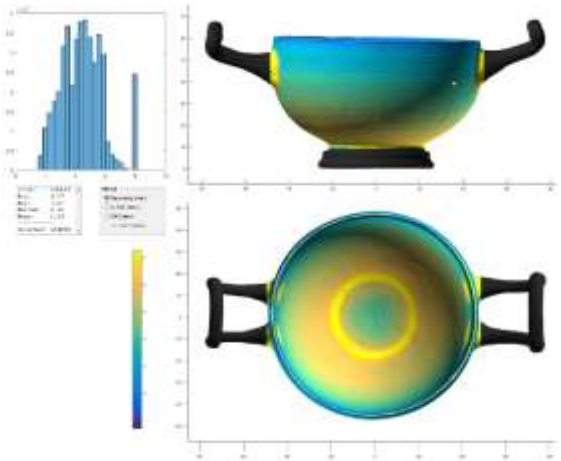

Figure 11: *MHNC-UP-020060: front (top) and top (bottom) views. Colour map showing the variability of the thickness of the body of the vessel – from blue (thin) to yellow (thick), corresponding to low to high values of the thickness; grey tone indicates unselected areas. Some underdrawing traces are visible; the joining of the handles and foot to the body of the vessel is indicated in yellow.*

4. CONCLUSION

This article has briefly highlighted that using 3D imaging and computational methods in archaeological and conservation studies can contribute to a better comprehension of ancient pottery. Moreover, the non-contact and non-destructive nature of the approach, from structured light and computed tomography scans to digital data analysis, renders it of particular value in cultural heritage best practice. Although the SL-derived 3D digital surface models were not produced to the highest possible quality of the system, the accuracy, resolution, and precision of the measurements were high enough to fulfil the aims of this work. The CT imaging of one of the vessels enabled the documentation of its inner structure and morphology, and the visualisation of significant technological and functional features, as well as revealing hidden details. A preliminary characterisation and analysis of four vessels was presented, making the most of a small set of analytical tools. Different methods and techniques have been used to compute and analyse distinct and representative features of 3D digital models of archaeological objects as well as to generate scientific illustrations. Three-dimensional data produced stimulating results as they enabled the extraction of meaningful morphological, technological and functional information from distinct archaeological artefacts. Although the results presented are preliminary, they contribute to the current body of knowledge in pottery studies. Another thing that makes ancient pottery special is that vessel shapes show great typological and morphological variety over time and space. However, we are well aware that quantifying and interpreting chronological or geographical (dis)continuities of such features would undoubtedly require a much larger dataset.

In short, digital imaging and computational methods and techniques enabled to document, measure, analyse and visualise features beyond the limits of conventional tools. Even though a 3D digital model does not provide a complete representation of the object, it should be understood as a powerful tool, potentially with valid data, for cultural heritage research and conservation that complements other analytical techniques and fields of knowledge [8][27].

5. ACKNOWLEDGMENTS

We would like to acknowledge the Natural History and Science Museum of the University of Porto, for granting access to the vessels for 3D and CT scanning. Special thanks extended to Morph - Geomática e Geociências, Lda., for providing the 3D structured light scanner, and to the Hospital Veterinário do Porto, for carrying out the CT scanning.

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Reviving the past: Visualising cultural heritage in dynamic user interfaces

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ABSTRACT: In today's digital age, the preservation and comprehensive documentation of cultural heritage are imperative for safeguarding our shared identity and historical legacy. This paper illuminates the journey from data acquisition to the effective utilisation and re-use of cultural artefacts within the Mnemosyne project at the Cyprus University of Technology. Centred on the seamless integration of humanities with cutting-edge digital technologies, it places a particular emphasis on the meticulous process of gathering and processing data from various cultural assets. Within this context, the paper delves into three interdisciplinary case studies: a Holy Bread Prosphora Seal, a collection of coins featuring Hercules Melqart, and a Temple-boy limestone statuette. These case studies creatively harness historical contexts and insights, artfully presented within dynamic user interfaces, thereby showcasing the transformative potential of cultural heritage artefacts in the digital realm. By ensuring the preservation and accessibility of our heritage to contemporary audiences, this paper underscores the profound synergy between humanities and advanced technologies, assuring the enduring presence of cultural heritage in the digital landscape and transcending temporal boundaries.

1. INTRODUCTION

In an era characterised by profound digital advancements, the preservation and comprehensive documentation of cultural heritage have assumed a paramount role in safeguarding the collective identity and historical legacy of humanity. This paper emerges as a product of the Horizon 2020 ERA Chair in Digital Cultural Heritage: Mnemosyne project, conducted under the auspices of the Cyprus University of Technology (CUT). Spanning from January 2019 to December 2023, this project, funded through the 'Establishing ERA Chairs' programme, stands as a testament to CUT's commitment to elevating its research and innovation capacities to enduring excellence.

The project strategically revolves around a meticulous research agenda encompassing six critical thematic dimensions: Data acquisition, Data processing, Semantic data modelling, Knowledge management, Data long-term preservation, and Data use and reuse **(Figure 1:** *Collaboration among groups in the Mnemosyne project***)**

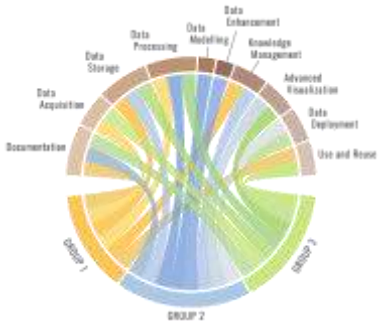


Figure 1: *Collaboration among groups in the Mnemosyne project.*

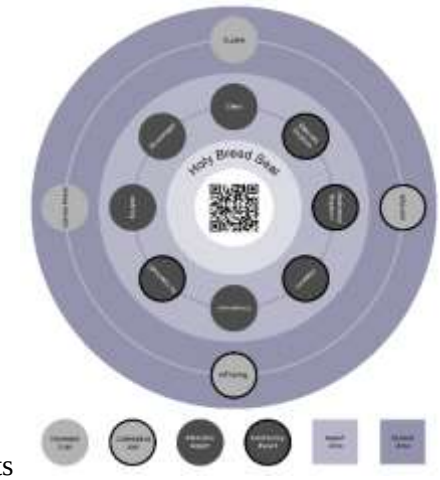
Seventeen case studies were meticulously chosen for their intricate and distinctive characteristics. The selection process involved a comprehensive evaluation, considering various parameters. Factors such as the nature of the materials, whether the artefacts were tangible or intangible, and their mobility or immobility were among the key considerations. These elements played a significant role in shaping the approach to digitisation and documentation for each case study and adhering rigorously to criteria mandated by the European Union, UNESCO, Europa-Nostra, and ICOM. Additionally, the paper unveils innovative research methodologies that have been meticulously developed by the Mnemosyne research team. These methodologies encompass the formulation of an integrated digi for tangible Cultural Heritage assets, a user classification system, and the creation of Data Acquisition and Digitisation pipelines.

This paper's primary focus extends to the examination of three specific case studies: a Holy Bread Prosphora Seal, a collection of coins featuring Hercules Melqart, and a Temple-boy limestone statuette. Collaboratively presented with colleagues specialising in data acquisition and use-reuse, these case studies illuminate not only the historical context but also the profound implications of these cultural artefacts within dynamic user interfaces, with a significant emphasis on the concept of use and reuse. This interdisciplinary exploration represents a pivotal contribution to the discourse on preserving cultural heritage in the digital era. This paper embarks on an exploration of the intricacies surrounding data acquisition, utilisation, and the iterative process of reusing data. In doing so, it orchestrates a seamless fusion of the traditionally distinct domains of humanities and digital technologies. This interdisciplinary collaboration is instrumental in deciphering and amplifying the value of cultural heritage artefacts within the dynamic digital landscape.

Within this paradigm, data acquisition serves as the foundational pillar upon which the entire endeavour rests. The meticulous and technologically advanced processes of collecting data from a diverse range of cultural artefacts are essential for the comprehensive documentation and preservation of our shared heritage. The richness and authenticity of this data underpin its utility in diverse applications.

Concurrently, the paper navigates the terrain of data use and reuse, unveiling the transformative potential of these artefacts within dynamic user interfaces. Through this exploration, it elucidates how historical context, insights, and perspectives can be harnessed and reinvigorated in novel ways. This iterative process of extracting value from cultural artefacts in the digital realm showcases their enduring relevance and adaptability.

The integration of humanities and digital technologies is the linchpin of this scholarly pursuit. It bridges the chasm between the humanistic understanding of culture and the technological prowess required for its digital documentation and dissemination. This holistic approach ensures that the complexities and nuances of cultural heritage are not only preserved but also made accessible and meaningful to an ever-evolving multidisciplinary community of experts ***Figure*** **2)**.



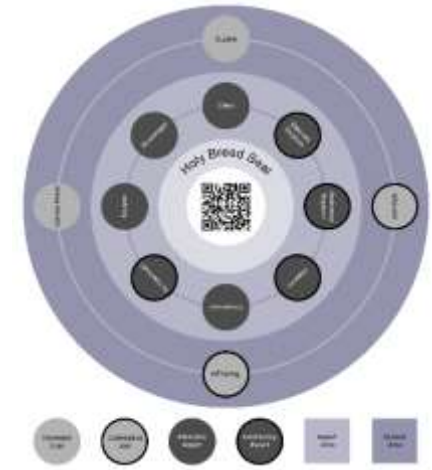


Figure 2: *The multidisciplinary community of experts and users involved in the documentation and*

knowledge of a movable object (Holy Bread Prosphora Seal).

This paper serves as an empirical testament to the profound transformative potential engendered by the symbiotic relationship between humanities and advanced technologies. Within this dynamic partnership, we undertake the intricate task of unravelling the multifaceted complexities enshrouding cultural heritage. Through rigorous empirical examination, we illustrate how these venerable artefacts can be adroitly harnessed and elucidated within the digital terrain. Our findings resoundingly affirm their profound capacity to actively engage and resonate with contemporary audiences.

In its essence, this scholarly work encapsulates the quintessence of its title, deftly resuscitating historical narratives. It serves as a seminal conduit for the manifestation of our cherished cultural heritage within the dynamic user interfaces of both the present and the unfolding vistas of the future.

2. CASE STUDIES

2.1 Holy Bread Prosphora Seal

The Holy Bread Prosphora Seal (**Figure 3**), dating back to the 6th century AD, constitutes a distinctive and enigmatic artefact of considerable historical and cultural significance [1]. This circular seal, measuring approximately 10 cm in diameter and meticulously crafted from limestone, bears a central cross motif, of the four arms - three exhibit scissor tips while the fourth remains straight. Although its exact provenance remains elusive, the artefact has found a prominent place within the esteemed collection of the Bank of Cyprus Cultural Foundation. The scholarly discourse surrounding the Seal revolves around its potential liturgical role within the Early Christian period. It is speculated to have been employed in the process of sealing either bread or lead objects, which were consecrated as blessings or memorial offerings during pilgrimages to revered sites [2]. The seal's circular inscription, written in a fusion of Greek and Latin characters, reads “Blessings of Konstantinos, Paulus, Dommitius”, yet the precise liturgical function of this inscription continues to elicit scholarly debate [1].

Figure 3: *Holy Bread Prosphora Seal.*

The Seal's uniqueness, coupled with its intimate connection to Christian worship practices, elevates its stature as an invaluable artefact shedding light on Early Christian religious rites [3]. Moreover, the application of cutting-edge digital technology in the creation of a high-fidelity 3D replica of the seal represents a pioneering approach to heritage preservation [4]. This digital twin not only facilitates the preservation of the artefact but also enables its novel use as a meaningful gift—a commendable endeavour aligning with contemporary trends in digital heritage [5]. The artefact, in its tangible and digital forms, underscores its enduring relevance and resonance within the dynamic landscape of cultural heritage. Ongoing research endeavours are dedicated to unravelling the multifaceted aspects surrounding the Holy Bread Prosphora Seal, thus promising deeper insights into its historical role, symbolic significance, and implications within the broader framework of Christian liturgical practices and the preservation of cultural heritage [6] [7]. This interdisciplinary exploration stands as a testament to the enduring dialogue between historical artefacts and digital technology, offering profound contributions to the scholarly discourse on cultural heritage preservation.

The preservation and digitisation of cultural artefacts, as exemplified by the Holy Bread Prosphora Seal, are dynamic processes that bridge the gap between history and modern technology. This section delves into the meticulous process of employing advanced digital tools and techniques to bring this artefact to life in a novel and immersive way. The journey begins with data acquisition and processing, where historical records and detailed imagery, including high-resolution photographs and 3D scans, were collected. Photogrammetry, a technique used to

reconstruct three-dimensional objects from photographs, played a pivotal role in capturing the intricacies of the Seal. These foundational steps ensured that the digital twin of the seal faithfully represented its physical counterpart. The next phase involved leveraging cutting-edge technology to create an interactive and immersive experience. The Mixed Reality Toolkit (MRTK 2) emerged as a vital asset, enabling the development of applications for extended reality [8]. A Unity-based application was meticulously crafted to operate seamlessly on the Microsoft HoloLens 2 device [9] [10]. To breathe life into the Seal and its surroundings, a diverse array of 3D objects from the same historical period was imported into the Unity platform [10]. These objects were carefully selected to provide context and authenticity to the virtual environment. C# scripts were skilfully implemented to orchestrate the functionalities of the application, ensuring that users could engage with the virtual setting in a meaningful and immersive manner.

The overarching goal of this digital resurrection was to transport users back in time, allowing them to experience the cultural and historical context in which the Seal played a role. A carefully crafted scenario was exported, creating a cohesive narrative within the application. This scenario unfolds as a "story" for the user, guiding them through a series of interactive actions that mirror the real-world use of the seal. Users find themselves at a virtual table, where the Seal and an uncooked piece of bread await. To truly engage with history, users are tasked with stamping the bread, placing it in a virtual oven, and patiently awaiting its transformation into baked bread (***Figure*** 4). This interactive experience not only educates users about the practical use of the seal but also immerses them in the rituals and practices of the time.

Figure 4: *Extended reality (Microsoft HoloLens 2) environment of the Holy Bread Prosphora Seal.*

In this section of the application, sound effects play a crucial role in immersing users in the historical context. As virtual bread bakes in an antique oven, the crackling of firewood brings the auditory dimension to life, transporting users to a bygone era and enhancing their connection with history. Furthermore, when applying the Seal to the virtual loaf, a distinctive stamping sound reinforces the seal's significance and bridges the gap between the user and historical actions. These sound effects serve as both evocative and educational tools, deepening users' understanding of cultural heritage.

The application goes beyond mere interaction by providing users with the opportunity to closely examine the details of the Seal and other associated artefacts. Focusing on the case study of the blessing seal, users can explore its intricate features and discover the meaning behind its inscriptions. Complementing the immersive experience, the application offers a comprehensive description of the Seal, providing users with historical insights and contextual information. This educational aspect enhances the user's understanding of the artefact's significance within the broader framework of cultural heritage [11].

The use and reuse of the artefact, as exemplified in this immersive digital application, stands as a testament to the transformative potential of advanced technologies in the realm of cultural heritage preservation. This project not only ensures the artefact's digital preservation but also fosters a deep and engaging connection between contemporary audiences and the cultural heritage of the past. Through innovative digital experiences, history is no longer confined to textbooks; it is a vibrant and tangible encounter with the past, accessible through the lens of modern technology.

2.2 The Collection of Cypriot Coins with Hercules Melqart

Mnemosyne's second selected case study delves deeply into the captivating world of the Hercules Coins (**Figure 5**), a journey marked by their historical and cultural significance within the rich tapestry of Cyprus's heritage. These remarkable coins, hailing from the 6th century BC and now carefully preserved in esteemed collections such as the Numismatic Museum in Athens and the Bank of Cyprus Cultural Foundation in Nicosia, transcend their numismatic origins to offer

profound insights into the intricate connections between Cyprus and the broader Mediterranean world.

Figure 5: *The Coins with Hercules Melqart.*

At the core of this case study lies the captivating iconography of Hercules, a celebrated figure in Greek mythology, renowned for his exceptional feats and divine attributes. Hercules's enduring legacy stretches far beyond the confines of Hellenic culture, finding echoes in the mythologies of Mesopotamia, Egypt, Babylon, and Phoenicia.

Within the specific context of Cyprus, select Cypriot coins housed at the Numismatic Museum of Athens portray Hercules in the guise of Melqart, a transformation that not only underscores Cyprus's historical role as a cultural crossroads but also unveils the intricate societal dynamics that once characterised the island—a strategic nexus of ancient Near Eastern and Mediterranean cultures [12].

Historical records attest to the division of Cyprus into distinct kingdoms as early as the 8th century BC. Until the conquest by Ptolemy I in 309 BC, these autonomous kingdoms minted their coinage in various metals, each distinguished by unique iconographic motifs and inscriptions. The scripts employed on these coins ranged from Cypriot-syllabic and the Greek alphabet to the enigmatic Eteocypriot script—an enduring linguistic puzzle. Notably, among these kingdoms, the kings of Kition, located in modern-day Larnaca, left a numismatic legacy that highlights robust Phoenician cultural influences in the region [13] [14]. The presence of altars, religious inscriptions, coins, and an array of artefacts in Kition bears witness to the veneration of Phoenician deities, including Melqart and Astarte. Intriguingly, many representations of Melqart exhibit striking resemblances to Hercules, sharing distinctive physical attributes. However, Cypriot depictions of Hercules often portray him without a beard, marking a departure from classical Greek renderings.

The integration of the case study into the Unity application stands as a testament to the project's commitment to blending rigorous scholarship with immersive technology. In this particular case, our focus centres on a singular silver coin, identified as Baalmilk II, dating to approximately 425/20-400 BC. This silver siglos weighs 10.97 grams and has a diameter of 21 millimetres. The coin showcases Hercules on the obverse, confidently striding to the right. He is adorned in a lion's pelt, a bow in his left hand, and a raised club in his right, emblematic of his legendary exploits. Adjacent to this dynamic scene, a dotted circle contains an ankh· symbol, adding layers of symbolism and intrigue to the coin's imagery. On the reverse of the coin, a lion hunts a kneeling deer to the right, situated above a Phoenician inscription ‘b-almlk’, within a dotted and incuse square. This coin serves as a remarkable artefact encapsulating the historical and cultural significance of Cyprus, offering profound insights into the intricate connections between Cyprus and the broader Mediterranean world [14].

Figure 6: *Heracles-Melqart silver coin.*

To digitise these coins for the project, we employed state-of-the-art techniques, including photogrammetry and other advanced imaging technologies. These methods allowed us to create highly detailed 3D models of each coin in our study, preserving their intricate features and historical authenticity. Within the Unity application [9], however, we meticulously curated the experience to focus solely on the 3D object of the silver coin from the 5th century BC. This specific coin served as the centrepiece of the application, allowing users to delve deeply into its details and historical significance. To ensure historical accuracy during the application's

development, we meticulously researched and designed every aspect [11]. When donning the Microsoft HoloLens 2 [10] and immersing themselves within the extended reality environment, users are presented with a meticulously crafted tableau comprising an anvil, a hammer, moulds, and a piece of silver material. This tableau faithfully replicates the coin-making process of antiquity, with the added augmentation facilitated by MRTK 2 [8].

Users engage with the simulation by placing the silver material in the lower mould and securing it with the upper mould—an essential initial step in ancient coin production. A virtual hammer strike on the upper mould completes the process, forming the coin. To enhance the authenticity of this action, a sound effect resembling the striking of metal with a hammer is expertly incorporated, providing users with both visual and auditory cues reminiscent of the ancient coin-making process. Users can then remove the mould to unveil the freshly minted coin, allowing for a comprehensive examination of every intricate detail. The application also provides the opportunity to scrutinise individual elements closely, enabling a focused analysis of the case study, the coin itself, the moulds, and more (**Figure 7).**

Figure 7: *Extended reality (Microsoft HoloLens 2) visualization of the creation process of the Heracles – Melqart silver coin.*

2.3 The Temple-boy limestone statuette

Mnemosyne's third selected case study embarks on a captivating journey into the enigmatic realm of a limestone statuette known as the "Temple-boy," dating from the 5th century BC to the middle of the 4th century BC This exceptional artefact holds a significant place within the George and Nefeli Giabra Pieridis Collection of Cypriot antiquities, generously donated to the Bank of Cyprus Cultural Foundation in Nicosia, where it is currently on public display.

The temple-boy statuette (
Figure **8**) represents a unique type of votive offering, intriguing in its dedication to both male and female divinities of ancient Cyprus. What sets these statuettes apart is their scarcity within tombs, a rarity that has piqued the curiosity of scholars regarding their precise function and significance within the religious and cultural landscape of ancient Cyprus during this era. One prevailing theory proposes a connection between these temple-boy statuettes and the ritual of circumcision, although the precise nature of this link remains a subject of ongoing scholarly inquiry [15].

Figure 8: *The temple-boy statuette*

The prominence of temple-boy limestone statuettes in Cyprus is underscored by the impressive assemblage of three hundred specimens meticulously curated by Cecilia Beer [15]. Additionally, the Censola Collection boasts fifty-one examples of these statuettes, further attesting to their paramount importance in the religious practices of ancient Cyprus. Notably, traces of similar statuettes have been unearthed in the Levant, hinting at potential trade or local production by Cypriot artisans and highlighting the broader cultural and commercial ties of ancient Cyprus [16].

Turning our attention to the specific statuette under scrutiny, it depicts a youthful figure garbed in a chiton and a himation, with the folds of the garments delicately rendered through shallow grooves, evoking a sense of artistic simplicity. The youth is depicted wearing sandals, and the statuette's base provides a stable foundation for the figure. A scroll is gracefully draped across the youth's knees, with one end gently held in his left hand, while his right hand grasps a stylus resting on a papyrus sheet. The figure's curly hair is meticulously rendered, and a wreath of leaves adorns his head. Traces of red paint, discernible on the garments, lips, and hair, provide valuable insights into the original appearance of these votive offerings [16].

In the realm of digital scholarship and immersive technology, the integration of this case study into the Unity application [9] is a testament to Mnemosyne's dedication to marrying rigorous research with cutting-edge innovation. The specific focus of this case study centres on this remarkable limestone statuette, allowing users to delve into its details and historical importance. Utilising the capabilities of the MRTK 2 [8] on the Unity platform, 3D objects were seamlessly incorporated to facilitate reusability within the application. C# scripts were thoughtfully implemented to enhance user interaction and functionality.

Historical precision remained paramount throughout the application's development, aimed at providing users with an immersive experience of the world of ancient scribes and their craft. Donning Microsoft HoloLens 2 [10], users step into an extended reality environment, where they encounter a scene featuring a scribe seated at a desk, ready to inscribe upon a papyrus scroll.

To authentically represent the scribe's art, users engage by inputting text into a virtual text field, a symbolic gesture of writing. As users transmit their text, the scribe within the application initiates the process of writing upon the virtual papyrus. This interactive experience not only immerses users in the scribe's world but also allows them to closely examine the details of the scribe statuette itself (***Figure*** 9).

Figure 9: *Extended reality (Microsoft HoloLens 2) environment of the Temple boy limestone statuette*.

This application offers a compelling opportunity for users to explore the intricacies of ancient scribal practices while providing detailed descriptions to enhance their understanding of the scribe statuette's historical context. By combining immersive technology with academic insights, Mnemosyne endeavours to provide users with a captivating journey into the rich tapestry of Cyprus's cultural heritage and its connections to the wider ancient world. This fusion of historical research and technological innovation underscores the project's commitment to preserving and elucidating cultural heritage within the dynamic digital landscape.

3. CONCLUSION

In conclusion, this paper has illuminated the profound synergy between the preservation of cultural heritage and the transformative capabilities of advanced digital technologies. Through meticulous examination of three distinct case studies— the Holy Bread Prosphora Seal, the collection of coins featuring Hercules Melqart, and the Temple-boy limestone statuette a recurring theme emerges: the dynamic interplay between heritage conservation and the innovative potential of digital mediums. This interaction culminates in a profound and enduring impact on the understanding and appreciation of cultural artefacts.

The intrinsic value inherent in these case studies transcends mere historical significance, manifesting in their capacity to bridge the temporal abyss between antiquity and the contemporary digital age. The Holy Bread Prosphora Seal, through its digital replication and immersive applications, establishes a palpable connection between 6th-century artefacts and modern audiences, providing a dynamic platform for exploring their historical context and cultural importance.

Similarly, the Coins with Hercules Melqart study reveals not only the historical importance of ancient coinage but also the transformative potential of digitisation in making numismatic studies engaging and enlightening. This case study traverses the physical dimensions of these ancient treasures and their socio-cultural connotations, transcending the conventional boundaries of academic discourse. The temple-boy limestone statuette, steeped in enigma and historical ambiguity, serves as an exemplar of the boundless potential inherent in digital technologies. By offering an immersive journey into the realm of ancient scribes, it uncovers not only the craftsmanship of the past but also the intricate rituals and societal facets of ancient Cyprus.

In the contemporary digital landscape, the preservation and dissemination of cultural heritage attain unparalleled significance. This scholarly pursuit, symbolising a resounding clarion call to action, invites continued exploration of the limitless possibilities of technology in the preservation of shared history and heritage.

In closing, the journey to revive the past through dynamic user interfaces remains an ongoing endeavour. Further exploration and innovation are encouraged, challenging the boundaries of technology and scholarship. As the tapestry of collective history continues to be unravelled, cultural heritage remains a living, breathing part of the digital present, forming an enduring legacy for the future.

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Visualising Drawings: from Archives to QGIS. A methodological overview.

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ABSTRACT: This paper aspires to propose a methodology to visualize and preserve the documentary heritage in museum archives, using the case study of the Archaeological Park and Museum of Lilybaeum-Marsala (TP, Italy). In particular, we will focus on those documents that have the possibility of being georeferenced, such as maps, project plans and excavation surveys contained in the archives of the Park and the Superintendence for Cultural and Environmental Heritage of Trapani.

It is therefore a matter of re-proposing an objective history, considering the printed papers as the bearers of objectivity and immodifiability, the "written" history of the folders. In particular, here we will look at the methodology applied to the visualization of the boards drawn by the architects for the perimeter of the park. Approximately 50 boards including design drawings, satellite photos and the excavation surveys carried out since the first project to establish the park were analyzed. All the material was georeferenced in QGIS for more precise and agile consultation. The use of this method will give not only the possibility to understand and visualize the chronology of the works, of the choices made for conservation, but also to prospect future works for layouts and to better plan exploratory essays and archaeological excavations.

1. INTRODUCTION

On 5 June 1994, the French philosopher Jacques Derrida made the following statement during the international symposium *Memory*: *The Question of Archives* in London:
«Non bisogna [forse] cominciare dal distinguere l'archivio da ciò al quale lo si riduce troppo spesso, specialmente l'esperienza della memoria e del ritorno all'origine, ma anche l'arcaico e l'archeologico, il ricordo e lo scavo, in breve la ricerca del tempo perduto?» [1].
Translation: *"Should we not [perhaps] begin by distinguishing the archive from that to which it is too often reduced, especially the experience of memory and return to the origin, but also the archaic and the archaeological, remembrance and excavation, in short, the search for lost time?"*
The text was then published in the *Preghiera da inserire/ Prayer to be inserted*, placing it before the beginning of *Mal d'archivio* (*Le concept d'archive. Un'impression freudienne*). It is no coincidence that Derrida quotes Proust's Recherche in which the theme of memory, of the dizzying passage of time and the disaster it has wrought upon us and the world, stands out. Novels, as well as archives and all binders of written memories, are places where time is

celebrated and sculpted to the tune of words and, as in the present case, especially to the tune of protocol numbers.
For the philosopher, the archive corresponds to a dual value: container and content; it also contains the capacity to create 'occasions' by activating re-readings of context and object and triggering new, critical, and creative processes. The management and communication of archives must also be ensured according to scientific competence, involving the competencies tangential to it [2].
The archive is thus an authoritative and indispensable tool for the knowledge and transmission of memory.
A particular case study of archives is that of museum archives, more specifically archives of archaeological museums. Often the events concerning the birth and creation of the museum itself are as exciting as the history that the museum itself divulges and communicates. Such events generally belong to a history that is chronologically closer, but because it is often a history that is still in progress, on which one can intervene, more or less indirectly, to redirect those lines of protection and enhancement that have not always taken the correct turn, perhaps by seeking appropriate and fitting comparisons. History is written by men, decisions are made by men, mistakes are made by men. All this is traced and traceable precisely because of the documents kept in the folders.
In museum archives, as is the case somewhat in all archives, time stands still. An affair is immortalized like a photograph through the redaction of an administrative act, with a phonogram, or through the preservation of the clipping of a newspaper article that caused a stir and now demands a press correction.

1.2 THE ARCHAEOLOGICAL SITE OF LILIBAEUM-MARSALA

This paper will address a particular type of data that forms the core of the documents that led to the establishment of the Lilybaeum-Marsala Archaeological Park and Museum (which we will refer to here by the abbreviation PMALM) in Sicily (province of Trapani).
In order to better frame the site under analysis in the Sicily region, it should be specified that the archaeological area is located on the promontory of Capo Boeo, south of the Stagnone of Marsala, in the province of Trapani, and is one of the island's points closest to the North African coast, an element that should not be underestimated since it was decisive for the history of the Lilybaean settlement. After the destruction of the city of Mozia in 397 BC, the surviving inhabitants moved to Capo Boeo, fleeing the island besieged by the tyrant Dionysius of Syracuse. The newly founded Lilybaeum thus became an important trading point and a compulsory stop on the sea routes both in the direction of Sicily and the Tyrrhenian Sea. The city was equipped with three harbors that allowed landing in all weather conditions, and with imposing fortifications, which are still preserved today.
Another important milestone in Lilyba's history occurred after the Battle of the Egadi in 241 B.C., which not only determined the end of the First Punic War, but marked the Roman conquest over Carthaginian territory.

1.3 THE INSTITUTION OF PARK AND ARCHAEOLOGICAL MUSEUM

Since the late nineteenth century as a result of the systematic research begun with Antonio Salinas, the Marsala City Council took important and far-sighted actions in safeguarding the Capo Boeo area from building expansion, sparing the ancient city from destruction.
In 1939, during work on the construction of the municipal stadium, the large domus with mosaics was discovered. From that moment a real policy of protection of the area began, which converged in 1949 with the Ministerial Declaration of Particularly Important Interest of the land at Capo Boeo.
The first project for the realization of the park was drawn up by the technical study of engineer Luigi Giustolisi and Renato Bazzoni in 1973. It was not until 1986 that Baglio Anselmi, now the site of the museum, was finally opened to the public, where not only artifacts from excavations in the city, but also the Great Punic Ship unearthed in those years, were preserved.
The project continued with the expropriation of the entire area and buildings starting in 1990.
The municipal roads of Via Vittorio Veneto and Via Nazario Sauro, which cut through the park as bisectors, are also acquired by the Regional State Property Office under a memorandum of understanding between the Department of the Presidency, the Superintendency of Archaeological Cultural Heritage of Trapani and the Municipality of Marsala in 2003 and then included in the park's perimeter in 2005

(from 2004 to 2006 the restoration and enhancement of the Church of San Giovanni and the underlying "Cave of the Sibyl" [3] are also included in the perimeter.
Now the park enjoys financial and administrative autonomy (A.D. No. 42 of 07/27/2020).

2. MATHERIALS AND METHODS

The goal is to create a tool for archiving, analysis, research, protection and subsequent valorization of the heritage that is received in the GIS, starting with archival records. It is necessary to have a streamlined, fast and homogeneous container that also serves at the administrative level to have a clear view of the territory, facilitates data query procedures and is a useful support for the valorization of the archaeological heritage.
If the use of PCs and computer tools could be occasional until 2009[4], to date it remains essential and indispensable for the establishment of an automated system for archiving, management and processing of documentation especially for excavation. Here we find a slightly different application, in that historical materials were georeferenced. purely administrative in nature, and not reports of ongoing excavations.
"In order to frame our work, first of all, we began from the so-called "human factor" - that is, we applied all that networking, knowledge, and meetings with the Director and Park officials. Already from the first meetings it became clear that over the years the PMALM archive represented only a partial section of the entire documentation pertaining to the city of Lilybaeum-Marsala.
The retrieval of the plates was therefore not immediate and simple: in fact, most of the administrative documentation pertaining to the institution is kept not only in the archives of the museum itself, but also in the archives of the Soprintendenza per i Beni Culturali e Ambientali di Trapani (SBCA-Trapani) and, albeit to a small extent, in the archives of the Soprintendenza per i Beni Culturali e Ambientali di Palermo (SBCA-Palermo).

This phase of requesting permits from all institutions took several months to be granted. In fact, the PMAML granted access on February 25, 2022 and the digital document acquisition work was completed in March 2023 with the acquisition of 1,218 files, the SBCA-Trapani granted access permission on April 21, 2023 (prot. no. 007230), and the SBCA-Palermo on May 26, 2023 and is still in progress and document acquisition for the SBCAs. It is important to emphasize this because the establishment of contacts and relationships with institutions is essential and vital to move the project forward and to get information that the folders do not provide, e.g., it was essential to interview the Park's archaeological officer, Dr. Maria Grazia Griffo, and the architects, Drs. arch. Giovanni Nuzzo and Enrico Caruso, who were personally involved in drawing up the perimeter plans for the PMALM.

Institution	Folders	Weight (GB)	Number of files	Status
PMALM	28 on 28	8,43 GB	1.218	Completed
SBCA-Trapani	40 on 114	3,67 GB	444	In progress
SBCA-Palermo	6 on 21	9,28 GB	681	In progress

Table 1: *Panoramic view of the material collected from the archives.*

In tab. 1, the digitized material was broken down by the number of folders scanned out of the total number, weight in GigaBytes, number of files (consisting of .pdf scans, metadata in word and photographs, and scans in .jpg), and the status of progress.
To date (November 2023), the material described in Tab 1 has been collected.
Digitally sifting and scanning all this amount of material, which at first glance may seem an unnecessary and excessive operation, is what allows for contextualization of the documents even at a later date precisely because they remain available and in consultation for study purposes.
It remains essential to make this explicit from a methodological point of view because archives are not always accessible and in Italy they are rarely digitized and freely usable, especially the administrative ones, and, to access them, it is necessary to make appointments with officials well in advance. In addition, there were not always indexes for these types of folders, as is good practice in archival work. So each folder was a surprise.

2.1 THE DRAWINGS SELECTION

It should be pointed out that for this work a selection of the documents to be treated was made: precisely in order to shed light on the events that led to the current establishment of the Archaeological Park and Museum of Lilybaeum-Marsala, it was decided to use the

maps, plates and drawings of the old projects for the establishment and perimeter of the institution.
Therefore, only what was useful for georeferencing was selected for this work, arriving at the following in Tab. 2.

	Scanned Folders	Selected Folders	% utile
PMALM	28	7	1.96 %
SBCA-Trapani	40	1	0.4 %
SBCA-Palermo	6	0	Null

Table 2: *Selection of the material to be geo-referenced.*

The maps selected for georeferencing are, in the totality of the 8 folders, a total of 48, of various and varying sizes. Digitization was done by scanning at 300 dpi with large format plotters at the University of Palermo printing center.

2.2 DIGITAL MAIPULATION OF THE DRAWINGS

QGIS, as will be seen in section 2.3, allows maps to be overlaid as layers, and no matter how much we play with the program's opacity functions and transparency values, images will always be displayed as if we were overlaying paper sheets on top of each other. The visibility of the underlying sheet is not perceptible (fig. 1).

Figure 1: *Example of overlapping board on QGIS (elaborated by C. Vitaloni).*

Faced with this problem of overlapping and not being able to manage the transparency and opacity of all the maps by selecting a particular color, it became imperative to use software (Photoshop) to clean from the background, effectively making each map in .jpg (fig. 2) a .png.

From the map in exported in .png format, all those disturbing factors, such as cartouche, northern directions, legends, were also removed, also by virtue of the fact that these could be easily retrieved from the map in original, also georeferenced (fig. 3).

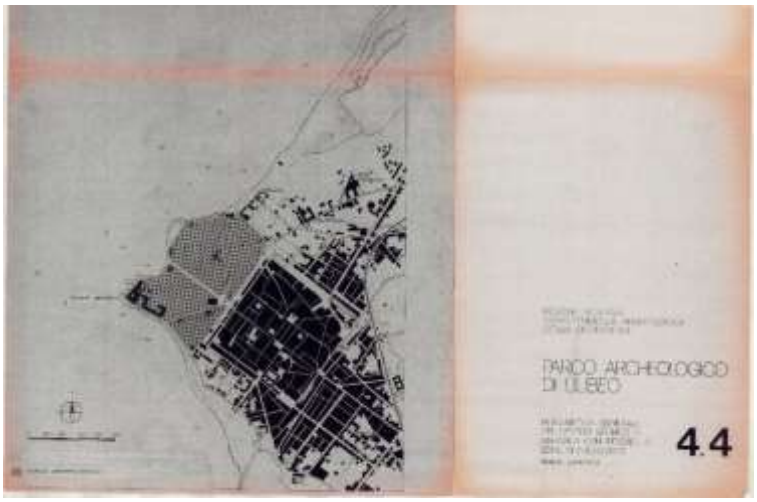


Figure 2: *Example of original map 4.4- "Planimetria generale del centro storico di Mardaka con indicate le zone di intervento" (elaborated by C. Vitaloni).*

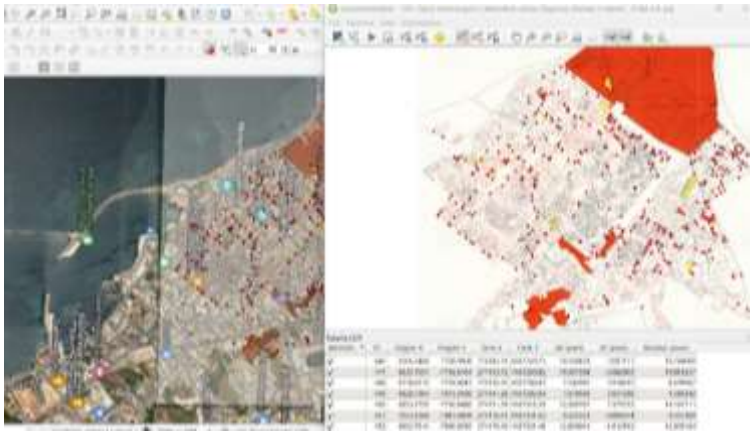
Figure 3: *Example of the map 4.4 in .png after the manipulation in Photoshop (elaborated by C. Vitaloni).*

2.3 QGIS

In this case-study, as has already been anticipated, the Geographic Information System included the tables of the projects that led to the establishment of the Archaeological Park and Museum of Lilybaeum-Marsala.
A free GIS program, such as the open-source software QGIS (https://www.qgis.org) in its stable version 3.28.1 Firenze was used for the management of the Geographic Information System applied to the methods of digital cartography.
As is the case with stratigraphic units, archival documents and tables must also be entered objectively, with their own attributes (including information inherent to the preservation of the table, acquisition parameters, table author, etc.), so that the digital translation of the documentation is not over-interpreted. The GIS must therefore be functional, flexible, and objective so that data can be preserved and queried in a dynamic and chronological order, by project attribution and archival ownership.
With the Geographic Information System we have two ways of describing the world: first we have location information (where it is in space), second we have descriptive information (what it is and what are its attributes). The first type of information provides us with graphical data, i.e., the elements of a map in a specific reference system (SR), and attribute-type data, which express the characteristics of the map elements and can be associated as an "attribute table". This kind of attribute table is inserted into the GIS or it is linked to it through relationship with an external DB. In the case presented here, the attribute table was used instead of a DB (for the distinction see [5]). However, the pragmatism of archaeology tends to lose the richness derived from the conceptualization of theoretical resources that lead to the definition of the method. An attempt will therefore be made to define the archive according to its possible declinations.
The tables were geo-referenced using Ground Control Points (GCPs), which are anchor points of features that have not changed topographically over time.

Since the sheets were designed by architectural firms in the 1970s, the grid indicating the Reference System was not available, except for the metric scale. The GCPs used to anchor the sheets were the corners of the known buildings (i.e., the "Baglio Anselmi" and the historic bagli, historic churches of the city), avoiding instead the coastlines, which -as is well known- are subject to erosion and changes even over the course of a few decades (fig. 4).

Figure 4: *Example of the georeferencing with GCP*



in QGIS (elaborated by C. Vitaloni).

The Reference System (SR) used for this project is ED50/UTM zone 33N - Datum: ED50 - Projection: UTM - Zone: 33N - EPSG: 23033, since the GCPs were anchored to the available Google Satellite map.

In order to maintain an orderly criterion and avoid possible loss of information, the maps were organized according to which each map belongs to a group in which the original and "cleaned" tables were placed and renamed with "_contours" (Fig. 5).

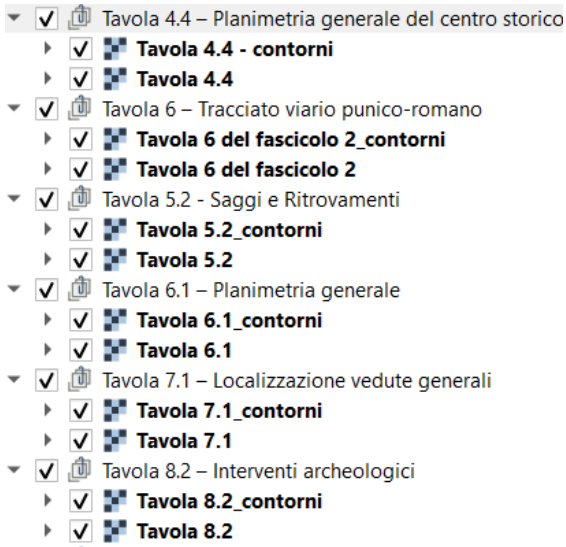


Figure 5 : *Example of the layers management using the .jpeg and .png georeferences for each drawn (elaborated by C. Vitaloni).*

3. DISCUSSIONS

The archive remains an indispensable and authoritative physical tool for the preservation of information related to the history (and thus the identity) of the museum itself.

Figure 6: *Concentration map for Files scanned about Park and Archaeological Museum of Lylibaeum-Marsala. (elaborated by C. Vitaloni).*

Figure 7: *Concentration map in terms of Gigabytes collected about Park and Archaeological Museum of Lylibaeum-Marsala (elaborated by C. Vitaloni).*

Although this is still a work in progress, it can be seen from the concentration maps (Figs. 6 and 7) that the amount of material collected is not directly proportional to its weight in GB. This has depended on the numerous images scanned in image format (.jpg) and not as .pdf scans present mainly at the "Di Stefano" archive of the SBCA in Palermo, of which -to date- no plan useful for georeferencing has been found. The only forms of "maps" are only freehand sketches on squared paper by Dr. Di Stefano, a leading archaeologist in the research at Lilybaeum [6], known for having devoted her research activity to ancient Lilybaeum during her work both at the Park and in the City. Thus, as can also be seen from Tab. 2, for the Palermo archive, no items were included in the georeferenced documentation.

Moreover, quantity does not mean quality: only an insignificant percentage (1.96 % and 0.4 %) went to constitute material useful for populating the GIS.

There is, however, a margin of error in geo-referencing: for example, for the table "2011_ Archaeological and Environmental Park at Stagnone, Marsala and Comuni limitrofi_ ZONE A B" as many as 4011 GCPs were needed for an average of about 30 hours of work (about 150 GCPs per hour) to obtain a satisfactory result that overlapped with the base of the SR (fig. 3).

It should also be pointed out that dealing with numerous (48 original .jpg and 48 in .png) large raster files could lead to a program crash, but it depends on the technical characteristics of the machine you are working with.

Certainly, vectorizing the .png files could help the handling and loading speed of the layers.

4. RESULTS

The results of the present work, although partial since the folders were not surveyed in their entirety, already show that they can be used for the creation of thematic maps.

By overlaying multiple layers, it was possible to reconstruct and georeferenced the 2011 Delimitation Project. Another indispensable support for a greater understanding of the data was the comparison with the project report, which allowed the attributes related to the decoded area to be included in vector format: A) for state-owned areas in the city center; B) for areas of archaeological interest subject to constraints; C) for areas of landscape interest.

Thanks to this cross-layering, it was also possible to georeference some archaeological essays and place them with their sections directly in a SR. One example is essay 3 along Isonzo Avenue (fig. 9). To obtain this valuable information, it was necessary to overlay three maps:

- the Google Satellite base as an anchor point;
- the table in which traces of the excavation appeared, but not in detail (here specifically Table 6 in PMALM Folder 26 entitled "Table of the Punic-Roman layout of the project area" from 1973, scale 1:500);

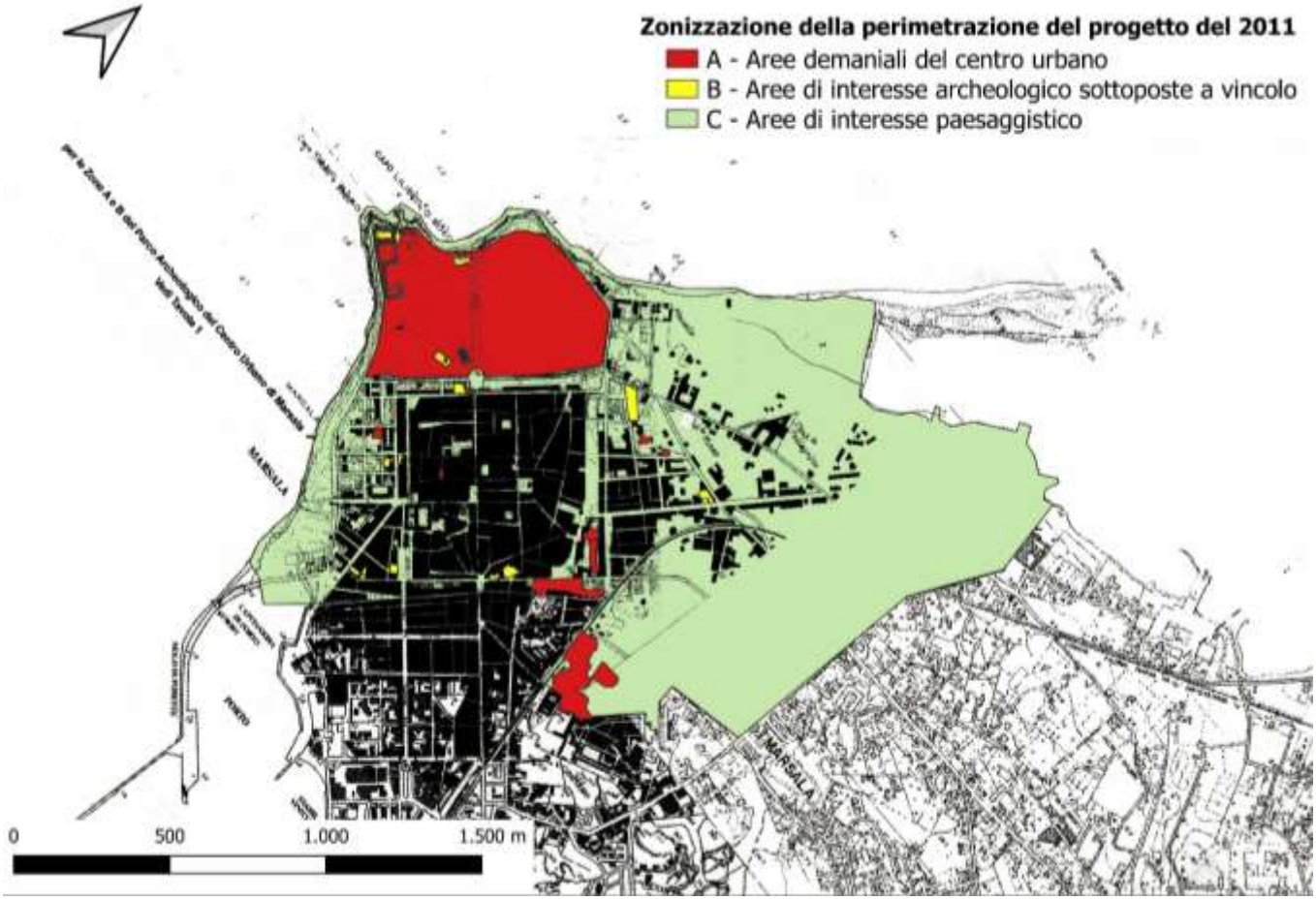


Figure 8 : *Map of the archaeological zones for Park and the city of Lylibaeum-Marsala (elaborated by C. Vitaloni*).

- the detailed survey of the archaeological essay (table 6.7 "Essay 3" in PMALM's 1980 folder 33, scale 1:50).

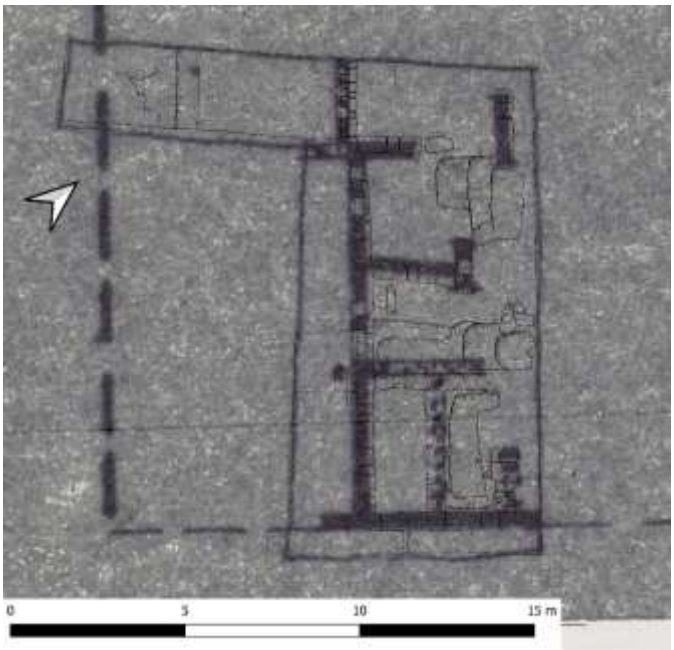


Figure 9: *Example of an excavation georeferenced (elaborated by C. Vitaloni).*

5. CONCLUSION AND FUTURE DEVELOPEMENTS

Historical archives, like the foundation of a house, form the essential second floor for the creation and subsequent development of a museum institution. To understand how a museum came into being, developed and is evolving, it is necessary to start with the analysis of each brick. In our case, the bricks are the archives folders and they form the core, the heart, of the institution.

The work here did not delve into the specific historical issues, but rather preferred to focus on the methodological vision, which, in summary, involved scanning (by photography or scanner plotter), organizing and georeferencing the papers on GIS. This is making it possible to reconstruct the history of the museum institution, its establishment, its past projects and their evolution over the decades. As well as planning for possible future excavations. The identity use of archives is linked to the concept of identification by the producing subject-institution that operates the recovery of its memory, responding to a cognitive need, but also, and above all, to the need to guide and

define its image and choices in a perspective of evolution that looks to the future [2].

Future development thus involves first concluding the screening of the remaining folders, vectorizing the .png files to lighten GIS consultation, and likely contextualizing all the tables chronologically.

6. ACKNOWLEDGMENT

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SESSION IV

Standards und Formate | Standards and Formats

Moderation: Frank v. Hagel
(Wissenschaftliche Museumsdokumentation, digitales Sammlungsmanagement | Institut für Museumsforschung | Stiftung Preußischer Kulturbesitz)

EVA Berlin

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Berliner Kulturerbe digital: Ein quantitativer Blick auf die Metadatenqualität

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KURZDARSTELLUNG: Die Metadatenqualität bestimmt wesentlich den Nutzen und Wert von Kulturerbedaten. ‚Gute' Metadaten erhöhen die Auffindbarkeit, Interoperabilität und Nutzbarkeit von Daten signifikant. Mit Blick auf Retrieval bzw. Discovery, Vernetzung im Kontext von Linked Open Data und wissenschaftliches Data Mining hängt die Qualität dabei wesentlich von der Verwendung von maschinenlesbaren kontrollierten Vokabularen ab. Diese wird in der vorliegenden Arbeit quantitativ untersucht. Als Datengrundlage dienen die in der Deutschen Digitalen Bibliothek aggregierten Metadaten aus Berliner Museen (ca. 1,2 Millionen Metadatenobjekte im LIDO-Format).

1. EINFÜHRUNG

Metadaten zur Beschreibung digitaler Objekte des kulturellen Erbes sind für deren effiziente Auffindbarkeit unerlässlich. Durch die stets zunehmenden digital verfügbaren Datenmengen und die Aggregation von Kulturerbedaten insbesondere auf Plattformen wie der Deutschen Digitalen Bibliothek (DDB, [1]) oder der Europeana gewinnen die Metadaten zunehmend auch als Forschungsdaten eigenen Rechts Bedeutung. Im Santa Barbara Statement [2] (aktualisiert im Vancouver Statement [3]) wird die Bedeutung von Collections as Data, d.h. der Wert von Sammlungsdaten als Forschungsdaten hervorgehoben. Die DDB und in jüngeren Jahren auch die großen nationalen Infrastrukturbemühungen der Nationalen Forschungsdateninfrastruktur (NFDI, https://www.nfdi.de/) schaffen Grundlagen für eine intensive Nutzung von Sammlungsdaten, und Leuchtturmprojekte wie z.B. Datenraum Kultur (https://www.acatech.de/projekt/datenraum-kultur/) schließlich indizieren ein erhebliches politisches Interesse an Kulturdaten. Auch Linked Open Data hat als Paradigma im Kulturerbesektor Fuß gefasst und wird absehbar an Bedeutung zunehmen und sukzessive auch technisch realisiert werden. Metadatenqualität wird in Zukunft also immer wichtiger werden.

Metadatenqualität zu definieren ist nicht einfach. Die FAIR-Prinzipien [4], nach denen Daten *findable*, *accessible*, *interoperable* und *reusable* sein sollen (siehe https://www.go-fair.org/fair-principles/) sind wichtige Leitlinien, die an den jeweiligen Anwendungsfall angepasst werden müssen. Für den technisch-infrastrukturell, institutionell und inhaltlich überaus diversen Kulturerbesektor stellen FAIR-Prinzipien eine große Herausforderung dar. Viele Einrichtungen sind nicht ohne Weiteres in der Lage, Daten den FAIR-Prinzipien entsprechend bereitzustellen. Die DDB als intermediäre Aggregatorin kann hier unterstützen, indem sie die Daten auf einer einheitlichen Plattform verfügbar macht. Die DDB ist mit aktuell fast 52 Millionen Objekten von über 800 datengebenden Institutionen aus sieben Sparten die bei weitem größte nationale Plattform für Kulturerbedaten.

Die DDB stellt Objektdigitalisate und die dazugehörigen Metadaten über eine graphische Such- und Präsentationsoberfläche sowie über technische Schnittstellen (APIs) zur Verfügung. Schon die Such- und Filterfunktionalität der DDB ist wesentlich von der Metadatenqualität, für die die datengebenden Institutionen verantwortlich zeichnen, abhängig. Auch die vielfältige Nachnutzbarkeit der Daten durch Dritte wird durch ‚gute' Metadaten befördert.

Doch was sind ‚gute' Metadaten im skizzierten Kulturerbekontext? Ein Beurteilungskriterium ist die jeweilige *fitness for purpose* [5]. Findability und Accessibility hängen im DDB-Kontext ganz wesentlich von der zentralen technischen DDB-Infrastruktur ab (z.B. persistente Identifikatoren für Metadatensätze und Ausgestaltung der API) und sollen daher im Folgenden ausgeklammert werden. Interoperabilität und Nachnutzbarkeit liegen primär im Einflussbereich der Datengeber:innen. Diese sollen in dieser Arbeit im Zentrum stehen. Interoperable und nachnutzbare Daten sind maschinenlesbar und möglichst standardisiert. Zentrale Standardisierungsinstrumente sind kontrollierte Vokabulare, die über URIs eingebunden werden. Als wesentliches Qualitätskriterium soll also für folgende Untersuchung die Normdatenabdeckung im Mittelpunkt stehen. Nachrangig fließt auch die Maschinenlesbarkeit von Maß- und Datumsangaben ein.

In dieser Arbeit werden erste quantitative Qualitätsanalysen zu Metadaten aus Berliner Museen vorgestellt. Als Mitarbeiter von digiS, dem Forschungs- und Kompetenzzentrum Digitalisierung Berlin (www.digis-berlin.de), beschränke ich mich auf Berliner Einrichtungen. digiS unterstützt durch ein umfassendes Beratungs- und Workshopangebot Berliner Kulturerbeeinrichtungen in allen Fragen der Digitalisierung und legt hierbei besonderen Wert auf die Qualität der Metadaten. Diese stellt gerade im musealen Bereich wegen der Heterogenität der Objekte eine besondere Herausforderung dar. Museen machen überdies im seit nunmehr über zehn Jahren bestehenden Förderprogramm die bedeutendste Kulturerbesparte aus.

Im Folgenden soll also zunächst ein knapper Überblick über einschlägige Arbeiten zur Metadatenqualität gegeben werden (2). In einem weiteren Schritt werden die Methoden der Datenakquise und Datenanalyse (3) dargelegt. Es folgen die Präsentation und Diskussion der Ergebnisse (4). Zuletzt werden die Ergebnisse der Arbeit zusammengefasst (5).

2. VORARBEITEN

Die wesentlichen Arbeiten zur Qualitätsmessung von Metadaten im Kulturerbesektor entstammen dem bibliothekarischen Bereich [6, 7] und konzentrieren sich auf Metadaten zu verhältnismäßig homogenem Material im MARC21-Format. Im Europeana-Kontext hat eine Arbeitsgruppe Empfehlungen zur Metadatenqualität zusammengestellt [8].

Einen bemerkenswerten anderen Ansatz zur Qualitätsmessung von Metadaten stellt der PuQi-Index von museum-digital dar [9]. Hier wird insbesondere durch Verrechnung von Stringlängen in bestimmten Feldern (Objekttitel, Objektbeschreibung etc.) ein Qualitätsindex für Objektdatensätzen ermittelt. Durch die Implementierung in museum-digital (https://de.about.museum-digital.org/software/musdb/) werden Institutionen, die Daten über diese Plattform erschließen und ausspielen, dazu motiviert, die Datensätze möglichst aussagekräftig zu gestalten. Das primäre Ziel des PuQi ist freilich nicht die Verbesserung der Maschinenlesbarkeit.

3. METHODE

Das Vorgehen zerfällt in zwei Teile: die Beschaffung der Daten von der nationalen Kulturerbedatenaggregationsplatform DDB einerseits und die quantitative Analyse der Daten andererseits.

3.1 DATENAKQUISE

Die DDB stellt verschiedene Schnittstellen zur Verfügung (REST, OAI-PMH, vgl. https://pro.deutsche-digitale-bibliothek.de/daten-nutzen/schnittstellen), über die Daten nach Autorisierung per kostenlos erhältlichen API-Schlüssel programmatisch abgerufen werden können.

Da der Kooperationsvertrag der DDB in der Version des Jahres 2017 die Möglichkeit eines Opt-Outs beinhaltet (https://pro.deutsche-digitale-bibliothek.de/downloads-links/kooperationsvertrag), mit der Datengeber:innen die Auslieferung der Metadaten über die Schnittstelle explizit

verweigern konnten, sind nicht alle Metadaten über die Schnittstellen zu beziehen. Der aktuelle Kooperationsvertrag des Jahres 2023 (https://pro.deutsche-digitale-bibliothek.de/downloads-links/kooperationsvertrag-2023) sieht diese Möglichkeit nicht mehr vor, sodass in Zukunft der Anteil der über die API ausgespielten Daten steigen dürfte.

Aktuell ist die Verfügbarkeit der Daten über die Schnittstelle jedoch gerade im musealen Sektor (Sektor 6 in der DDB) vergleichsweise schwach ausgeprägt. Während in den anderen Sektoren die Datenverfügbarkeit über API 97-99% beträgt (mit Ausnahme von Sektor 3, dem Denkmalschutz, der es immerhin auf 88% bringt), werden nur etwa 47% der Metadaten aus Museen über die API ausgespielt. Für die Berliner Museen ist die API-Verfügbarkeit besonders niedrig, hier lassen sich nur ca. 24% der Daten über die API abrufen. Die über die REST-API nicht ausgegebenen Daten mussten folglich teils per Web-Scraping über den normalen Web-Auftritt der DDB bezogen werden (die Metadaten im strukturierten XML-Format sind unter der URL https://www.deutsche-digitale-bibliothek.de/item/xml/<Objekt-ID> abrufbar).

Es wurden für die Analyse jeweils nur die von den Datengeber:innen bereitgestellten Quelldatensätze verwendet. Die DDB bereitet die Daten ihrerseits für die Online-Stellung nochmals auf und bietet sie im Europana Data Model an [10]. Der Quelldatensatz ist im XML-Datensatz im Element <source:source> enthalten. Museale Metadaten sind in aller Regel (in unserem Sample in 99,5% der Fälle) im LIDO-Format (https://cidoc.mini.icom.museum/working-groups/lido/lido-overview/) repräsentiert. Nur diese insgesamt ca. 1,19 Millionen LIDO-Daten werden im Folgenden berücksichtigt.

3.2 METRIKEN DER QUANTITATIVEN ANALYSE

In dieser Arbeit soll als wesentliches Kriterium für Metadatenqualität die Normdatenabdeckung herangezogen werden. Named Entities wie Personen, Orte, Organisationen oder in einem weiteren Sinne auch Sachbegriffe, die Akteur:innen, Orte, Schlagwörter oder z.B. auch Objekttypen bezeichnen, sind im Sinne der Interoperabilität zu normieren, d.h. mit einem kontrollierten Vokabular (in diesem Zusammenhang im Wesentlichen synonym mit Normdatei bzw. authority file) zu verknüpfen. Diese Verknüpfung erfolgt technisch idealiter über einen URI. Nur ein URI garantiert eine maschinell auflösbare eindeutige Verknüpfung. Nummern allein (auch im Verbund mit wie auch immer gearteten Hinweisen auf den jeweiligen Referenzrahmen) erschweren die maschinelle Auflösung des Verweises. Die Angabe „GND 118529579“ ist, obzwar für informierte Nutzer:innen unmittelbar als auf die Gemeinsame Normdatei (GND) bezogener Identifikator interpretierbar, für einen Rechner nicht ohne Weiteres auflösbar. Nur der URI in seiner kanonischen Form, im konkreten Beispiel https://d-nb.info/gnd/118529579, erlaubt eine eindeutige Auflösung der Referenz und eine stabile Referenzierung z.B. im Linked-Open-Data-Kontext.

Im Rahmen dieser Arbeit wird zunächst überprüft, welcher Anteil der relevanten Entitäten über eine Referenz verfügen. Es wird also für jede Person/Körperschaft, jeden Ort in einem Datensatz usw. geprüft, ob mindestens ein Identifikator vorhanden ist. Der Abdeckungsgrad hat einen Wert zwischen 0 (keine Abdeckung) und 1 (volle Abdeckung). In einem weiteren Schritt wird untersucht, welche kontrollierten Vokabulare referenziert werden.

Eine zweite Qualitätsprüfung betrifft Datums- und Maßangaben. Hier wird überprüft, ob die Datumsangaben in einem an ISO 8601 angelehnten Format gehalten und die Maßangaben strukturiert und maschinenlesbar sind.

Technisch erfolgt die Analyse mit Python-Code in verschiedenen Jupyter-Notebooks, die unter https://github.com/alexander-winkler/metadatenqualitaet_EVA2023 (DOI: 10.5281/zenodo.10073653) zum Nachvollzug und zur Nachnutzung bereitstehen.

3.3 LIMITATIONEN

Der Datenabzug über die REST-API der DDB ist zeitaufwändig. Der nicht-parallelisierte Abruf der 1,2 Millionen Datensätze dauert bei durchschnittlich 1,5 Zugriffen pro Sekunde über 220 Stunden, d.h. über neun volle Tage. Die Daten sind also schon aus diesem Grund nicht leicht tagesaktuell zu halten.

Für diese Untersuchung wurden die Daten über einen längeren Zeitraum im Wesentlichen im September 2023 geladen und späterhin vereinzelt komplettiert bzw. ersetzt. Es ist nicht auszuschließen, dass nicht alle zugrundeliegenden Daten dem aktuellen Datenstand in der DDB entsprechen.

Hinzu kommt, dass die Daten in der DDB selbst nicht zwingend die Qualität widerspiegeln, die die datengebenden Institutionen heute zu erbringen imstande wären – sei es durch eine bessere Erschließungsqualität oder einen optimierten Export. Der Altersmedian der hier untersuchten Metadaten in der Form, in der sie in der DDB vorliegen, ist 1129 Tage, d.h. ein Gutteil der Daten ist fast über drei Jahre alt.

Abschließend ist zu berücksichtigen, dass bei den Berliner Kulturerbedaten der Anteil der jeweiligen Datengeber:innen sehr heterogen ist. So entfallen über die Hälfte der Daten aus Berliner Museen auf eine einzige Institution. Die entsprechenden Eigenheiten der Institution im Bereich Erschließungsqualität und Freigabe für die DDB-API schlagen sich somit deutlich in der Gesamtstatistik nieder.

4. ANALYSE UND DISKUSSION

4.1 SCHEMAVALIDITÄT

Zunächst ein Blick auf die Schemavalidität: 96,7% der Daten validieren gegen das LIDO-Schema der Version 1.1 (http://lido-schema.org/schema/v1.1/lido-v1.1.xsd), die mit der Version 1.0 rückwärtskompatibel ist.

4.2 NORMDATENABDECKUNG

Die Normdatenabdeckung wurde im Rahmen dieser Untersuchung für folgende Felder erhoben. In Klammern werden die einschlägigen LIDO-Elemente angegeben:

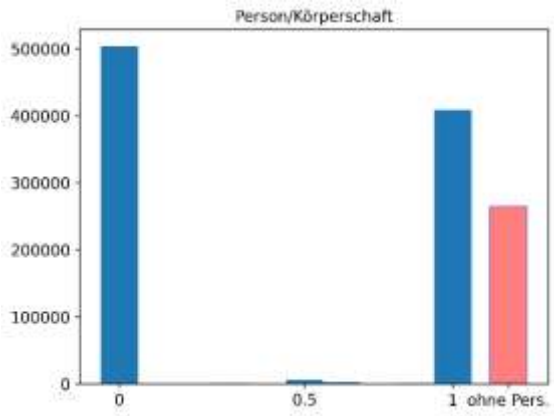
- Person/Körperschaft (<lido:actor>)
- Ort (<lido:place>)
- Inhaltsschlagwort (<lido:subjectConcept>)
- Objekttyp (<lido:objectWorkType>)

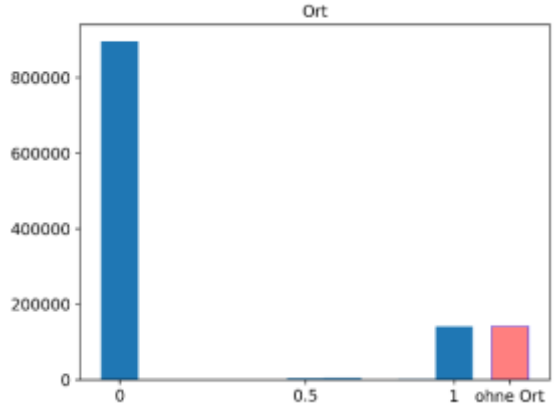
Die Auswahl und die Bezeichnungen orientieren sich am Minimaldatensatz der Fachgruppe Museum der DDB (www.minimaldatensatz.de). Für weitere technische Details zum LIDO-Format verweise ich auf die LIDO-Dokumentation [11].

Es wurde für jeden Datensatz die Normdatenabdeckung je Datensatz für jedes der oben genannten Elemente ermittelt. Gibt es also in einem Datensatz zwei <lido:actor>-Elemente, von denen beide über je mindestens einen per Identifikator normierenden <lido:actorID>-Kindknoten verfügen, ist die Normdatenabdeckung 1. Hat nur ein <lido:actor>-Element mindestens ein <lido:actorID>-Kindelement, beträgt die Abdeckung 0.5. Hat kein Element ein <lido:actorID>-Element, ist die Abdeckung für den Datensatz 0.

Analog ergeben sich auch die Abdeckungsraten für die anderen der oben aufgeführten LIDO-Elemente. Für jeden Datensatz gibt es damit je einen Normdatenabdeckungswert für Personen, Orte, Inhaltsschlagwörter und Objekttypen.

Die folgenden Diagramme zeigen die Häufigkeit der jeweiligen Abdeckungsraten je Element an.





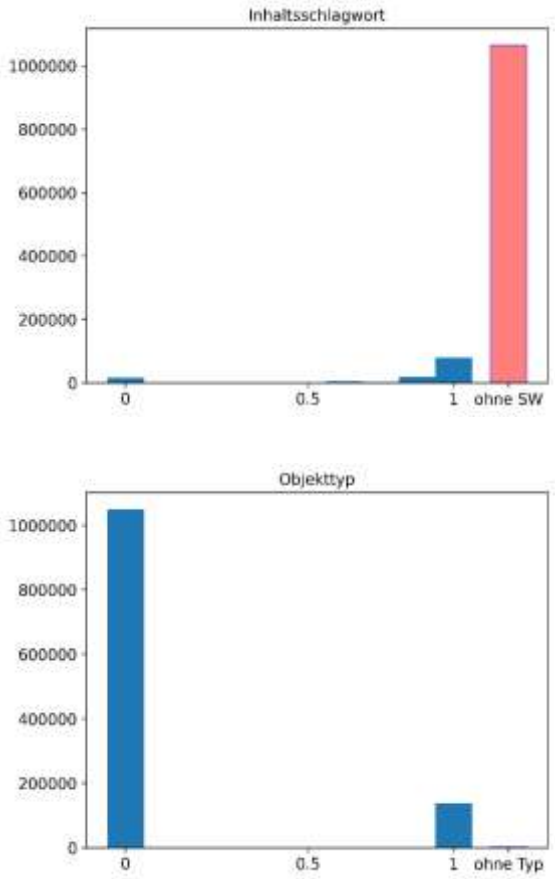
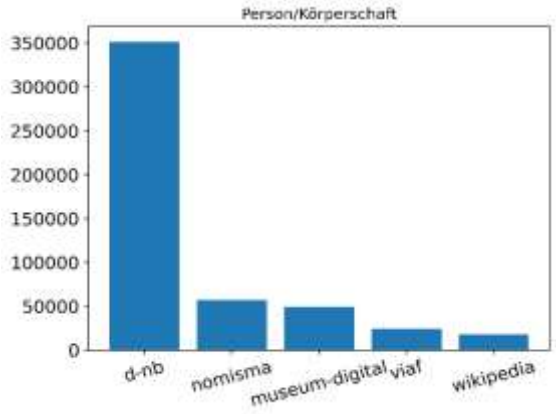


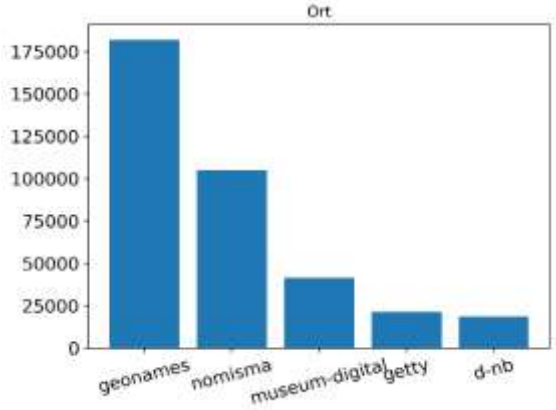
Abb. 1-4: *Häufigkeitsverteilung der Normdatenabdeckungsraten über das Untersuchungscorpus. Die y-Achse gibt die Zahl der Datensätze an, die die auf der x-Achse verzeichnete Abdeckung aufweisen.*

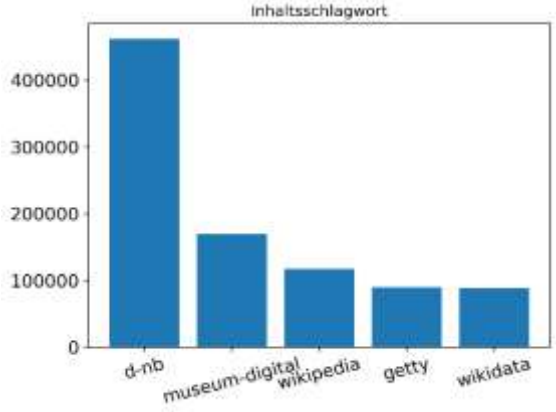
Es zeigt sich eine generelle bimodale Verteilung der Normdatenabdeckung, d.h. die Abdeckung je Datensatz ist zumeist entweder komplett (1) oder nicht gegeben (0). Es gibt nur sehr wenige Datensätze, bei denen die Entitäten nur teilweise normiert sind. Die bimodale Verteilung wird gewiss durch den Umstand befördert, dass die Elemente häufiger nur einmal vorkommen (im Falle der Personen/Körperschaften gibt es z.B. ca. anderthalb Mal so viele Datensätze mit einer Personenangabe wie Datensätze mit zwei oder mehr Personenangaben) und ein Element entweder normiert oder eben nicht normiert ist. Die starke Ausprägung der Verteilung deutet jedoch auch auf eine systemische Ursache hin: es liegt die Vermutung nahe, dass aufgrund der verwendeten Erfassungssoftware oder einer entsprechenden Schreibanweisung Normdaten entweder konsequent erfasst werden oder eben nicht.

Eine Normierung erfolgt, wie aus den Diagrammen hervorgeht, bei Personen recht regelmäßig (in etwa 45% der Fälle), bei Orten und Objekttypen ungleich seltener (nur in etwa jedem zehnten Fall). Von den Inhaltsschlagwörtern sind, auch wenn sie grundsätzlich deutlich seltener zu finden sind, immerhin fast zwei Drittel normiert.

Die fünf jeweils am häufigsten über einen gültigen URI referenzierten kontrollierten Vokabulare sind für die untersuchten vier Elemente (angegeben ist jeweils die Top-Label-Domain des URI):







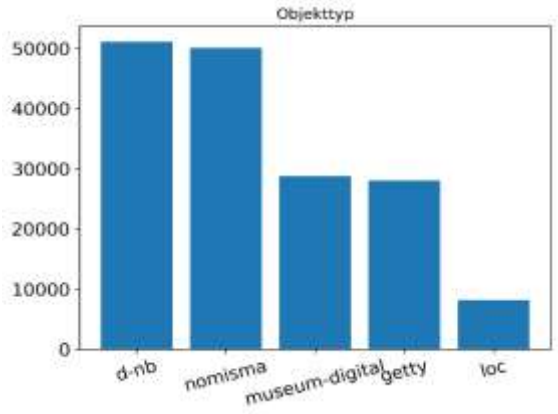


Abb. 5-8: *Die am häufigsten verwendeten kontrollierten Vokabulare*

Erwartbar ist die GND als wohl bedeutendste Normdatei im deutschsprachigen Raum prominent vertreten. Sie wird insbesondere für Personen/Körperschaften und Inhaltsschlagwörter verwendet. Für Geographica hingegen ist GeoNames (http://www.geonames.org/) das Vokabular der Wahl. Auffällig schwach vertreten ist (noch) die universelle, frei zugängliche und allgemein editierbare Wissensdatenbank Wikidata (https://www.wikidata.org), die lediglich bei den Inhaltsschlagwörtern überhaupt nur in der Spitzengruppe in Erscheinung tritt und damit ganz offensichtlich ihr Potenzial noch nicht voll zur Geltung bringt [12].

Zu beachten ist überdies, dass bei weitem nicht alle verwendeten Identifikatoren tatsächlich auch URIs sind und somit, wie unter 3.2 dargelegt, eine maschinelle Prozessierbarkeit garantieren. So verfügen nur zwei Drittel der Personen/Körperschaften mit Identifikatoren über mindestens einen validen URI. Dies bedeutet im Umkehrschluss, dass für ein Drittel der im Grunde normierten (d.h. mit einem wie auch immer gearteten Identifikator versehenen) Daten eine automatisierte Nachnutzung nur eingeschränkt möglich ist, da die Identifikatoren erst aufgelöst werden müssen.

4.3 MASCHINENLESBARE DATUMSANGABEN

Die zeitliche Einordnung relevanter Ereignisse der Objektgeschichte ist fraglos von großer Bedeutung für die Nachnutzung von Objektmetadaten. Folglich ist die eindeutige Maschinenlesbarkeit von Datumsangaben wesentlich für die Metadatenqualität. Die Normierung von Datumsangaben erfolgt durch ISO 8601. Dieser Standard erlaubt Datumsangaben z.B. in der Form YYYY oder YYYY-MM-DD, negative Jahreszahlen freilich nur bedingt. Überdies geht der Standard von vierstelligen Jahreszahlen aus. Bei der hier vorgenommenen Überprüfung der Datumsangaben wurden negative sowie weniger als vierstellige Jahreszahlen jedoch als ebenfalls gültig angesehen.

Im LIDO-Format finden sich Datumsangaben zur Objektgeschichte im <eventDate>-Element. Dieses kann ein <date>-Element zur strukturierten Angabe des Datums enthalten. Dabei wird immer von Zeitspannen zwischen einem frühest- (<earliestDate>) und spätestmöglichen Zeitpunkt (<latestDate>) ausgegangen.

Eindeutig maschinenlesbar sei ein Datum im Folgenden nur dann, wenn im <date>-Element die Werte von <earliestDate> und <latestDate> dem ISO 8601 (mit den beschriebenen Toleranzen) entsprechen. Auch hier wird ein Abdeckungswert von 0 bis 1 berechnet, der angibt, welcher Anteil der <eventDate>-Elemente eines Datensatzes maschinenlesbare Datumsangaben nach obiger Definition enthält.

Bei den Datumsangaben zeigt sich, dass ein überwiegender Teil der Datensätze über maschinenlesbare Datumsangaben verfügt.

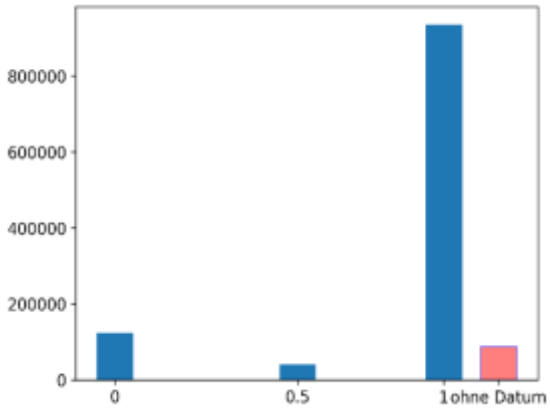


Abb. 9*: Häufigkeitsverteilung der Grads der Maschinenlesbarkeit von Datumsangaben*

4.4 MASCHINENLESBARE MAßANGABEN

Analog zum Datum ist auch bei Maßen und Gewichten die Maschinenlesbarkeit ein relevantes Kriterium. In LIDO werden Maßangaben strukturiert im Element <lido:measurementsSet> erfasst. Dieses muss

über folgende drei Kindelemente verfügen: <lido:measurementType> gibt an, welches Attribut gemessen wird, <lido:measurementUnit> gibt die Maßeinheit an und <lido:measurementValue> schließlich den numerischen Wert.

In unserem Zusammenhang wird eine Maßangabe als maschinenlesbar angesehen, wenn diese drei Elemente vorhanden sind und <lido:measurementValue> als Wert tatsächlich eine Zahl enthält.

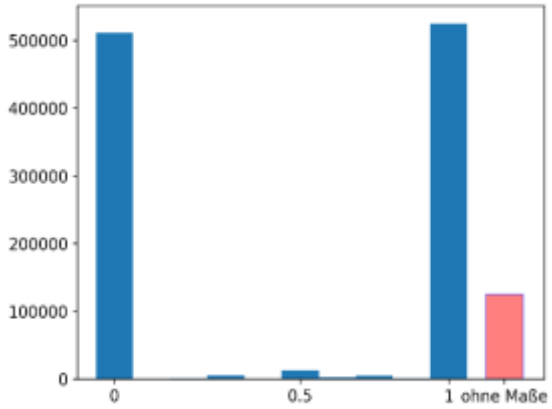


***Abb. 10**: Häufigkeitsverteilung der Grads der Maschinenlesbarkeit von Maßangaben*

Hier zeigt sich ein disparateres Bild als bei den Datumsangaben: Datensätze mit und ohne maschinenlesbare Maßangaben halten sich die Waage. Vor dem Hintergrund der verhältnismäßig hohen Komplexität von Maßangaben (Verzeichnung mehrerer Dimensionen wie Länge und Breite, Hinzufügung von Einheiten etc.), die vermutlich nicht in allen Erschließungssystemen auch eine adäquate Berücksichtigung findet, überrascht dieser Befund nicht.

5. ZUSAMMENFASSUNG

In dieser Arbeit habe ich versucht, Aspekte der Metadatenqualität einer größeren Datenmenge quantitativ zu fassen. Untersuchungsgegenstand waren die in der DDB aggregierten Metadaten aus Berliner Museen.

Die hierfür nötige Datenakquise stellte eine erste Hürde dar, da nur ein kleiner Teil der Daten über Schnittstellen für einen programmatischen Abruf zur Verfügung stehen. Da Metadaten zu Objekten des musealen und sonstigen Kulturerbes wichtige Forschungsdaten sind, ist zu hoffen, dass die sich Verfügbarkeit und Zugänglichkeit dieser Daten in Zukunft verbessern.

Die Qualitätsmessung nahm vier für die museale Objektbeschreibung bedeutende Elemente in den Blick (Person/Körperschaft, Ort, Inhaltsschlagwort, Objekttyp). Als wesentliches Kriterium für die Metadatenqualität wurde die Normdatenabdeckung herangezogen. Es wurde untersucht, welche der relevanten Angaben mit potenziell maschinenlesbaren Identifikatoren versehen sind. Es zeigte sich eine insgesamt schwache Normdatenabdeckung. Die meisten Informationen liegen also in für die Nachnutzung schwer zugänglicher Form vor.

Datumsangaben hingegen sind weitgehend standardisiert und maschinell auswertbar. Bei Maßangaben ergibt sich ein gemischtes Bild. Für knapp die Hälfte der Fälle muss mit unzureichend strukturierten Angaben gearbeitet werden, was bei der Nachnutzung zu einem größeren Aufwand und zu einer höheren Fehleranfälligkeit führt.

Die Qualität ihrer Metadaten beeinflusst die Auffindbarkeit und Sichtbarkeit von Objekten des kulturellen Erbes nicht zuletzt auch auf zentralen Aggregationsplattformen wie der DDB oder Europeana. Ihre Verfügbarkeit und maschinelle Prozessierbarkeit ist eine wesentliche Voraussetzung etwa für die kreative und wissenschaftliche Nachnutzung der Daten.

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Nutzung von Normdaten zur Optimierung von Suche und Filter für Museumsobjekte in der Deutschen Digitalen Bibliothek

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KURZDARSTELLUNG: In diesem am *Institut für Museumsforschung* angesiedelten Forschungsvorhaben wird untersucht, wie durch die konsequentere Einbeziehung von Normdaten die Nutzbarkeit bestimmter Suchfilter in der *Deutschen Digitalen Bibliothek* optimiert werden kann. Daran anknüpfend werden Ansätze entwickelt, wie dieses Wissen rund um die Nutzung von Normdaten in der Museumscommunity vermittelt werden kann. Das Projekt setzt unmittelbar an der Datenquelle an: der Erfassung im Museum. Ausgehend von den Besonderheiten von Museumsdaten und der musealen Objekterschließung wird eruiert, warum die Heterogenität, Form und Qualität bestimmter Museumsdaten die Nutzbarkeit ausgewählter Suchfilter in der *Deutschen Digitalen Bibliothek* beeinträchtigen. Gleichzeitig werden aber auch Lösungsvorschläge erarbeitet; diese können dank der engen Verzahnung des Forschungsvorhabens mit der Fachstelle Museum der *Deutschen Digitalen Bibliothek* sowie weiteren Akteur*innen des Portals, insbesondere im Bereich *Servicestelle und Datenmanagement*, direkt in die operative Arbeit der *Deutschen Digitale Bibliothek* einfließen.

1. EINLEITUNG

Museumsdaten liefern oftmals in der *Deutschen Digitalen Bibliothek* unbefriedigende Suchergebnisse, zumal bestimmte Suchfilter für Museumsobjekte nicht wie vorgesehen genutzt werden können. Kein Wunder, dass Erschließungsinformationen in Museen häufig pauschalisierend, sei es im spartenübergreifenden Vergleich, sei es unter Bezugnahme auf die spezifischen Anforderungen des Datenaustausches, als unzureichend bezeichnet werden. In Anbetracht dessen stellt eine konkret auf die Museumssparte zugeschnittene Untersuchung der wesentlichen Stellschrauben für Datenqualitätsprobleme, die sich konkret auf die Suche und Nutzbarkeit der jeweiligen Filter in der *Deutschen Digitalen Bibliothek* niederschlagen, ein wichtiges Desiderat dar. Eine Annäherung an diese Thematik ist Gegenstand des am *Institut für Museumsforschung* angesiedelten Forschungsvorhabens „Nutzung von Normdaten zur Optimierung von Suche und Filter für Museumsobjekte in der Deutschen Digitalen Bibliothek". Doch genügt es, grundlegende Probleme aufzuzeigen, durch die die Suche im Portal *Deutsche Digitale Bibliothek* erschwert wird? Eine Suggestivfrage, die mit einem klaren „Nein" zu beantworten ist: Natürlich müssen und werden im gleichen Zuge auch Lösungsansätze folgen und der Dreh- und Angelpunkt all dieser Lösungsansätze sind Normdaten.

2. URSACHENANALYSE

2.1 MUSEUMSDATEN SIND ANDERS!

Einen Schritt zurück: Warum werden gerade Museumsdaten, öfters auch als Bibliotheks- oder Archivdaten, von verschiedenen Richtungen aus ganz pauschal als unzureichend empfunden? Um diese Frage zu beantworten, bedarf es einer genauen, über die spezifischen Bedarfe, die vor allem aus den FAIR- und CARE-Principles erwachsen, hinausgehende Festlegung, was eigentlich „gute" Daten ausmacht – ein Qualitätskriterium also für Museumsdaten, bei dem auch der Verwendungszweck musealer Erschließungsinformationen mitgedacht wird. Es wäre vermessen, ein solches Qualitätskriterium im Rahmen eines einzelnen Forschungsprojektes festlegen zu wollen. Ein

kleiner, aber nicht unwichtiger Baustein für die Beantwortung der obengenannten Frage und somit auch ein nicht ganz unbedeutender Beitrag für die Festlegung eines solchen Qualitätskriteriums soll aus einem gemeinschaftlichen Publikationsvorhaben eines Autor*innenkollektives am *Institut für Museumsforschung* hervorgehen. Am Autor*innenkollektiv wirken weiterhin mit: Stephanie Götsch, Frank von Hagel, Chiara Marchini, Lisa Quade und Stefan Rohde-Enslin. Eine der zentralen Fragestellungen wird lauten: „Worin liegen die Unterschiede zwischen Museumsobjektinformationen und Archiv- oder Bibliotheksobjekt-Informationen? Worin liegen Gemeinsamkeiten?“

Einen Schwerpunkt der Artikelserie bilden die Besonderheiten der Kulturdaten aus der Museumssparte – Besonderheiten, die nicht zuletzt auch aus der Andersartigkeit von Museumsobjekten und von (insbesondere die Erschließungspraxis betreffenden) Arbeitsvorgängen im Museum erwachsen: Museumsobjekte bringen im Hinblick auf die Erschließung andere Bedarfe mit sich als Objekte aus anderen Kultursparten. Allein die Ansetzung eines Titels oder Objektnamens gestaltet sich in der Museumssparte in Anbetracht der Tatsache, dass die wenigsten Museumsobjekte von Hause aus einen von der Herstellerin/Künstlerin/Verfasserin oder dem Hersteller/Künstler/Verfasser vorgegebenen Titel haben, schwieriger als in anderen Kultursparten. Für die Erfassung von Museumsobjekten werden mitunter andere Datenfelder benötigt als im Bibliotheks- oder Archivbereich – man denke etwa an die Objektbeschreibung oder an Beschriftungen respektive Inschriften. Gleichzeitig werden einige Datenfelder mit anderen Objektinformationen befüllt, als dies für gleichnamige Datenfelder in anderen Kultursparten der Fall ist – dies betrifft mitunter den Objekttyp, aber auch Klassifikations- und Schlagwortangaben sowie Angaben zum Material. Doch auch die Erfassung in einer (spätestens beim Export obligatorischen) Ereignisstruktur ist weitgehend eine spartenspezifische Besonderheit der musealen Objekterschließung.

2.2 UM WERTEVORRAT AUSGEWÄHLTER SUCHFILTER

Die Besonderheiten der Erschließungsinformationen von Museumsobjekten in Abgrenzung von denen der Kulturerbeobjekte anderer Sparten müssen auch bei einer Ursachenanalyse für die Befüllung der Suchfilter in der *Deutschen Digitalen Bibliothek* stets mitgedacht werden. Der Fokus liegt dabei auf den Suchfiltern mit offenem Wertevorrat (also auf den Suchfiltern mit Freitextangaben im Quellsystem, die somit keine Auswahlmöglichkeit vorgegebener Werte über ein Dropdown-Menü vorsehen): Diese sind die eigentlichen Stellschrauben für unzureichende Suchergebnisse für Museumsobjekte in der *Deutschen Digitalen Bibliothek.*

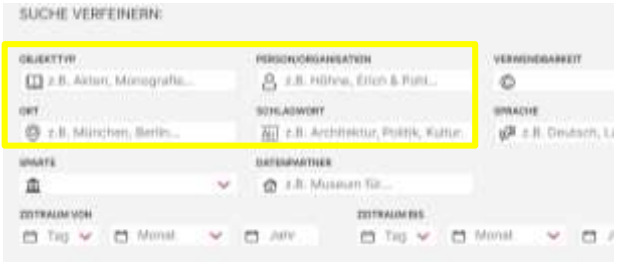

Abb. 1: *Suchfilter mit offenem Wertevorrat in der Deutschen Digitalen Bibliothek*

Ein besonderer Mehrwert des Forschungsvorhabens besteht darin, dass es an der Datenquelle selbst ansetzt: der Erfassung im Museum. Daher wird beispielhaft anhand der Erfassung in einschlägigen Datenbanksystemen aufgezeigt, wie sich bestimmte Erschließungspraktiken in den Quelldaten negativ auf die Befüllung von Suchfiltern in der *Deutschen Digitalen Bibliothek* auswirken: Gerade dann, wenn Suchfilter nicht über Normvokabular befüllt werden, ist ihr Wertevorrat mitunter zu unspezifisch oder auch zu fach- bzw. institutionsspezifisch, werden sie semantisch falsch befüllt oder die Syntax der Filterwerte ist für ein sinnvolle Nutzung des Filters nicht geeignet. Im Folgenden können nur wenige ausgewählte Probleme beispielhaft angerissen werden.

Ein erster Blick gilt dem Suchfilter *Objekttyp*. Dieser spielt für Filtervorgänge im Portal eine exponierte Rolle, da er oft als erster Filter verwendet wird, um Suchergebnisse einzuschränken. Wünschenswert wäre, dass, einer in der Museumsdokumentation sehr verbreiteten dokumentarischen Grundregel

folgend, „für die Angabe des Objekttyps […] der spezifischste Begriff aus der Hierarchieleiter des kontrollierten Vokabulars benutzt“ wird, wie in der über eine öffentlich zugängliche Wiki-Seite veröffentlichte Dokumentation von DDB-LIDO, dem Anwendungsprofil für Datenlieferungen an die *Deutsche Digitale Bibliothek* aus den Sparten Museum, Mediathek Fotografie/Ton und Denkmalpflege, gefordert wird [1]. Nur so lässt sich filigran und zielgenau nach bestimmten Objekttypen filtern. Bei Datenlieferungen aus der Erfassungsdatenbank kuniweb (Portal *Kulturerbe Niedersachsen*, seit Herbst 2022 Aggregator [2] der *Deutschen Digitalen Bibliothek*) war dies zunächst nicht gewährleistet; im Portal *Deutsche Digitale Bibliothek* wurde der Suchfilter *Objekttyp* unzureichend befüllt: Bei einer ersten Datenlieferung überwogen unspezifische und semantisch unpassende Werte in diesem Suchfilter, die sich für spezifische Filtervorgänge nicht eigneten. Dieser Umstand ist in erster Linie darauf zurückzuführen, dass in kuniweb für den „Objekttyp“ kein verpflichtendes Datenfeld vorgesehen ist, was im Hinblick auf die Übertragung von kuniweb-Datenfeldern auf den DDB-*Objekttyp* respektive in den entsprechenden Suchfilter problematisch ist; bei dem verpflichtenden Datenfeld, das in kuniweb *Objekttyp* heißt, handelt es sich eigentlich am ehesten um die Angabe des Medientyps. Das kuniweb-Datenfeld *Kategorie* wird ersatzweise für die Übertragung auf den DDB-*Objekttyp* verwendet, wenn das eigentlich dafür vorgesehene optionale Datenfeld in kuniweb nicht befüllt ist.

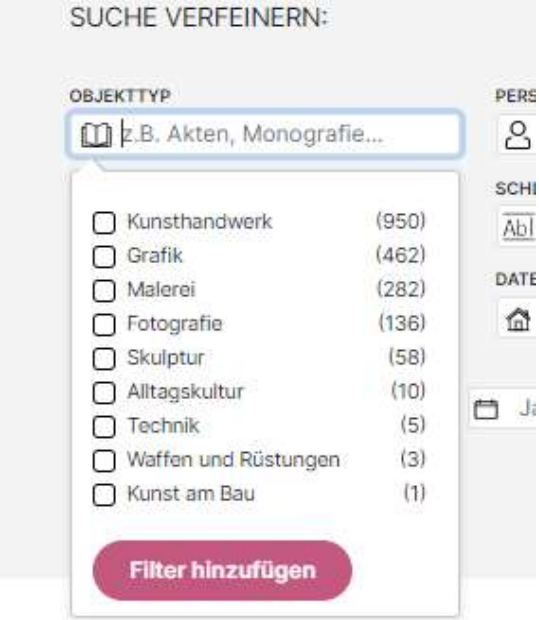

Abb. 2.: *In einem Datenset einer anonymisierten, von Kulturerbe Niedersachsen aggregierten Einrichtung erschienen ursprünglich im Suchfilter Objekttyp unspezifische und mitunter semantisch unpassende Werte. Der Screenshot zeigt einen Arbeitsstand vor der Nachbereitung des Exports in Zusammenarbeit mit der Verbundzentrale des GBV und der AG Metadatenmanagement des Bereichs Servicestelle und Datenmanagements der Deutschen Digitalen Bibliothek.*

Als Folge dessen ergaben sich im Portal *Deutsche Digitale Bibliothek* ursprünglich unzureichende Einträge im Suchfilter *Objekttyp*, die im Sinne der für die Datenmodellierung richtungweisenden LIDO-Terminologie [3] eher sogenannte „Themenkategorien“ [4] und „Objektgattungen“ [5] sind und somit (im Falle von Themenkategorien) semantisch unpassend oder (im Falle von Objektgattungen) zu unspezifisch für einen sinnvollen Filterwert in diesem Suchfilter waren.

Im Suchfilter *Schlagwort* sind im Portal *Deutsche Digitale Bibliothek* nur Werte erwünscht, die einen thematischen Bezug oder den Inhalt eines Objektes zum Ausdruck bringen. Neben diesen sogenannten Themen- bzw. Inhaltsschlagwörter werden in der Verbunddatenbank *museum-digital* (aus der routinemäßig Datenlieferungen an die *Deutsche Digitale Bibliothek* erfolgen) aber auch assoziative Schlagwörter aus dem semantischen Umfeld, Themenkategorien, Materialangaben, Periodenangaben im Datenfeld

Schlagwort/Bezug erfasst – was für die museale Erfassung durchaus legitim ist: Für die museale Erfassung bedarf es in jedem Fall auch assoziativer Schlagwörter; für die Verschlagwortung einer „Kaffeetasse“ ist zumindest für bestimmte Anwendungskontexte das assoziative Schlagwort „Kaffee“ zwingend erforderlich. In *museum-digital* besteht sogar grundsätzlich die Möglichkeit, diese Schlagwörter zu kategorisieren, wodurch man theoretisch auch Themen- bzw. Inhaltsschlagwörter von assoziativen Schlagwörtern unterscheiden könnte [6] – in der musealen Erfassung wird davon derzeit allerdings kaum Gebrauch gemacht; ob dies daran liegt, dass die Möglichkeit der Typisierung relativ neu ist, oder ob diese für die Verschlagwortung als zu aufwendig empfunden wird, sei dahingestellt. Jene assoziativen Schlagwörter landen beim Export an die *Deutsche Digitalen Bibliothek*, zumindest, wenn von der Möglichkeit der Kategorisierung nicht Gebrauch gemacht wird, ebenfalls im Suchfilter *Schlagwort*, was dessen Nutzbarkeit für ausschließlich thematische Bezüge und Inhalte von Objekten erheblich erschwert. Dadurch wird die Recherche im Portal erheblich beeinträchtigt.

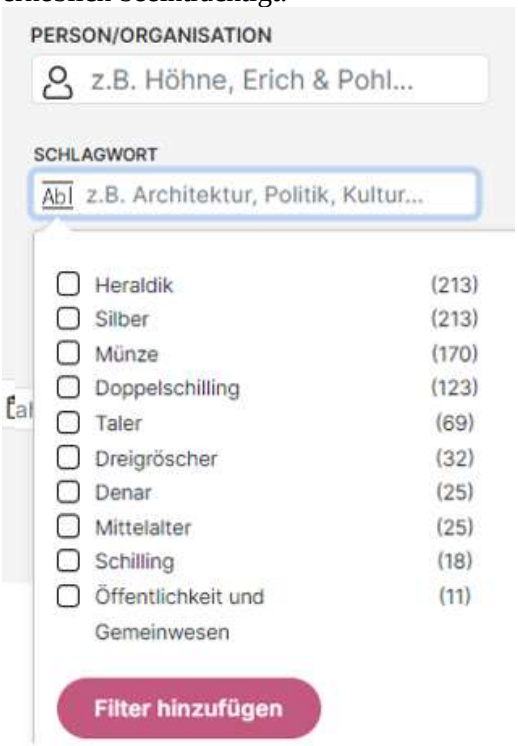

Abb. 3.: *Wie sich assoziative Schlagwörter auf den Wertevorrat im Suchfilter Schlagwort auswirken und dessen Nutzbarkeit für seinen eigentlich vorgesehenen Zweck beeinflussen können, zeigen die Filterwerte eines anonymisierten Datensets, das aus museum-digital an die Deutsche Digitale Bibliothek geliefert wurde.*

Auch die Nutzbarkeit des Suchfilters *Ort* wird durch spezifische Erfassungspraktiken in der musealen Erschließung beeinträchtigt. So ist es in einigen Fachdisziplinen üblich, historische Ortsnamen anzugeben, in anderen liegt der Fokus auf modernen Ortsbezeichnungen. Selbst in den Staatlichen Museen zu Berlin wird dies innerhalb verschiedener Sammlungen unterschiedlich gehandhabt: Das *Vorderasiatische Museum* gibt in recherche.smb.museum im Datenfeld *Geografische Bezüge* sowohl den historischen Fundort als auch den modernen Fundort an und liefert unter *Fundortdetail* spezifizierende Angaben. Dies führt dazu, dass sowohl „Babili“ (als historischer Fundort) als auch „Babylon“ (als moderner Fundort) im Wertevorrat des Suchfilters *Ort* landen. Hingegen gibt das *Münzkabinett Berlin*, das in ikmk.smb.museum erfasst, die historische *Münzstätte*, eine moderne *Region* und das moderne *Land* an. Die *Antikensammlung* erfasst indes, was aus Erfassungsperspektive durchaus nachvollziehbar ist, teilweise historische Ortsangaben (z. B. „Pergamon“ statt „Bergama“), teilweise aber auch moderne Ortsnamen (z. B. „Köln“). Dies hat zur Folge, dass in der *Deutschen Digitalen Bibliothek* sowohl historische als auch moderne Ortsangaben im Suchfilter *Ort* landen und eine genaue Unterscheidung nicht vorgenommen wird. Gerade über die Nutzung von Normvokabular könnte man theoretisch eine sinnvolle Trennung von historischen und modernen Ortsangaben im Suchfilter gewährleisten, wobei einschränkend darauf hinzuweisen ist, dass es noch keine Thesauri für historische Ortsnamen mit ausreichender Abdeckung gibt. Mindestens aber wäre eine stringente Typisierung erforderlich, die im Einzelfall nachvollziehbar macht, ob es sich um eine historische oder eine moderne Ortsangabe handelt. Hiermit geht die Frage einher, ob Orte nach moderner politischer oder nach historischer geographischer Zugehörigkeit strukturiert werden sollen: Mit einem Blick auf die Ortsangaben in den Daten des *Museums für Vor-und Frühgeschichte* stellt sich etwa die Frage: Soll die Gemeinde Grebieten also der Oblast Kaliningrad, die wiederum zu Russland gehört, oder der Provinz Ostpreußen im Königreich Preußen des Deutschen Reiches zugeordnet werden? Je nach Schwerpunkt der Sammlungsausrichtung wird eine solche geographische Zugehörigkeit gegebenenfalls unterschiedlich erfasst. In jedem Fall wäre es notwendig, dass geografische

Zugehörigkeitsketten in den Daten spätestens beim Datenexport so aufgesplittet werden, dass der Suchfilter *Ort* in der *Deutschen Digitalen Bibliothek* nicht mit Filterwerten in Gestalt von syntaktisch ungeeigneten Entitätsketten befüllt wird, wie in untenstehender Abbildung gezeigt. Dies erschwert die Nutzbarkeit des Suchfilters erheblich und schränkt dessen intuitive Handhabung erheblich ein.

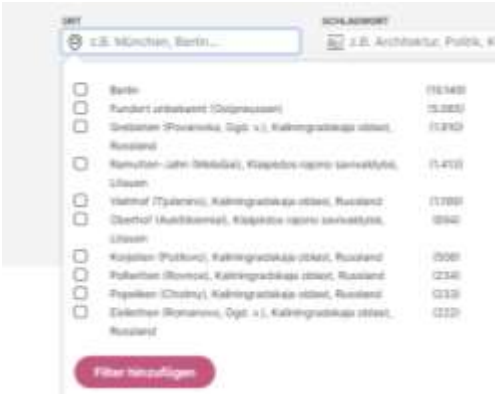

Abb. 4: *Wertevorrat im Suchfilter Ort bei allen Daten des Museums für Vor- und Frühgeschichte in der Deutschen Digitalen Bibliothek.*

3. LÖSUNGSANSÄTZE

Sowohl Anzeige- als auch Filterwerte können im Portal in aller Regel nur so gut sein wie die Quelldaten, die an das Portal geliefert werden. Trotzdem muss man sich bei der Suche nach geeigneten Lösungsansätzen für die Optimierung der Suchfilter in der *Deutschen Digitalen Bibliothek* genau diesen Tatbestand bewusstmachen. Die Filterwerte werden erst dann besser und brauchbarer, wenn in höherem Maße normiertes Vokabular Eingang in ihren Wertevorrat findet – doch müssen sie vor allem auch semantisch richtig nach einheitlichen Vorgaben befüllt werden.

3.1 DIE MINIMALDATENSATZ-EMPFEHLUNG

Einen Anhaltspunkt hierfür, der einerseits bewusst möglichst niederschwellig gehalten ist, andererseits aber auch ein Mindestmaß an Datenqualität gewährleistet und zudem eine Kompatibilität mit dem Datenaustauschformat LIDO einschließt, ist die Minimaldatensatz-Empfehlung für Museen und Sammlungen [7]. An deren Entstehung und Weiterentwicklung wurde und wird im Rahmen des Forschungsvorhabens mitgewirkt (zusammen mit Vertreter*innen der *Fachstellen Museum* und *Mediathek* der *Deutschen Digitalen Bibliothek*, der *AG Digitalisierung* der *Konferenz der Museumsberatungsstellen in den Ländern* (KMBL), des Instituts für Museumsforschung, der Fachgruppe Dokumentation im Deutschen Museumsbund, von digiCULT-Verbund eG, museum-digital, NFDI4Culture, digiS Berlin und der Koordinierungsstelle für wissenschaftliche Universitätssammlungen in Deutschland). Ziel der Empfehlung ist es, Museen und Sammlungen bei der Online-Veröffentlichung ihrer Kulturdaten zu unterstützen. Sie enthält ein Kernelemente-Set derjenigen Datenelemente, die am häufigsten für eine qualifizierte Suche und Filterung von Kulturerbe-Daten herangezogen werden. Nutzt man hier kontrolliertes Vokabular, das mit URIs versehen und daher in Linked-Data-Kontexten auswertbar ist, dient dies einer deutlich verbesserten Auffindbarkeit, Zugänglichkeit, Interoperabilität und Nachnutzbarbeit der Daten (FAIR-Prinzipien). Die Minimaldatensatz-Empfehlung trägt so dazu bei, die wertvollen Bestandsdaten von Sammlungen für neue und ambitionierte Nutzungsarten fit zu machen. Auch soll Museen und Sammlungen dadurch der Weg in Portale wie die *Deutsche Digitale Bibliothek* und *Europeana* geebnet werden.

Einen wichtigen Mehrwert und eine Grundvoraussetzung dafür, dass bei Orientierung an der Minimaldatensatz-Empfehlung an die *Deutsche Digitale Bibliothek* Normdaten geliefert werden, die idealerweise auch in den Suchfiltern Eingang finden sollen, sind einschlägige Vokabularempfehlungen; diese sind im Rahmen des Forschungsvorhabens mit weiteren Mitgliedern der AG Minimaldatensatz für die einzelnen Datenfelder der Empfehlung erarbeitet worden. So werden etwa, um nur ein einziges Beispiel zu nennen, für den Objekttyp Begriffe aus der *Objects Facet* des *Art & Architecture Thesaurus*, aus der *Gemeinsamen Normdatei* (Entitätstyp Schlagwort sensu stricto), aus *Wikidata* oder aus der (bestenfalls dritten Hierarchiestufte der) Objektbezeichnungsdatei empfohlen. Für die *Deutsche Digitale Bibliothek* bedeutet dies, dass Einrichtungen, die sich an der Minimaldatensatz-Empfehlung orientieren, idealerweise Begriffe aus dem *Art & Architecture Thesaurus* oder der *Gemeinsamen Normdatei* liefern, die für die Befüllung des Suchfilters *Objekttyp* als sinnvoll erachtet

werden; dies wiederum entspricht der Vokabularempfehlung in den auf einer öffentlichen DDB-Wikiseite veröffentlichten Anforderungen an die Lieferdaten der *Deutschen Digitalen Bibliothek*, denen zufolge „zur Unterstützung der Nutzungsszenarien […] ein URI für den Begriff aus der Gemeinsamen Normdatei (GND) und/oder aus der Objects Facet des Art & Architecture Thesaurus (AAT) bevorzugt“ [8] wird, alternativ aber auch ein URI aus Wikidata geliefert werden könne [9].

3.2 DAS KUNIWEB-DDB-NORMDATEN-MAPPING

Ein weiterer Lösungsansatz für die Verbesserung des Wertevorrates in den Suchfiltern der *Deutschen Digitalen Bibliothek* setzt nicht direkt bei der Erfassung im Museum an, sondern baut auf der engen Abstimmung mit Aggregatoren (also Diensten, die Metadaten sammeln, verwalten und weitergeben) sowie der gemeinsamen Optimierung des Datenexports. Die Zusammenarbeit mit dem Aggregator *Verbundzentrale des GBV* (VZG), der das Portal *Kulturerbe Niedersachsen* betreibt, und der *AG Metadatenmanagement* des Bereichs *Servicestelle und Datenmanagement* der *Deutschen Digitalen Bibliothek* ist ein Paradebeispiel dafür, wie zum einen durch die enge Zusammenarbeit verschiedener infrastruktureller Ebenen die Nutzung von Normdaten verbessert und ein bedeutsamer Suchfilter optimiert werden kann – aber zum anderen auch dafür, wie bestimmte Projektergebnisse durch die enge Zusammenarbeit mit dem Bereich *Servicestelle und Datenmanagement* der *Deutschen Digitalen Bibliothek* in die operative Arbeit der *Deutschen Digitalen Bibliothek* einfließen können. So lässt sich etwa durch eine gezielte Normdatenfeld-Priorisierung eine erhebliche Verbesserung des Suchfilters *Objekttyp* erreichen: Ist das primär für die Übertragung in den Objekttyp vorgesehene Datenfeld nicht befüllt oder ist zusätzlich zu einem Eintrag in jenem Datenfeld noch eine Bezeichnung aus der *Objektbezeichnungsdatei* erfasst worden, werden anstelle des ursprünglich dafür vorgesehenen kuniweb-Datenfeldes *Kategorie* mit seinen großenteils semantisch unpassenden und zu unspezifischen Begriffen in einer bestimmten Reihenfolge Vorzugsbezeichnungen anderer Normvokabulare (namentlich *Objektbezeichnungsdatei* und *Hessische Systematik*) in den DDB-*Objekttyp* übertragen, sodass einerseits spezifischere Begriffe in diesen Suchfilter Eingang finden und andererseits die Befüllung des Suchfilters semantisch optimiert wird.

Sind keine der für diese Priorisierung in Frage kommenden Datenfelder belegt, werden die Begriffe des kuniweb-Datenfeldes Kategorie über eine gemeinsam mit dem Aggregator erarbeitete Konkordanz wahlweise auf die *Gemeinsame Normdatei* oder den *Art and Architecture Thesaurus* gemappt. In den DDB-*Objekttyp* wird dann die Vorzugsbezeichnung aus einem dieser beiden Vokabularen gewählt, wofür im Sinne einer optimalen Filter-Befüllung die Singularform präferiert wird; im gleichen Zuge werden Identifikatoren (URIs) aus dem *Art and Architecture Thesaurus* oder der *Gemeinsame Normdatei* mitgeliefert. Die kuniweb-*Kategorie* „Malerei“ wird zum DDB-*Objekttyp* „Gemälde“, „Medizin“ wird zu „Medizinisches Gerät“ und „Alltagskultur“ wird zu „Gebrauchsgegenstand“, um nur wenige einschlägige Beispiele zu nennen.

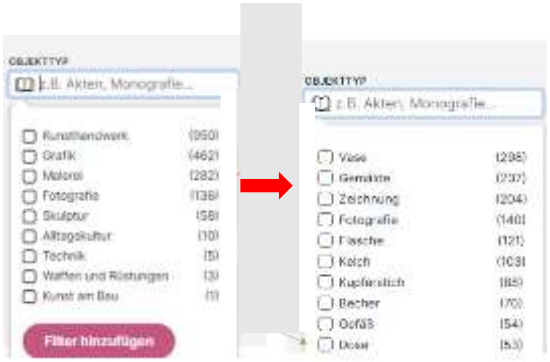

Abb. 5: *Schaubild zur semantischen Optimierung und Spezifizierung des Wertevorrates im Suchfilter Objekttyp im Zuge des kuniweb-DDB-Normdaten-Mappings anhand eines anonymisierten Datensets.*

4. ZUSAMMENFASSUNG UND AUSBLICK

Nachdem kurz angerissen wurde, welche spartenspezifische Herausforderungen die Erschließung von Museumsobjekten mit sich bringt, dürfte deutlich geworden sein, dass sich die Heterogenität und die Spezifika der unterschiedlichen hausinternen Erfassungslogiken und -praxen mitunter negativ auf die Nutzbarkeit gewisser Suchfilter in der *Deutschen Digitalen Bibliothek* auswirken. Ist der Objekttyp in der Erfassung nicht verpflichtend und wird daher das entsprechende Datenfeld in der Erfassung nicht befüllt, so beeinträchtigt dies in der *Deutschen Digitalen*

Bibliothek die Nutzbarkeit des Suchfilters *Objekttyp*. Wird bei der Erfassung nicht zwischen assoziativen Schlagwörtern und Themen- bzw. Inhaltsschlagwörtern unterschieden, wirkt sich das auf den Wertevorrat im Suchfilter *Schlagwort* aus, der nur für ganz bestimmte Schlagwörter vorgesehen ist. Nicht minder hat eine fehlende Disambiguierung von historischen und modernen Ortsangaben in der Erfassung Rückwirkungen auf die Qualität des Wertevorrats im Suchfilter *Ort*. Lösungsansätze sollten idealiter, wie die Minimaldatensatz-Empfehlung für Museen und Sammlungen, direkt bei der Erfassung im Museum ansetzen oder auf eine enge Zusammenarbeit mit Aggregatoren im Hinblick auf einen eng auf die Bedarfe des Portals abgestimmten Umgang mit Normdaten hinauslaufen. Als weitere Lösungsansätze sind denkbar: Hilfestellungen für die Verschlagwortung und die Unterscheidung zwischen assoziativen Schlagwörtern sowie Themen- und Inhaltsschlagwörtern; allgemeine Guides und Anleitungen für die bessere Einbeziehung von Normdaten und deren Mapping unter Berücksichtigung der Bedarfe der *Deutschen Digitalen Bibliothek* oder auch ein normdatenfokussierter Beispieldatensatz, der im Rahmen der Dokumentation des LIDO-Anwendungsprofils DDB-LIDO erarbeitet werden soll.

5. REFERENZANGABEN

[1] https://wiki.deutsche-digitale-bibliothek.de/x/0AmuB. Das LIDO-Element <objectWorkType> / <term> ist hier dokumentiert: https://wiki.deutsche-digitale-bibliothek.de/x/HYTABg.
[2] Begriffserklärung unter https://pro.deutsche-digitale-bibliothek.de/glossar/aggregator.
[3] Cf. http://terminology.lido-schema.org.
[4] Cf. http://terminology.lido-schema.org/lido00932.
[5] Cf. http://terminology.lido-schema.org/lido00853.
[6] Cf. https://blog.museum-digital.org/2023/05/11/categorizing-an-objects-tags/.
[7] Cf. www.minimaldatensatz.de (Beta-Version).
[8] https://wiki.deutsche-digitale-bibliothek.de/x/25ClAQ (s. v. „Vokabularempfehlung“).
[9] Ibidem.

EVA Berlin

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Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Von der digitalen Sammlung zur „Sammlung als Daten“ mit effizientem Qualitätsmanagement

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KURZDARSTELLUNG: In Kulturerbe-Einrichtungen herrscht mittlerweile die Erkenntnis, dass Objekt-Sammlungen heute, sobald sie ins Digitale transferiert werden, zum Bestandteil einer globalen *Knowledge Base* werden können. Mit dem Fokus auf Museen und Sammlungen regt der Beitrag alle Einrichtungen des GLAM-Sektors dazu an, Aufbau und Vermittlung ihrer digitalen Bestände entsprechend der *collections as data*-Initiative sparten- und materialübergreifend zu planen. Die damit verbundenen Arbeitsprozesse sollten grundsätzlich mehr vom digitalen Publizieren ausgehend gedacht werden, eine Auffassung, die zumindest vielen Museen und Archiven in dieser Form noch fremd sein dürfte. Durch ein möglichst zweckgebundenes Qualitätsmanagement auf Institutions-, Projekt- und auf Datenebene können die Lösungswege für ein solches Vorhaben schrittweise erarbeitet werden. Die Nationale Forschungsdateninfrastruktur (Konsortium *NFDI4Culture*) legt dafür das Fundament, indem sie Leitlinien für die Praxis erarbeitet und an der Schnittstelle zwischen den beteiligten Akteuren „Wissenschaft und Forschung“ sowie „GLAM-Einrichtungen“ vermittelt.

1. EINFÜHRUNG

Im Rahmen einer kürzlich durchgeführten Workshopreihe zu Datenqualitäts-Strategien für Museen und Sammlungen wurden die Teilnehmenden zu den gewünschten Nutzungszielen für ihre Sammlungsdaten befragt.[1] Der Großteil entschied sich für die Verbesserung der Publikation ihres Bestandes, gefolgt von einer angestrebten Nutzung durch die Forschung und der Vernetzung als Linked Open Data sowie der Veröffentlichung auf externen Plattformen. Auf die Frage, womit Museen aktuell die meisten Qualitätsprobleme mit ihrem Datenbestand haben, gab die Mehrzahl der Teilnehmer:innen Defizite für die interne Verwendung an. Ein weiterer Teil bemängelte die unzureichende Datenqualität für die Online-Publikation auf Plattformen oder für die Präsentation auf der Website ihrer Einrichtung, um bestimmte Nutzerwünsche erfüllen zu können. Die Ergebnisse der Umfrage scheinen einerseits den Wunsch nach neuen Formen der Nutzung von hausinternen Datenbeständen zu belegen. Andererseits zeigen sie aber auch, dass sich Museen und Archive in Zukunft verstärkt mit den Themen Forschungsdatenmanagement und digitales Publizieren sowie mit dem Aufbau von Publikationsdiensten, den notwendigen Arbeitsschritten und Werkzeugen beschäftigen sollten. Ihr Engagement fällt damit in einen Bereich, der bislang mehr oder weniger ausschließlich den Bibliotheken vorbehalten war.

Dass eine Orientierung in diese Richtung möglich ist, zeigt auch die Initiative *Collections*

as data, die alle Einrichtungen des kulturellen Erbes als eine Einheit begreift und den Aufbau sparten-, material- und formatübergreifender Sammlungen unterstützt.[2] Ein strategisches und nachhaltiges Datenqualitätsmanagement ist der Schlüssel zur Erreichbarkeit dieses Ziels und sollte alle Einrichtungen begleiten, die sich mit dem Gedanken tragen, ihre Sammlungsdaten öffentlich zu machen und zu teilen. Ein besonderes Augenmerk muss den künftigen Publikationsanforderungen für Sammlungsdaten und den möglichen Arbeitsschritten für deren umfassende Erfüllung gelten. Dabei ist wichtig, dass eine Qualitätssicherung und Verbesserung von Bestandsdaten immer auch als gradueller Prozess verstanden werden muss.

2.1 *NFDI4CULTURE* UND TASK AREA 2

Das Konsortium *NFDI4Culture* ist als Teil der Nationalen Forschungsdateninfrastruktur für eine nachhaltige Standardisierung, Sicherung und Bereitstellung von Forschungsdaten des kulturellen Erbes zuständig. Es bedient neben der Kunstgeschichte (insb. Architektur) auch die Musikwissenschaft, die Theater-, Tanz- und Medienwissenschaft, also eine ausgesprochen heterogene Fächergruppe, die entsprechend verschiedenartige Datentypen für die digitale Forschung einsetzt.[3]

Typischerweise gibt es zwei große Zielgruppen: zum einen die Fachvertreter:innen bzw. Forschenden in den Digital Humanities, zum anderen die datenhaltenden Einrichtungen (sog. GLAM-Einrichtungen, Datenportale, Repositorien etc.). Die Wissenschaftler:innen sind die klassischen **Datennehmer** in diesem System. Die datenhaltenden Einrichtungen kann man als **Datenanbieter** bezeichnen. Idealerweise müssen die Bedarfe beider Gruppen gleichermaßen in den Blick genommen werden, um zu einem guten Produkt zu gelangen. Eine strikte Trennung von Datennutzung und Datenversorgung lässt sich jedoch kaum halten, denn es handelt sich um ein System, in dem Datenflüsse nicht zwischen zwei Polen, sondern kreislaufartig verlaufen: Die Forschenden stellen ihre Daten für andere Forschende zur Verfügung, die diese für ihre eigene Arbeit nachnutzen möchten. Sie können also auch als Datengeber fungieren. Umgekehrt beziehen Repositorien ihre Daten in der Regel von Einzelpersonen oder Forschungsgruppen und Aggregatoren von unterschiedlichen Anbietern. Beide üben also auch die Rolle des Datennehmers aus. In vielen Fällen produzieren sowohl Forschende als auch datenhaltende Einrichtungen ihre Daten selbst, und zwar in dem einen Fall für befristete Projekte (lokale Datenspeicherung) und im anderen Fall im Rahmen von Digitalisierungs- und Erfassungskampagnen (langfristige Speicherung, Datenkuration).

NFDI4Culture ist aufgeteilt in verschiedene Aufgabenbereiche (Task Areas), die sich thematisch entlang der Stationen im Datenlebenszyklus bewegen und wichtige Bestandteile der Dateninfrastruktur liefern sollen. Task Area 2 „Standards, Datenqualität und Kuratierung“ engagiert sich für den Aufbau eines effizienten Qualitätsmanagements für alle Forschungsdaten, die bei der Arbeit mit materiellen und immateriellen Kulturgütern entstehen können. Dabei geht es weniger um die technische Umsetzung der Datenerzeugung und -erfassung, sondern vielmehr um die Ebene der regelbasierten formalen und inhaltlichen Erschließung und Dokumentation mit Metadaten. Dies geschieht durch geeignete Metadaten- und Austauschformate, durch kontrollierte Vokabulare und Normdaten. Die Gewährleistung, Verbesserung und Sicherung von (Meta-)Datenqualität spielt eine entscheidende Rolle. Der Beitrag möchte die notwendigen Stellschrauben und Weichenstellungen vorstellen, die innerhalb der Task Area gesammelt, erarbeitet und diskutiert worden sind.

2.2 HINWIRKEN AUF EIN ZUSAMMENWACHSEN DER GLAM-EINRICHTUNGEN

Vergleicht man die Aufgaben innerhalb der drei Sparten Bibliothek, Archiv und Museum ([G]LAM), so fällt auf, dass sich die Arbeitsfelder im Groben annähern. Bibliotheken widmen sich dem Erwerben, Erschließen, Bereitstellen und Bewahren. Archive sammeln, verzeichnen, bewahren, erforschen und vermitteln. Museen werden auf das Sammeln, Dokumentieren, Erforschen, Bewahren, Vermitteln und Präsentieren festgelegt. Sammeln, Ordnen, Verfügbar machen und Bewahren sind gemeinsame tragende Säulen aller Infrastruktureinrichtungen (Abb. 1), wobei Archive und Museen traditionell enger verwandt sind, denn sie verwalten unikale und oftmals heterogene Objekt- und Materialgattungen, die in der Regel nicht der

Öffentlichkeit für die Benutzung bereitgestellt werden.[4] Monografien und Zeitschriften sind hingegen genormte Medien, die immer gleichförmig aufgebaut sind, serienmäßig hergestellt und seit langem nach festen Regeln erfasst werden.

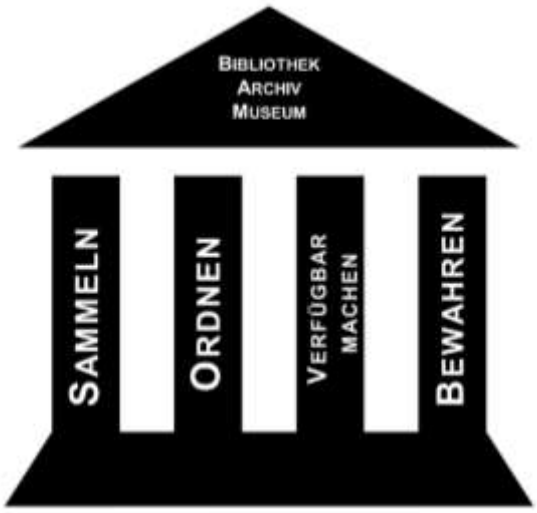

Abb. 1: *Gemeinsame Arbeitsbereiche aller (G)LAM-Sparten, Grafik via pixabay*

Bei der Erschließung von Archiv- und Museumsbeständen steht außerdem die historische Kontextualisierung im Mittelpunkt. Entsprechend geht ein individueller Forschungsprozess voraus, der die Sammlungsdaten um eine Vielzahl an Inhaltstypen (z.B. Ereignisse in der Objektgeschichte) bereichert. Sammlungsdaten sind also zunächst nur bedingt mit bibliografischen Metadaten vergleichbar, obwohl beide Kategorien als Forschungsdaten dienen können. Entsprechend gibt es für Museen nur wenige übergreifende, zentral vorgegebene Verfahrens- und Ordnungsweisen für die Erschließung.[5]

Mit der konsequenten Digitalisierung der Bestände kann diese traditionell gewachsene Kluft zwischen den einzelnen Sparten überwunden werden. Digitale Sammlungen aller Einrichtungen bestehen jetzt nur noch aus **Datenobjekten**, die technisch alle gleichförmig aufgebaut sind (Abb. 2). Sie setzen sich zusammen aus den Datenelementen (z.B. 2D-Bild, 3D-Objekt, Video- oder Audio), die als Bitsequenz maschinell verarbeitet werden können, aber selbst keine Auskunft über das Datenobjekt geben; außerdem den zugehörigen Metadaten, welche die Summe der möglichen Aussagen über ein Informationsobjekt darstellen, und schließlich den Persistenten Identifikatoren (PIDs), welche alle Teile des Datenobjekts referenzierbar machen.[6]

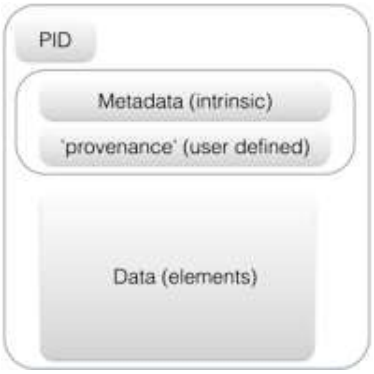

Abb. 2: *Canham, Steve und Ohmann, Christian: A metadata schema for data objects in clinical research. Trials 17. 2016. Nr. 557 Fig. 1.*

Bei einer **physischen Sammlung** ist (auch heute noch) entscheidend, jedes Artefakt möglichst originalgetreu zu erhalten, damit es für Ausstellungen zur Verfügung steht. Alle Erfassungsdaten können dazu verwendet werden, die Sammlung zu erhalten oder zu beforschen; ebenso denkbar ist die Abwicklung von Arbeitsprozessen im Museum (i.e. Berichte, Leihverkehr, Ausstellungsplanung, Öffentlichkeitsarbeit etc.). Werden die Artefakte digitalisiert, spricht man allgemein von einer **‚digitalen Sammlung'**. Bei der Umwandlung in eine digitale Sammlung fungiert jedes Digitalisat als Surrogat für das physische Objekt und kann zum Beispiel als Anschauungsmaterial für Online-Ausstellungen auf Websites und Portalen eingesetzt werden. Erfassungsdaten aus dem Sammlungsmanagementsystem unterstützen die Präsentation auf der eigenen Website, gegebenenfalls können die Metadaten zum Objekt zusammen mit dem Digitalisat datensatzweise heruntergeladen werden.

Mit dem Wandel von der ‚digitalen Sammlung' zu einer **‚Sammlung als Daten'** ändert sich dieses Verständnis: Das Artefakt wird zu einem Objekt, das in der Masse computerbasiert verarbeitet werden kann. Die Erschließung mit Metadaten wird mit speziellen Verfahren direkt an der digitalen Reproduktion vorgenommen bzw. in dieses hineingeschrieben. Spezielle Software unterstützt zudem die automatisierte Integration von URIs, den einheitlichen Identifikatoren für Ressourcen. Diese so

erzeugten Datenobjekte (s.o. Abb. 2) können nicht nur als Ausgangsbasis für computerbasierte Analysen dienen, sondern auch als Linked Data für die Darstellung von Wissenskontexten in Graphdatenbanken (sog. Knowledge Graphs) integriert werden.[7] Jede Art von Sammlungseinrichtung (GLAM) wird auf diese Weise animiert, ihre digitalen Bestände für weitergehende Forschung und Entwicklung bereitszustellen, um zufällige Entdeckungen (*serendipity*), neue Verbindungen, Tendenzen oder Muster sichtbar zu machen. Datensilos werden aufgelöst und können synchron befragt werden, etwa nach der Zahl der Objekte, nach Objektkategorien, Künstlern, Werktiteln, Bildthemen, Anzahl der Digitalisate etc.

Über eine Schnittstelle können ganze Sammlungen oder Teilsammlungen in einer Größenordnung von Tausenden oder gar Millionen von Datenobjekten für die eigene Forschung heruntergeladen oder befragt werden. Es ist ebenso denkbar, sich mithilfe der maschinellen Auswertung von Sammlungsdaten innerhalb spezieller Tools einen Überblick über die thematische, gattungsbezogene und zeitliche Verteilung der eigenen Bestände, über Künstler, über Zu- und Abgänge, über kontextuelle Bezüge zwischen Werken, Personen, Orten, Zeiten, Ereignissen usw. in Form von Visualisierungen ausgeben zu lassen. Das Sammlungsmanagement und das Monitoring der eigenen Arbeit kann auf diese Weise erleichtert werden.

2.3 DIE *COLLECTIONS AS DATA*-INITIATIVE

Die Kampagne *Collections as Data* (‚Sammlungen als Daten') an den Universitäten Iowa und Nevada Las Vegas hatte den Aufbau sparten- und formatübergreifender digitaler Sammlungen zum Ziel. Im Fokus stand die Frage, welche Services die Arbeit mit den Sammlungsdaten optimal unterstützen. Über einen Zeitraum von drei Jahren arbeiteten Wissenschaftler, Informationstechnologen, Bibliothekare, Archivare und Museumsmitarbeiter gemeinsam daran, Dienstleistungen und Zuständigkeiten neu auszurichten. Alle Sammlungseinrichtungen wurden auf diese Weise animiert, kreativ darüber nachzudenken, wie sie die Qualität ihrer Daten verbessern können, etwa durch die Öffnung für digitale Forschung und Entwicklung. Zu den diskutierten Themen gehörten unter anderem Interoperabilität, Prozessdokumentation, spezifische Bedarfe der Nutzung sowie ethische und rechtliche Barrieren. Ergebnis war das *Santa Barbara Statement on Collections as Data*.[8] Einzelne Fallstudien, die *Collections as Data Facets*, beschreiben beispielhaft die Zugänglichmachung von Sammlungsdaten aus Kulturerbe-Institutionen.[9]

Ähnliche Bestrebungen verfolgt das vom britischen Arts and Humanities Research Council finanzierte Forschungsprojekt ‚The Sloane Lab: Looking back to build future shared collections'. Es ist Teil der *Collections as Data*-Initiative und gehört zum übergreifenden Programm *Towards a National Collection* (TaNC).[10] Ziel ist es, die umfangreichen Sammlungen von Sir Hans Sloane (1660-1753) im British Museum, dem Natural History Museum, der British Library und weiteren Institutionen digital zu vernetzen. Als Hauptergebnis wird ein frei zugängliches Online-Labor für Forschende und die allgemeine Öffentlichkeit erwartet. Auch innerhalb der Research Data Alliance (RDA) Community formiert sich mittlerweile eine Interessengruppe für Kulturerbe-Daten, welche die Arbeit der RDA mit anderen Netzwerken, Konferenzen und Berufsverbänden im GLAM-Sektor vernetzen will.[11]

In Deutschland strebt bekanntermaßen die Deutsche Digitale Bibliothek (DDB) bereits seit 2009 eine Zusammenführung und Vernetzung der Bestände von Kultureinrichtungen und Wissenschaftseinrichtungen an. Auch die Deutsche Forschungsgemeinschaft (DFG) und der Rat für Informationsinfrastrukturen (RfII) schließen Sammlungsdaten explizit in ihren Forschungsdatenbegriff ein.

Das *NFDI4Culture*-Konsortium möchte die Entwicklungen und Aktivitäten der *Collections as Data*-Initiative weiterhin verfolgen und für die eigenen Bemühungen um eine effiziente Zusammenführung der Sammlungsbestände aus unterschiedlichen GLAM-Einrichtungen im Blick behalten.

2.4 NOTWENDIGE MECHANISMEN DES DATENQUALITÄTSMANAGEMENTS

Man kann sich vorstellen, dass gute Qualität eine wichtige Grundbedingung für den Aufbau einer ‚Sammlung als Daten' ist. Datenqualität lässt sich in erster Linie durch gutes Management erreichen. Dies betrifft:

1. die **Einrichtung**, ihre Strategie und Organisationsstruktur.
2. jedes **Projekt** innerhalb der Einrichtung. Gute Planung, ein leicht verständliches Konzept, ein realistischer Zeitplan mit Festlegung der typischen Arbeitsschritte und Aufgaben kann die Qualität des Datenoutputs positiv beeinflussen.
3. Werte, Inhalte, Struktur und Organisation der **Daten** selbst, diese ist am Ende der erheblichste Faktor im Qualitätsmanagement.

ad 1. Ein Organigramm der einzelnen Abteilungen in der Einrichtung hilft bei der Definition ihrer Arbeitsbereiche und Zuständigkeiten (z.B. Bestandsaufbau, Bestandsvermittlung, Bestandsanreicherung, Bestandspflege etc.). Es sollte für alle GLAM-Institutionen verpflichtend sein und kann durch eine Ablauforganisation mit Flussdiagrammen für jede Abteilung ergänzt werden. Ein Sammelprofil oder Sammlungskonzept mit den verwendeten Regelwerken und Richtlinien ist in diesem Zusammenhang ebenfalls sinnvoll. Für die eigene Zielsetzung ist eine Ist-Soll-Analyse hilfreich (Anforderungen definieren), darüber hinaus ein Maßnahmenkatalog, Definition von Qualitätskriterien (z.B. Konsistenz, Genauigkeit, Korrektheit, Präzision, Eindeutigkeit, Vollständigkeit, Verständlichkeit etc.) und zu messenden Kennzahlen.

Die organisatorische Ebene des Datenqualitätsmanagements umfasst drei Gestaltungsbereiche: die eigentliche Abwickelung mit Verantwortlichen und ihren Rollen, Aufgabenbereichen und Rechten, das ‚Datenqualitäts-Controlling' und die Prozesse und Methoden, nach denen die Mitarbeiter arbeiten. Hierzu gehören u.a. Handlungsanweisungen, Kriterien und Messverfahren sowie Prüfregeln.[12]

ad 2. Die Umsetzung von digitalen Projekten, ihre genaue Planung und Durchführung sind eng verzahnt und stetigen Veränderungsprozessen unterworfen. Datenmanagementpläne (DMP) sind ein sinnvolles Werkzeug für die rechtzeitige Weichenstellung und – projektbegleitend – eine notwendige fortlaufende Anpassung für das Projektmanagement. Sie bestehen in der Regel aus einer großen Sammlung zumeist offener Fragen zur Datenerhebung und -verarbeitung, zur Dokumentation, zum Datensicherungskonzept, zum rechtlichen Rahmen, zum Nachnutzungspotential der entstehenden Daten in puncto Zugänglichkeit und Lizenzen, zur Dialogfähigkeit, dauerhafter Zitierfähigkeit sowie zur Strukturierung der Daten.

Neben generischen Datenmanagementplänen liegen mittlerweile eine Reihe von fachspezifischen Templates vor, in denen die Fragen auf bestimmte Bedarfe von Disziplinen zugeschnitten sind.[13] Die meisten dieser Fragen lassen sich jedoch weder nach Priorität sortieren noch kann man konkrete Erfüllungsmaßnahmen daraus ableiten. Vielen Anwender:innen ist diese Struktur nicht konkret genug und zu wenig angelehnt an den eigenen Arbeitsprozess. Immer mehr digitale Projekte erfordern ein praxistaugliches Betriebskonzept, das Projekt- und Datenmanagement vereinigt und das Aspekte der Datenerzeugung und Datenkuratierung miteinander vereinbart. Es daher wäre ratsam, nicht nur von Fachdiziplinen auszugehen, sondern auch konkrete Anwendungsfälle für verschiedene Sparten zu identifizieren und Nutzungsszenarien für Daten zur Ausgangsbasis für die Entwicklung von spezifischen DMP zu machen.

Um am Ende einen idealen DMP-Standard für jedes Szenario zu entwickeln, ist ein Grundgerüst mit flexiblen modularen Erweiterungen (z.B. zur Planung von Workflows, Erschließungs- und Publikationskonzepten) am besten geeignet. User Stories können hilfreich sein, um den Plan der Datennutzung und das angestrebte Endprodukt zu formulieren. Zumindest sollten Hinweise und Arbeitsschritte zur Umsetzung empfohlen werden. Zusätzlich können andere Tools für zeitliche Terminierung und Aufgabenverteilung (Ticketsysteme etc.) eingesetzt werden.

ad 3. Für das eigentliche Datenmanagement empfiehlt es sich, nach den Etappen im Datenlebenszyklus vorzugehen, von der Datengenese und -erfassung, über die Verarbeitung und Analyse, die Sicherung und Publikation bis zur Nachnutzung. Eine Forschungsdaten-Policy und die entsprechende Datenstrategie sollten schriftlich fixiert werden. Eine möglichst zweckmäßige Modellierung der Daten muss festgelegt werden, und zwar abgestimmt auf den Sammlungsgegenstand, z.B. mit dem CIDOC Conceptual Reference

Model, das als Datenmodell in der Dokumentation des Kulturerbes verwendet wird. Ebenfalls festgelegt werden sollten mögliche Einheiten der Erfassung als Daten und die Zusammenhänge zwischen diesen Einheiten sowie die gewünschte Granularitätsstufe. Ein Datenfeldkatalog legt fest, was unter welchen Bedingungen in einem Metadatensatz enthalten ist. Für die korrekte und einheitliche Datenerfassung dienen Regelwerke und Schreibanweisungen. Die gewünschte Nachnutzung der Datenbestände (intern oder extern) sollte ebenfalls festgelegt und die Bedingungen dafür (Austauschfähigkeit etc.) fixiert werden. Zur Sicherung und Verbesserung der Datenqualität können bestimmte Arbeitsgänge (Daten sichten, bewerten, auswählen, aufarbeiten und anreichern bzw. korrigieren) und Hilfsmittel eingesetzt werden.

Um eine Datengenese und -erfassung qualitativ hochwertig durchführen zu können, wird das Studium von Handreichungen und Leitfäden vorausgesetzt. Dazu gehören z.B. die aktualisierte Fassung der *DFG-Praxisregeln Digitalisierung* oder die *Handreichung für ein FAIRes Management kulturwissenschaftlicher Forschungsdaten*, die von Task Area 2 entwickelt wurde.[14] Sie beinhaltet Maßnahmen zur konkreten Umsetzung der 15 sogenannten ‚FAIR Data Principles'. Die Einhaltung der Prinzipien garantiert die bestmögliche Auffindbarkeit, Zugänglichkeit, Interoperabilität und Wiederverwendbarkeit von Forschungsdaten, und zwar auch als Linked Data.[15] Weitere Maßnahmen zur Sicherung der Datenqualität vor der Eingabe sind etwa der Einsatz von XML-Erfassungsstandards für Kulturobjekte (LIDO, TEI, MEI, EAD) und die Entwicklung von speziell zugeschnittenen Metadatenschemata, z.B. mithilfe der LIDO-Anwendungsprofile für verschiedene Objektgattungen.[16] Bestimmte Visualisierungstechniken können Planung, Prozesse und Arbeitsabläufe erleichtern (z.B. Roadmaps, Flow Charts, Zeitstrahl/Timelines, Priority Trees, Mind Maps, Eisenhower Matrix etc.).

Im XML-Editor wird ein Qualitätscheck während der Dateneingabe durch laufende maschinelle Prüfung (Validierung gegen das Schema) vorgenommen. Auch wird die Wohlgeformtheit der Struktur des Datei überprüft; innerhalb einer Datenbank geschieht eine Prüfung durch Eingabehilfen und -kontrollen auf der Basis von Regelwerken und Schreibanweisungen, durch das Anlegen von separaten Registerdateien und Wortlisten, durch manuelle inhaltliche und formale Prüfung per Autopsie, unterstützt durch entsprechende Erfassungsrichtlinien; außerdem durch die Verwendung von kontrollierten Vokabularen, die automatisiert mit PIDs aus Normdateien und Thesauri integriert werden können und somit den Verweis auf große Referenzvokabulare enthalten.

Ein Qualitätscheck nach der Eingabe kann unter Einsatz spezieller Check-Verfahren und Tools erfolgen sowie durch automatisierte Qualitätsprüfungen für digitale Daten. [17][18] Für die Problembehebung empfiehlt das Projekt ‚KONDA – Kontinuierliches Qualitätsmanagement von dynamischen Forschungsdaten zu Objekten der materiellen Kultur unter Anwendung von LIDO'[19] ein dreistufiges Verfahren:

- Qualitätsprobleme können anhand von zuvor festgelegten Qualitätsdimensionen (z.B. Vollständigkeit, Genauigkeit, Eindeutigkeit, Korrektheit etc.) zuerst kategorisiert und dann ausführlich anhand von beispielhaften Datensätzen beschrieben werden, z.B. fehlende Quellen, falsch platzierte Informationen, mehrere Informationsteile in einem Feld, markierte Unsicherheiten, keine Anbindung zu Normdaten, unvollständig ausgefüllte Felder, unklare Bezugsgrößen, fehlende eindeutige IDs, etc.
- Auf Basis dieser Einordnung ist es wiederum möglich, lösungsorientiert bestimmte Anforderungen und Ziele für die Qualitätsverbesserung zu formulieren, z.B. Quellen angeben, Information verschieben, Informationen trennen, explizit modellieren, Normdaten hinzufügen, Bezugsgröße festlegen, Feld vervollständigen etc.
- Anschließend kann überlegt werden, welche Maßnahmen, Schritte, Ressourcen und Werkzeuge jeweils zu einer Umsetzung führen.

Generell wäre bezüglich der Bearbeitung von Sammlungsdaten ein Umdenken notwendig. Das bedeutet, dass alle Arbeitsgänge prinzipiell stärker vom Publizieren her gedacht werden können (Abb. 3). Die Daten werden in Geschäftsgängen so bearbeitet, dass sie am Ende den Nutzenden in einheitlichen,

strukturierten Basis-Formaten zur Verfügung stehen. Diese Zielformate sollten in Ausprägung und Umfang zuvor im Team festgelegt werden. Bei Bedarf kann es je nach Materialart oder Objektkategorie auch mehrere solcher Formate oder Sub-Typen eines Hauptformats geben. Die bereits erwähnten LIDO-Anwendungsprofile können hier eine guter Startpunkt sein. Ein Mapping mit anderen Spartenformaten und eine leichte Konvertierung sollte möglich sein, um Interoperablilität bei der Datenweitergabe zu gewährleisten.

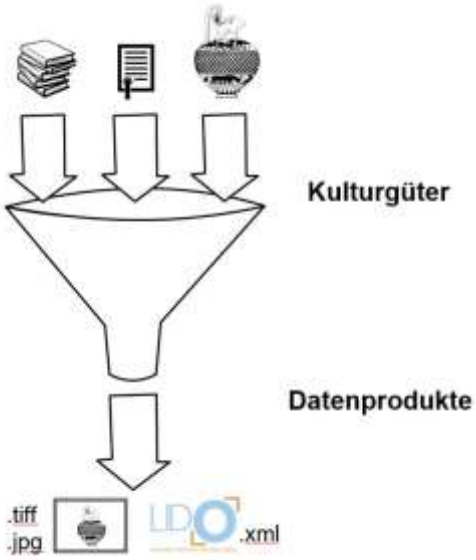

Abb. 3: *Arbeitsgänge für Sammlungsdaten aus GLAM-Einrichtungen vom digitalen Publizieren her denken. Grafiken via pixabay*

Der letzte Abschnitt dieses Beitrags bündelt ein paar allgemeine Fragestellungen für ein effizientes Datenqualitätsmanagement. Dazu gehören prinzipiell alle Aspekte der grundlegenden Informationsstrukturierung: Welche digitalen Objekte sind im Datenbestand identifizierbar? Welche ‚Schichten' bezüglich Daten, Metadaten und Meta-Metadaten gibt es, wie beispielsweise die Aufteilung in Sammlung, Teilsammlung/Konvolut und Einzelstück, die verschiedenen Rechteschichten für Objekte, Digitalisate und Metadaten, die Aufteilung in Basisdaten bzw. Kernfelder, Grunderschließung und Tiefenerschließung bei der Erfassung? Welche Sinneinheiten müssen in welcher Granularität durch einen Identifikator adressiert werden? Wie sind diese Einheiten als Informationseinheiten untereinander verbunden (z.B. durch Teil-Ganzes-Relationen oder Relationen zwischen Objekt-Bild-Inhalt)? Bezüge aller Art sollten dabei immer aus der Perspektive des Objekts erfasst werden, das Gegenstand des Datensatzes ist. Sollen vorhandene digitale Reproduktionen in allen Einzelteilen den Metadaten zugeordnet werden? Insgesamt erscheint es sinnvoll, alle anpeilten Qualitätslevel immer gemeinschaftlich zu definieren und bei der Umsetzung schrittweise vorzugehen.

3. SCHLUSS

Die in diesem Beitrag vorgestellten vielschichtigen Ergebnisse zu den Mechanismen des Datenqualitätsmanagements sind als work in progress der Task Area 2 von *NFDI4Culture* zu verstehen. Sie sind am Deutschen Dokumentationszentrum für Kunstgeschichte im Rahmen einer Workshopreihe für die Einrichtungen der GLAM-Sparte zusammengefasst worden. Der Wechsel vom immer noch verbreiteten Verständnis der ‚digitalen Sammlung' hin zu einer ‚Sammlung als Daten' wurde dabei ausführlich erläutert. In diesem Zusammenhang erscheint es lohnend, die Produkte der NFDI nicht nur fachspezifisch, sondern zunehmend fächer- und spartenübergreifend auszurichten, das heißt sich ein Stück weit vom Begriff der Fachcommunitys oder GLAM-Communitys zu lösen und stattdessen von Datencommunitys zu sprechen. Das Selbstverständnis dieser *Data Communitys* wird in erster Linie durch die verwendeten Datentypen („a certain type of data") und den mit ihnen verbundenen Praktiken definiert.[20]

Die vom RfII genannten Leitideen für gute Datenqualität sind im Text allesamt vertreten.[21] ‚Normierung und Standardisierung' bildet den stärksten Fokus in den Aufgaben von Task Area 2. Der Leitgedanke manifestiert sich dort vor allem in der Verwendung und Vermittlung von möglichst gebräuchlichen Erfassungsstandards und Normen (CIDOC CRM-Referenzmodell, LIDO-Standard, Einsatz von Thesauri u.a.), aber auch in der Standardentwicklung für die genannten Zielgruppen. Standardsetzungen schaffen eine Grundlage, um Daten in bereits normierter Weise zu erstellen beziehungsweise in normierte Systeme zu migrieren, oder bieten auch Übersetzungsregeln zwischen gewachsenen Systemen, so etwa das OAI PMH-Protokoll für das Harvesting von Metadatenbeschreibungen. Ein weiterer

international etablierter Standard ist der Spectrum Standard für die Verwaltung von Museumssammlungen. ‚Leitlinien und Policies' bilden einen zentralen Eckpfeiler in der Vermittlung von Datenqualität in die Communitys. Erwähnt wurden etwa die Forschungsdaten-Policies, die FAIR Data Principles und spezielle Handreichungen. Auch ‚idealtypische Prozesse und Verfahren' kamen zur Sprache, verkörpert etwa im Lebenszyklus von Forschungsdaten und in der Beschreibung von Datenflüssen zwischen Datengebern und Datennehmern. Darüberhinaus kann das OAIS-Referenzmodell für die generischen Prozesse in einem offenen Archivierungssystem genannt werden. Die Leitidee der ‚Operationalisierung und Validierung' manifestiert sich vor allem im konsequenten Einsatz von Datenmanagementplänen (DMP) und in den genannten Verfahren der Qualitätsdefinition, Qualitätsmessung und Qualitätsanalyse. Nicht zuletzt fallen darunter auch die Zertifizierungsmaßnahmen für Forschungsdatenrepositorien (DINI-Zertifikat, CoreTrustSeal etc.)

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KONFERENZ II | CONFERENCE II

TRANSFORM II

SESSION I

Digitale Reproduktion | Digital Reproduction

Moderation: Prof. Dr. Andreas Bienert
(EVA-Berlin Vorsitz | ehem. SMB)

EVA Berlin

EVA Berlin 2023 Conference
30. November – 01. December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Interactive Volumetric Video in VR Experiences Technology, Design & Evaluation

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ABSTRACT: In this paper, an overview of the recently launched Virtual Reality Experience "Eva Umlauf—Her Testimony" is presented along with the latest results from user evaluation by high school students. This VR experience unfolds the story of Dr. Eva Umlauf, one of the youngest Jewish survivors in the concentration camp Auschwitz. We use volumetric video technology and combine it with meaningful surroundings; additionally, we explain the main aspects of volumetric video production including a novel approach to interactively modify the volumetric character. Further, we present design principles for creating the VR experience, with a special focus on educational goals and a first evaluation of users' reactions.

1. INTRODUCTION

The preservation of memories of survivors from the Holocaust becomes more and more important. In addition to classic 2D video documentation and text, eXtended Reality and volumetric video offers a completely new way to present testimonies of contemporary witnesses in a highly realistic and immersive manner. The recently finalised Virtual Reality experience of "Eva Umlauf—Her Testimony" demonstrates the capabilities of this new technology in an impressive way.

2. PRODUCTION & TECHNOLOGY

In 2021 Eva Umlauf was filmed in the volumetric capture studio of Volucap GmbH in Potsdam-Babelsberg with 32 cameras. 50 minutes of video were recorded while Eva Umlauf was telling different episodes of her life. The 2D video data were processed with a complex volumetric video production workflow in order to generate a highly realistic dynamic 3D representation of Eva Umlauf, called volumetric video. This novel media format is then integrated into a Virtual Reality experience to allow the user to follow the narration of Eva Umlauf, life-sized and in 3D. In addition, a new technology to interactively animate the head orientation of Eva Umlauf was integrated. This method offers the capability to achieve eye contact with the Holocaust survivor while watching her from different perspectives. The VR experience is complemented with additional media such as video interviews, historical photographs and audio material, offering a network of Eva Umlauf's memory media.

For the VR experience, users encounter Eva Umlauf by means of a Head-Mounted Display (HMD) in three scenes, which were depicted from the filming to create an experience lasting 30 minutes. Users "meet" her representation in a living room, where she—in reality—often gives interviews; in the sauna at Auschwitz-Birkenau, where

she was tattooed; and in front of the iconic gate of Auschwitz-Birkenau, recalling the two speeches she gave at memorial events in 2011 and 2023.

Images 1 – *Three Scenes of the VR Experience*

In each scene, Eva Umlauf speaks for 6 to 8 minutes about her life. These individual scenes are enriched with additional media: photographs and documents about her family's background in scene 1, photos of her last visit to Auschwitz in January 2023 in scene 2, and two video sequences in scene 3 that span from her first oral history interview in 1997 to her interactive digital testimony in 2019.

Images 2 – *Memory Book & Integrated Media*

Media are tied together by a virtual book that imitates the look of her published memoir; the media of remembrance used in the VR are embedded in the virtual book. The installation can be accessed in German language or/and with English subtitles.

3. EVALUATION

Since the VR experience is designed for educational purposes and offered to schools as a media format for teaching history and reflecting on media, we designed it according to principles of multimodal learning environments. From this perspective, it is crucial that Eva Umlauf's narrative is underpinned with media that underscore her statements. Therefore, we pursue a close combination of place and image to make the narrative visible and foster understanding by users.

In July 2023, we conducted a study with the central research question: How do students perceive this media format? So far, we have surveyed fifteen 9th-grade students having little experience with VR media. In our qualitative survey, we combine think-aloud methods with structured interviews, enriched by observing protocols.

The impact of VR experiences is strongly dependent on the level of immersion and the accuracy of representation. The students overwhelmingly state that they often forgot they were actually in VR and that they were impressed by how realistically Eva Umlauf and her surroundings were depicted. These features promote a sense of presence and ensure attention to Eva Umlauf's narrative. Regarding affective and cognitive effects, they emphasize that they felt a high level of interest and motivation to engage with the topic. Self-critically, they note this could also be due to the novelty of the medium. They also feel a sense of closeness and empathy with the individual and her fate, as they can physically come so close to her.

4. CONCLUSION

To sum up, we have achieved an important goal of cultural remembrance with the VR experience "Eva Umlauf—Her Testimony:" learners engage with a survivor's story and come to terms with her fate. In further studies, we will continue to empirically reflect on technical innovations to unfold the potentials of VR for education.

4. ACKNOWLEDGMENT

The VR experience is the result of the VoViREx project, which was generously funded by the EVZ Foundation (ID 18303).

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Digital reinassance. The Calabrian coast towers depicted in the Codex Romano Carratelli.

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ABSTRACT: The contribution describes a research project aimed at creating a multimedia platform capable of connecting significant places in the Calabrian coastal landscape with the surrounding area: the architecture depicted in the sixteenth-century *Codice Romano Carratelli*, 99 coastal towers built in Calabria by the Spanish government with the aim of controlling invasions from the sea by Saracens and pirates. Having lost their original lookout function, the towers can become the nodes of a network of coastal routes, a digital network for "slow" tourism that is attentive to environmental issues, the valorization of local resources and the cultural regeneration of the territory.
The research phases are as follows:
- survey of existing towers (via laser scanner and aerial and terrestrial photogrammetry), 3D modeling of the actual state;
- morphological and typological analysis, abacus of elements;
- project of a network of routes that connects the towers to each other and interfaces with the other points of cultural interest;
- development of multimodal devices for the analysis and enhancement of architecture, including the extensive use of ICT (3DMapping, Virtual Reality, Augmented Reality, holograms, 360° shooting);
- 3D printing for museum education and for disadvantaged users;
- creation of a multimedia platform in which all the contents described in the previous points can be consulted interactively.

1. INTRODUCTION

For some years our studies have been focusing on an ancient manuscript from the end of the 16th century called the *Codice Romano-Carratelli* from the name of the owner family. It is a document composed of 99 watercolours depicting fortified cities, castles, defensive structures placed in the Calabria Ultra territories. The *Codice* is protected by the Italian Ministry of Cultural Heritage (MIBAC) and it is in excellent state of conservation.

The set of tables is extremely interesting because it illustrates the theme of the defence refers to coastal area of Catanzaro, Crotone, Vibo Valentia and Reggio Calabria provinces by presenting the fortified cities, castles and the territory.
In particular, the typologies and characteristics of the existing towers are reported, identifying the places where the new towers built was necessary for the design of new towers the construction cost is indicated.

The *Codice Romano Carratelli* can be defined as a fundamental anthropo-geographical document of Calabria Ultra, the oldest and most complete known. In the representation of the tables, a new aspect takes shape, that is an order of signs and a graphic methodology that determine a unique communicative elegance.
The descriptive method, the coordination of colours, few but intense, the composition of the tables, gives the document the definition of "Code". The colour describes the transition between the survey of what exists and the design of new architecture to be built: existing architecture is represented in red-ochre, everything that needs to be designed is represented in grey-blue.
The choice of colour is consequent to a modern thought: the colour of the existing towers reflects the sedimentation of anthropic signs, the blue-grey colour is the sign of modernity which is insert into the context in a coherent way.
In the *Codice*, the places are represented with mixed systems, between perspective and axonometric schemes, due to the clear military setting; the point of view is placed high up, a bird's eye view, with a prevailing view from the sea towards the costs.

Figure 1: *A page from the Codex: Capo Rizzuto's Tower*

2. ON-SITE DISSEMINATION OF THE MONUMENTAL HERITAGE OF THE CALABRIAN COAST.

This research project is a part of the large *Tech4you* project (PNRR), and specifically fits into Spoke 4 relating to *Technologies for resilient and accessible cultural and natural heritage*. The research elaborates a strategy for communication and definition of real paths that lead to the knowledge and perception of the historic architectural heritage that punctuates the Calabrian Coast. The development of new channels for the enhancement and communication of tangible and intangible heritage in the Calabrian territory contributes to the awareness of the value of heritage in the local population. Awareness is the first step to conservation. Furthermore, the diffusion of this heritage can increase the tourist flow and contribute to the economic recovery of the area.
The Project workflow (fig. 3) returns the structure and components of the analyses that will complete the final picture.
The first aspect that characterizes the research is a wide-ranging analysis of the *Codice Romano-Carratelli*: its diffusion, the meaning that this document has for Calabria Region and for the entire South of Italy.

Figure 2: *A page from the Codex: Cavallara's Tower*

The historical and documentary value relating to the Calabrian land scape of the XVI Century. In fact, in the *Codice* there are 99 watercolour papers in which the geographical data characterizing the most significant stretches of the Calabrian coasts are distinguished: watercourses, coastlines, altimetric variations and compact urban aggregates: walls, bell towers, towers, architectures emerging. The resulting picture can be defined as a fundamental anthropo-geographical document of Calabria Ultra, the oldest and most complete known.
A study was conducted to trace and identify the sites on which the towers, described by the Codice rise, or once stood. The identification work crosses a lot of data and places the location of the towers and the current denomination on an interactive map, compared with what is reported in the Codice.

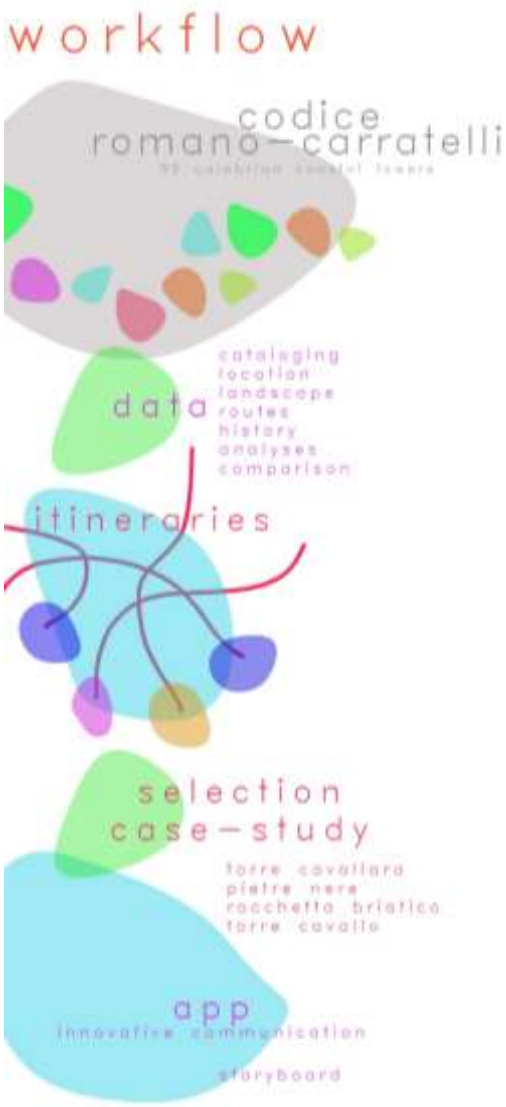

Figure 3: *Research project workflow*

Some case studies have been selected and will be analysed in detail: Torre Cavallara, Pietre Nere, Rocchetta Briatico, Torre Cavallo. Many other towers, and their routes, will be analysed during the research. Specifically, the visual relationships between towers and between the single structure and the landscape that host it will be highlighted.
Each route, with the specificities and history that characterizes it, will be enhanced within the app, with three-dimensional simulations, augmented reality, and historical news. The design of the app will be developed by forming a complex storyboard and considering the impact that the communication strategy and graphics can have in spreading the message.

2.1 SURVEY, MODELING AND INCLUSIVE FRUITION

The research path involves surveying and making related models in HBIM of four coastal towers that are still available, although in a ruined state: Torre Cavallara, Catanzaro; Torre La Rocchetta, Briatico (VV); Pietre Nere, Palmi (RC); Torre Cavallo, Costa Viola (RC). Surveys of the first two towers have already been carried out on June 19 and 23, 2023, respectively.
An integrated type of survey was carried out for Torre Cavallara in Catanzaro: range-based (Faro Focus X 330 phase difference laser-scanner) and image-based (DJI Mavic Air 2 drone) methodology.
The laser-scanner survey enabled the acquisition of point clouds related to the exterior envelope of the tower and the only covered space. For this purpose, 13 scans were used, including 10 for the exterior space and staircase and 3 for the interior. The scans were aligned with spherical targets of diameter Ø 145 mm, appropriately placed in the survey scenario. The acquired data were supplemented with an additional image-based survey that also allowed the parts not accessible with the scanner-laser to be documented. Georeferenced aerial photos (resolution 4000x2250 pixels) were taken, in DNG and JPG format, with the help of a DJJ Mavic Air 2 drone and covered the entire exterior surface of the tower. A total of 597 photographs were taken, including 225 with zenith shot, 296 with frontal shot, and 76 with inclined shot. The two surveys, range-based and image-based will be integrated in order to obtain a complete point cloud of the monument. Torre La Rocchetta in Briatico, being devoid of inaccessible parts, was surveyed exclusively

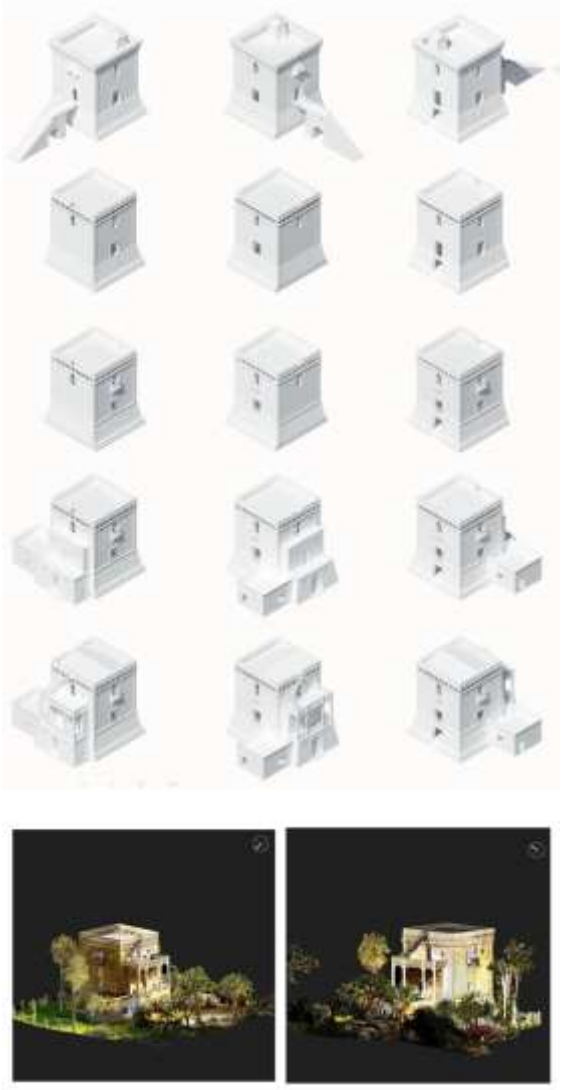

Figure 4: *Critical modeling and point cloud of the Tower of Soverato n.59 of the Carratelli Roman Code. (Drawings by Claudio Patanè).*

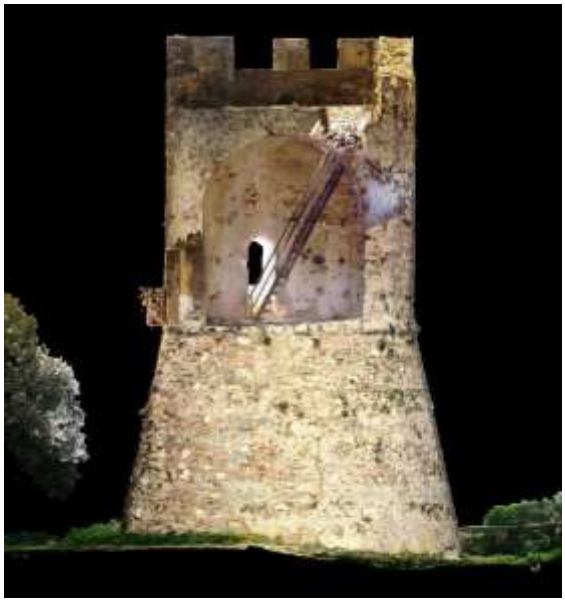

Figure 5: *Point cloud of the Torre delle Pietre Nere survey*

Figure 6: *Point cloud of the Torre Cavallara survey, near Catanzaro*

with range-based methodologies (Faro Focus X 330 phase-difference laser-scanner). The monument required 12 scans, 8 of which were external scans for the perimeter facades and 4 internal scans: three at ground-floor level to survey the stone pavilion vault; one at the top of the staircase leading to the upper level. The connection between the external and internal scans was made through the wide gap on the northern side.
The point clouds of the surveyed towers will be used to render HBIM models. Through interactive functions, they will make usable technical and popular information addressed to different types of users: geolocation, historical and bibliographical news, information on construction techniques, data on the state of preservation etc. Comparisons with the corresponding images of the Roman-Carratelli Codex and hypotheses of the original configuration, based on philological reconstructions, will also be proposed. These models will be included in a web-accessible database and will also be usable through a multi-platform application for mobile devices from which it will be possible to activate visualizations in VR (Virtual Reality), AR (Augmented Reality) and MR (Mixed Reality). For the realization of such materials, maximum attention will be paid to inclusive communication, usable even by the most disadvantaged categories and in line with the indications of *The London Charter* of 2008 and *The Principles of Seville* of 2011, ensuring the necessary criteria of reliability and scientificity.

2.2 VISUAL, PHYSICAL AND DIGITAL PATHS

The system of towers depicted in the *Codice Romano Carratelli*, designed to prevent threats from the sea, allowed obtaining a panoptical vision extended to the entire coastal development of Calabria Ultra.
The position of the towers on the territory made it possible to control a vast portion of the sea, and to communicate visually with the two adjacent towers and, sometimes, with the hinterland. It is therefore a mixed visual system, of a conical-linear type; a further network of physical routes was connected to it, designed to reach the inhabited centers in the shortest possible time and warn them of possible raids (fig. 7). The attribute "cavallara" (for horses), often associated with the tower, indicates the presence of stables on the ground floor intended to house horses, which at the time were the fastest means of transport.
The communication project is inspired precisely by this dual connection system: visual (conical-linear) and terrestrial routes (linear).
As regards the visual system, it is expected:
- construction of a diorama (spherical photo) of the view from the top of each tower of the Codex (fig. 8). The photograph is viewed (on a monitor or 3D device) with a field angle similar to that of human vision (vertical angle of 150°, horizontal angle of 55°), therefore it is not perceptible in its entire development, but it is necessary to navigate using the mouse or visual pointer.
- construction of a panopticon, composed of the fusion of all the spherical views obtained from the top of each tower. The spherical photos are sectioned at the point where each optical cone intersects with the two adjacent ones; therefore, the horizontal angle taken into consideration is smaller than that of the single photo. Navigation within the panopticon occurs discontinuously, from photo to photo.

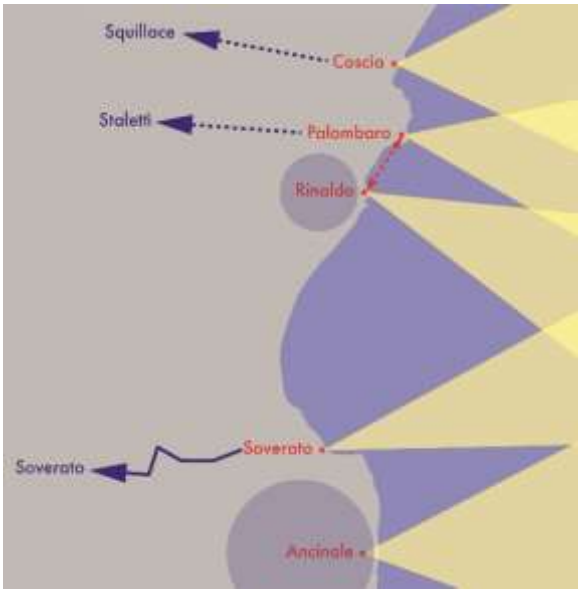

Figure 7: *The visual system of the towers south of Squillace (Catanzaro). It allowed full control of the sea in front. The Coscia and Palombaro towers were in visual communication with the towns of Squillace and Staletti (blue dotted arrow). The Rinaldo tower was the defense of two farmhouses and some freshwater springs close to the coast; it was in visual connection with that of the Palombaro (red dotted arrow). The Soverato tower was a "for horses" tower; a track departed from it which reached the internal center of the same name, not visible from it (continuous blue arrow). The Ancinale tower protected the mouth of the river of the same name.*

- view from the tower to the town (or towns) inland, and vice versa. These are single photographic images, taken with a normal lens (focal length 50 mm).
In the event that the current conditions of the building prevent photography from the ground, the images will be obtained by drone; the slight change in the height of the point of view will not affect the continuity of the overall perception.
The system of land routes, once used mainly in the absence of visual connection between the tower on the coast and the inland towns, have been entirely redesigned to allow the visit of the still existing towers, the sites where they stood and those on which planned its construction.

Figure 8: *Diorama of the "Ravagnisi" tower (also called Torre Lupo), in the southern outskirts of Reggio Calabria, and visual relationship with the adjacent towers of San Leo and Calamizzi.*

Figure 9: *The three levels of the route system for visiting and observing the towers between Palmi and Bagnara (Reggio Calabria).*
- main road network (SS 18, in green);
- secondary driveways (in yellow);
- pedestrian traffic (in blue). In particular, the Tracciolino hiking trail allows you to observe the Costa Viola and its towers (now inaccessible) from above.

We believe it is of little significance to reconstruct the ancient routes between the tower and the hinterland; we preferred to redesign a system aimed at tourist use, organizing it according to three different levels (fig. 9):
- the first (coastal development), entirely accessible by car, follows the coastal profile of the entire territory.
- the second level is made up of sections that branch off from the coastal path and allow you to get further closer to some towers by car.
- the third level is made up of sections that join the first or second level route and can only be covered on foot. It is used to visit the towers that cannot be reached by car.
The route system also represents the layout on which thematic networks are grafted, intended for better tourist enjoyment and the valorization of the territory. Among these.
- the network of food and wine points of sale and tasting.
- the hospitality network.
- the network of monuments and points of cultural interest.
There are also itineraries that allow you to visit multiple towers over the course of a day on foot or in a mixed mode (hike plus bicycle).

2.3 INNOVATIVE COMMUNICATION FOR LANDSCAPE ICONEMES

The coastal towers represented in the *Diario delle Meraviglie* known as the Carratelli Roman Code perform the function of territorial attractor of excellence; positioned along the perimeter of the Calabrian coast they become an element of visual and cultural connection.
They are the cornerstones of a linear path that is intended to connect to reconstruct a cultural scenario not only aimed at tourists and/or travellers, but capable of improving the quality of the relationship between communities and their heritage.
The goal is to create a digital tape for the use of the Towers with the declination in 'itineraries' conceived as a key to reading, knowledge and communication of the cultural resources of the Calabrian coastal territory.
Communication based on an integrated system of information that can be consulted online, to highlight the submerged excellences of an unknown territory and to promote inclusive tourism. Through the digital artifacts that allow the survival of the existing monument (subject to the erosion of time, abandonment, neglect) and the visualization of an architecture that has

Figure 10: *Solid model and 3D prints made by Claudio Patanè and Andrea Marraffa.*

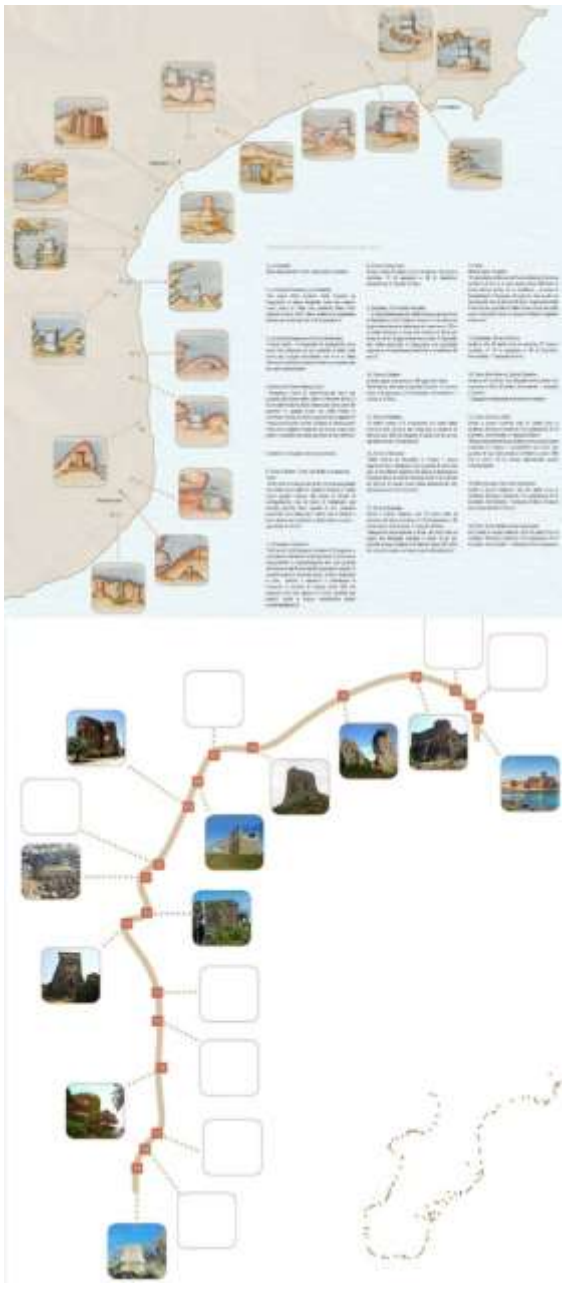

Figure 11: *Coastal defense planning on the ionian sea*

never been built, there will be a tendency to verify a phenomenon of interactivity with history, with the places of the past and with those present, offering the user a full involvement in cultural immersion experiences.
The identification and interpretation of the territory's resources through Cultural mapping operations provides a mapping of the characteristics and resources that form the cultural scene that emerges in the surroundings of each individual Tower: cultural activities and events; cultural innovation environments; historical, artistic, and environmental heritage; specialized agricultural productions; handicrafts; forms of cultural expression ethnic minorities etc.
Furthermore, reference is made to some fruition modality indicators: reachability and accessibility (path conditions, private property, opening hours, etc.); visibility (signage, local promotion, search for historical information, etc.); state of conservation (abandoned, degraded, tampered with).
The digitization of a suitable number of Towers makes the physical heritage available for a series of processing in which digital models will be used multimodally through VR or AR technologies involving visual display, gesture detection or audio rendering.
Users will be able to use all the information available in digital format through simple commonly used tools.

3. CONCLUSION

Through the digital artifacts that allow the survival of the existing monument (subject to the erosion of time, abandonment, neglect) and the visualization of an architecture that has never been built, there will be a tendency to verify a phenomenon of interactivity with history, with the places of the past and with those present, offering the user a full involvement in cultural immersion experiences.

4. ACKNOWLEDGMENT

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paragraph “Innovative communication for landscape iconemes”. The authors thank Claudio Patanè, author of the doctoral thesis “Architetture parlanti nel paesaggio fortificato Calabrese. Il Codice Romano Carratelli. Progetto e costruzione di un itinerario terracqueo”, who contributed to the preparation of this study.

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Digitization of object rich natural history collections with DORA – a Multi-organizational approach to success

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ABSTRACT: Digital transformation of natural history collections addresses mainly the digital cataloguing of metadata to relate the collection objects in central databases. However, most collections struggle to fulfil this task in a decent amount of time due to a lack of standardized workflows and a vast amount of data. Therefore, new ways of fast and effective inventory, as well as semi-automated pictorial digitization needs to be brought up in natural history collections. To achieve this, the Museum für Naturkunde Berlin started an action plan in 2020 regarding the full inventory of the approx. 30 million collection objects, creating a complete digital catalogue of its holdings within 10 years. The biggest challenges here are the object rich collections like Mollusca, fossil Invertebrates or insect collections.

1. INTRODUCTION

At the MfN, managers of digitization and collection staff team up with partners from other institutions as well as industries to invent, create and further develop ways of digitization using new techniques and/or workflows. One of these new techniques and next generation digitization stations is DORA, jointly created by the Museum für Naturkunde Berlin (Dr. Berger, Dr. Lentge-Maaß) and the Fraunhofer Institute for Factory Operation and Automation IFF (Mr. Trostmann, Mr. Schiller). DORA is a Scanner with four industry cameras. Three cameras are used for object digitization and are able to produce sharp images using focus stacking, while the fourth camera captures the labels and is able to read QR-codes. In a testing phase, it became clear that four DORA scanners, reaching each a throughput of about 75 catalogue objects (lots) a day, will fulfil the task of a full collection disclosure of the 250.000 catalogue objects (lots) within four years. In an application process using a tender, we found the company ArchivInForm from Potsdam, who reviewed our workflow, found additional scan operators and helped to set up a fluid workflow with tracking tools.

Here we present the Scanner and techniques that were used to form a Multi-organizational team with the task to disclose a full natural history collection of about 7 Million single collection objects (within 250.000 lots) by inventing a new digitization station, acquiring staff and using this various fields of expertise.

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Integriertes modulares Stacking-System Deimos

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ABSTRACT: Das Museum für Naturkunde Berlin verfolgt im Rahmen der Sammlungserschließung gezielt die Entwicklung neuer Technologien zur effizienten Digitalisierung von Sammlungsobjekten. Neben Systemen, die auf Prozesse der Massendigitalisierung abgestimmt sind, wurden in den letzten Jahren auch Aufbauten zur hochauflösenden 2D- Digitalisierung von Einzelobjekten optimiert. Eine Herausforderung in naturkundlichen Sammlungen liegt in der heterogenen Materialität und einem bedeutenden Größenspektrum innerhalb verwandter Objektgruppen. Das in Entwicklung befindliche integrierte modulare Stacking-System Deimos schließt eine kritische Lücke in der Bildgebungstechnologie, indem es eine vielseitige Losung für die Objektfotografie in dem gesamten Größenspektrum von 0,2 mm bis ca. 30 cm bietet.

1. INTRODUCTION

Die Kernkomponenten von Deimos bestehen aus einer DSLR-Kamera, einem Stacking-Schlitten mit eigenem Controller, einer Reihe kompatibler Objektive, Tuben und Adaptern sowie adaptierbaren Leuchten. Der halbautomatische Arbeitsablauf wird durch den Einsatz der Software von Capture One und Helicon Focus ermdglicht, die auf einem leistungsfahigen Rechner laufen. Durch den modularen Aufbau des Systems wird die Anwendung flexibler Lichtszenarien, die Verwendung von objektspezifischen Hintergriinden sowie der Einsatz verschiedener Optiken erleichtert. Durch die vielfaltigen Anpassungsmoglichkeiten können verschiedenen, disziplinabhängigen Anforderungen an die wissenschaftliche Objektfotografie erfüllt werden. Ferner bietet die Austauschbarkeit einzelner Komponenten den wichtigen Vorteil der kontinuierlichen Weiterentwicklung, indem technologische Neuerungen in das System integriert werden können. In der praktischen Anwendung werden bei sehr kleinen Objekte Ergebnisse erzielt, die mit denen von Mikroskopen vergleichbar sind.

Da durch Deimos ein größeres Objektspektrum abgedeckt wird, kann die Anzahl von spezialisierten Systemen in der Digitalisierungsinfrastruktur deutlich reduziert werden. Die typische Objektvielfalt einer naturkundlichen Sammlung erfordert i.d.R. verschiedene Lösungen für die bildgebende Digitalisierung mit unterschiedlicher Hard- und Software. Anwender:innen benötigen systemspezifische Schulungen, die in Abhängigkeit der Komplexität mit sehr steilen Lernkurven verbunden sein können. Insbesondere bei kleineren Digitalisierungsprojekten kann dann beim Einsatz ungeschulten Personals die Trainingszeit im Missverhältnis zur Durchführung der eigentlichen Bildgebung stehen. Die hier vorgestellte modulare Lösung erfordert ebenfalls eine gewisse Anwendungsexpertise, doch der Schulungsaufwand kann reduziert werden,

indem mehrere Personen gleichzeitig geschult werden und der Wissenstransfer auch lateral erfolgen kann. Weitere Vorteile ergeben sich aus der Reduzierung des Wartungsaufwandes und einer besseren Auslastung, was zur Platzersparnis führt.

Zu den potenziellen Nachteilen gehören jedoch ein höherer initialer Einrichtungsaufwand, aufwendigere Kalibrierungsschritte im Regelbetrieb, sowie im Vergleich zu einfachen Reproaufbauten höhere Einstiegskosten. Die Anbindung verschiedener Softwarekomponenten ermoglicht eine offene Workflowgestaltung, die auf institutionelle Anforderungen abgestimmt werden kann, erfordert aber gleichzeitig entsprechende Expertise in der Gestaltung von Datenpipelines. Insbesondere die Durchführung weiterer Bildbearbeitungsschritte, wie z.B. das Rendering eines Maßstabs, kann mit Systemwechseln und dem Einsatz verschiedener Softwarelösungen verbunden sein.

Der Fokus dieses Vortrags wird neben der ausführlichen Einführung in das System auf der kritischen Darstellung der Vor- und Nachteile aus Management- und Anwendungsperspektive liegen. Darüber hinaus werden die Perspektiven zur Weiterentwicklung der Prototypen aufgezeigt. Die Autoren sind davon überzeugt, dass die Anpassungsfahigkeit und Skalierbarkeit das System Deimos zu einer vielversprechenden Lösung machen, die die hochauflösende Objektfotografie im Bereich der Sammlungsdigitalisierung und darüber hinaus erheblich voranbringen kann.

SESSION II

3D-Modelle und Repliken | 3D Models and Replicas

Moderation: Prof. Dr. Andreas Bienert
(EVA-Berlin Vorsitz | ehem. SMB)

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New Scale Model of the City of Pergamon

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ABSTRACT: For the reopening of the Pergamon Museum Berlin, two new models are being prepared in the Hall of the Great Altar to replace the old models that previously stood at the foot of the stairs. The first is the model of the altar itself, which shows it in its actual spatial arrangement, i.e. not as the elements of the frieze of the giants as they are displayed on the wall of the great hall, and the second is a section of the city mountain, which, unlike before, will make it clear that almost the entire mountain was covered with buildings. In addition, it will reflect the current state of science, nominally the year 2023, and will also be executed as a tactile model. On a scale of 1:333, which may be unusual but is nevertheless customary in architecture, it will depict the hilltop around the altar, so that the altar itself will be at the centre of the model. Unlike before, the model will be placed in the room in such a way that all three altars, the life-size reconstruction, the isolated altar model and the city hill, will be in the same orientation, i.e. the lines of the buildings will be parallel to each other. Apart from the technical conversion of the surface model used for the visualisations into a volume model, the implementation as a tactile model represents the greatest creative challenge. For here, in the existing production process, milled, not printed, both the milling machine's movement capabilities and the resistance to destructive forces have to be weighed against the visual scientific-spatial expression.

1. INTRODUCTION

The cooperation with the Bergama excavation and the Istanbul Department of the German Archaeological Institute in charge of this excavation has been running continuously since 2008. The Roman Lower Town at the foot of the city hill is currently being completed, as well as some large complexes in the surrounding area. Although at least the entire city hill represents the current state of research, only the upper section is to be reproduced in the museum as a haptic model, virtually in its entirety of course, but not in the hall itself. The selection of the section is primarily based on the fact that the actual centrepiece of the hall, namely the altar, which in archaeology is obviously not referred to as the Pergamon Altar but as either the Great Altar or the Altar of Zeus, is largely prominent as the centrepiece of the model (Fig. 1). This also allows a somewhat larger scale for a given absolute dimension of the model. The chosen scale would be 1:333, a value that at first glance may seem strange, but as the fraction 3/1000 it is already more reasonable, as it is a fairly usual scale in architecture between the more common 1:200 and 1:500, and as a triple of 1:1000 it is also relatively easy to use in calculations. The decision to recast the model in the first place is primarily due to the fact that the earlier model shows the earlier state of research, which

portrays the mountain largely as a landscape, albeit not quite as undeveloped as it is today (Fig. 2). The current situation is that the city hill was almost completely built on (Fig. 3). This is the point at which it becomes recognisable that Pergamon was a real metropolis (Fig. 4) and not a park-like complex of large buildings and a few secular buildings scattered around (Fig. 5).

2. CONVERSATION OF A VISUAL MODEL AND THE DESIGN OF A 3D MODEL

The virtual model, which includes several time phases and a terrain model covering several square kilometres, which in turn consists of both local surveys and satellite data, has so far been projected solely for image purposes. As a result, it consists almost entirely of bare surfaces whose enclosed volume is not yet defined as a numerical volume. However, this visually irrelevant difference prevents 3D printers from producing anything. However, this fact is the least of the problems; the conversion of surfaces into volumes is basically a technical process that, apart from the usual uncertainties when working with CAD, should run smoothly.

Basically, the challenge in designing a 3D model is similar to the composition of a perspective in the absolute size in the presentation medium. The actual material of the physical model in conjunction with the production method define the possible level of detail. This means that some details that are clearly visible in the visualisation are either no longer visible in the model or cannot be realised statically. Fragile parts in particular, especially columns, are often too vulnerable. Either they cannot be produced in the first place or they are so sensitive that the model has to be protected behind glass. One solution is to support free-standing elements by adding further structures. Colonnades can thus be reproduced using half-columns. The curved portico of the imperial palaces on the Palatine Hill in Rome (Fig. 6) is so small in its 1:1000 scale model and its columns so thin that it could only be reproduced in the form of semi-pillars (Fig. 7), as the 3D print should be made in one piece. The situation was different with the Temple of Apollo, another prominent building on the Palatine Hill, but its columns could be printed at a scale of 1:100 so solidly that they could remain free-standing (Fig. 8).

3. INTUITIVENESS, RECONTEXTUALISATION AND HYPOTHESES

Another topic, but also of importance here, is the question of differentiating between findings and hypotheses. The claim is often made that a distinction is required between findings and additions in both pictorial and physical representations. However, this added value of information is at the same time a limitation in the architectural expression. Using an exemplary series of images from the Gymnasion in Pergamon, it is easy to recognise that the reduction of information about the findings - the surviving fragments are dark - overlays the architecture with a very lively graphic design, which certainly could not have been the intention of its builders (Fig 9). On the contrary, the fragmentation is historically entirely coincidental. This falsifies the architecture in its entirety, specifically the intention to create a regular row of columns. The loss of information about the fragments is at least compensated for by the gain in architectural expression. Therefore, abstraction is not a loss, but a focus, here on the architectural statement as opposed to the archaeological information.

As the new physical model in the Pergamonmuseum will stand directly in front of its original, it can be assumed anyway that the two media will combine in the visitor's imagination in the best possible way, so that in the best case scenario the viewer will be able to empathise with the site even better than before when alternately viewing the original and the abstract urban context (Fig. 10). This effect is likely to be similar to that which can be achieved with recontextualised sculpture when it is placed directly and physically in space in front of room-sized perspectives, so that the perspective can act as a visual context (Fig. 11). This works particularly impressively when the spatial distance dissolves as the view of the sculpture is entirely framed by the context (Fig. 12).

Fig. 1: *Planned physical model of the Pargamon M 1:333*

Fig 2.: *Western prospect of the Pergamon today*

Fig. 3: *Western prospect around 200 CE*

Fig. 4: *Pergamon around 200 CE*

Fig. 5: *Traianeum in Pergamon*

Fig. 6: *Palatine hill and Circus Maximus in Rome · 2nd to 4th century AD*

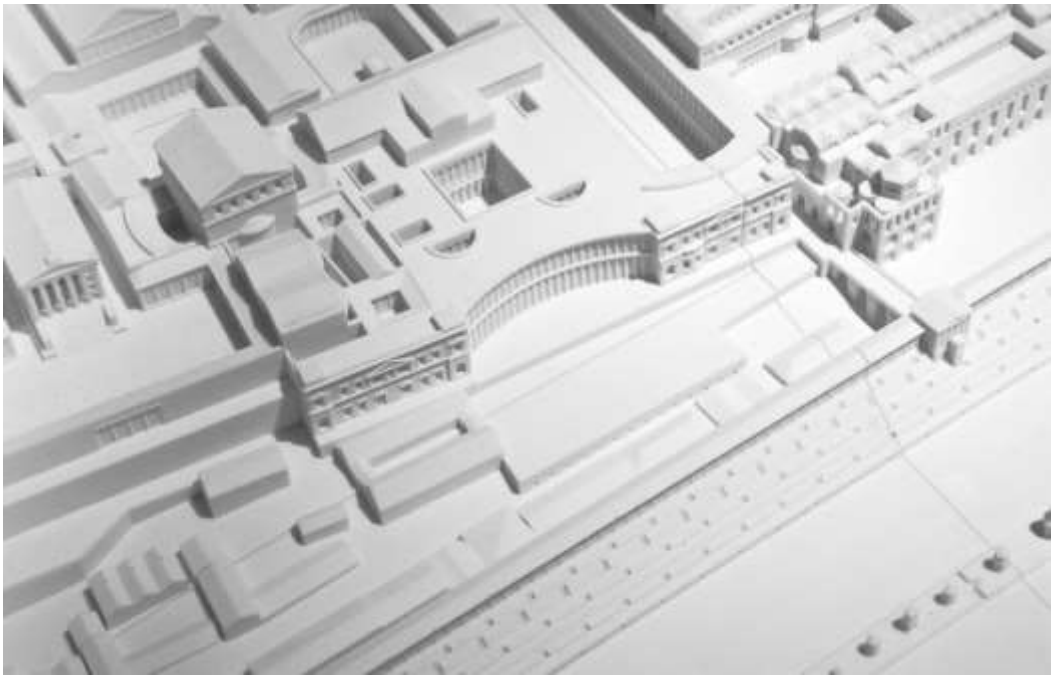

Fig. 7: *Palatine hill and Circus Maximus in Rome · 2nd to 4th century AD*

Fig. 8: *Temple of Apollon on Palatine hill · Exhibition in Pergamon Museum Berlin*

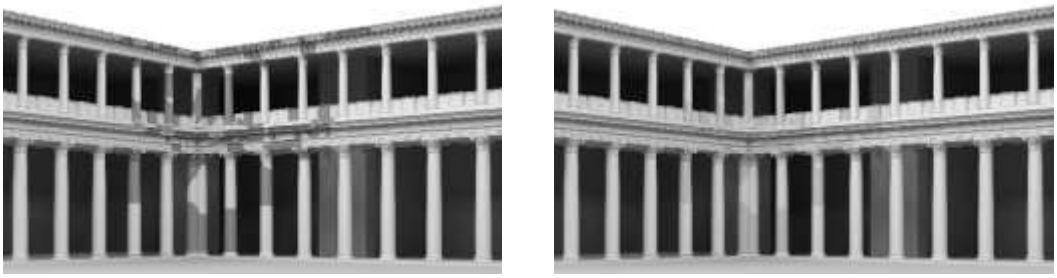

Fig. 9: *Gymnasion in Pergamon*

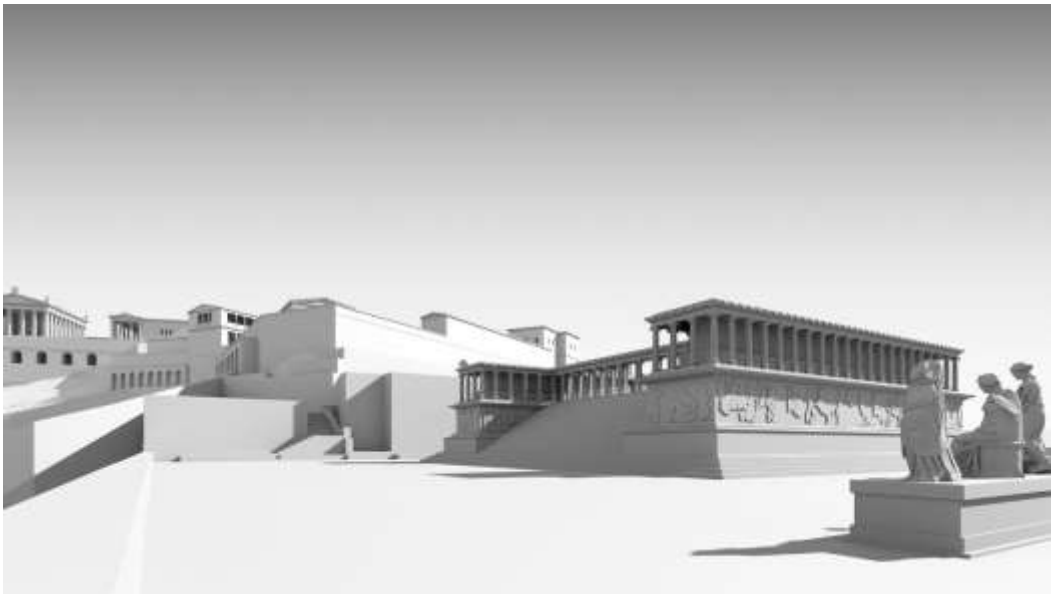

Fig. 10: *Terrace of Great Altar in Pergamon*

Fig. 11: *Gruppo Ludovisi of Pergamon recontextualised ·*
Exhibition in Plaster Collection Berlin Charlottenburg

Fig. 12: *Gruppo Ludovisi of Pergamon recontextualised ·*
Exhibition in Plaster Collection Berlin Charlottenburg

4. THE INFLUENCE OF TANGIBILITY AND THE CHOSEN MATERIAL ON THE DESIGN

A significant special feature of the physical model of Pergamon, however, is the condition that it should also be a haptic model, i.e. one that can be touched. The choice of material was therefore Corian, a ceramic-like material used for surfaces in kitchens and bathrooms. However, Corian cannot be produced using the 3D printing process. Instead, Corian, which is produced in sheets, can be bent and milled. This significant limitation compared to 3D printing will have a major impact on the design of the 3D model, as the possibilities of the milling machine are restricted by the accessibility of the geometry. Cavities such as half-open halls (Fig. 13) are not achievable from a single piece in this way; only the complex process of manufacturing discrete components with subsequent assembly would make such a model possible. However, this should be avoided to a large extent, especially in order to keep costs within limits. The modelling of the conversion from a surface model to a volume model will therefore be based to a large extent on the capabilities of the milling machine (Fig. 14). However, as it will not be an option to walk through the physical model anyway, real hollow bodies are not even necessary. Instead, the aim is to use the capabilities of the milling process in such a way that the current state of research is reproduced as accurately as possible, both visually and haptically.

5. TEACHING FABRICATION

In teaching at our chair, we attempt to translate these findings into the design of contemporary architecture. The aim is to combine 3D printing and visualisation for architectural design. Visual and constructive forms should be found that utilise the specific technical properties and potentials and at the same time contrast with the limitations of conventional production methods. As in model making, the aim of visualisation is to create visions that evoke architecture. Here, however, its aim is to intuitively recognise the intention of a realisation, which is why the results are produced at a much more advanced level of specification. (DL, JS)

Fig. 13: *Courtyard in the Palatine palaces · Rome*

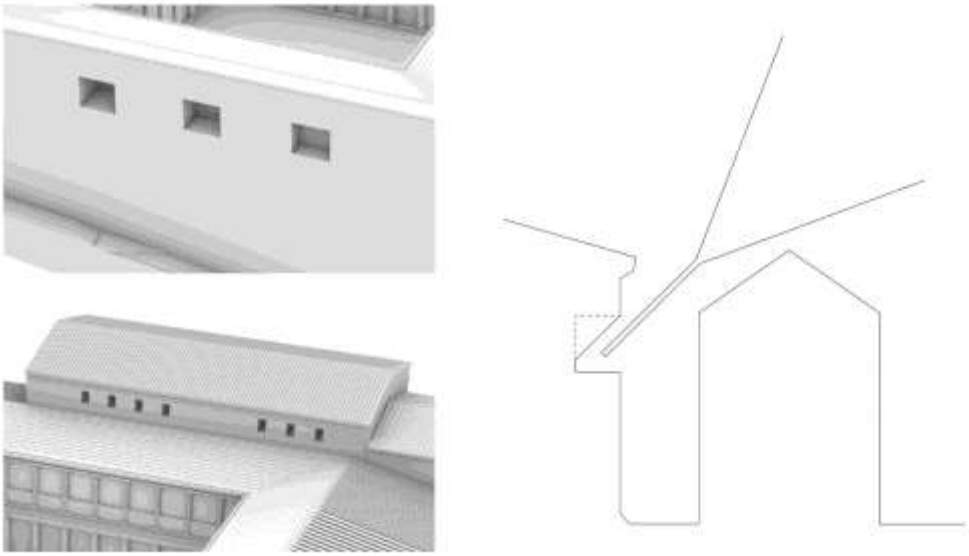

Fig. 14: *Milling limitations*

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Let´s Play´s from Buildings, Exhibitions and museum pieces

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Kurzdarstellung: Let´s Play´s sind kurze Videoschnipsel von Computerspielen, mit denen Profi Gamer besonders interessante Szenen aus Computerspielen einfangen und, meist kommentiert, auf den gängigen Internetplattformen wie YouTube, Tiktok und Co vorstellen. Das Computerspiel wandelt sich dabei in ein virtuelles Filmset für eine Social-Media-Plattform.

Überträgt man nun ein Museumsstück, eine Ausstellung oder ein historisches Bauwerk in eine leistungsfähige Game Engine, kann man nicht nur die unzähligen Möglichkeiten eines Computerspieles zur Präsentation von Kulturobjekten in ansprechenden Auflösungen von 4 oder 8K nutzen, sondern das Spiel selbst auch als virtuelles Foto- oder Videostudio betrachten. Hat man in einem Museum eine leistungsfähige Computerspielecke eingerichtet, können Kuratoren oder Besucher ihren Lieblingsstücken als Let´s Play´s Videos auf den unterschiedlichen Plattformen präsentieren und damit breitere Interessentengruppen ansprechen.

Am Beispiel der Kaiserringausstellung vom Winter 2021/22 im Mönchehaus Museum für Moderne Kunst in Goslar wird aufgezeigt, wie ein ganzes Museum mit allen Exponaten einer temporären Ausstellung digitalisiert und in ein Computerspiel überführt wird, und was bei der Einrichtung einer Computerspielecke im Museum zu berücksichtigen ist. Es folgt die Darstellung eines virtuellen Ausstellungsbesuchs mittels Avatar und dessen Aufzeichnung als Let´s Play Video.

Die Arbeiten wurden im Projekt „Digitales Kaiserring Archiv - vom Schauraum zum Kommunikationraum“ durchgeführt, und von der Kulturstiftung der Länder im Rahmen von Neustart Kultur finanziert. Die Arbeiten wurden von illustrated architecture konzipiert und in Zusammenarbeit mit dem Mönchehaus Museum und dem Hasso-Plattner-Institut Potsdam durchgeführt.

1.VORARBEITEN

Illustrated architecture ist 2002 entstanden, seitdem beschäftigen wir uns intensiv mit der 3D-Digitalisierung von Denkmalen mittels Laserscanning und Fotogrammmetrie. Von Anfang an gab es eine fruchtbare Zusammenarbeit mit dem Deutschem Zentrum für Luft- und Raumfahrt (DLR) Robotik und Mechatronik Centrum in Oberpfaffenhofen und Berlin und der Bayerischen Verwaltung der Staatlichen Schlösser, Parks und Seen. Im Zuge dieser Zusammenarbeit wurden im MuSe Bayreuth Projekt 2012-2014 (multi-scale / multi-sensor 3D-Dokumentation und 3D-Visualisierung höfischer Prunkräume) ein Verfahren entwickelt, um in der Kombination von Laserscanner und Fotogrammmetrie barocke Prunkräume in ihrer architektonischen Ausprägung, und aller Einbauten in einem 3D-Basismodell mit 1-2 mm Auflösung zu erfassen, und anschließend die architekturgebundene Kunst und die farblichen Fassungen in einer höheren Auflösung mit 0.25-1mm Auflösung zu ergänzen [1] [2].

Diese Verfahren mit zwei Maßstabsebenen wurde 2019 zur 3D-Digitalisierung der Typographia Sinica der Berliner Staatsbibliothek durch eine dritte Ebene auf eine Auflösung ab 0.1mm gesteigert [3]. Damit war die Grundlage gelegt auch ein größeres Gebäude mit allen Ausstattungselementen in einer dynamischen Auflösung von 0.1 bis 2 mm zu digitalisieren.

2.DIGITALISIERUNG

Der Kaiserringpreis für moderne Kunst der Stadt Goslar wird seit 1975 an hervorragende bildende Künstler der Gegenwart verliehen und seit 1984 wird auch das Kaiserring Stipendium an Nachwuchskünstler vergeben. Damit verbunden ist jeweils eine temporäre Ausstellung der geehrten Künstler im Mönchehaus Museum für moderne Kunst, ebenfalls in Goslar. Das Museum wird durch bürgerschaftliches Engagement getragen. Schaut man sich die Liste der Preisträger an, kann man den Preis auch als den Nobelpreis für Moderne Kunst begreifen.
Bedingt durch die Corona Einschränkungen kam in mehreren Gesprächen mit Frau Dr. Ruhrberg, Direktorin des Museums, die Idee auf ein virtuelles 3D-Ausstellungs Archiv aufzubauen und zukünftig im Museum zu präsentieren. Daraus entwickelte sich ein Projekt, welches das Museum und illustrated architecture mit Unterstützung des Hasso Plattner Instituts in Postdam durchführen konnte. Das Projekt wurde durch die Kulturstiftung der Länder im Rahmen von „Neustart Kultur“ gefördert.

Die Digitalisierung der Ausstellung des Kaiserring Preisträgers von 2020, Hans Haacke, und der Stipendiatin von 2021, Zandile Tshabalala, konnte coronabedingt erst im Winter 2021/22 erfolgen. Die 3D-Digitalisierung des Museums erfolgte analog zu dem im Muse Bayreuth Projekt entwickelten Verfahren für das gesamte Museum, sowie einer erhöhten Auflösung von 0.1 mm für ausgewählte Objekte. Für Malerei wurde zusätzlich zur Erreichung einer hohen Farbauflösung das in [3] beschriebene Pixelschift eingesetzt. Die Digitalisierung erfolgte mit einem ZF-Laserscanner 2016 in Farbe und mit einer Sony A7RII Digitalkamera. Für die 7 Ausstellungsräume sowie verbindende Treppen und Galerien wurden insgesamt 120 Laserscans und ca. 12.000 Messbilder aufgenommen. Die Laserscans wurden mit der Software des Herstellers vororientiert und anschließend in einem gemeinsamen Bündelansatz mit den Messbildern endgültig ausgeglichen. Für diese und alle Berechnungen bis zum fertigen 3D-Modell wurde das Softwarepaket RealityCapture (Epic Games) genutzt. Mittlerweile konnten auch die Ausstellungen vom Winter 2022/23 digitalisiert werden.

3.ÜBERTRAGUNG IN EINE COMPUTERSPIEL SOFTWARE

In moderner Spielesoftware kann etwa die 20-fache Menge an 3D-Polygonen und die 100 fache Texturinformation im Vergleich zu guten Internetbasierten Lösungen an den Betrachter transportiert werden; damit können auch große Anzeige Systeme mit 4K oder 8K Auflösung zur Präsentation von 3D-Modellen genutzt werden. Meist existieren auch Treiber für gängige Brillensysteme. Zur Übertragung des Museums in die Software Unreal (ebenfalls Epic Games) wurde das umfangreiche 3D-Digitalisat des Museums in 3 Teile zerlegt und die Gemälde der Stipendiatin, sowie einige Videos aus der Ausstellung extra eingebaut.
Das aus den Daten entstandene „Computerspiel“ kann mittels eines Game Controllers bedient werden. Um sich durch die Räume zu bewegen, wird ein einfacher Avatar eigesetzt, der dem Nutzer die Möglichkeit gibt in First- oder Second Person Perspektive durch das Museum zu wandern. Innerhalb des Spieles gibt es mehrere Funktionen zum Zoomen der Bilder, zur extra Anzeige von Schrifttafeln und für virtuelle QR-Codes, die mit weiteren Informationen, die nicht in das Spiel eingebaut werden müssen, verlinkt werden können. Über diese QR-Codes kann der Nutzer wie in einer realen Ausstellung Informationen zu Objekten auf sein Handy übertragen.

4.AUFBAU DER 3D-SPIELECKE

Im Mönchehaus Museum wurde im Zuge des Projektes eine 3D-Spielecke eingerichtet. Ursprünglich sollte das im neu zu gestaltenden Kaffee des Museums erfolgen; durch eine langwierige Abstimmung mit der Denkmalbehörde konnte diese Umgestaltung bis heute noch nicht umgesetzt werden. Daher wurde eine provisorische Ecke im Eingangsraum aufgebaut. Die Hardware besteht aus einem leistungsfähigen Gaming PC und einem 4K Monitor mit 2m Diagonale. Neben dem 3D Computerspiel werden dort auch aktuelle Videos zu den Künstlern der verschiedenen Ausstellungen gezeigt.

Abb. 1: 3D-Spieleecke im Mönchehaus (Bild Verfasser)

Abb. 2: Besuch einer 3D-Ausstellung mittels Avatar (Bild Verfasser)

5. ERSTELLUNG VON LET´S PLAY VIDEOS

Für die Bayerische Landesausstellung 2020 haben wir erstmals ein 3D-Digitalisat des virtuellen Modells des historischen Holzmodelles der Stadt München von 1570 des Drechslermeisters Jakob Sandtner in 5 kleinen Videofilmen vorgestellt. Ziel der Arbeit war es einer großen Besuchermenge das 3D-Modell nahe zu bringen und anhand von „Guided Tours“ die wichtigsten Entwicklungen der Stadt München von der Gründung bis zur Renaissance vorzustellen. Dabei sollte das einzigartige historische Architekturmodell und wissenschaftlich recherchierte begleitende Information für sich wirken.

Abb. 3: Sandtner Stadtmodell von München 1570 auf einem 3D Web Server (Bild Verfasser)

Abb. 4: Videos vom Modell für die Baeyrische Landesausstellung 2020 (Bild Verfasser)

Auf unnötige Spielereien einer aufwendigen medialen Inszenierung wurde bewusst verzichtet, ein Grundsatz, den man auf alle musealen Objekte anwenden kann. Im Winter 2019/2020 wurden dabei die Videos noch mit klassischen Softwaretools wie 3D-Studio erstellt, da es nicht möglich war die Datenmenge des 3D-Digitalisates für Anzeigesysteme mit hoher Auflösung ohne starken Datenverlust oder intensive Nachbearbeitung in eine Gaming Engine zu übertragen.

Mit der zunehmenden Bedeutung von Real World 3D Daten in Spieleumgebungen hat sich dies aber innerhalb von 2 Jahren komplett verschoben. Heute kann man dank leistungsfähiger LOD (Level of Detail) Systemen sehr umfangreiche 3D-Digitalisate in Game Umgebungen übernehmen und flüssig visualisieren. Benutzt man nun eine Game Umgebung, die es ermöglicht Spielzüge direkt als Video mit erklärendem Kommentar aufzuzeichnen, besteht für jeden Kunstwissenschaftler/Kunstvermittler direkt die Möglichkeit seine „Lieblingsobjekte“ in einer virtuellen Ausstellung über alle gängigen Videoplattformen oder im Live Stream zu präsentieren.

Abb. 3: Let´s Play Videomitschnitt eines virtuellen Ausstellungsbesuches mittels Avatar der Ausstellungen Winter 2021/22 im Mönchehaus Museum (Bild Verfasser)

Für erfahrene Let´s Player ist dabei die Herausforderung möglichst komplexe und lange Spielzüge flüssig, ohne den Einsatz eines Schnittprogrammes, zu präsentieren. Für weniger Gameaffine Mitmenschen ist es aber einfacher eher kleine Videoschnipsel aufzuzeichnen und sie später in einem Schnittprogramm zusammenzufügen.

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The representation of pastoral stone architectures: Towards a graphic reconstruction

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ABSTRACT: This contribution concerns the representation of pastoral dry stone architecture, in a path that goes from the documentation of the existing, to the graphic reconstruction, from the point cloud to 3D modeling. Starting from integrated survey operations, the methodological path undertaken to talk about these architectures is presented through specific cases. The documentation produced is intended for different users and with different purposes, for the knowledge of the existing heritage and to projecting the theme into cultural tourism circuits.

1. INTRODUCTION

This work refers to an ongoing research which has as its objective the knowledge and the enhancement of pastoral architecture, both in terms of documentation of the existing and of encouraging the use of places through the definition of cultural itineraries. We refer to structures such as huts, fences, shelters, in detail, while on a larger scale it refers to connections, in relation to the territory and the landscape. These are structures that are poorly preserved and which risk disappearing along unmarked, bumpy and disconnected paths.
Here the theme of the representation of these architectures is investigated in particular, addressing the fields of architecture and archaeology. We approach the latter due to the fact that many of the structures are not in use, are found as traces and refer to different periods. The reference context, in which the case studies were identified, relates to the Aspromonte National Park in Calabria, south Italy. The case studies are however contextualised and compared with similar examples in Europe and in the Mediterranean basin.

The structures analyzed are scattered across the territory, above a thousand meters high, in the municipality of Samo (RC). They can be identified in the form of settlements or as single structures. There are no documents useful to dating the structures at the moment, it can be indicated that the sites were frequented during the last decades of the 19th century and an already well-rooted construction culture which refers to the origins of architectural archetypes. In this case we want to highlight the process adopted for documenting with the aim of being able to preserve them.

2. DRY STONE STRUCTURES

The dry stone structures have characterized the Aspromonte landscape, they are part of the places and are the result of close contact with nature. At the same time they refer to similar structures widespread in the Mediterranean. “Pur essendo strettamente legate alla natura dei singoli luoghi, queste costruzioni rievocano regioni e tempi lontani, dando l’impressione di

esistere da sempre e dappertutto, in forme identiche."[1].
The structures analyzed are made with lithic fragments (Fig. 1). The materials were found *in situ* and were of different sizes, favoring fragments of considerable size at the base. This aspect is due to the need to have the construction material in the place, in order not to have to face costs, both of the material itself and of transport, underlining a non-flourishing socio-economic condition and the impossibility of transporting construction materials to inaccessible areas. In some cases, the constructed element is placed against a large boulder, to provide greater stability and shelter from atmospheric agents.
The stone has seen greater use and resistance to the passage of time, but no less important other materials such as wood and broom, used above all for the roof of stone huts, or for doors or even for shelves intended for interiors very minimal. The abandonment of the areas with the almost total disappearance of the shepherd's presence led to a progressive abandonment of the places and consequently of the architectures.
The wooden parts and branches, which required maintenance and in many cases a periodical replacement, were lost, also causing damage to the underlying structures, having the task of covering the structure.

Figure 1: *Detail of the connection system of a dry stone structure. Photo by the author.*

2. THE CASE STUDY

Among the case studies that are part of the research, two architectural typologies from the pastoral settlement of *Santa Nicola* were selected for the preparation of this contribution. The settlement is located in the municipality of Samo (RC) and its articulation can be traced back to two parts: a recently abandoned part, characterized by the presence of structures made with materials such as insulated panels and corrugated sheet metal placed on pre-existing dry stone and wood; an older part abandoned for at least twenty years where traces of traditional structures are still present (Fig. 2).

Figure 12: *Santa Nicola settlement, aerial photography of the old part. Photo by the author.*

In particular, two architectural elements of considerable interest have been identified on the site: a dry stone hut and a small dry stone house, a shepherd's refuge. These are two elements, although extremely simple and made up of a single environment and a single opening, which have different shapes and functions.
The dry stone hut has a circular plan (Fig. 3).
A conical roof made of a wooden frame covered with intertwined broom branches was superimposed on the cylindrical stone base element, which still exists. This structure has had various uses over time, being used both as a shepherd's refuge and more recently as a tool storage and animal shelter.

Figure 3: *Remains od the dry stone hut in Santa Nicola. Textured mesh. Author's elaboration.*

The small dry stone house has a quadrangular plan. It is characterized by the presence of a large boulder against which the built elements were placed (Fig. 4). The roof, with a single, slightly sloping pitch, was made with wooden joists and reused materials. This structure has always had a residential function. Although the abandonment of the sites is relatively recent, the structures have rapidly lost their structural integrity, due to the absence of roofing elements, caused both by the perishability of the material and by their removal for new uses.

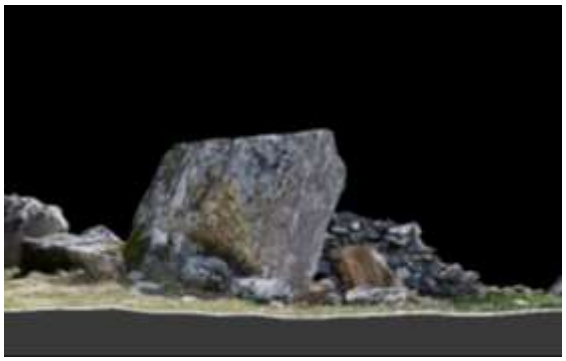

Figure 4: *Remains of the shepherd's house in Santa Nicola and the large natural boulder. Textured mesh. Author's elaboration.*

3. METHODOLOGICAL APPROACH

The first phase of the study consists of cognitive investigations characterized by field inspections, conducted directly and with the aid of specific instrumentation.
The case studies are documented through integrated survey operations, with terrestrial camera and UAV photogrammetry. This phase is followed by different treatment processes based on the purpose.
The acquisition operations are followed by data processing (Fig. 5). The image sets are processed through the use of Agisoft Metashape software. The first step involves aligning the photographs and generating the sparse point cloud. The second step involves the calculation of the dense cloud, which can be exported for use in third-party software, or used to calculate the mesh. The mesh obtained is textured and used for the virtual visualization of the detected state of fact.

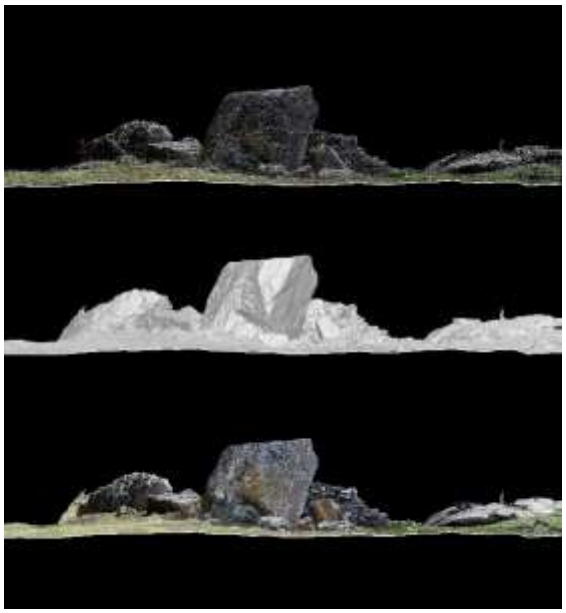

Figure 5: *Processing phases. Remains of the shepherd's house, Santa Nicola Settlement, Samo (RC). Author's elaboration.*

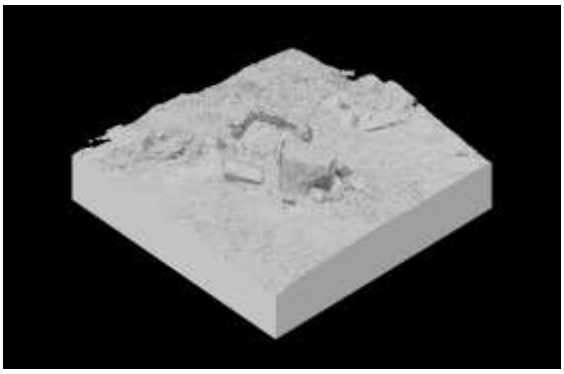

Figure 6: *3D Mesh. Remains of the shepherd's house in Santa Nicola. Author's elaboration.*

The mesh in these terms is conceived as a digital cast of the architecture in its state of ruin and a starting point for the graphic reconstruction of the element investigated (Fig. 6).
The graphic reconstruction therefore proceeds with the drawing for a first two-dimensional graphic reconstruction, based on the surveys and on the documentation produced by archive images and with the interactions with the witnesses of the places.
This is the step in which these different factors act and which precedes the three-dimensional graphic reconstruction.

4. PERSPECTIVES

Among the research perspectives it is envisaged to trace cultural paths in which the architectures are inserted, to know their current state but also to provide indications regarding their use and their original form.
For the purposes of shared use of the heritage under investigation, also for educational and dissemination purposes, virtual and augmented reality applications are being prepared.
The drawings constitute essential documentation for structures not investigated from this point of view in this geographical area. Digital data, point cloud, 3D mesh and textures form the basis of a virtual use of pastoral heritage.

Figure 7: *Perspective view of the point cloud. Author's elaboration.*

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From digital survey to physical model: The underground church of Sotterra in Paola (CS)

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ABSTRACT: The document presented intends to propose an experience of architectural survey and representation, relating to the Underground Church of Sotterra in Paola (CS). In a first part, the main historical and interpretative problems relating to the building investigated are illustrated; a literary review relating to studies conducted on the church is presented. In the second part the process that leads from the real object to representations of the object itself in virtual space, such as point cloud, TIN mesh, textured mesh, is described. The virtual object is then brought back into the 'real' space through the use of a 3D printer, albeit in the form of a model and as a reduced cast of the real space. The model produced is constituted as a 1:100 scale cast of the negative architectural space, a space that is the result of the sum between the original spatial configuration and the modifications made at the end of the 19th century, in the context of the rediscovery of the building. The documents produced offer the possibility of understanding and highlighting the results of these modifications, in reference to an interesting underground space dedicated to Christian worship. The work presented here constitutes an intermediate and synthetic stage, in reference to a study still in progress.

1. INTRODUCTION

The experience described is part of a research on the underground as a place of worship, co-financed by the Calabria Region Operational Program (POR-Calabria) 2014/2020. The project refers to the Tourism and Culture sector and to the large area of Humanistic Culture, Creativity, Social Transformations, Inclusive Society of the PNR 2021-27, and is consistent with the policies and interventions envisaged for strengthening the Regional Innovation System (Regional S3). The research refers to the scientific disciplinary sector (SSD ICAR/17) Drawing, and dialogues, in an interdisciplinary way, with the Christian and Medieval Archeology sector (SSD L-ANT/08). A first phase of the research involved the census of the underground and rock Christian places of worship in the region: 30 sites have been identified. A second phase involved the launch of a program of explorations and inspections, through which 13 study cases were selected for further investigation. The selected sites generally fall within the territory of the Metropolitan City of Reggio Calabria (RC); however, it was chosen to carry out three surveys in other provinces, due to the particular importance of these three sites. Below is the list of the 13 sites investigated:

1. Cave of St. Elia Speleota in Melicuccà (RC);
2. Caforchi caves in Seminara (RC);
3. Cave of St. Antonio in Seminara (RC);
4. Crypt of St. Fantino in Taureana di Palmi (RC);
5. Rock site of Pignarelle in Palmi (RC);
6. Sanctuary of Madonna della Grotta in Bombile di Ardore (RC);

7. Rock Church of St. Nicola del Cofino in Gerace (RC);
8. Cave of the Shepherdess in Stilo (RC);
9. Cave of St. Angelo in Stilo (RC);
10. Cave of the Madonna della Stella in Pazzano (RC);
11. Church of Piedigrotta in Pizzo (VV);
12. Underground Church of Sotterra in Paola (CS);
13. Caves of St. Michele arcangelo and St. Vito in St. Donato di Ninea (CS).

This paper, after a historical and bibliographical review, illustrates graphic developments and reflections relating to the case of the Underground Church of Sotterra in Paola (CS).

2. THE CHURCH

In the town of Paola (CS), in the Gaudimare area, there is an underground church whose dating and interpretation have always presented multiple problems. The church was discovered in 1876, during the construction of the new upper church. The first mention is due to G. B. Moscato [1].
To date, it is not clear whether the church was originally conceived as an underground environment or whether it was buried over the centuries (Tab. 1). This latter opinion was shared among others by F. Russo [2], author of the first monographic work dedicated to the church (Fig. 1).

Figure 1: *La Chiesa Bizantina di Sotterra a Paola (Storia e Arte), Francesco Russo, 1949.*

This hypothesis seems to be supported by the results of the excavations conducted in the years 1990 and 1993 by A. B. Sangineto [3]. However, the presence of two deep lateral niches which would considerably exceed the wall thickness, today partly occupied by one of the nineteenth-century reinforcement arches, leaves us to think that the idea of an underground or semi-underground structure cannot be completely discarded, at least for some phases of the life of the building. The same problem had already been raised by G. Rubino, who went so far as to hypothesize that the building could originally have had an architectural configuration on two levels.
Still in 1874, for the construction of the new church, the remains of an existing chapel had to be demolished; we do not know its exact position and consistency.

Hypothesis of the original configuration of the building	Authors
Underground church or crypt	Galli (1926), Isnardi (1928), Frangipane (1929), Cappelli (1936), Venditti (1967), Barillaro (1972), Rotili (1980), Verduci (1991), Coscarella (1996), Di Dario Guida (1978).
Buried *sub divo* church	Russo (1949), Minuto (1985), Napolitano (1994), Benvenuto (1999), Musolino (2002).
Crypt with *sub divo* oratory	Rubino (1973).

Table 1*: Summary table of the hypotheses regarding the original configuration of the building. Author's elaboration.*

The church lacks any literary reference, therefore the dating hypotheses are to be referred to historical and stylistic evaluations (Tab. 2). The dating to the 7th-8th century was proposed, for the first time, by E. Galli [4] and shared by G. Isnardi [5] and at first by A. Frangipane [6], while F. Russo leans towards the 10th and 11th centuries. In relation to the name, F. Cuteri writes "esso è stato finora riferito o alla conformazione ipogeica dell'edificio o al suo interramento per cause alluvionali. Ma in verità il luogo di culto, che apparentemente non ha un titolo ufficiale, potrebbe celare nell'insolito nome una più antica dedica al Cristo Salvatore (Ho Soter) o alla Salvatrice" [7].

Author and year of publication	Proposed construction period
Galli (1926)	VII-VIII
Isnardi (1928)	VII-VIII
Frangipane (1929)	VII-VIII
Cappelli (1936)	VII-VIII
Frangipane (1938)	IX-X with reconstruction in the 14th century
Russo (1949)	IX-X
Cappelli (1958)	IX
Venditti (1967)	VII-VIII
Barillaro (1972)	IX-X with reconstruction in the 14th century
Rubino (1973)	VII-VIII
Rotili (1980)	IX-X
Verduci (1991)	IX-X with modifications in the 13th-14th century
Napolitano (1994)	IX-X
Benvenuto (1999)	VII-VIII
Musolino (2002)	VII-VIII

***Table 2**: Summary table of proposed construction periods. Author's elaboration.*

The church has a single rectangular nave ending in an apse (Fig. 2), with smooth walls divided by three round arches built in 1876 to support the new upper church. The nave has maximum dimensions of 16.30 meters longitudinally and 4.75 m at the presbytery.

The presbytery and the apse are characterized by the presence of a cycle of frescoes attributable to different eras, and in any case relating to a period between the 9th and 15th centuries. The apse vault preserves a fresco in a very poor state of conservation, depicting Christ, while in the basin a series of apostles or saints (depending on the interpretation) is depicted, with the Madonna in the centre. On the back wall there are two frescoes of the annunciation, while on the left wall there are a fresco of the *virgo lactans* and a figure of a saint. For a brief bibliographical framework regarding the frescoes, see Zappani (2018).

***Figure 13:** The interior of the Church. Photo by the author.*

3. HISTORY OF SURVEYS AND REPRESENTATIONS

The church appears to be one of the most investigated among the Calabrian underground and rock evidences dedicated to Christian worship. For this reason it is possible to find in the literature, since the beginning of the 20th century, the presence of surveys and graphic works relating to it. The first survey was carried out in 1925 by Paolo Ricca (Fig. 3). The drawing shows the plan and section of the actual state on the left, while on the right a hypothesis is proposed regarding the original configuration, through a plan and three sections.

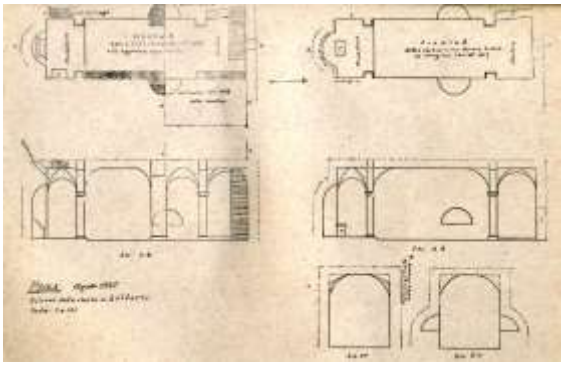

***Figure 14**: Survey of the underground church of Sotterra, 1925 by Paolo Ricca.*

A survey consisting of the plan, performed by E. Sansone, is on page 29 of the cited work by F. Russo. A further drawing, consisting of the plan alone, is on page 223 of the important text by A. Venditti on Byzantine Architecture in Southern Italy. A survey consisting of the plan and two sections is attached to the work of G. Rubino on Medieval Rock Architecture in Calabria. Further surveys and graphic representations have been made over time, as can be seen from the tables attached to the book by A. Martello Panno, dedicated in particular to the technical-structural evaluations of the building. In these graphic works it is possible to grasp in particular the relationship between the underground church and the new upper church.

A work that marks the watershed between analogue representations and the execution of digital surveys, was published in 2018 by A. A. Zappani. The author, in particular, made an integrated survey performed with both range-based and image-based techniques. The graphic works created on the basis of this survey are characterized by a systematic reading of measurements and proportions; an interpretation of the structures based on the geometric analysis of the elements is proposed in this work.

4. OUR DIGITAL SURVEY

A photogrammetric survey was conducted at the church with Structure From Motion (SFM) technology. 941 photographic images were acquired using two Fujifilm mirrorless digital cameras. No particular problems were encountered regarding lighting, as the church has an efficient lighting system. Therefore, it was not necessary to use auxiliary lighting systems.
The acquired images were included in a single chunk within the Agisoft Metashape software. The images were then processed and aligned, obtaining a sparse point cloud composed of 648,628 points. After the generation of the depth maps, the dense point cloud, consisting of 81,251,821 points, was generated (Fig. 4).

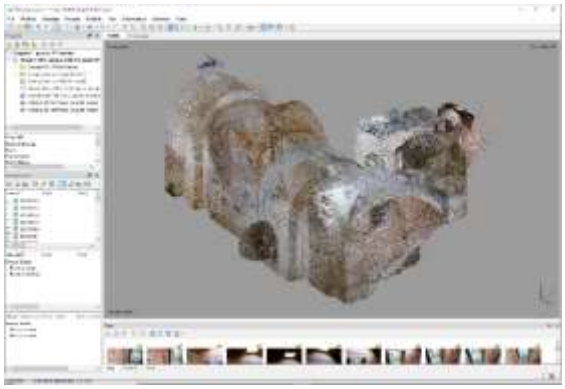

Figure 3: *The point cloud in Metashape environment. Author's elaboration.*

The Triangular Irregular Network (TIN) type mesh was generated within the same software. Consequently, the mesh was textured, thus obtaining a virtual model of the underground environment, referring to the internal surface. In the following figure we can see a virtual exploration of the textured mesh (Fig. 5). The detail of the processing produced, in particular with respect to the texturing of the mesh, offers the possibility of virtually enjoying it not only from a geometric point of view, but also with respect to the visualization of the frescoed.

Figure 4: *Internal view of the obtained textured mesh. Author's elaboration.*

The documents obtained gave the possibility of drawing, within CAD software (Autodesk Autocad) and also through the use of software for the management of raster images (Adobe Photoshop), canonical graphic documents such as plan, section and axonometry.
The following figures are an example of graphic works obtained after the mesh processing; Figure 6 is a vector drawing of the plan; Figure 7 is a textured longitudinal section; Figure 8 is an axonometric view.

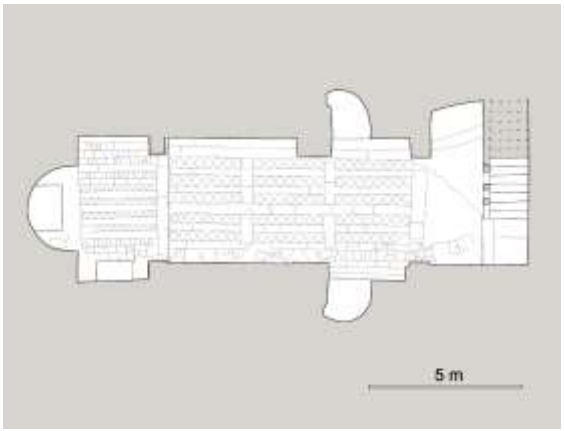

Figure 5: *Plan of the underground Church of Sotterra, Author's elaboration.*

Figure 6: *Cross section of the underground Church of Sotterra, Author's elaboration.*

Figure 7: *Axonometric view of the underground space, Church of Sotterra, Author's elaboration.*

5. PREPARATION AND 3D PRINTING OF THE PHYSICAL MODEL

Subsequently, through the use of a software for the management and treatment of mesh surfaces, Meshlab (Fig. 9), the mesh was treated in order to finally be imported into Ultimaker Cura, an application for the management of 3D printers. In particular, it was necessary to reverse the direction of the active surface, from the internal one to the external one.

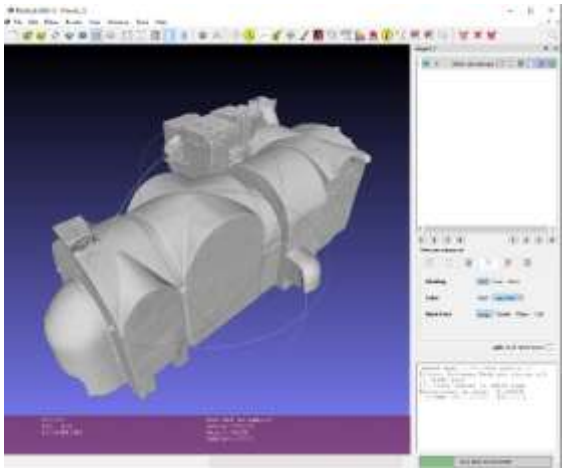

Figure 8: *The mesh within the Meshlab interface, Author's elaboration.*

This led to the realization of the 3D model, obtained through the use of an FDM printer, and constituted as a small-scale cast (1:100 scale) of the underground space investigated. The methodology used for the production of the physical model is constituted as a direct passage between the surface detected through digital photogrammetry with structure from motion techniques, and the model obtained.

Figure 9: *Three-dimensional physical model of the underground space. Author's elaboration.*

The analog model, with its own material physicality, allows a glance at the underground space as a whole, in a way that cannot be reproduced within the virtual space, also contributing to the interpretative reading of the monument.

6. DISCUSSION AND OPEN PERSPECTIVES

From a graphic point of view, the process adopted, describes the phases of the study according to the following scheme:

1) in the photogrammetric acquisition and processing of the point cloud/mesh the transition from real space to virtual space occurs;
2) in the printing of the physical model through the use of the mesh, a direct transition is produced from virtual to physical, in the form of a scale model;
3) the third phase, under development, involves the use of the physical and virtual model for augmented and virtual reality applications, through software capable of referring to queryable virtual visualizations or to the simple virtual application of the texturized mesh on physical model.

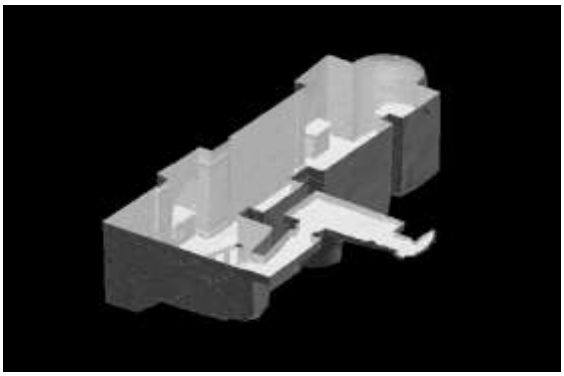

Figure 10: *Horizontal section of the untextured mesh. Author's elaboration.*

In terms of the historical reading, in our opinion, it is not currently possible to provide further clarifications with respect to the chronologies. In reference to the problem of the original configuration of the building itself, we believe that the presence of the two large niches exceeding the wall thickness testify to a phase of use of the structure, in at least a semi-underground form. The work presented here constitutes an intermediate and synthetic stage, in reference to a study still in progress.

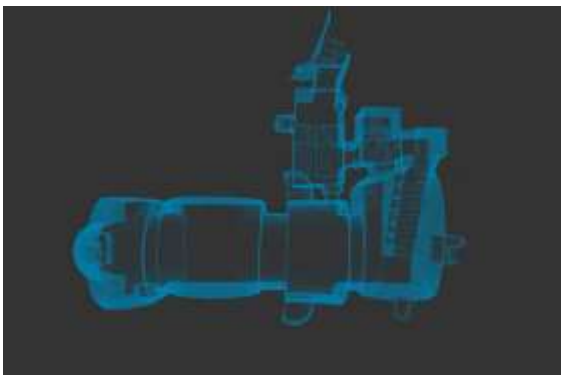

Figure 11: *X-ray view of the underground structures. Author's elaboration.*

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SESSION III

Multimodale Erfahrungen | Multimodal Experiences

Moderation: Sandro Schwarz
(Referent für IT Strategie | Stiftung Preußischer Kulturbesitz)

Kurzfristig vertreten durch | Briefly represented by:
Katja Sternitzke
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Multimodale Wissenschaftskommunikation in einer interaktiven Ausstellung

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KURZDARSTELLUNG: Die Ausstellung „#Krisenalltag – Kommunikation in der Pandemie“ im Berliner Museum für Kommunikation zeigte vom 13. Juli bis zum 15. Oktober 2023 erste Erkenntnisse des Forschungsprojekts MIRKKOMM. Sie bot den Besucher*innen einen Rückblick auf die Pandemiekommunikation von Behörden, Journalist*innen und Social-Media-Akteur*innen. Dieser Artikel beleuchtet die gestalterischen Herausforderungen bei der Präsentation von Forschungsergebnissen im Rahmen des Ausstellungsdesigns. Wesentliche Ziele der Ausstellung waren somit auch, den Prozess von Forschung zu veranschaulichen, einen Rückblick auf die Kommunikation in der Pandemie und eine kritische Reflexion zu ermöglichen, realisiert durch einen kreativen und multimodalen Transformationsprozess von Forschungsergebnissen.

1. EINFÜHRUNG

Die Präsentation von Forschungsergebnissen im Rahmen einer öffentlich zugänglichen Ausstellung ist eher ungewöhnlich: Einerseits ist die Komplexität der Fragestellungen für Fachfremde oft zu hoch. Andererseits wird in der Forschung vor allem das Ziel verfolgt, von anderen Wissenschaftler*innen der Scientific Community Aufmerksamkeit zu erhalten [1]. Dementsprechend muss zwingend darauf geachtet werden, die Ergebnisse angepasst an die unterschiedlichen Bedürfnisse einer breiten Öffentlichkeit zu formulieren und die neu gewonnenen Erkenntnisse entsprechend aufzuarbeiten.

Das MIRKKOMM-Projekt wird im September 2024 abgeschlossen. In der Ausstellung wurden folglich Zwischenergebnisse zur COVID-19-Pandemiekommunikation unterschiedlicher Akteure und der Rezeption dieser gezeigt. Beleuchtet wurde insbesondere die Online-Kommunikation auf digitalen Plattformen, welche die u. a. von diversen Unsicherheiten geprägten Pandemiejahre bezeugte [2].

Trotz oder gerade wegen der großen Unsicherheiten war es zwingend erforderlich, dass sowohl von staatlicher als auch von journalistischer Seite aus kommuniziert wurde, um die Bevölkerung zu informieren und zu bestimmten Handlungen aufzufordern und so das Virus eindämmen zu können [3]. Folglich wurde auch ein fluider Forschungsstand an die Bevölkerung kommuniziert und der Prozess der Erforschung des Virus‘ musste für das Verständnis einer breiten Öffentlichkeit transparent gemacht werden, um u. a. der Verbreitung von Falschinformationen etwas entgegenzustellen [4].

Die digitale Kommunikation ermöglicht es, Informationen multimodal zu kommunizieren [5], durch Text, Ton, Grafik, Bewegtbild, Animation etc. darzustellen. Außerdem erlaubt es die digitale Kommunikation einer Vielzahl von Kommunikatoren, Erfahrungen, Informationen und Meinungen über Social Media zu verbreiten [6].

Die Ausstellung hatte das Ziel, Good-Practice-Beispiele multimodaler Risiko- und Krisenkommunikation von Organisationen der Gesundheitssicherung und Beispiele mit Optimierungspotenzial im Rahmen der COVID-19-Pandemie anhand von interaktiven und partizipativen Exponaten zu zeigen und die Komplexität multimodal aufbereiteter Kommunikate z. B. über Eye-Tracking erlebbar zu machen.

2. DAS FORSCHUNGSPROJEKT MIRKKOMM

MIRKKOMM fokussiert die **M**ultimodalität **i**n der **R**isiko- und **K**risen**komm**unikation und analysiert die interne und externe Kommunikation von Organisationen der Gesundheitssicherung unter den Bedingungen einer Pandemie. MIRKKOMM wird durch das Bundesministerium für Bildung und Forschung im Programm „Forschung für die zivile Sicherheit“ gefördert. Neben dem Bundesinstitut für Risikobewertung sind das Karlsruher Institut für Technologie, die Technische Universität Ilmenau, die SRH Berlin University of Applied Sciences sowie die Europa-Universität Viadrina beteiligt. Die wissenschaftliche Expertise ergänzt ein Praxispartner, die mecom Medien-Communikations-Gesellschaft mbH, eine Tochtergesellschaft der Deutschen Presseagentur dpa. Unterstützung erfährt das Projekt zudem durch Forscher*innen aus den USA, den Niederlanden, Australien und Deutschland sowie durch assoziierte Partner wie u. a. das Robert Koch-Institut, das Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, die Bundeszentrale für politische Bildung, die Deutsche Presseagentur und Landau Media.

Im Mittelpunkt des Forschungsprojekts stehen die Fragen, inwiefern das kommunikative Zusammenspiel von Behörden, Medien und weiteren Öffentlichkeitsakteuren in Vorbereitung auf und zur Bewältigung von Krisen verbessert werden und wie Rechtssicherheit für die behördliche Praxis garantiert werden kann. Vier Forschungsperspektiven werden miteinander verbunden: 1) die Perspektive der Kommunikator*innen von Organisationen der Gesundheitssicherung auf kommunaler, Länder- und Bundesebene, sowie von journalistischen Medien sowie Social-Media-Akteur*innen, 2) die Perspektive auf Medieninhalte (Diskurse, multimodale Arrangements), 3) die Perspektive auf die Rezeption der Kommunikation und 4) die rechtswissenschaftliche Perspektive auf behördliche und wissenschaftliche Kommunikation und die Social-Media-Kommunikation in Krisenzeiten.

Untersucht wird, mit welchen multimodalen Arrangements Organisationen der Gesundheitssicherung Kernzielgruppen wie Bürger*innen, Journalist*innen und Social-Media Akteur*innen erreichen und wie diese den Informationsoutput der Organisationen rezipieren und bewerten. Multimodalität beschreibt den simultanen Einsatz verschiedener Symbolsysteme, wie gesprochene oder geschriebene Sprache, Zeichnungen, Grafiken, Bewegtbilder, Farben, Intonation, Gestik, Mimik, Design oder Typografie. Besonders ausgeprägt sind diese hybriden und multimodalen Kommunikationsformen in den digitalen Medien. Auch in der Risiko- und Krisenkommunikation sind unterschiedliche Modi der Darstellung und Präsentation präsent, wie etwa Grafiken, Icons, statistische Visualisierungen, Texte, Ton, Animationen etc. Die Erforschung des Zusammenspiels der unterschiedlichen Modi in Bezug auf die visuelle, textliche und auditive Sinnkonstitution verbindet die Forschung in den Teilprojekten [7]. Insgesamt bringt das Projekt die Befunde zu institutionellen, instrumentellen und symbolisch-relationalen Aspekten der Risiko- und Krisenkommunikation [8] mit den Ergebnissen der Multimodalitätsforschung zusammen. Institutionell steht die Frage im Mittelpunkt, wie Multimodalität u. a. inter- und intrabehördliche Koordinations-, Entscheidungs- und Produktionsprozesse beeinflusst. Instrumentell stehen Auswahl und Strukturen von Krisenplänen, Darstellungsformen, Mediengenres, Social-Media-Profilen oder Pressemitteilungen im Fokus. Symbolisch-relational wird die geeignete Gestaltung von Botschaften näher betrachtet, um Vertrauen, Verständlichkeit, Eindeutigkeit und Effizienz zu erreichen.

In der Folge eröffnet das Verständnis für das Zusammenspiel der unterschiedlichen Modi ein Optimierungspotenzial der Kommunikation in Krisen, das die Sicherung von Akzeptanz, Vertrauen, Verständlichkeit, Eindeutigkeit und Effizienz umfasst. Ziel der Optimierung von Botschaften in Form und Inhalt ist es, dass Medien und Organisationen der Gesundheitssicherung ihre Zielgruppen besser erreichen [9].

Damit trägt das Projekt dazu bei, über die Analyse multimodaler Risiko- und Krisenkommunikation von Organisationen der Gesundheitskommunikation sowohl aus Sicht der Kommunikator*innen als auch aus Sicht der Rezipient*innen den Mehrwert der jeweiligen sinnvoll arrangierten Kommunikate, z. B. in der Wissenschaftskommunikation, zu steigern. Die Kombination der verschiedenen Perspektiven erlaubt Aussagen darüber, welche Effekte Informationen, staatliche Anordnungen, Warnungen und Empfehlungen abhängig von der Präsentationsform auf Wahrnehmung und Handlungsintentionen haben. Darüber hinaus wird die Effektivität multimodaler Risiko- und Krisenkommunikation im Rahmen von Usability-Studien untersucht und werden Aspekte der Rechtssicherheit beleuchtet (vgl. **www.mirkkomm.de**).

3. AUSSTELLUNGSKONZEPT #KRISENALLTAG

Abb. 1: Blick in die Ausstellung mit Multitouch-Tisch im Vordergrund

Im Museum für Kommunikation stand ein Raum mit 102 m^2 für die Ausstellung zur Verfügung. Die Beleuchtung war variabel (Lichtspots an der Decke, Schienensysteme), mehrere Bodentanks für die Stromversorgung waren vorhanden, Wandfarbe war auf Wunsch variabel neu aufzubringen.

Der im MIRKKOMM-Projekt zentral angelegte Fokus auf Multimodalität wurde zugleich zum Kerngedanken der Ausstellung: Ziel war es, nicht nur möglichst multimodale Inhalte z.B. als Best-Practice-Beispiele und erste Forschungsergebnisse zu präsentieren, sondern auch die Ausstellung selbst möglichst multimodal zu gestalten und moderne Präsentations-technologie zur Interaktion und Visualisierung einzusetzen. In Absprache mit dem Museum für Kommunikation in Berlin wurde der Anspruch formuliert, die Ausstellung möglichst digital, interaktiv und partizipativ zu gestalten, zumal es sich um die erste objektlose Ausstellung im Museum handelte, also keine physisch greifbaren Exponate gezeigt wurden. Im Fokus der Ausstellung standen die während der Pandemie angewandten digitalen Kommunikationsstrategien. Anhand von Beispielen multimodaler Risiko- und Krisenkommunikation von Organisationen der Gesundheitssicherung sollte zugleich auch das Optimierungspotenzial aufgezeigt werden, etwa in Bezug auf Kohärenz, Eindeutigkeit und Effizienz sowie die Anschlusskommunikation von Journalismus und in den sozialen Medien.

Parallel sollten die Handlungslogiken der verschiedenen Kommunikator*innen (Medien, Organisationen der Gesundheitssicherung auf Bundes-, Länder- und Kommunalebene, Social-Media-Akteure) erkennbar werden. Zudem sollten die Besucher*innen die knapp drei Jahre dauernde Pandemiezeit für sich Revue passieren lassen können. Damit lag es nahe, die Entwicklung der Pandemiekommunikation anhand verschiedener Phasen seit Anfang 2020 abzubilden.

Der Wunsch, die Herausforderungen der Pandemiekommunikation multimodal darzustellen, musste also im Kontext der oben erwähnten Gedanken zu den Botschaften, dem zur Verfügung stehenden bzw. noch zu produzierenden Content, vor allem aber im Zusammenhang mit den machbaren bzw. sinnvollen technischen Präsentationsoptionen gedacht werden. Dabei wurde der Forschungsverbund von der Berliner Firma *Garamantis* als Dienstleister unterstützt. *Garamantis* ist spezialisiert auf interaktive Ausstellungen, Showrooms, Virtual Reality, interaktive Projektionen und immersive Erlebniswelten. Gemeinsam mit dem Team des Museums für Kommunikation in Berlin wurde ein inhaltlich, gestalterisch und technisch passendes Konzept erarbeitet. Die enge Zusammenarbeit mit dem erfahrenen Team von *Garamantis* führte zu einer wichtigen Erkenntnis: Wenn eine multimodal-interaktive Ausstellung Besucher*innen begeistern soll, dann ist eine geschickte Verknüpfung von Technologie, Ambiente und Storytelling erforderlich.

Das Museum für Kommunikation ist für breite Öffentlichkeit zugänglich. Dementsprechend musste die Ausstellung ausgerichtet sein. Neben der allgemeinen Öffentlichkeit sollten speziell Multiplikator*innen und Wissenschaftler*innen, die sich mit Risiko- und Krisenkommunikation befassen, angesprochen werden. Das Vorwissen zum Thema variierte entsprechend stark. Zugleich war zu berücksichtigen, dass alles bilingual auf Deutsch und Englisch zu präsentieren war, da das Museum auch von vielen internationalen Gästen besucht wird.

4. VISUALISIERUNGS- UND INTERAKTIONSKONZEPTE

In der Ausstellung *#Krisenalltag - Kommunikation in der Pandemie* wurden visuelle und interaktive Darstellungskonzepte kombiniert. Ein begleitendes Rahmenprogramm mit vier Veranstaltungen förderte den direkten Dialog zwischen den am Projekt Beteiligten, den Besucher*innen und den Organisationen zur Gesundheitssicherung.

Abb. 2: *Screen mit Einhandkopfhörer*

Abb. 3: *Screen mit Icon-Ratespiel*

4.1. VISUALISIERUNGSKONZEPT

Wie die Ausstellung aussehen und wirken wird, lässt sich anhand von dreidimensionalen Computer-Renderings besprechen, inklusive Details wie Materialien, Lichtstimmung und Positionierung von Centerpieces. Zur Erstellung erster Renderings musste zunächst die visuelle wie auch inhaltliche Leitidee entwickelt werden, die sich als roter Faden durch die gesamte Ausstellung ziehen und eine schlüssige und originelle Erzählung ermöglichen sollte. Das rhetorische Stilmittel des Oxymorons „Krisenalltag“ bildete schließlich den zentralen Begriff, kombiniert mit „Kommunikation in der Pandemie“ als erläuterndem Untertitel. Das Key-Word „Kommunikation“ in Verbindung mit der Pandemie wurde mit drei eigens für die Ausstellung entworfenen Icons kombiniert, die auf vielfältige Weise in der Ausstellung wiederkehrten (s. u.). Hintergrund hierfür war die Feststellung, dass Icons, wie zum Beispiel das Emoji in Virusform, in der öffentlichen Krisenkommunikation eine wesentliche Rolle spielten [10]. Für den Titel der Ausstellung wurden die Icons gewählt, die Virus, Sprechblase und Megaphon symbolisieren.

Um den gesamten Content auf den verschiedenen digitalen Devices präsentieren zu können und eine größtmögliche Flexibilität bei der Erstellung der Inhalte zu gewährleisten, wurde von *Garamantis* ein zentrales Content-Management-System (CMS) eingerichtet. Mit diesem System konnten bestehende Inhalte und deren Darstellungsformen verwaltet, modifiziert, freigeschaltet und aktualisiert werden. Die Bearbeitungsrechte lagen bei ausgewählten Personen, die die Ausstellung bequem per Tablet oder Smartphone steuern konnten. Damit war ein ständiger und direkter Zugriff für das Kuratorium möglich.

Zentrales Element der Ausstellung war ein raumfüllender Zeitstrahl, in dessen Verlauf insgesamt 16 Multitouch-Screens integriert wurden. Der Zeitstrahl bildete das Pandemiegeschehen von 2020 bis 2023 in enger Anlehnung an eine durch das Robert Koch-Institut entwickelte Phaseneinteilung ab. Es wurden über 110 nationale und internationale Ereignisse und politische Entscheidungen zur Bekämpfung der Pandemie ausgewählt, die ganz unterschiedliche gesellschaftliche Bereiche betrafen, und datumsgenau platziert. Der

Zeitstrahl war als physisch abgehbarer Print auf einer 30 Meter langen und 2,5 Meter hohen, wellenförmigen Holzwand dargestellt. Den optischen „Leitfaden“ dieser **Chronik** bildete die Inzidenzkurve (generiert auf Basis der RKI-Daten). Die bereits mit der Form der Wand aufgegriffene Thematik der Corona-Wellen wurde so zusätzlich visualisiert. Die Jahr- und Monatsangaben waren im oberen Rand, die Pandemiephasen parallel am unteren Rand platziert. Die Wand erlaubte es Besucher*innen, die Zeit sprichwörtlich Revue passieren zu lassen bzw. eine Zeitspanne abzulaufen. Die so angelegte Chronik erzeugte durch die Intensität von Farbe, Design und Beleuchtung ein neues Raumgefühl – ein physisch erfahrbarer Reflexionsraum war geschaffen.

In den Zeitstrahl waren Screens mit Instagram-Posts und Tweets der Regierungen und Behörden mit einer Auswahl von Kommentaren, sowie YouTube-Videos aus allen Phasen der Pandemiezeit integriert. Über eine Kooperation mit Picture Alliance, die zur Deutschen Presseagentur gehört, konnte auf eine große Bild-/Fotodatenbank zugegriffen werden. Gewählt wurden einerseits Bilder, die die Auswirkungen des Virus‘ im öffentlichen Raum zeigten, andererseits solche zu zentralen Ereignissen und Entscheidungen, die auf dem Zeitstrahl erfasst waren.

Die Fotos aus dem öffentlichen Leben, die Instagram-Posts und Tweets sowie die YouTube-Videos wurden auf insgesamt zwölf Multitouch-Screens präsentiert. Auf diesen konnten mehrere Ebenen interaktiv gesteuert werden. Die gesamte Pandemiezeit wurde in vier größere Zeitabschnitte unterteilt, die jeweils mehrere Phasen der Pandemie umfassten. In jedem Zeitabschnitt wurden zunächst 15 bis 20 Fotos aus dem öffentlichen Leben präsentiert. Es folgten die Instagram-Posts und Tweets (jeweils 10 bis 15) sowie auf dem dritten Screen YouTube-Videos. Die Screens wurden passgenau in die Zeitstrahl-Wand integriert und ergänzten so die aufgedruckten Informationen komplementär und interaktiv-digital.

Im „Ruhezustand“ (nicht durch Berührung aktiviert) erhielten die Screens ein spielerisches Design-Element: In Anlehnung an das Key-Visual – und im Stil eines „Einarmigen Banditen“ – bildeten sich stets neue Dreierkombinationen aus verschiedenen Icons. Diese standen jeweils für einen zentralen Begriff der Pandemie, z. B. „Ausgangssperre“, „Reiseverbot“, „Homeschooling“ etc. Nach einigen Sekunden wurde der Begriff unter den Icons eingeblendet, sodass Besucher*innen begannen, mitzuraten. So entstand ein einfaches, aber attraktives Gamingelement (vgl. Abb. 3).

Nach Aktivierung der Screens durch Berührung gab es zunächst eine Ebene, auf der kurze Informationen zum nachfolgenden Content enthalten waren. Auf der zweiten Ebene konnte auf die Fotos (inkl. Bildunterschrift), Instagram-Posts etc. zugegriffen werden. Die weitere Navigation erfolgte durch Pfeilsymbole (rechts = vor; links = zurück) und Swipen nach unten oder oben. Jeder Bildschirm bot zudem durch ein kleines, links oben im Bildrand verortetes Kreissymbol die Umschaltoption von deutschen auf englische Texte (vgl. Abb. 2).

Um die Inhalte für die Screens optimal zu gestalten, wurde ein Powerpoint-Template vorbereitet, in dem zusätzlich die Option bestand, einen QR-Code zu platzieren, um mit dem Smartphone auf die Original-Posts zu gelangen. Im CMS war dazu eine Eingabe für die entsprechende URL vorsehen, und die Software generierte den QR-Code an einer fixen Position. Die Verfasser*innen der Kommentare wurden durch Verpixeln unkenntlich gemacht. Die so aufbereiteten Powerpoint-Dateien wurden in hochauflösende PNG-Bilder umgewandelt, um sie ins CMS hochladen und schließlich auf den Screens abrufen zu können. Dort, wo für Videocontent Ton vorhanden war, gab es seitlich des Screens individuell gefertigte Einhandkopfhörer in Form eines Coronavirus (vgl. Abb. 2).
Auf einem weiteren Screen wurden besondere Kommunikate oder Informationen präsentiert: Auf einem Bildschirm konnte bspw. das Dashboard des RKI und eine Kampagne aus NRW „#BeatTheVirus“, die sich speziell an Jugendliche richtete, die Coronaregeln einzuhalten, angeschaut werden.

Zudem zeigte ein weiterer Screen Fotos davon, wie Menschen auf der ganzen Welt welche Masken getragen haben – u. a. zu Beginn der Pandemie häufig selbstgemachte. Zusätzlich wurde ein künstlerisches Kurzvideo abgespielt. Auf einem Einzelscreen waren sechs 3-minütige Kurzreportagen zu sehen, in denen die

Teilvorhabensleiter*innen des Forschungsverbundes vorgestellt wurden und über zentrale Aspekte ihrer Forschung berichteten.

4.2. INTERAKTIONSKONZEPTE

Im Rahmen eines interaktiven Corona-Quiz auf einem der Screens konnten Besucher*innen in 15 Fragen zu zentralen Begriffen ihr Wissen testen. Die Antworten waren im Multiple-Choice-Format gestaltet. Bei einer falschen Antwort erschien eine rote Markierung, während die korrekte Antwort grün angezeigt wurde.

Auf einem Screen wurde eine interaktive Eye-Tracking-Software präsentiert, wodurch Besucher*innen einen Einblick in eine Methode des Forschungsdesigns erhalten konnten. Besucher*innen konnten sich hier nacheinander für jeweils ca. 30 Sekunden unterschiedlich gestaltete Bilder anschauen. Nach jedem Bild zeigte die Software an, auf welche Stelle wie lange geschaut wurde. Weiße Flächen standen dabei für eine kurze Dauer, während rote eine längere Betrachtung bedeuteten. Veranschaulicht wurde so zudem, wohin nicht geschaut worden war. Die wissenschaftliche Blickaufzeichnungsmethode verdeutlichte zugleich, welche Modi und welche Inhalte für die Besucherin bzw. den Besucher von Interesse waren.

Abb. 4: *Interaktive Grafik*

Auf dem Anfangsbereich der Printwand war auf ca. drei Metern eine Skizze aufgebracht, die eine genderneutrale Person von hinten an einem Schreibtisch sitzend zeigte, umgeben von sechs Medien: auf einem Tisch stehend bzw. liegend ein Nachrichtenmagazin, ein Laptop, ein Smartphone, ein Tablet und ein Bildschirm sowie ein Gesetzbuch. Rechts und links der Grafik waren die Bezeichnungen der sechs Teilvorhaben aufgedruckt und mit einem thematisch passenden Icon versehen. Mittels einer für die Besucher*innen nicht sichtbaren infrarotbasierten Toucherkennung war diese Wandzeichnung an einen Beamer gekoppelt. So entstand eine **interaktive Infografik**, die es den Besucher*innen ermöglichte, die im analogen Schaubild gezeichneten Medien mit passgenauen „echten" Medieninhalte (innerhalb des gezeichneten Mediums) digital durch Projektionen zu ergänzen. Sobald die interaktive Wand an den entsprechenden Stellen berührt wurde, wurden im unteren Bereich der Grafik die zentralen Forschungsfragen der Teilvorhaben eingeblendet. Parallel rahmte das jeweilige Teilvorhaben-Icon ein eingeblendeter Leuchtring, um die Zuordnung der Forschungsfragen zu verdeutlichen (vgl. Abb. 4).

Zentral im Ausstellungsraum positioniert, fungierte ein **360° frei drehbarer Multitouch-Screen** als Augmented-Reality-Interface, um digitale Ergänzungen zu den Informationen auf der gedruckten Wand anzuzeigen. Im Einklang mit den auf der Printwand hervorgehobenen neun Pandemiephasen generierten sich auf dem Bildschirm dynamische Wortwolken. Durch das Drehen des Bildschirms ließen sich die verschiedenen Phasen ansteuern. Diese Wortwolken basierten auf Daten aus der öffentlichen Onlinekommunikation, die mit Fanpage Karma, einem Online-Tool für Social-Media-Analyse, zusammengestellt wurden. Hierbei wurde Kommunikation auf Bundes-, Landes-, Kommunalebene und von Social-Media-Akteuren berücksichtigt. Die 75 meistgenannten Begriffe mit Coronabezug wurden ausgewählt. Ihre Größe in den Wortwolken zeigte die jeweilige Häufigkeit ihrer Erwähnung. So konnten Besucher*innen direkt erkennen, wie sich die öffentliche Diskussion in den verschiedenen Phasen entwickelt und z. T. drastisch verändert hat (vgl. Abb. 5).

Abb. 5: *Drehbarer Screen mit Wortwolken*

Ein **Multitouch-Tisch**, der frei am Ende der Ausstellungsfläche aufgestellt war und mit einer individuell entwickelten Software ausgestattet wurde, ermöglichte interaktives Storytelling. Dies bot insbesondere vertiefende Einblicke in die bis dahin gewonnenen Forschungsergebnisse der sechs Teilprojekte des MIRKKOMM-Projektes (vgl. Abb. 6). Auf der Startoberfläche konnte man sechs Bubbles mit den Themen-Icons der Teilvorhaben und entsprechender Betitelung sehen. Diese waren flexibel hin und her zu bewegen und durch eine entsprechende Berührung konnten die dazugehörigen Fenster geöffnet werden. Zunächst waren Mitarbeiter*innenporträts der einzelnen Teilvorhaben zu sehen. Es folgten Charts mit Untersuchungsmaterial und grafischen Ergebnisdarstellungen. Zusätzlich bot der Tisch an zwei Ecken eine Scanfunktion, die während besonderer Events wie etwa der Ausstellungseröffnung, genutzt werden konnte: Auf Kärtchen konnten Besucher*innen ihre Corona-Erlebnisse notieren oder aufzeichnen und dann in den Scanbereich einlegen. Der Tisch digitalisierte diese Kärtchen und zeigte sie auf der Tischoberfläche an. So entstand eine Art digitales Erinnerungstagebuch: „Notes of Corona“. Der Multitouch-Tisch bot somit die Möglichkeit, sich intensiv in die Forschungsmaterie des Projektes einzulesen. Mehrere Besucher*innen konnten gleichzeitig am Tisch die Dokumente ansehen und dabei Informationstiefe sowie Rezeptionsgeschwindigkeit individuell steuern.

Dieses Centerpiece bot zudem noch ein Gaming-Element: Durch Umschaltung wurde ein überdimensionales Memory-Spiel aktiviert, das aus den eigens für die Ausstellung gestalteten Icons bestand und eine Spielzeit von jeweils drei Minuten umfasste (vgl. Abb. 7).

Abb. 6: *Multitouch-Tisch*

Abb. 7: *Multitouch-Tisch im Memory-Modus*

4.3. RAHMENPROGRAMM

Im Rahmen der Ausstellungseröffnung fand eine Podiumsdiskussion statt, in der die Leiter*innen der jeweiligen Teilprojekte dem Publikum ihre Erkenntnisinteressen und aktuelle Forschungsergebnisse vorstellten. Fünf weitere Veranstaltungen beleuchteten verschiedene Aspekte der Ausstellung. In der ersten Veranstaltung „Meet the Journalist“ stellte das Factchecking-Team der Deutschen Presseagentur (dpa) Methoden zur Verifikation von Informationen vor. In der zweiten Veranstaltung, dem Junior Science Café, entwickelten Schüler*innen einer 10. Klasse aus Berlin über eine Minizukunftswerkstatt eigene Ideen zu einer Optimierung der Kommunikation in einer Gesundheitskrise. Während des Berliner Kinderkulturmonats konnten Familien kostenfrei das Museum für Kommunikation besuchen und in einem Quiz ihr Wissen zum Selbstschutz in Krisen und Katastrophen testen. Ermöglicht hat das in Kooperation mit dem BfR das im Forschungsprojekt assoziierte Bundesamt für Bevölkerungsschutz (BBK). Hier haben engagierte Kolleg*innen zahlreiche Angebote für unterschiedliche Altersstufen organisiert: von der Berliner Feuerwehr über Mal-, Bastel- und Verkleidungsstationen bis hin zur Möglichkeit, die Nachrichten zu einer Krisensituation zu sprechen.

Während des „Meet the Scientists“ präsentierten mehrere Projekte aus der Sicherheitsforschung wichtige Erkenntnisse zu aktuellen und vergangenen Krisen. Bei der letzten Veranstaltung, dem parlamentarischen Abend, stand der Austausch mit politischen Akteuren aus dem Bevölkerungs- und Katastrophenschutz im Vordergrund. Partner waren hier ebenfalls das BBK sowie das BfR und das Deutsche Komitee

Katastrophenvorsorge e.V. Alle Veranstaltungen waren darauf ausgelegt, in interaktiven Formaten mehr über Forschung zu Risiko- und Krisenkommunikation zu erfahren.

5. ZUSAMMENFASSUNG

Die Realisierung der multimodalen Ausstellung stellte alle Beteiligten vor vielfache Herausforderungen. Eine zentrale Aufgabe bestand darin, von Anfang an ganzheitlich und integrativ zu planen. Dabei war stets zu berücksichtigen, dass die Besucher*innen des Museums für Kommunikation unterschiedliche Hintergründe haben, verschiedene Sprachen sprechen und mit verschiedenen Vorkenntnissen und Erwartungen Informationen auf ihre eigene Weise verarbeiten.

Genau aus diesem Grund boten die vielfältigen Ansätze multimodaler Wissensvermittlung eine ideale Lösung. Bei der Gestaltung der Ausstellung lag der Fokus insbesondere auf der Anpassung der Inhalte an die (Sprach-)Kenntnisse und Interessen der Besucher*innen. Durch spielerische und interaktive Elemente, wie beispielsweise ein Quiz, ein Eyetracking-Selbstexperiment, ein Memoryspiel oder Icon-Tryptichons, wird das vermittelte Wissen nachhaltiger verankert.

Die enge Zusammenarbeit mit dem erfahrenen Team von *Garamantis* führte letztlich dazu, eine multimodal-interaktive Ausstellung, die durch koordinierte Technologie, ein konsistentes Design und passende Inhalte bestach, zu realisieren. Das Zusammenspiel aus kreativen Ideen, technischen Raffinessen und multimodaler Wissensvermittlung ermöglichte eine innovative Transformation komplexen Wissens.

Die Besucher:innen erhielten durch die im Projekt angewandten Methoden, wie auf dem Touchtable oder durch das Eyetracking-Selbstexperiment dargestellt, Einblicke in die Erforschung der Pandemiekommunikation. Die Ausstellung thematisierte den fluiden Kenntnisstand, den die Besucher:innen bereits aus der Pandemiezeit kannten. Dadurch wurde ein vertieftes Verständnis für Forschungsprozesse sowie für sich wandelnde Informationen gefördert.

Eine Evaluation der Ausstellungsentstehung wird derzeit durch die Universität Münster durchgeführt.

6. DANKSAGUNG

Die Ausstellung konnte nur als interdisziplinäres Kooperationsprojekt gelingen, bei dem viele unterschiedliche Gewerke zusammenarbeiten mussten. Das MIRKKOMM-Forschungsteam möchte sich an dieser Stelle beim Museum für Kommunikation in Berlin bedanken, insbesondere bei der Direktorin Anja Schaluschke, bei Veit Lemmrich, dem Teamleiter Ausstellung und Recherche, und bei Dietrich Wolf Fenner, dem Abteilungsleiter Öffentlichkeitsarbeit. Dass wir die Ausstellung dort zeigen durften, war ein großer Gewinn und thematisch konnte es keinen besseren und schöneren Ort dafür geben. Gleichgroßer Dank geht an das Team von *Garamantis*, das die kreative wie technische Realisierung ermöglicht hat. Stellvertretend für alle seien Oliver Elias, Andreas Will, Markus Dittebrand und Max Pohlenz (unsere Main Developer) genannt. Die Zusammenarbeit war auch vor dem Hintergrund enger Deadlines stets sehr gelungen. Großer Dank gebührt auch den zahlreichen Studierenden der SRH Berlin University of Applied Sciences aus den Studienbereichen Film- und Fernsehproduktion sowie Design, die Video-Content für die Ausstellung produziert, Vorschläge für das Key-Visual erarbeitet und die Vernissage medial mit der Produktion einer Sendung begleitet haben. Stellvertretend dafür geht unser Dank an Prof. Bettina Borchardt, Prof. Ricarda Wallhäuser, Prof. Gabor Kovacs, Prof. Ralf Kemer und an den Dokumentarfilmer und Journalisten Prof. John A. Kantara. Gedankt sei allen, die die Ausstellung sowie das umfangreiche Rahmenprogramm tatkräftig unterstützt und ermöglicht haben: Zu nennen sind hier insbesondere das Bundesamt für Bevölkerungsschutz und Katastrophenhilfe, mecom Medien-Communikations-Gesellschaft mbH, Picture Alliance von der dpa, das RKI, das BMBF sowie das BMG und dem Referat für Kommunikation (M 3), Öffentlichkeitsarbeit des Ministeriums für Arbeit, Gesundheit und Soziales des Landes Nordrhein-Westfalen.

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The Transformer Tower

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ABSTRACT: Within the field of Research by Design in Architecture, The Transformer Tower project represents a convergence of "plastic-symbolic content forms" with "technological content forms" through the integration of various fields of knowledge: philosophy, art, architecture, science, and technologies (structural, mechanical and electronic engineering). This research introduces a novel technology that incorporates kinetics, dynamic motions, and anthropomorphic bodily movements into architectural design, aiming to evaluate their advantages in terms of sustainability and aesthetic qualities. The Transformer Tower is an innovative example of kinetic architecture, utilizing basic rotational and translational movements. The project is originated from a series of hand-drawn conceptual sketches, exploring metaphorical images, which were subsequently translated into digital architectural designs. These designs facilitated diverse compositional combinations, utilizing 2D and 3D models, as well as digital animation, resulting in the exploration and visualization of numerous metamorphoses. The movements are applied to the façade envelope, slabs, interior walls, and rooftop. As a result, instead of a static building, with only one form, we create a dynamic iconic skyscraper with 1001 forms.

1. INTRODUCTION

The Transformer Tower marked the initial phase of an ongoing applied research project, ESTAT – Eco-Solar Transformer Architecture Technology[1], which originated from participation in an architectural design competition for a small skyscraper design for a fashion museum in Omotessando Street em Tokyo [Jorge Cruz Pinto, 2010]. It focuses on dynamic architectural imagination as an expression of the impermanence of existence and the transformations and metamorphoses occurring in the cosmos, in nature, in life, and in contemporary society, where everything is in constant flux. As Buddha stated.: “All condicioned things are impermanent (…) Everything changes, nothing remain without changes”.

Despite architecture conventionally being considered a static art, it has incorporated dynamic elements in its evolution, extending beyond mere hinges and tracks. From the 18th century onwards, the metaphor of the machine, guided by "the clock's law," served as a significant source of inspiration for architecture, as noted by Eduardo Prieto[2]. The advancements brought about by the industrial revolution, including the use of steel and the introduction of mechanical technologies such as elevators, escalators, ventilation systems, and skylights, have deeply revolutionized the field of architecture.

The industrial revolution exerted a profound influence on the avant-garde movements of the modernist era, shared by the fields of architecture and visual arts, including cubism, futurism, functionalism, esprit nouveau, and constructivism. They introduced the concept of "space-time," aligned with Einstein's theory of relativity, where the metaphor of machinery and motion served as a poetic catalyst for innovative artistic, architectural, and urban concepts [3]. Within the functionalist ideology of *l'esprit nouveau*, Le Corbusier famously proclaimed that "the house is a machine for living," drawing inspiration from the progress in aeronautical technologies and naval architecture, as elaborated in *Vers une Architecture*[4].

Images of dynamism permeate the futurist manifestos, as well as their experimental paintings and sculptures. In his "Messaggio," Antonio Sant'Elia aptly declared, "The modern building is like a gigantic machine(...) We must draw our inspiration from the new mechanical world we have created, with architecture as its most fitting expression," [quoted by R. Banham[3]]. In addition to futurism, Marcel Duchamp's "Nude Descending a Staircase" and Escher's metamorphoses, represents expressions of kinetic art. Under the experimentalism of new materials and industrial technologies applied to architecture, Jean Prouvé developed new architectural models, and Buckminster Fuller conceived the "Dymaxion" project (1929). The use of animal and mechanical metaphors gave rise to the utopian proposals of the Archigram group, with "Walking City" and "Plug-in City" (1964). The remarkable research on "Kinetic Architecture", developed by W. Zuc and R. Clark in the early 1970s, considered by its authors as in its initial stages, still stands as an indispensable reference, with proposals rooted in a new design philosophy with dynamic possibilities, aligning with the rapid changes in contemporary society[5].

Among various examples in contemporary architecture that exemplify the Transformer concept, whether through modifications in facade design, or the integration of kinetic systems with sustainable energy capture technologies, we can mention a few state-of-the-art cases. For instance, Jean Nouvel's design for the Institut du Monde Arabe is a remarkable example of a facade composed of photo-sensitive mechanical diaphragm mashrabiya. Meanwhile, D. Fisher's proposal for a kinetic skyscraper in Dubai enables dynamic metamorphoses in the three-dimensional form through the rotation of each floor via wind turbines. The Al Bahar Towers in Abu Dhabi feature a double kinetic facade composed of fiberglass triangles, inspired by traditional mashrabiya, which responds to digitally controlled solar incidence. The kinetic solar skin façade develop at ATH Zurich, combines inteligent shading and photovoltaics panels integration.

It is within this experimental and avanguard framework, that we have created Eco-Solar Transformer as an integrated project designed for high-performance buildings, particularly small and medium-sized skyscrapers. By "integrated project," we mean a holistic and experimental approach that aims to harmonize various aspects including poetic-cultural, aesthetic, functional, technological, climatic, and more. In this heuristic approach, the goal is to connect symbolic and artistic expressions with the technological content related to structural, bioclimatic, renewable energy, mechanical, and computational systems, all within a perspective of ecological sustainability and a new aesthetic experience that extends into the future.

2. MOTION AND TRANSFORMER TOWER

2.1. A PRIORI CONCEPTS: MOTION – FROM COSMOS TO ARCHITECTURE

Everything in the Universe is in motion, from galaxies to planetary systems to subatomic particles. In the planetary system, we recognize two fundamental movements: the rotation of planets around their own axes and the corresponding translational movement along elliptical orbits around the Sun. Movement is understood as the inscription of time in space and is associated with the cycles of eternal return that record changes in nature: the periods of the day and the seasons of the year that mark the transfigurations and transformations in the natural landscape. The action and apparent movement of the Sun are recorded on Earth, where life is intimately linked to solar energy. The evolution of life and the growth of plant and animal species are subject to transformations and movements.

In the plant world, various movements known as tropisms are identified: phototropism responds to light stimuli; geotropism, linked to gravity, is responsible for rooting; hydrotropism seeks the presence of water, and thigmotropism responds to touch.

The dynamic physics of vertebrate animals and humans is also related to rotational and translational movements linked to joint systems. The curved rotational movement around an axis is associated with joints, tendons, muscles, and the movement of the eyes in eye sockets, while translational movement is associated with linear trajectories. The combination of these two kinetic principles results in the multiplicity and complexity of body movements, an analogy that can be applied to architecture.

The analogies between the principles of cosmic mechanics and utilitarian mechanical inventions and architecture date back to classical antiquity. In the 1st century AD, Vitruvius, in his work *The Ten Books on Architecture*, in addition to construction, recognized the importance of solar geometry and mechanics. The first seven books are dedicated to construction and aspects related to materials, strength, building types, utility, beauty, and site selection. The penultimate book is dedicated to Gnomics, the ancient Chaldean cosmological science related to the construction of sundials and analemmas based on solar trajectory and shadow geometry. The final book is dedicated to mechanics, derived from the kinetic principles of cosmological origin applied to the construction of machines for various utilitarian purposes, drawing from the Greek heritage of Archimedes and developed by the Romans[6].

The application of two kinetic principles of translation and rotation in architecture has been recognized since ancient civilizations, beginning with the invention of basic mechanisms applied to doors and windows that enable spatial modulation: the hinge axis allowing rotational movement and the track ensuring translational movement through sliding. These universal principles, observed in both the cosmos and the human body, served as the foundational premises underpinning the idealisation of the Transformer Tower presented in this paper.

Figure 1: *Space-Limit Categories Conceptual painting (J.Cruz Pinto)*

In the epistemological domain, the conception of the Transformer Tower was also intentionally supported by the aprioristic concepts stemming from the theory of J. Cruz Pinto "Space-Limit" [7]. These concepts anthropomorphically relate to:
-"Appearance", involving the superficial effects of the building's skin (cladding and LEDs) associated with images of "Transfiguration."
-"Emergence", which pertains to aspects of shape-changing and the "Transformation" of the building's physical structure through rotational and translational movements.
-"Latency", referring to the invisible aspects that vitalize the dynamic system of the structure: photovoltaic energy and digital intelligence controlling integrated building systems.
-lastly, the "praise of emptiness" [8] relates to the empty framework of the GreenGrid and the vacant space between the mobile envelope and the fixed building structure, allowing for the variability of tower transformations.

2.2. INOVATIVE ORIGIN: TRANSFORMER TOWER AND SYMBOLIC IMAGES

As mentioned in the introduction, the project of the Transformer Tower began with the emplyment of a priori concepts of motion, translation and rotation, into architectural proposal for a fashion museum design competition on Omotesando Street in Tokyo. The program called for the creation of a small 100-meter high skyscraper with a footprint of approximately 30m x 30m. The poetic conception of the project converged various

symbolic images related to "forms of artistic expression." On one hand, the model of the female body associated with fashion and the mutability of appearance through clothing served as one of the metaphorical starting points, linked to "appearance" and the concept of "transfiguration".

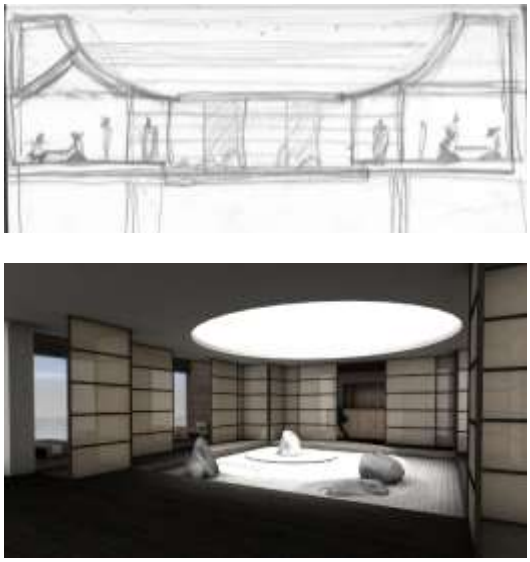

Figure 2: *Rooftop, conceptual sketche and render*

On the other hand, references to Japanese culture were sought, from traditional pagodas to Isamu Noguchi's paper sculptures, to the concept of Zen Buddhism's emptiness, expressed in the white circle of yen notes, the Japanese flag, and the stone garden of Ryoan-ji Temple in Kyoto, which are directly reflected in the rooftop courtyard of the Transformer Tower. In addition to these allusions to Japanese culture, the architectural imagination drew from other references, including previous projects by the author, such as a skyscraper inspired by Brancusi's "Infinity Column" [J. Cruz Pinto, 2010].

Figure 3: *Conceptual sketches (J.Cruz Pinto)*

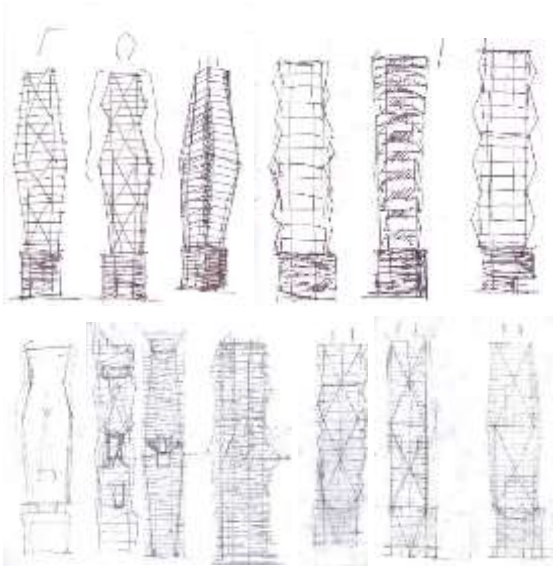

Figure 4: *Conceptual sketches (J.Cruz Pinto)*

Here, the poetic-intuitive conceptual method through manual drawing, which gave birth to the Transformer Tower project, is emphasized. The project also draws from a priori theoretical foundations that underpinned it, strengthened by subsequent research and the state of the art, to better justify its place within the context of historical and contemporary architectural culture. The project underscores the importance of digital tools, such as 2D and 3D models and digital animation, which are fundamental for the design, presentation, and comprehension of the aesthetic-kinetic metamorphoses of the skyscraper. The development of technological components, including studies of mechanical structural movements, in line with bioclimatic solutions and energy efficiency, is also highlighted.

Figure 5: *Conceptual sketches (J.Cruz Pinto)*

The initial idea, linked to the concept of "transformation," was to clad the fixed structure of the skyscraper with a photovoltaic fabric that would enable metamorphoses through mechanical extensions. This idea of transformation would eventually evolve into a double-skin facade system, comprised of kinetic panels, allowing numerous transformations of the tower's envelope.

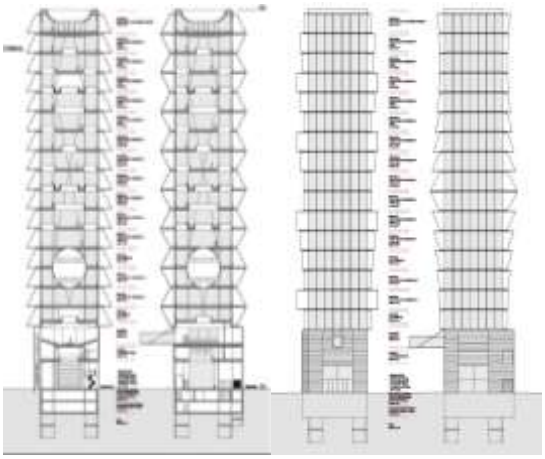

Figure 6: *Transformer Tower, Sections and facade*

These were initially studied through hand sketches and subsequently developed in 2D, 3D models, and animations. The modular panels of the facade, referred to as the 'GreenGrid', were designed in the style of Asian lattices and Arab mashrabiya, geometric grids with filled and empty spaces that assume the passive bioclimatic function of natural shading and ventilation. The GreenGrid incorporates photovoltaic square units that enable active bioclimatic function, ensuring the building's energy efficiency. The Transformable Eco Solar Tower constitutes an innovative paradigm in terms of BIPV Building Integrated Photovoltaics.

Figure 7: *The Transformer Tower, contextualization on Omotessando Street, Tokyo*

LEDs (Light Emitting Diodes) are incorporated at the intersections of the grid, enabling light design performances and image and film projections, transforming the tower into an informative display and urban icon. The introduction of sensors for digital control of the panels, based on solar movement and weather conditions, contributes to the design of an intelligent building based on "Forms of Technological Content."

2.3. DEVELOPMENT: FROM TRANSFORMER TOWER TO ESTAT TECHNOLOGY

The Transformer Tower was the basis of ESTAT – Eco-Solar Transformer Architecture Technology, which advanced regarding its aesthetic identity and sustainability features by incorporating Sun tracking motions. This led to the "metamorphosis" of the Eco-Solar Transformer Tower inherently ingrained at all levels along the day.

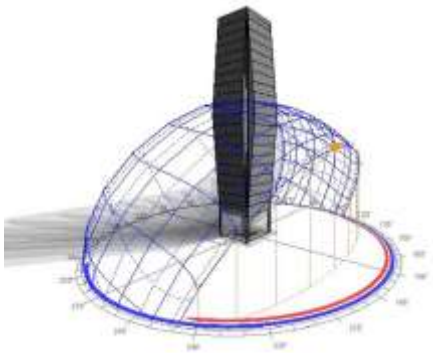

Figure 8: *Solar Diagram*

During the day, the second skin facade's panels, equipped with solar-tracking sensors, effortlessly follow the sun's path, optimizing energy efficiency. As evening falls, they can be reconfigured into various shapes, catering to specific design goals for the envelope transformation, enhanced by light design alterations or advertising displays. These visual and technological performances collectively transform the building into an urban icon, symbolically associated with brand identity, cultural institutions, or scientific establishments.

Figure 9*: ESTAT Metamorphosis Visualization (J.Cruz Pinto, L.Cavic)*

From the basic form of a parallelepiped, the Eco-Solar Transformer Tower can achieve prismatic, crystal-morphic to fractal forms, searching to exhaust infinite geometries … to act, deform, expand, contract, mimic, assert itself, order itself, deconstruct, reorder...

In this heuristic approach, ESTA Technology harmonizes forms of symbolic and plastic expression with forms of technological content. It encompasses systems such as structure, bioclimatic features, renewable energy, mechanics, sensors, computing, and more. This perspective prioritizes ecological sustainability while introducing a new aesthetic experience that evolves over time. In an era when architects are in search of unconventional architectural forms for static buildings, this project offers an alternative within a singular building, thanks to its capacity for form adaptability through mechanical reconfiguration, harnessing and utilizing solar energy .

The ESTA Technology constitutes a holistic solution integrating multiple systems and components, suitable for whole, partial, or individual production, commercialization, and application. The components can be used independently, partially, or collectively, flexibly accommodating changing user needs. This technology advances existing photovoltaic membrane solutions, addressing formal, functional, and aesthetic aspects. These GreenGrid encompasses a paneling system consisting of: a) Modular grid-frame, b) SolarSkin - photovoltaic components, c) Shading components, d) LED components, e) Sensor components, f) Mechanical motion system, and g) Controlling software.

The GreenGrid paneling system features a modular frame and secondary supporting structure with a 5cm x 5cm grid. The grid integrates photovoltaic, void shading, and LED components. Inspired by traditional Mashrabiya, these "green grid" panels offer thermal comfort (shading and natural ventilation), privacy, and introduce an innovative application and aesthetic enhancement of integrated photovoltaic shading systems with a range of geometric pattern designs.

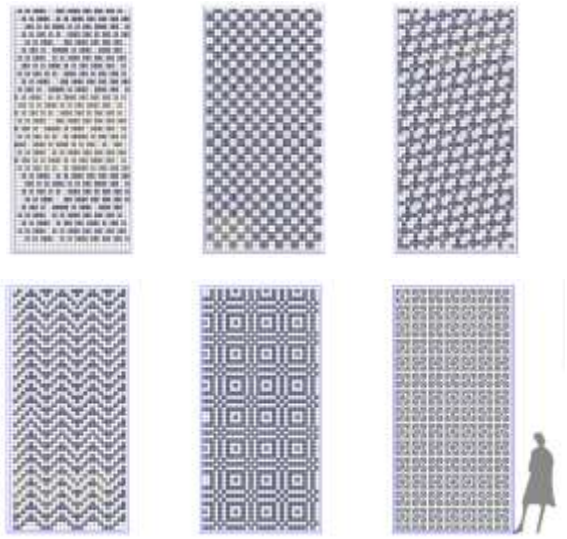

Figure 10: *Greengrid panel patterns*

Figure 10: *Greengrid prototype*

SolarSkin photovoltaic components are made of mono-crystalline composition with an energy efficiency of nearly 20%. They serve dual purposes as shading and view-filter devices, their application tailored to various coverage patterns depending on shading and transparency requirements, specific usage, user preference, or context. The shading system also effectively controls panel overheating, a common issue in photovoltaic applications on facades. These modular panels feature decorative patterns containing photovoltaic cells and sun-tracking sensors, improving both form and function. The system has the capability to generate the building's required energy and redirect excess energy to the local grid. SolarSkin is a subtype of GreenSkin that utilizes Traditional Crystalline Silicon PV technology, offering an extensive array of design patterns that significantly enhance the aesthetic aspect of common BIPV. It can be employed as a facade system for new buildings, a secondary facade for existing structures, or as a roof or shading solution.

LED Components contribute to the visual transformation performance of the skin facade, particularly in terms of lighting design and displays. LEDs are evenly distributed across the secondary bearing grid (at 5cm intervals) to create a screen effect when viewed from a

distance exceeding 10 meters. When used as a screen, the panels offer advertising and marketing potential. The Display Skin features a matrix of ultra-low-power LEDs powered by an energy-harvesting and autonomous system. A dedicated power-management unit manages the energy supply to the LED matrix. All displayed images can be remotely controlled in real-time through a master computer server.
The Mechanical Motion System incorporates extendable steel arms that enable translational movements of the panels and swivel ball joints that facilitate multidirectional panel rotation. This system is crucial for optimizing panel orientation to capture as much solar energy as possible. The motion facade provided by ESTA Technology offers the potential for building form and appearance modification, especially in symbolic and commercial facilities.

SensorSkin and Software: The dedicated controlling software is closely associated with transformer performance programming and various smart sensor skin types (light, thermal, humidity, wind, etc.). These sensors provide real-time measurement data and other essential weather and physical parameters to a global "internet-of-things (IoT)" system. These sensors feature sensor-to-digital interfaces and wireless capabilities for data communication based on "Bluetooth low-13." They continuously assess solar conditions and user preferences for shading and viewing, adjusting panel positioning accordingly. On days with limited sensor functionality due to cloud cover, the control software simulates past movements. It combines solar tracking with user input about their current shading and viewing requirements. The software enables the building to adapt not only to its surrounding climate but also to the users it serves. It calculates potential active solar gains, considering panel motion energy consumption, passive gains from shading and natural ventilation benefits, viewing obstacles, and comfort requirements for shading and natural ventilation.

2.4 INTERIOR MOTION AND ROOFTOP TRANSFORMATIONS

The same kinetic principles of rotation and translation applied to the panels of the skin facade are also employed within the Interior spaces, using walls and slabs to provide great functional flexibility and plasticity, allowing for seamless transitions between spaces and floors. Similar kinetic solutions are applied to the 5th facade on the ceiling rooftop of the Transformer Tower. The roof can partially open or close based on atmospheric conditions, through a morphologically adaptable diaphragmatic mechanical system tailored to different climates and symbolic forms of each culture in which the Transformer Tower may find its context. For example, the diaphragmatic roof opening can take the form of a cross in Western countries, a star shape in Muslim cultures, a Tao symbol in Southeast Asian countries, or a crystalline-shaped greenhouse in colder climates.

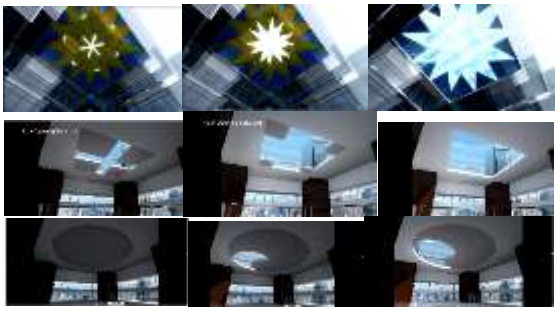

Figure 11: *Three rooftop ceiling transformations, according to different cultural symbolic forms*

3. CONCLUSION

The ESTAT in general and Greengrid system in particular were initially conceived for small to medium-sized new skyscrapers. However, they can also be adapted for use in the renovation and retrofitting of existing buildings, enhancing their bioclimatic conditions, ensuring energy self-sufficiency, and extending their lifespan. Moreover, the technology can be widely implemented across various building scales, ranging from small and medium-sized structures, rooftops, parking facilities, to large service facilities, industrial parks, and commercial areas.

This is the current state of affairs, which we elaborated on in another publication [M. Tuschinsky[9]]. Presently, partnerships are being established with other research centers, including the Universidade Nova de Lisboa, to develop control and monitoring software. Collaborations are also being forged with industrial sectors involved in facade construction, photovoltaics, LEDs, and sensors to produce integrated mechanical and bioclimatic prototypes, thus refining the system for real-time, full-scale demonstrations. In parallel, efforts are being made to engage with political and business entities to raise awareness among decision-makers (politicians and investors) about the realization of the Eco-Solar

Transformer Architecture Project and the application of its components.

Moreover, the GreenGrid pannel prototype was tested by Professor João Murta Pina, in the lab environment - solar simulator of the Department of Electrical and Computers Engineering of the NOVA School of Science and Technology of NOVA University of Lisbon - reaching TRL 4.

Figure 12: *Greengrid prototype under solar simulator*

	Measured parameters (T_{cell} = 44 °C, = 212 W/m²)	Predicted parameters (T_{cell} = 25 °C, = 1 000 W/m²)
$\alpha_{U_{OC}}$ (V/°C)	-0.0162	
$\alpha_{I_{SC}}$ (A/°C)	0.0856	
U_{OC} (V)	8.5	8.6
I_{SC} (A)	35.3	158.9
P_{MPP} (W)	167	788
FF (%)	55.3	

Table 1: *Measured and predicted parameters of the BIPV module*

In brief, through productive imagination, this project connects deep-rooted cultural and historical influences with cutting-edge technologies. Furthermore, it integrates various methods of architectural creation, spanning from hand drawings to CAD and parametric design.

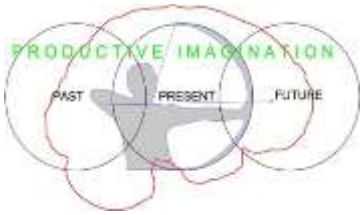

Figure 13: *"Archer's Metaphor" Productive Imagination, J. Cruz Pinto*

The Transformer Tower project draws a parallel to the "Archer's Metaphor" [J.Cruz Pinto, [10]] in the sense of projecting, of releasing the projectile. The archer positions themselves in the present, fully aware of the tension and intention of their art. With one hand, they hold the bow. With the other, they grasp the arrow and pull the string, turning their elbow backward, towards the past that holds accumulated knowledge and experiences. Meanwhile, their gaze is fixed on the target, the future in which the Transformer Tower project will come to fruition.

4. ACKNOWLEDGMENT

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Digital shift of Knjaževac museum towards accessible collections

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ABSTRACT: The paper will present an overview of the digitization process of the museum collections in the Homeland Museum of Knjaževac, with a special focus on the importance of multifunctional use of digital materials and contents as proven tools in preserving, presenting, and interpreting museum collections and cultural heritage. The use of digitized collections and various forms of digital tools has been recognized as useful in the process of improvement of accessibility and inclusion. Various models of using digitized collections and the content combined with the sensory experience will be presented as possible approaches toward increased access and inclusion of the Homeland Museum of Knjaževac.

1. INTRODUCTION

The Homeland Museum of Knjaževac has been working on the digitization of the museum collection for over fifteen years. The importance and multifunctional use of digital materials and contents were proven in preserving, presenting, and interpreting museum collections and cultural heritage. The use of digitalized collections and various forms of digital tools has been recognized as useful in the process of improvement of accessibility and inclusion.

This paper tends to explain the experience and results of the Homeland Museum in Knjaževac, in the process of digitization of the cultural heritage, museum collections, publications, and finally development of digital content accessible for all, based on the knowledge gained through the training and financial support of the Balkan Museum Network, Serbian Ministry of Culture and others.

Valuable cooperation and new partnerships were established between the Homeland Museum of Knjaževac, Technical University, and scientific institutions, but also new relations with small private companies, as a model of the public-private partnership should be emphasized.

2. STARTING POINTS

The Homeland Museum of Knjaževac is a complex museum consisting of three historical buildings and the Roman archaeological site Timacum Minus, all recognized as monuments of culture and therefore preserved by state law. Any architectural intervention leading to the removal of physical barriers is forbidden. Any other interventions towards decreasing physical barriers, such as mobile platforms, lifts, etc. usually require significant financial costs and expensive technical solutions.

Figure 1: *The Homeland Museum of Knjaževac*

As a museum funded by the local municipal government, and occasionally financed by the state Ministry of Culture and other donors, Knjaževac Museum has tried to find and incorporate small-scale, low-budget, or even no-budget elements to improve the presentation and interpretation of the museum collection, but also to improve accessibility and inclusion of museum collections, programs and spaces.

The final strategy and main steps were determined according to the analysis made through the Access Survey done by the experts of the Balkan Museum Network. Some suggestions were followed and implemented, based on their expertise and previous experience. Following the principles of the Social model [1], it was clear that the Homeland Museum of Knjaževac has to start working toward removing barriers and making museum collections and exhibitions more accessible and inclusive.

3. SMALL STEPS TOWARD BIG GOALS

A shift toward accessible Knjaževac museum started with the reduction of physical barriers with the use of removable ramps and the formation of info points that should help in overcoming the problems in the presentation of the museum exhibitions. Accessible points were determined and touch-screen computers, equipped with digital content, were installed.

Figure 2: *The entrance to the Museum Gallery*

The first accessible bilingual website was created based on the Universal Design, with 360° virtual tours, audio-video descriptions, and sign-language interpretation, but also other assistive technology tools incorporated, such as a text enlargement option, text reader, etc. Tablets with headphones were provided as mobile museum guides offering the same content as on the touch-screen computers.

Figure 3: *Accessible website of the Knjaževac Museum*

On the other hand, some hands-on tactile elements were created based on the concept of the Museum in a suitcase, and incorporated into the permanent museum exhibition spaces, such as QR codes, magnifying glasses, or special magnifying foil, enlarged prints, legends and museum guides printed in Braille…

Figure 4: *Tactile elements of the archaeological exhibition in the Archaeo-ethno park in Ravna, museum depandance.*

Some solutions were developed combining a more "traditional" approach with some technical elements such as QR codes implemented in the spaces of the museum's permanent exhibitions. We have produced tactile images of museum artefacts supported by QR codes as links to audio-video descriptions or 3D models.

Figure 5: *Exhibition of tactile images with legends in Braille, QR codes, and audio-visual interpretation for blind and partially sighted persons*

The Homeland Museum of Knjaževac has developed nine Android/iOS applications, testing their use as tools for the improvement of access and inclusion in museums. Eight of nine apps were developed in cooperation with the ArchiMedia research group of The Mathematical Institute of The Serbian Academy of Sciences. First Android/iOS multilingual applications were developed, with implemented accessible audio-visual content supported by the sign-language interpretation, but also with VR and AR elements interactive with images, interpretative boards, booklets…

Figure 6-8: *Interactive Android Museum apps*

Some of the apps developed were part of the larger educational programs, and are interactive with parts of the books printed or connected with the program website, such as "The Suitcase of Knowledge of the Homeland Museum of Knjaževac[2].

Figure 9-10: *Interactive book and App*

Also, some apps were developed to present books in a more accessible and inclusive way, such as "The First World War Diary of Stojan Jevtić [3].

Figure 11: *Elements of the Android app based on the book – diary from the First World War*

Many of the previously mentioned contents are in connection with tactile elements in the exhibition spaces, tactile images and replicas used for the improvement of sensory experience for all, in the Homeland Museum of Knjaževac.

Figure 12: *Tactile experience in the museum*

All the abovementioned digital programs and contents, such as digitised publications accessible online on the Museum's e-library, interactive books and interpretative boards, educational programs, applications, and audio-visual content supported by sign language interpretation and bilingual subtitling are some of the small steps that were necessary to undertake to reach the bigger goals.

Figure 13: *Museum's YouTube channel*

Now, Knjaževac Museum has a YouTube channel with interpretative videos supported by bilingual subtitling and sign-language interpretation. There is an online E-library with digitised museum publications. There are virtual galleries of the museum's collections, a complete digital artistic opus of one of the most prominent Serbian contemporary painters Dragoslav Živković, etc.

Figure 14: *Virtual gallery of* Dragoslav Živković

One of the most recent, and very important steps in the digitization of the cultural heritage is dedicated to the sacral art and architecture of the Knjaževac Municipality. The specialized website was created that represents not only photos, data, and architectural plans of the churches and iconostasis, but also photogrammetry 3D models and virtual presentation of the interior of 30 churches, dating from the medieval period to modern days.

Figure 15: *Sacral Topography of the Knjaževac Municipality*

Determined to contribute to more accessible and inclusive cultural institutions in Serbia and the region, The Homeland Museum of Knjaževac has participated in many events and research in connection with this important topic. The most recent results published by the Serbian Institute for Cultural Development Research show that only 61.4 % out of 97 Serbian museums and galleries consider themselves partially accessible, while 57 % are not physically accessible [4].

The Homeland Museum of Knjaževac participated in another regional program "Improving the accessibility of museums in the Balkans for people with disabilities" which resulted in an e-publication, digital database, and interactive online map of more than 40 accessible museums, galleries, open-air museums, and archaeological sites in the Balkans [5].

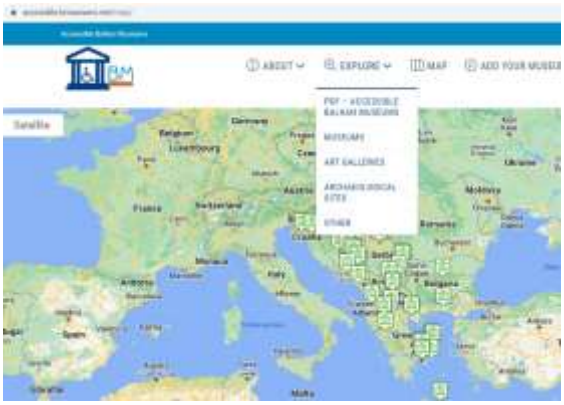

Figure 16: *Interactive map of accessible museums, galleries, and sites in the Balkans*

All the abovementioned have led to participation in the SHIFT project supported by the Horizon 2020 programme. The Homeland Museum of Knjaževac, a member of the Balkan Museum Network, has been involved in the SHIFT project as a use-case provider.

The SHIFT project represents a possible way of metamorphosis of cultural heritage into

augmented hypermedia assets for enhanced accessibility and inclusion and supports the adoption of digital transformation strategies and the uptake of tools within the creative and cultural industries (CCI), where progress has been lagging. It will increase the appeal of historical artefacts, improving their accessibility and usability for everyone through better content representation, enriched user experiences, inclusive design, training, and more engaging business models.

Figure 17: *The SHIFT – Horizon 2020 Project*

The Homeland Museum of Knjaževac has provided audio-visual materials, images, and 3D models of artefacts to be tested and used for the development of digital solutions that will involve a visual toolkit, auditory toolkit, haptic toolkit, textual toolkit, IPR toolkit, XR accessibility framework developed by the technical partners, members of the SHIFT consortium. The future results based on the novel technologies will be presented in the special exhibition organized in the Homeland Museum of Knjaževac.

4. CONCLUSION

The road toward accessible and inclusive museums and galleries is long, but it is necessary and most of all obligatory. Everyone is entitled to participate fully and equally in all aspects of life [6] and to enjoy access to places where cultural performances and services are organized. Therefore, referring to the new ICOM definition of a museum [7], besides all other aspects mentioned, museums as institutions that serve society should be open to the public, accessible and inclusive, and should foster diversity and sustainability. As museum professionals, we should ask ourselves if we are fulfilling our duties and accomplishing our roles.

Working on the improvement of access and inclusion we are not only contributing to specific aspects of our work dedicated to a specific target group. Making our museums and galleries more accessible and inclusive means making them more meaningful and better places for all.

The Homeland Museum of Knjaževac continues to work on the improvement of accessibility and inclusion shifting towards new technologies, and using digital and/or more conventional tools, to be able to open its doors for everyone.

Figure 18: *Accessibility Shift of Knjaževac Museum*

5. ACKNOWLEDGMENT

On this occasion, we would like to thank the Balkan Museum Network for the continuous support on our way toward an accessible and inclusive museum, all members of the Balkan Museum Access Group for useful advice, inspirative mentorship, and professional support, especially dear colleagues PhD Irena Ružin, Željka Sušić, Tatjana Mijatović, Jove Pargovski and most of all Aida Vežić for sharing knowledge, and providing opportunities for continuous growth and cooperation.
Also, we should thank the U.S. Embassy in Serbia for its support, the Serbian Ministry of Culture, and the Consortium of the SHIFT project, supported by the Horizon 2020 programme, for opening a new digital phase and providing possibilities for becoming a more accessible and inclusive museum by implementing new technologies and creating a new professional network.

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Performatics, creativity, conceptual art and YouTube tuts

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ABSTRACT: This paper discusses the challenges of exposing the process and the art intent in a journey into the conceptual aspects of computational creativity. Examining the role of online video platforms and 'tuts' exposition/tutorial on aspects in the creation of electronic art and creative computational works. The papers explores how YouTube creative coding tutorials can be considered being performative of generative art - Explore the complexity of system based work and the challenge of communicating the generative nature of work to audiences. It explores evidence from numerous artist/practitioners operating on YouTube and explores auto ethnographic reflections from the author's own experiences running the 'Art and Code' YouTube channel providing creative coding tutorials and expositions of making self-directed electronic art. [1]

1. INTRODUCTION

What is creativity? This is a question that has been asked throughout history, with many different answers given. For some, creativity is the ability to come up with new ideas. For others, it is the ability to make something new out of what already exists. And for still others, it is the ability to see the world in a new way. In the field of computational art, creativity is often embodied in the exploration and negotiation with new algorithms, systems, processes or ways of exploring or solving artistic questions. This is particularly relevant where the artistic exploration and intent is intertwined with the discussion below the visual surface, in the underlying dynamic systems that have been created.

In this paper, I will explore some concepts of computational creativity, and discuss how YouTube creative coding tutorials can be considered to be performative of computational and generative art. I will expose the process and the art intent in a journey into the conceptual aspects of computational creativity. Commonly, computational creativity refers to the use of computational process to explore new things, ideas, processes and outputs. New ideas, new artworks, new music, new algorithms and dynamic conceptual; structures embodied by computer code or processes. There are many different ways to explore this aspect of computation and creativity.

The creative process is sometimes described as divided into four stages: inspiration, conception, development, and realisation. Inspiration is when an idea is born. Conception is when that idea is developed and turned into a plan. Development is when the plan is put into action. And realisation is when the idea is brought to fruition. Computers can be used to help with all four stages of the creative process. For example, they can be used to help generate new ideas, to help develop new ideas, to help

implement new ideas, and to help evaluate new ideas. In the broader world of arts and engagement with art, there is a growing mainstream interest in the appreciation, practice and enjoyment of digital and electronic art and computational creativity.

2. ELECTRONIC ART AS A PARTICIPATORY PRACTICE

Where art or artistic practice is a process and the product is transitory, especially in the arena of generative and collaborative systems based art, the exposure of the internal discussion and art of system is an important and complex one. Often the art within an artists work is within creating and animating a system as an externally active thing. The output, or instantiation of this then serves to communicate the internal processes and development of systems. These intangible but essential elements then could be considered as the central activity to be conveyed in the 'art experience'. Especially when the conceptual or systematic underpinnings are as important as the aesthetic surface.

In light of this framing of the argument this paper discusses the use of the Youtube creative coding 'tut 'as artistic output and activity central to certain kinds of 'experience sharing ' and artistic-communication in the artisan craft based approach to poetic and creative computation. This paper is both ethnographic in its focus and approach and in part driven by auto-ethnographic experience. Bringing the direct experiences as an artist and researcher and writer together. This paper is written from the perspective of the author having run a an evolving Youtube channel [1] exploring electronic art and digital creativity over several years.

Where the artist practitioner is working in the role of artist, artisan or crafter within the digital realm the industrially orientated tools of mass production and digital distribution of products do not necessarily serve auteur artistic intents and outputs well. With little or no general access to a gallery system for all but a tiny minority of artists in the field and little opportunity to unpack the intents and practices behind -often- visual works presentations of artists works often appear as linear video on large scale screens and monitors hung in (arguably) homage to paintings in white cube galleries. This allowing audiences to engage primarily with the apparently linear surface of the works. An art-artist-audience relationship developed over hundred of years. In other environments works co-opt or appear as if part of the world of corporate video advertising utilising the same spaces, screens, surfaces and devices and sometimes aesthetics as main-stream luxury-product advertising.

In recent years the growth of digital platforms, combined with changes visual and media literacy, consumption trends and access to production tools has brought an explosion of short form tutorial content 'tuts 'on platforms such as YouTube, twitch, vimeo et al. Amongst these are a number of artists working in digital and generative arts using the medium to both teach and entertain but also use the short form video as a component of a mixed reality of what a digital artwork might be. Where the tut itself becomes a performative part of the final coded work.

3. THE CHALLENGE OF INTERACTIVE AND DYNAMIC ARTS

When showing art that uses computational processes or generative systems to audiences, one challenge is how or why to communicate the dynamic of generative nature of a work. Generative or systems art is often seen as a 'black box', where the artist's role is reduced to pushing a button and the resulting artwork is a product of the machine's autonomous processes. This lack of communication or visibility about the generative nature of the work can leave the audience confused, and unable to appreciate important aspects of the complexity of the artwork. One way to overcome this challenge is to collaborate or journey with audiences to share the artist's conceptual intent. This papers argues that is is being done now through a kind of performative co-making, where the audience is invited to collaborate with the artist in the creative process. This allows the audience to engage with the art in a hands-on way, and to understand the generative processes used to create the artwork.

One process whereby many younger artists in the electronic art arena are communicating the generative nature of the work is through these tuts. Tutorials can be used to explain the cognitive and dynamic processes used in the creation of the artwork, and embodied in code, and to demonstrate how and why artworks were created. This helps to give the audience a better

understanding of the generative nature of the work, and allows them to appreciate the complexity of the artwork. Overall, by collaborating with audiences and sharing the artist's conceptual intent through performative co-making or tutorials, the generative nature of the work can be communicated and the complexity of the artwork appreciated. This enhances the nature of the work, and allows the audience to engage with the artwork in a meaningful way.

Figure 1. *Sabine 'Bleeptrack' Wieluch*

4. THE STATE OF ART

YouTube creative coding tutorials can be considered being performative of generative art. By exposing the process and the art intent, they can be seen as a journey into the conceptual aspects of computational creativity. The tutorials often show the code being written in real time, and engage the viewer with artist's thoughts and decisions as they create new works. This can give the audience a better understanding of how the work was made and what went into creating it. Many of the tutorials also discuss the art intent behind the work. For example, in one tutorial, the artist explains that they are trying to create a work that is "both chaotic and ordered, random and structured, beautiful and ugly". This type of discussion can help the viewer to better understand the artist's goals and motivations for creating the work. The tutorials can also be seen as a way to learn about computational creativity. By watching the artist create the work, the viewer can learn about the different techniques and methods that can be used to create generative art. This can help to expand the viewer's knowledge and understanding of computational creativity. Overall, YouTube creative coding tutorials can be considered being performative of generative art. They expose the process and the art intent, and they can be used to learn about computational creativity.

Among the many examples of artist, practitioners explored were Tim Rödenbroker, an artist designer and coder with 15,000 followers on YouTube who says;

> "The intersection of creative coding, design and education is my personal sphere of action." [2].

Other practitioners include 'thedotisblack' a channel with 15,000 subscribers launched in 2014 by David Mrugala, a German architect, designer and educator based in Korea. Mrugala describes his channel as;

> "a platform for research design on (generative) drawings made with code. thedotisblack attempts to combine natural science studies, sound and visual narratives with coding. " [3]

Other notable practitioner artists or channels appearing on YouTube (amongst many not mentioned here) include Daniel Schiffman @theCoding Train (1.5million subscribers), Zach Lieberman, Saskia Freeke, Tim Holman and Sabine Wieluch (making videos under the moniker @bleeptrack) who says simply of her 10,000 subscriber YouTube channel

> "I create generative stuff of all sorts. Watch me create generative art and procedural generate cool projects." [4]

Figure *2. TheDotIsBlack YouTube pages*

5. LIVE CODING, ART AS VISUAL EXPERIENCE AND ELECTRONIC ART BEYOND THE DECORATIVE

This drive to expose the internal and conceptual logic and practices inside computational arts can be see most clearly in the the live coding and algorave scene, where the ideas, processes concepts and systemic creation of computationally based (commonly) audio works is made explicit with live feeds of code

being projected or screened to participants and audience experiencing both the music created but the conceptual art of creation, in collaboration with an active machine system.

In some areas of contemporary electronic art there is a predominant visual aesthetic and the works are often portrayed as visual or decorative experiences. Audiences are encouraged and supported in exploring this‘ art as experience ’in the staging, scale and situations of works. In some quarters this is (perhaps unkindly) described as ‘instagram opportunities ’reinforcing the explicit engagement with the aesthetic surface of the work. Large scale, and extremely popular contemporary electronic art experiences in the field are exemplified by works from artists/groups such as Japan’s Team Lab [5], Refik Anadol [6] et al.

According to well known artist, researcher and writer, Philip Galanter;

> “generative art refers to any art practice where the artist uses a system, such as a set of natural language rules, a computer program, a machine, or other procedural invention, which is set into motion with some degree of autonomy contributing to or resulting in a completed work of art” [7]

Galanter also notes that this idea of autonomy or process can include things such as;

> “a chemical reaction, the use of living plants, condensation and crystallization processes, melting substances, or any other physical process that can take place autonomously” [8]

Works exploring machine processes and electronic media predate contemporary computation by many years from generative sheet musical works printed on card to the 1 examples such as Terry Riley’s ‘in C’ [9] in 1964 to the futurist ‘art of noise ’to the dynamic ‘kinetic art’ sculpture of Alexander Calder [10] and self-destructive machines of Jean Tinguely [11] to the machine fetishism of the Italian futurists. This engagement with mass production and systems processes perhaps talks loudest in the example of the embracing of randomness and change of the Dadaists and the Cabaret Voltaire in Zurich in 1916. [12]. This search to communicate concepts beyond the immediately visual and the status of the message and also the meaning in the visual has been explored in depth in the work of Vilém Flusser where he elegantly espouses the theory of where meaning lies in ’technical images ’[13] [14]

6. PERFORMATICS AND COMMUNICATING CONCEPTUAL ART

As Sanakiewicz discusses in his 2019 exposition of the collision of Flusser’s conception of the ’technical image ’and ideas of Performatics "based on both the philosophy of language and anthropology, but equally on the study of theatrical phenomena and everyday practices” [15] he goes on to say;

> "This is because we are dealing with a complete reformulation of the image theory: the world presented, and, more precisely, the world that consists of a composition of concepts. These concepts – contained in a hybrid fusion of text and image – no longer refer to anything external, that is, they do not represent the world. Technical images, understood in the constructivist/performative spirit, are its presentation, manifestation, an enlivening of the imagination, which places us in a utopia, perceived as a journey towards a point without a clear reference. Flusser, therefore, focuses our attention not only on how the images report our being-in-the- world, but also on how, and – most importantly – why images form the basis of our contemporary, always and inevitably mediated culture. It is in technical images that Flusser sees a culture-creating potential, where culture is primarily understood as communication” [15]

The Flusser scholar and translator, Przemys!aw Wiatr, describes these technical images as a third degree of abstraction: referring not to reality, but to the text,

> "which in turn has its source in the traditional image, and this one is abstracted directly from reality” [16]

As Sanakiewicz notes "This means that technical images create a specific space, and at the same time separate – structurally – from

reality, which they could potentially “describe”. Thus they are anintrinsic part of it, by programming or “projecting” meanings into the world”

This is mirrored in what Lev Manovich implies when he describes in "Software takes Command”

> "Software has replaced a diverse array of physical, mechanical, and electronic technologies used before 21st century to create, store, distribute and interact with cultural artifacts. It has become our interface to the world, to others, to our memory and our imagination - a universal language through which the world speaks, and a universal engine on which the world runs. What electricity and combustion engine were to the early 20th century, software is to the early 21st century.” [17]

This idea of abstraction, and projection of concepts and conceptual relationships underpins much contemporary computational arts. This is especially true in the non-figurative, generative and conceptual arena, where the process of working with live and dynamic systems or specific data sources in a collaborative or ‘extensive; (ie extend practice through process or tools) manner is central to the practice. This is to say that the intent is embodied in the art and process more than the aesthetic or temporary fixed visual (or other, though it is often visual) outcome. IN this sense the artistic process is what can be described as performative or in the realm or performatics. Performatics, often identified with the work of Richard Schechner [18] comes from an interdisciplinary study of social behaviours, including those understood as artistic practices, particularly those with a use of participation or participatory observation.

In figure (1) described as 'Schechner’s Fan ’we see the performative range from rites and ceremonies to ritualisation walks through the domain of the‘ art making process ’giving different context from which to view to the performatic aspect of art process and practice. Whether this activity or action is explicitly in the‘ performance art’ domain or not. The exposure and sharing of art practice in the style of digital video sharing platforms such as tiktok, twitch and Youtube can be clearly considered in the context. where the intent is not performance and the outcome is a created digital art artefact of some description but intrinsic to the ‘art’, particularly in our context, that of electronic art, is the process and intent embodied by the final artefact. The example of ‘live coding ’is perhaps the most explicit of this where the music created is transitory and often secondary to the creative process illustrated live on projectors and screens. [19]

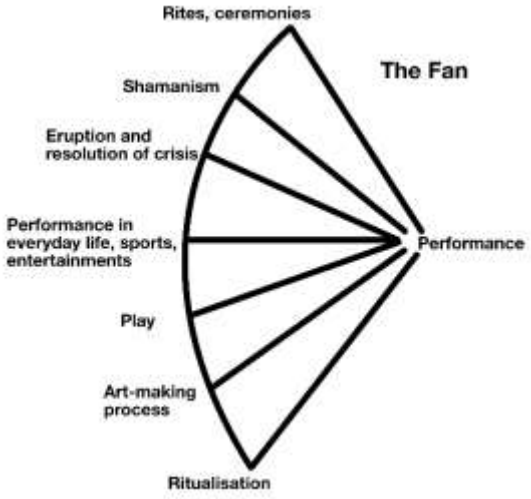

Figure 3. Schechner’s Fan

7. AUTOETHNOGRAPHIC EXPERIENCE MAKING ART ON YOUTUBE

The central observation from framing the subject in this was is the strong belief that YouTube creative coding tutorials can be considered performative of generative art, as they showcase the process and intent behind creating art using computational means. These tutorials offer a glimpse into the world of electronic, systems and generative art, which involves using computer programs to create art that is unique and original every time it is generated.”

Amongst the many video platforms, twitch, tiktok, vimeo etc, YouTube has become a popular resource for learning about a wide variety of topics within creative use of code, where it has become a popular resource for learning about software frameworks, ideas, processes, inspirations and tools for creating digital art.

Among the many creative coding channels on YouTube, the ‘ANOMYMISED for review’ channel originated as a resource for learning

about creative coding and making media art. (see figure 2) This YouTube channel, which at time of writing, has been running for more three years, provides creative coding tutorials using the C++ openFrameworks toolkit [20] . The video content, broadly framed as ‘tuts ’or tutorials discuss, expose and demonstrate the potential of media and generative art, as they show how to create complex, dynamic, and engaging art using code. The channel has become popular with a diverse audience across the world, for learning about art, the openFrameworks tools and electronic art ideas and processes.

Figure 4. *From the author’s YouTube creative coding channel*

The channel provides tuts that are easy to follow combined with discussion of artistic context and motivation. The videos are also in themselves performative, exposing the process and the art intent in a journey into the conceptual aspects of computational creativity. The tutorials on the channel are open and approachable for ‘beginners’, but they also provide depth for more engaged audiences. The examples on the channel are designed to be inspirational, and they provide a glimpse into the potential of openFrameworks for creating digital art.They are intended to engage and also to expose the process and the art intent in a journey into the conceptual aspects of computational creativity.

Overall, this paper argues that YouTube creative coding tutorials can be considered performative of generative art, as they provide a unique window into the world of computational creativity. These tutorials offer valuable insights into the challenges and possibilities of creating art using code, and demonstrate the potential of generative art to push the boundaries of artistic expression.

8. CONCLUSIONS

Generative art is a field that challenges traditional notions of art and creativity - explicitly foregrounding process over object. It involves using algorithms and computational processes to generate art, rather than relying on the artist's personal expression or technical skills. This approach to art-making has the potential to create new and unique forms of expression that would be impossible to achieve using traditional artistic techniques.

One of the key challenges of generative art is communicating the underlying process and intent to audiences. Generative art often involves complex systems and algorithms that are not immediately apparent to viewers. The ART and CODE channel addresses this challenge by providing clear and concise explanations of the code and algorithms used to create the art, as well as the artistic goals and inspirations behind the work.

9. THE EXPERIENCE AS SPECTACLE AS ART OBJECT AND CONCEPTUAL EXPERIENCE

There are evolving and new art practices and objects appearing within the sphere of electronic art with more emerging art practice beyond the physical gallery and gallery object. With the continuing digitalisation of both everyday life and the generation, sharing and consumption of art these new practices and processes of creation and consumption are evolving organically. This paper argues that amongst these issues a new perspective on sharing electronic art and the processes of art alongside an engage discourse on the practice of art.

This sharing of experience and knowledge can be seen to engage the borderlands of performatics in new and novel ways. Where performance of process becomes intrinsic to the creation of art objects. This aspect of performance however is not within the traditional realm of what might be termed theatre or performance art. Particularly as the performatic element is not the objective form of the central process of art-making, rather a way of opening that ‘blackbox ’of dynamic, systems orientated electronic art whilst actively resisting making the object an act of performance. This new form of exposition, the ‘tut ’can be seen as a fundamentally new, emergent arena for

electronic art in the creation, inception and conceptualisation of engaging in process based art practices.

In this paper I have attempted to outline a new way of considering a widely popular form of engagement in contemporary digital and electronic arts. Reflecting on the explicit performative nature of live-coding practices and using this as a lens to reconsider the YouTube 'creative coding 'tutorial 'tut '. This argument takes lessons from Flusser and the philosophy of technical images and from Schechner and concepts and perspectives on what the nature of performing and performatics may be. It proposes a reevaluation of the evidence of many hundreds of thousands of hours of performance of digital art practice on YouTube, TikTok, Twitch, Vimeo et al and suggests that this may genuinely be considered and new step in evolving digital arts practices and in the form of sharing future process driven or conceptual digital art.

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SESSION IV

Multisensorische Transformation | Multisensory Transformation

Moderation: Univ.-Prof. Dipl.-Ing. Dominik Lengyel
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Avatars of digital stories. From classic to enriched audio-video constructs

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ABSTRACT: As a collective initiative of research & innovation in the context of the SHIFT: MetamorphoSis of cultural Heritage Into augmented hypermedia assets For enhanced accessibiliTy and inclusion project, financed under HORIZON 2021-2027, the National Association of Public Librarians and Libraries in Romania (ANBPR) and the Augsburg University, Germany (UAU) and audEERING, Germany (AUD) are committed to giving new life to cultural heritage (CH) content in libraries with the support of text-to-speech (TTS) synthesis technologies and natural language processing (NLP) methodologies. This work aims to document and make possible the transformation of classic digital narratives produced by librarians and library service users of pre-existing into accessible, vibrant and emotionally imbued multi-modal constructs that are better received and internalized by to visually impaired or blind people, for whom, otherwise, these cultural constructs would remain a heritage impossible to decipher. This research pathway is nurtured by the dual aspiration of SHIFT partners to enrich CH and support the integration of these groups at risk of exclusion into the wider community of consumers of cultural and creative services. In combating the obstacles faced by the visually impaired in accessing cultural heritage assets, by using TTS technology in conjunction with NLP models for generating synthetic speech, SHIFT partners have tested, validated and refined different voice processing and playback models, resorting to complex semantic analysis tools, as well as elaborate summarization, translation and style transfer techniques. In this way, starting from a large base of digital stories from the ANBPR collection, new, recharged and impactful audio-video compositions were produced, adapted to the cultural and linguistic context of the original storytellers. This paper proposes a perspective centered on the optimized experience of users in relation to CH assets, from the perspective of ANBPR as a use case provider, in the wider context of the SHIFT project implementation. The present paper will analyze the different transformative layers of digital stories and how they become a more accessible and approachable version for visually impaired or blind people. ANBPR and partners took into account, on the one hand, the creative potential of digital stories about the cultural identity of communities, and, on the other hand, the inclusive valences of advanced technological solutions, which ultimately contribute to semantic and emotional

decoding of some precious content elements of CH. Using affective speech synthesis, CH artifacts are transmuted into vibrant and engaging narratives that evoke the imagination and create strong emotional connections. Thus, this sense, the pre-existing digital stories get a renewed, revitalized version, full of emotional expressiveness and, more importantly, easily accessible to visually impaired or blind people. This pioneering approach accredits the idea that advanced technological solutions such as TTS, NLP modeling, etc. contributes to the facilitation of inclusion for CH accessibility on a large scale.

1. INTRODUCTION

The method of storytelling has already been recognized as an essential means by which individuals understand, express, critically evaluate their everyday experiences and emotionally relate to the outside world. Through their profound formative valences and role as enhancers of inter-human connectedness, stories induce a powerful process by which individuals feel inspired to creatively interact with each other and their environment. Moving from traditional storytelling to digital storytelling, both individuals, exponents of different media, as well as creators and curators of cultural content in libraries and museums have intuited the huge expressive potential of this technique. Using digital storytelling involves a multifaceted endeavor that encompasses both a creative process that requires imaginative engagement and the cultivation of communication and expressive-artistic skills. Digital stories call for multi-disciplinary knowledge, requiring both literary and artistic skills, technology skills, a deep understanding of copyright issues, and critical thinking and public speaking skills.

This article proposes an exploratory approach regarding the analysis of the process of transforming pre-existing digital stories into drivers of renewable knowledge, especially in the aspect of valorizing cultural heritage assets in libraries and museums, with the support of technology.

2. EMPOWERING DIGITAL STORIES AS DRIVERS OF INCLUSION

In an attempt to promote a deeper connection between consumers of cultural products and the cultural heritage content available in libraries and museums, with a focus on making audio-video constructs accessible to visually impaired or blind people, the SHIFT project partners decided to capitalize on the convergences of objectives with a previous ANBPR project, namely Cultural Agora @ Your Library.

This project was funded under the Financial Mechanism of the European Economic Area (EEA) 2009-2014, promoting diversity in culture and arts within the European cultural heritage. Built on the collaborative relationships between the public libraries of four Romanian counties (Bucharest Metropolitan Library, "Octavian Goga" Cluj County Library, "ASTRA" Sibiu County Library and "Panait Istrati" Brăila County Library), this project trained members of various ethnic communities in the practice of digital stories as a means of stimulating the exchange of individual and collective experiences, to harness the power of community to generate positive change in terms of tolerance, resilience and co-creation. By creating over 1600 digital stories produced by librarians and users of library services, the Cultural Agora @ Biblioteca Ta project has put Romanian cultural capital, quality education and innovative library services at the center of its concerns, with the aim of encouraging people to participate to cultural life. Last but not least, this project contributed to increasing access to culture and promoting cultural diversity and inter-ethnic dialogue by supporting public libraries to become centers of socio-intellectual effervescence that stimulate curiosity, inspire, educate and connect the public through the use of digital storytelling techniques

2.1 VOICE SYNTHESIS, AUTOMATIC SUMMARIZATION & EMOTION ANALYSIS

SHIFT technical experts understood that software tools for voice synthesis, automatic summarization and emotion analysis can have

a profound impact in terms of updating the service offer of libraries and museums. Advanced speech editing and synthesis technologies have the potential to substantially transform the way libraries reach diverse user groups, providing a wide range of benefits. By integrating these types of techniques and technologies, libraries and museums can retain their current user base while also attracting new categories of users, such as the visually impaired. Thanks to these innovative techniques and technologies, visually impaired people can become full beneficiaries of accessible cultural content.

In support of the research efforts initiated by the technical partners within the SHIFT consortium, the National Association of Public Librarians and Libraries in Romania (ANBPR), one of the main providers of use cases within the project, made available to the technical experts from AUG and AUD, a database extended by digital stories that reflect the cultural identity of the ethnic communities in Romania consisting of digital stories produced within the Cultural Agora @ Your Library project. Building on pre-existing digital stories, technical partners explored the potential of using Text-to-Speech (TtS) technology enhanced by natural language processing (NLP) models to create emotionally rich and accessible digital narratives. The main aim is to improve the cultural heritage and to facilitate the inclusion of various groups of vulnerable users, especially people with visual impairments, in the wider community of consumers of cultural services.

Access to the cultural heritage of libraries and museums is critically important to preserving and enriching the cultural knowledge of the mass public. However, many vulnerable groups, such as the visually impaired, often face limitations in accessing these resources due to language barriers, the lack of assistive solutions and the absence of accessible presentation alternatives based on different sensory disabilities. In this context, the use of TTS technology enhanced with NLP models for synthetic speech generation becomes an indispensable tool.

In order to meet the technical experts, ANBPR made a preliminary selection of representative digital stories, taking into account both their relevance for the scope of the project and how much they offer in terms of semantic and emotional enrichment through SHIFT technological solutions.

Starting from a pre-existing collection of digital stories generated by librarians and users of library services in Romania, the technical partners focused primarily on two key aspects. First of all, they trained the SHIFT softwares regarding the diversity of language, styles and specialized cultural heritage content. Second, they explored various approaches where natural language processing (NLP) techniques could be used to shape language and create enhanced and engaging narratives tailored to the cultural and linguistic context of digital story creators in a given geographical space, in the present case from Romania. Basically, they analyzed, tested and applied methods and tools to derive acoustic correlates of emotions from pre-existing audio-video files representing Agora Culturala digital stories to bring them closer to vulnerable beneficiaries. These emotions were then integrated into speech synthesis for to convey emotions and subtext in digital constructs recreated with the support of modern technologies.

Figure 1: *My Beloved Family digital story initially narrated In Romanian, adapted in English that conveys equivalent emotion*

Through these advanced tools, SHIFT partners aim to provide an enhanced interaction experience to vulnerable people, with a focus on the visually impaired, enabling them to better access and understand CH assets through the mediation of advanced technologies. The goal of emotional speech synthesis is to transform CH elements into vivid and engaging narratives that stimulate the imagination and establish strong emotional connections. In this way, the pre-existing Agora Culturala digital stories gain a new path of use, by enhancing

emotional expressiveness and semantic and stylistic refining.

Beyond this, through the applied technological solutions, the pre-existing digital stories in the cultural heritage of ANBPR Romania have gone through a laborious process of transformation, including summarization, translation and style transfer. This transformation results in improved audio-video products, serving as improved options for exploring Romania's cultural heritage, with an important inclusion component for the visually impaired.

2.2 INCREASING THE IMPACT OF CH CONTENT THROUGH ACCESSIBILITY

This innovative approach has the potential to revolutionize the way we store and share CH assets. The technological solutions proposed and applied in the SHIFT project emphasize the importance of developing advanced tools to ensure that no community is marginalized in the process of making cultural heritage accessible. By facilitating the inclusion of these vulnerable groups in the community of consumers of cultural services of libraries and museums, the SHIFT demand-innovation initiative contributes to the preservation, enrichment and protection of global cultural heritage in the digital age.

The experiment carried out by SHIFT technical experts regarding the processing of audio-video materials of the Cultural Agora demonstrated that the use of high-quality voice synthesis technologies and the analysis of emotions based on NLP algorithms can lead to increasing the accessibility of CH content for visually impaired users. Users with certain sensory impairments can thus benefit from semantically and emotionally rich and diverse constructs for superior cultural experiences. By extrapolating how natural language processing algorithms can be used to synthesize and summarize the content of various audio-video constructs in libraries and museums, it is expected that SHIFT solutions can ensure the retention and loyalty of users of cultural goods on long term.

3. CONCLUSION

Following the SHIFT project demonstrations, the experts' conclusion revealed that, by creating technology-empowered avatars of classic digital stories, the libraries and museums of the future will move to another level of accessibility of cultural services, combating the implicit barriers of disability and promoting at the same time the reconciliation between various audiences and broadcasting media of audio-video constructs.

In the future, the integration of automatic summarization and text-to-speech services into current library and museum services may help visually impaired users identify and access culturally relevant information that would otherwise be inaccessible to them. Technologies and tools for voice synthesis, automatic summarization, text-to-speech or emotion analysis proposed by the SHIFT consortium have the potential to generate increased interest from audiences not included in current library or museum audiences.

For a sustainable implementation of SHIFT technology solutions, it is critically important to consider both the training of librarians and museum experts in the use of these tools, as well as the judicious observance of ethical responsibility requirements in the use, processing and recombination of cultural content.

Striking a fair balance between the long-term costs and benefits of implementing these technologies in libraries and museums, there are strong premises for these new technologies to gain a well-deserved place in the service offering of cultural and creative institutions, while ensuring increased accessibility, expanding learning participatory and co-creation, through which users will become part of the process of understanding, reinterpreting and deepening CH.

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Von Bronze zu Bits: Die Erforschung und innovative Vermittlung von Pompejis Lichtkunst

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KURZDARSTELLUNG: „Neues Licht aus Pompeji“, ein Forschungsprojekt am Institut für Klassische Archäologie der LMU München unter Leitung von Prof. Dr. Ruth Bielfeldt, widmet sich der Technologie, Ästhetik und Atmosphäre des römischen Kunstlichts. Eine publikumswirksame Forschungsausstellung präsentierte die Ergebnisse an den Staatlichen Antikensammlungen München und den Kapitolinischen Museen Rom der Öffentlichkeit. Schlüssel zu den schillernden römischen Lichtkulturen waren bislang kaum gesehene bronzene Beleuchtungsgeräte aus den Vesuvstädten: Öllampen, Lampenträger und Kandelaber. Das Licht der Vergangenheit zu entdecken – diese Aufgabe erforderte im Forschungsprozess und in der Präsentation digitale Methoden und Medien. Im Verbund von digitaler Technologie und experimenteller Archäologie wurden zwei Bronzelampen aus Pompeji digital erfasst und physisch rekonstruiert. An den nachgegossenen Repliken ließen sich nun Lichtexperimente durchführen. Ein weiterer Projektzweig widmete sich mit der Virtual Reality dem Ziel, antikes Kunstlicht zu simulieren und räumlich erfahrbar zu machen. Das „Virtuelle Triklinium“, der digital erzeugte Speiseraum der Casa di Giulio Polibio in Pompeji, ermöglichte es Besucher:innen, das Kunstlicht des Raumes selbst zu steuern und so die Raumatmosphäre nachzuempfinden. Das Projekt illustriert die Bedeutung digitaler Technologien in Verbindung mit kulturwissenschaftlicher Interpretation für das Verständnis der Sinneskulturen in historischen Gesellschaften.

1. EINFÜHRUNG

Im Rahmen des von der DFG geförderten Forschungsprojekts „Neues Licht aus Pompeji“ konzipierte und organisierte Ruth Bielfeldt zwei große und vielbeachtete Ausstellungen: zunächst die Auftaktausstellung „Neues Licht aus Pompeji“ [1, 6] in den Staatlichen Antikensammlungen München (9. November 2022 bis 8. April 2023) und gemeinsam mit Johannes Eber in den Kapitolinischen Museen Rom „Nuova Luce da Pompei a Roma“ (4. Juli 2023 bis 8. Oktober 2023) [2].

Das Projekt und die Ausstellungen widmeten sich einem bislang wenig erforschten Thema: der Technik, Ästhetik und Atmosphäre des römischen Kunstlichtes [1, 2, 3, 4, 5, 6, 7]. Ausgangspunkt waren großteils figürliche Beleuchtungsgeräte aus Bronze aus den Vesuvstädten Pompeji und Herculaneum, darunter Öllampen, Kandelaber und Lampenhalter. Der Fokus auf Kunstlicht bzw. Lichtkunst eröffnet dabei eine neue kulturgeschichtliche Perspektive auf Pompeji und seine Lebens- und Vorstellungswelten.

Mit dem Forschungsvorhaben und der Ausstellung war ein zentrales Ziel verbunden: die archäologischen, museal archivierten Objekte selbst wieder als Lichtwerkzeuge in Erscheinung treten zu lassen – anhand von digitalen Zwillingen und physischen Repliken, also originalgetreuen Nachgüssen. Im Forschungs- und Visualisierungsprozess selbst griffen daher viele Schritte ineinander: das

archäologische Studium der Objekte, die digitale Dokumentation und Rekonstruktion, die experimentelle Archäologie sowie die computergestützte Lichtsimulation.
Dieser Beitrag konzentriert sich auf die Verzahnung von Archäologie, digitaler Dokumentation und Visualisierung. Beleuchtet werden (1) die Erforschung und Rekonstruktion der archäologischen Objekte, (2) der daraus entstandene Erkenntnisgewinn und (3) der museumsdidaktische Einsatz der neu entwickelten digitalen Werkzeuge im Ausstellungskontext.

Die beiden Ausstellungen wurden museologisch engmaschig begleitet. Die Ausstellung appellierte an Neugier, Lust am Experiment, an Staunen, Emotion, Humor, an Technologie- und Wissensfreude. Die Besucher:innen waren einerseits eingeladen, es sich zwischen den römischen ‚Dingen', Räumen und Vorstellungswelten gemütlich zu machen – und sich andererseits immer wieder vom Gewussten und Gelernten zu distanzieren. Im Entree zeigte ein Modell der Casa del Poeta Tragico (Pompeji) eindrücklich, dass sich der römische Alltag im Haus wesentlich im Halbdunkel abspielte. Eine „Werkstatt" führte die Besucher:innen in die antike Bronzetechnologie ein und brachte die spezifische luminose Materialität von Bronze nahe. An einer Hands-On-Station konnten Erwachsene und Kinder einen drei Kilogramm schweren, qualitätvollen Nachguss der berühmten Fledermauslampe in die Hand nehmen und mit den Fingern erfühlen. Mit den phantasievoll gestalteten antiken Lichtobjekten und schillernden, zuweilen humorvollen Texten wurden vielfältigste Lebenswelten erzählt, in denen Licht eine Rolle spielte: die Nacht, das Fest, die Sklaverei, die Religion, Magie und Erotik. Das innovative „virtuelle Triklinium" zuletzt simulierte das Kunstlicht in einem Gelageraum Pompejis, der in der Ausstellung originalgetreu wiederaufgebaut worden war. Der sog. Apollo, die archaistische Figur eines Lampenträgers, die aus dem Gelageraum selbst stammt, war eines der Highlights der Ausstellung. Er war zweimal zu erleben: im Original hinter Glas und als Lichtobjekt mit zwei leuchtenden Lampen in der VR-Umgebung.

Wie kann zweitausend Jahre alte Lichtkunst dem heutigen Auge nahegebracht werden? Es versteht sich von selbst, dass die historischen Stücke aus konservatorischen Gründen nicht mehr entzündet werden dürfen. Wie alle defunktionalisierten archäologischen Objekte stellen die Bronzelampen aus Pompeji und Herculaneum für das Museum eine große Herausforderung dar. Trotz anschaulicher Präsentation in Vitrinen fehlt ihnen das Element Feuer, das sie, in Form von bewegter Flamme und Licht, Reflexion und Schatten, funktional lebendig werden lässt. Den museal geordneten Stücken sind auch ihre soziale Dimension und die Weise, wie sie in ihrem Umraum wirken, häufig nicht mehr abzulesen. Um den atmosphärischen Impuls der antiken Lichtgeräte im Raum wiederzugeben, hat die Ausstellung mit modernen Mitteln, mit gezielter Platzierung von Spots in den Vitrinen, Licht und Schattenspiele erzeugt (Abb. 1 u. 2). In abgedunkelten Nischen und Räumen entstand eine Atmosphäre, die zwischen antikem und heutigem Lichterleben vermittelte.

Abb. 1: *Die Tänzerlampe: Bewegte Schatten an der Wand in der Ausstellung in Rom. (Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber)*

Abb. 2: *Baumförmiger Lampenständer und sein Schatten – ein Blick auf die römische Nacht in den Kapitolinischen Museen. (Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber)*

2. VON BITS ZUR BRONZE ZUM LICHT

Kern der antiken Lichtkunst sind Öllampen, Bronzeobjekte, die durch ihre Flammen Licht abgeben und durch ihre metallische Oberfläche reflektieren, das gestaltete Volumen verschatten und damit mitgestalten [5]. Um die Lichtwirkung antiker Lichtinstrumente zu studieren und nicht zuletzt zu reproduzieren, ohne die wertvollen Originale zu gefährden, hat das Projektteam im Rahmen mehrerer Forschungskampagnen zwischen 2018 und 2022 rund 250 ausgewählte Bronzeoriginale systematisch durch Fotografien, nicht-invasive Materialanalysen und hochauflösende dreidimensionale Scans dokumentiert.

So haben wir im Zuge des Projektes zwei Prachtlampen aus dem 1. Jahrhundert n. Chr. originalgetreu aus Bronze nachgefertigen können, um sie unter anderem für Lichtexperimente zu nutzen: eine zweiflammige Lampe mit einem großen Reflektor in Form einer Fledermaus aus Stabiae (Abb. 3) und eine dreiflammige Lampe mit der Aufsatzfigur eines Tänzers aus Pompeji [5] (beide heute im Archäologischen Nationalmuseum Neapel, Inv. 72331, 72253).

Die unter der Leitung von Manuel Hunziker erfolgte Dokumentation mittels optischem Scanner ermöglichte es zunächst, die Oberfläche und die Volumina detailliert zu erfassen [12]. Zur Erfassung kam der Weißlicht-3D-Scanner „SmartScan HE-R8“ der Firma Hexagon/AICON vom Institut für Klassische Archäologie der LMU München zum Einsatz. Das Gerät ist für die Digitalisierung archäologischer Artefakte aller Art besonders geeignet, weil das Messsystem an jegliche Anforderungen der zu scannenden Objekte angepasst werden kann. Kleine bzw. filigrane Stücke lassen sich damit genauso effizient und detailgetreu erfassen wie meterhohe monumentale Statuen. Die Objekte wurden zudem durch Photogrammetrie erfasst, sodass die Modelle auch mit einer hochauflösenden Fototextur versehen werden konnten, was ihnen zusätzliche Tiefe und Realismus verleiht. Während sich die äußere Geometrie der Objekte gut aufnehmen ließ, stellte die Ermittlung der Wandstärke und der u. a. für Gewicht und Brenndauer entscheidenden Füllvolumina der Öllampen eine Herausforderung dar. Durch das digitale Prozedere konnten auch Elemente rekonstruiert und ergänzt werden, die am Original fehlen oder beschädigt sind.

Auf Basis der Röntgenfluoreszenzanalyse der Kupferlegierungen durch Alessandra Giumlia-Mair wurden in Zusammenarbeit mit Felix Lehner an der Kunstgießerei St. Gallen (CH) detailgetreue Repliken gegossen [8]. Dank einer präzisen Oberflächenbearbeitung wurden die Lampen durch Olaf Herzog, München, dem antiken Originalzustand der historischen Lichtwerkzeuge angenähert. Die Replik der verzinnten Fledermauslampe, die im beleuchteten Zustand eine besondere Wirkung entfaltet, bezeugt die aufwendige Bearbeitung der Oberfläche zum Zweck spezieller Lichteffekte (Abb. 3). Die umfassende wissenschaftliche Begleitung des gesamten experimentellen Reproduktionsprozesses stellte ein vertieftes Verständnis der antiken Herstellungsverfahren sicher.

Abb. 3: *Archäologisches Artefakt (links) trifft Nachguss (rechts) – römische Lampe des 1. Jh. n.Chr. mit Reflektor in Form einer Fledermaus. (Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber)*

Abb. 4: *Beleuchtungsexperimente mit dem Fledermaus-Nachguss. (R. Bielfeldt; LMU München, Neues Licht aus Pompeji, Foto: Johannes Eber)*

Diese neu geschaffenen, in der Ausstellung zur Berührung freigegebenen Repliken boten den Ausstellungsbesucher:innen die einzigartige Gelegenheit, Gewicht, Materialität und handwerkliche Beschaffenheit sehend und

fühlend zu erfahren. Selbst feine Bearbeitungsspuren ließen sich direkt ertasten.

Für die Forschung waren diese Nachbildungen eine wertvolle Ressource. Bereits 2017 hatte Ruth Bielfeldt anhand von historischen Repliken des 19. Jahrhunderts entdeckt, dass mehrflammige figürliche Lampen konzipiert waren, spezielle Licht- und Schatteneffekte zu inszenieren. [5] (Abb. 4). Die 2022 hergestellten Repliken in frischer, teils polierter Bronze erlaubten es nun, akkurate Beleuchtungsexperimente durchzuführen. Lars O. Grobe testete verschiedene Dochtgrößen und Ölmischungen auf ihre Lichtemission. Diese Experimente stützten sich auf tatsächliche Funde: In antiken Lampen erhaltene Dochtreste erlauben Rückschlüsse auf das Material und die Stärke der damals verwendeten Dochte. Der gesamte Prozess, von der Herstellung der Repliken bis zu den Lichtexperimenten, wurde filmisch und fotografisch dokumentiert.

3. DIGITALE VISUALISIERUNG UND SIMULATION

Die digitalen 3D-Modelle erlauben eine analytische Durchdringung des Licht-Schattenspiels. Die „digitalen Zwillinge“ können mit spezieller 3D-Modellierungs- und Simulationssoftware, etwa Blender, dynamisch und variantenreich visualisiert werden [12]. So können virtuelle Flammen in den Lampenschnauzen positioniert und Schattenspiele digital errechnet und dargestellt werden (Abb. 5). Verschiedene Parameter wie Reflexionseigenschaften, Farbtemperatur, Lichtstärke und Form der Flammen lassen sich nach Bedarf anpassen. An einer virtuellen Wand lässt sich eindrucksvoll demonstrieren, wie sich der Schatten je nach Abstand und Winkel zur Lampe verändert (Abb. 6).
Die Dynamik der Flammen kann über Blender jedoch nur unzureichend dargestellt werden. Dem typischen Flackern von Flammen liegen zwei Ursachen zugrunde: Erstens der Luftstrom und zweitens ein Ungleichgewicht zwischen Verbrennung und Brennstoffnachschub – Faktoren, die in der Visualisierung noch nicht berücksichtigt werden konnten. Eine digitale Umsetzung ist aber für die Zukunft geplant.

Die Ergebnisse der digitalen Visualisierungen lassen sich mit den Ergebnissen der analogen Lichtexperimente im Hinblick auf abgegebenen Lichtstrom, Eigenreflexion und Schattenwurf der Öllampen vergleichen und plausibilisieren. Beide Verfahren erlauben weitergehende methodische Reflexionen: Die digitale Methode bietet den Vorteil, dass ohne den aufwendigen Prozess des Nachgusses eine Vielzahl von Lampen simuliert werden kann. Lichtquellen können hinzugefügt und ohne großen Mehraufwand in ihrer Position verändert werden.

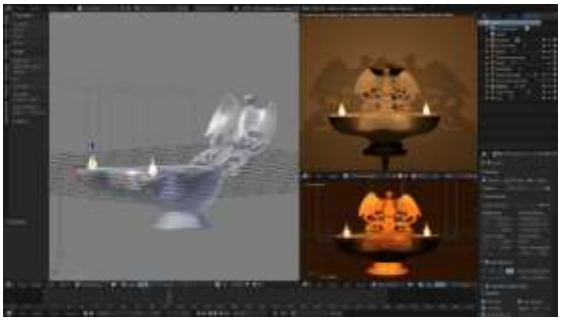

Abb. 5: *Einblick in die digitale Vorbereitungsphase – in Blender wird die Fledermauslampe für die Schattensimulation arrangiert. (Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)*

Abb. 6: *Digitale Simulation der Fledermauslampe – präzise berechnete Schattenprojektionen an der Wand. (Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)*

Auch das Verständnis vom archäologischen Objekt lässt sich durch 3D-Scans erweitern. Im digitalen Modell kann rekonstruiert und ergänzt werden: Verloren gegangene Elemente können digital wiederhergestellt, etwaige Beschädigungen mittels Software korrigiert und die durch die Jahrhunderte entstandene Patina kann durch die gelbgoldene Farbe der ursprünglichen glänzenden Bronze ersetzt werden.

Zu römischen Beleuchtungsgeräten gehören nicht nur Lampen, sondern auch Kandelaber oder figürliche Lampenträger. Erst im Zusammenspiel verschiedener Lichtobjekte entfaltet sich die materielle und luminose Pracht antiker Beleuchtung. Insofern die Positionierung von Lampen auf ihren Ständern

aufgrund konservatorischer Gründe heute oft nicht mehr möglich sind, bietet uns die Digitalisierung hier eine Chance. In der Ausstellung ermöglichten interaktive Bildschirme den Besucher:innen, mit unterschiedlichen Objekten digital zu experimentieren und die Parameter der Beleuchtung von statuarischen Lampenträgern zu verändern.

4. ANWENDUNG IN DER VIRTUELLEN REALITÄT: DAS „VIRTUELLE TRIKLINIUM“

Ein zweites zentrales Forschungsziel des Projektes ist, Licht und Schatten im Kontext eines antiken Raums zu erfassen, zu studieren und nicht zuletzt erfahrbar zu machen. Als Medium der Präsentation bot sich Virtual Reality (VR) an, die dank visueller und haptischer Stimuli ein körperliches Erleben des antiken Kunstlichtraums möglich macht. Dazu war ein Simulationskontext zu erarbeiten, der begehbar ist und mithilfe unterschiedlicher Lichtsituationen und variabler Raumausstattungen dynamisiert werden kann. Sämtliche digital erfassten archäologischen Gegenstände ließen sich nahtlos in eine solche virtuelle Simulation integrieren.

Das sog. Triklinium EE (Abb. 7 u. 8) aus der Casa di Giulio Polibio (IX 13, 1–3) in Pompeji stellt aufgrund seiner gut dokumentierten antiken Möblierung sowie seiner reichen Ausstattung mit Bronzeobjekten (u. a. Lampen, Kandelaber und ein figürlicher Lampenträger) den idealen Ausgangspunkt für die Rekonstruktion und Simulation einer konkreten pompejanischen Raumsituation kurz vor dem Vesuvausbruch im Jahr 79 n. Chr. dar [9].

Das für die Ausstellung erarbeitete „Virtuelle Triklinium“ ist Ergebnis jahrelanger Vorarbeiten [7, 15]: Der pompejanische Speiseraum und die angrenzenden Räume wurden 2021 mittels Laserscans durch den Archäologischen Park Pompeji und eigene Fotografien detailliert dokumentiert. Auf Basis dieser Daten wurde ein präzises geometrisches Modell des Raums erstellt und soweit nötig rekonstruiert. Die heute stark beschädigte antike Wanddekoration wurde auf Grundlage von Grabungsfotos und vergleichbarer Fresken von Lars O. Grobe in Kooperation mit Johannes Eber digital wiederhergestellt und auf die Wände des Modells projiziert. Die Wandmalerei hatte drei Zerstörungsphasen durchlebt: durch die Erdbeben zwischen 62 und 79 n. Chr., durch den Ausbruch des Vesuvs im Jahr 79 n. Chr. und schließlich durch Feuchtigkeit und Witterung nach ihrer Entdeckung in den 1970er Jahren. Durch den Vesuvausbruch im Jahr 79 n. Chr. wurde die ursprünglich bemalte Decke und die Attikazone des Wanddekors stark beschädigt. Mithilfe einiger ausgegrabener Fragmente konnten verschiedene Flächen der Decken- und Wandgestaltung vom Archäologischen Park rekonstruiert werden. Ein interessantes Detail ist die grau verputzte, undekorierte Nordwestecke. Hier war die Wandmalerei durch das Erdbebens 62 n. Chr. zerstört worden und die Wand zunächst undekoriert geblieben. Für die wohl geplante Reparatur war der Putz bereits aufgetragen, doch die Arbeit am Fresko wurde nie begonnen (Abb. 7).

Abb. 7: *Triklinium EE – Blick auf die Nordwand aus dem Innenraum. (Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber)*

Abb. 8: *Triklinium EE – Blick vom Inneren des Raumes in Richtung Süden. (Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber)*

Das digitale Modell kann aufgrund der Zerstörungen nur eine Annäherung an das Original darstellen. Für die Simulation bot es sich an, den Raum so darzustellen, wie er plausiblerweise vor seiner Verschüttung im Jahr

79 n. Chr. ausgesehen hat. Die sich in Renovierung befindlichen, zur Neubemalung vorbereiteten Flächen an der West- und Nordwand wurden daher als grob verputzte graue Flächen gezeigt. Der Rest des Decken- und Wanddekors wurde auf Grundlage der erhaltenen oder fotografisch dokumentierten Fragmente und unter Berücksichtigung einer symmetrischen Anordnung digital ergänzt. Der Digitalkünstler Donghwan Kim zeichnete das beschädigte mythologische Fresko der Ostwand nach und ergänzte es anhand von Fotografien, die nach der Ausgrabung gemacht worden waren. Die Farbwahl basiert auf präzisen Messungen durch Lars O. Grobe und Andreas Noback (TU Darmstadt) am Originalfresko. Bei der Rekonstruktion des Mittelbildes wurde besonderer Wert auf die Authentizität von Bildstruktur und Farbe gelegt. Die schwebenden, geflügelten Figuren in der rotgrundigen Mittelzone wurden teilweise durch Spiegelung der erhaltenen beiden Victorien ergänzt. Der Wanddekor war 79 n. Chr. v.a. in der Sockelzone wesentlich detailreicher. Einige der Details der Malerei waren zu schlecht erhalten und entzogen sich einer sinnvollen Rekonstruktion. Die Rekonstruktion ist somit immer nur als hypothetische Annäherung an die ursprüngliche Wandgestaltung zu verstehen.

Die gleichen Einschränkungen gelten auch für die restliche Ausstattung des „Virtuellen Trikliniums“. Um den digitalen Raum authentisch auszugestalten, wurden in einem weiteren Arbeitsschritt Teile des Mobiliars aufgrund der Funde im Raum und anderer Vorbilder aus den Vesuvstädten digital rekonstruiert.

In zwei Arbeitskampagnen 2020 und 2021 wurden die im Triklinium gefundenen, heute im Archäologischen Park Pompeji befindlichen Bronzeobjekte zum Zweck der Dokumentation [12] und der späteren Einbindung in das „Virtuelle Triklinium“ dreidimensional erfasst. Aus den Modellen wurden 3D-Drucke erstellt, die gleichzeitig für multimediale Darstellungen und wissenschaftliche Analysen geeignet sind [13, 14].
Unter den Bronzeobjekten wurde im Triklinium EE auch eine leicht unterlebensgroße, nackte Bronzefigur im Stil eines archaischen Kouros entdeckt: der sogenannte Apollo (Archäologischer Park Pompeji, Inv. 22924) [4, 10]. Die höchst detailreiche Statue wurde von Kopf bis Fuß, von den unterschnittenen Korkenzieherlocken der Stirn bis zu den Fußnägeln, hochauflösend digital gescannt. Zur Statue gehören zwei Ranken, eine Basis und eine Krone, die nicht fest an der Figur befestigt sind. Üblicherweise wird der Kouros der Öffentlichkeit ohne die montierten Ranken gezeigt, da letztere für seine fragilen Arme zu schwer wären und das Anbringen ohne zusätzliche Stützen die Statue beschädigen könnte. Aus Stabilitätsgründen steht der Kouros heute nicht auf der antiken Rundbasis, sondern auf einem modernen Sockel. Nur gelegentlich wird er mit der Krone gezeigt. In der digitalen Rekonstruktion konnten alle Elemente jedoch zusammengefügt werden (Abb. 9): Im virtuellen Raum steht der Kouros mit Krone wieder auf seiner antiken Basis und hält die Ranken. Das auf den Stützranken zu rekonstruierende, ebenfalls erhaltene Steintablett wurde digital modelliert; darauf konnten nun wiederum Lampen positioniert werden. Dieses digitale Modell ergänzte das Original um Perspektiven, die an der erhaltenen Statue nicht mehr dargestellt werden können.

Die Digitaltechnik kann gescannte Objekte, wie den Kouros, ihrem ursprünglichen Zustand annähern (Abb. 10). Für die Lichtsimulation ist dies insofern wichtig, als die Metalloberfläche einen großen Einfluss auf das Verhalten des Lichtes besitzt. Eine korrodierte Oberfläche streut das Licht anders als eine polierte. Für die Integration in das „Virtuelle Triklinium“ wurden daher von Zlatka Uzunova und David Ivanov, Virtual and Augmented Reality Laboratory Sofia, für alle Bronzeobjekte eine polierte Metalloberfläche programmiert. Die Korrosionswarzen auf dem Apollo wurden allerdings im Modell beibehalten, da ihre digitale Entfernung viel Zeit in Anspruch genommen hätte.

Neben den Eigenschaften der Oberflächen spielte das Illuminationsverhalten der Lampen im Raum eine entscheidende Rolle. Bei der gleichzeitigen räumlichen Simulation multipler Lichtquellen lässt sich die Lichtwirkung und der Helligkeitsgrad nicht einfach mittels Referenzobjekten bestimmen. Die räumliche Wirkung von Licht ist von zahlreichen weiteren variablen Faktoren abhängig, dem Reflexionsgrad der mit Wachs behandelten Wände oder der Präsenz lichtundurchlässiger Gegenstände im Raum. Daher wurde die Lichtpropagation im Raum in Vorstudien [11] von Lars O. Grobe und Andreas Noback untersucht und mithilfe der auf

Beleuchtungssimulation spezialisierten Software „Radiance“ errechnet. Die daraus resultierenden Daten wurden in die Game-Engine „Unreal Engine“, die der VR-Simulation zugrunde liegt, angenähert.

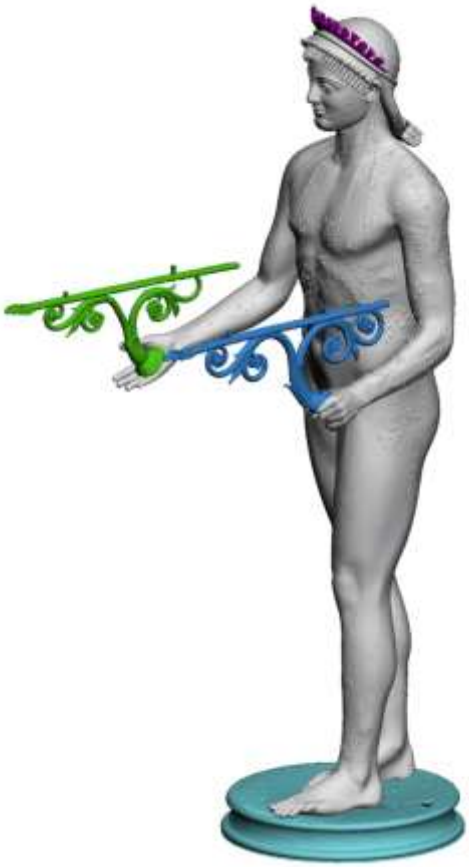

Abb. 9: *Apoll als Lampenträger – digitale Rekonstruktion.*
(Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)

Abb. 10: *Apollo Lampadoforo – Gegenüberstellung der Oberfläche des antiken Artefakts und der digital rekonstruierten Oberfläche.*
(Foto: LMU München, Neues Licht aus Pompeji, Johannes Eber / Manuel Hunziker)

Die Integration einer interaktiven Komponente in das Projekt erwies sich als besonders anspruchsvoll. Sie verlangte eine enge Verzahnung wissenschaftlicher Erkenntnisse und sich ständig weiterentwickelnder Technologien, weshalb die interdisziplinäre Zusammenarbeit unverzichtbar war. Das rekonstruierte Triklinium, samt seiner Beleuchtung und Einrichtung, wurde von Elisabeth Mayer (LRZ München) in eine Game-Engine übertragen, um es in einer interaktiven Umgebung darzustellen (Abb. 11). Diese Game-Engine („Unreal Engine“) fungierte als Verbindungselement zwischen den 3D-Modellen, der Lichtgestaltung und den Interaktionsfunktionen und ermöglichte die Darstellung in einem VR-Szenario [15]. Mithilfe der Engine konnten Beleuchtungs- und Reflexionsberechnungen so gestaltet werden, dass sie der tatsächlichen Lichtausbreitung im Raum nahekommen. Moderne Game-Engines verwenden in der Regel das „Physically Based Rendering“, wodurch die Beleuchtung unter Berücksichtigung physikalischer Grundlagen und realistischer Materialmodelle modelliert wird. Komplexe Lampenmodelle können als virtuelle Lichtquellen dienen und ein dynamisches Licht- und Schattenspiel ermöglichen. Diese Berechnungen werden in Echtzeit während der Interaktion durchgeführt. Ein kontinuierlicher Abgleich mit den Lichtsimulationsergebnissen stellt sicher, dass die in der VR-Umgebung präsentierte Lichtauswirkung sowohl realistisch als auch aus der Sicht der Wahrnehmungspsychologie stimmig ist [16].

Bei der digitalen Modellierung des Raumes war die Bedienbarkeit zu berücksichtigen. Aktuelle VR-Systeme bieten eine große Bandbreite an Steuerungsoptionen und sind so konzipiert, dass Benutzer:innen entweder den gesamten Raum nutzen oder an einer festen Position bzw. im Sitzen ein immersives Erlebnis haben. Für das „Virtuelle Triklinium“ stand in beiden Ausstellungen eine physische Fläche zur Verfügung, die den Abmessungen des Trikliniums EE in Pompeji entspricht. Die Besucher:innen konnten sich daher im simulierten Raum frei bewegen. Nach sorgfältiger Evaluierung wurde die HTC Vive Pro 2 als VR-System gewählt. Diese VR-Brille bietet eine hohe Bildauflösung und mit einer Bildwiederholrate von 120 Hz ein flüssiges und nahtloses Erlebnis. Ein weiterer Vorteil ist das breite Sichtfeld. Ein besonderes Merkmal des genutzten HTC-VR-Systems ist das räumliche

Tracking, durch das die Position der Benutzer:in im Raum ständig erfasst wird. In den Raumecken positionierte Base-Stations erkennen kontinuierlich Bewegungen sowie Positionsänderungen der User:innen und leiten diese Informationen an die Game-Engine weiter, was eine kollisionsfreie Bewegung im Raum möglich macht.

Abb. 11: *Gestaltung des virtuellen Trikliniums – Umsetzung in der Game-Engine „Unreal Engine". (Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)*

Abb. 12: *Der Raum in der Ausstellung – haptische Reproduktionen von Möbeln und Objekten, positioniert wie ihre virtuellen Entsprechungen. (Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)*

Abb. 13: *Blick durch die VR-Brille – durch angezündete Lampen illuminiertes Triklinium. (Foto: LMU München, Neues Licht aus Pompeji, Manuel Hunziker)*

Die freie Bewegung in dem digitalen Lichtraum lässt zahlreiche interaktive Erfahrungen zu. Einer der Controller wurde zu einem virtuell brennenden Kienspan. Mit ihm und seiner dynamischen Lichtquelle konnten die Besucher:innen durch den zunächst dunklen Raum navigieren und vier im Raum verteilte Öllampen entzünden. Die Position und die Anordnung der Lampen im Raum – auf dem Tisch, einem Kandelaber und dem Tablett des Kouros – orientierten sich an der Raumstruktur und den Nutzungsmöglichkeiten von Ausstattung und Mobiliar. Die entzündeten Lampen erzeugen einen spotlichtähnlichen Effekt, der Schatten auf Wände und Boden wirft. Abhängig von der Position und der Anzahl der entzündeten Lampen variieren die Licht- und Schatteneffekte (Abb. 13): Wände können stärker oder schwächer ausgeleuchtet werden, Schatten diffuser oder schärfer erscheinen. Dieses dynamische Spiel von Licht und Schatten erzeugte einen unmittelbaren Eindruck leiblicher Präsenz in lichtvermittelter antiker Atmosphäre.

Um die Immersion zu steigern, wurde das „Virtuelle Triklinium" in der Münchner Ausstellung physisch nachgebaut, d. h. mit Repliken (3D-Drucken oder handgefertigten Holznachbildungen) der in der VR dargestellten Objekte versehen (Abb. 12). Neben die visuelle trat so eine haptische Erfahrung; man konnte den Tisch berühren oder sich auf die Gelagebetten legen und zur Decke hinaufblicken.
Was fehlte, war die virtuelle Repräsentation des handelnden Körpers. Der virtuelle Kienspan schwebte „in der Luft". Zukünftig sollen Nutzer:innen in der Lage sein, einen körperlichen – der individuellen Körpergröße angepassten – Avatar zu übernehmen und zu lernen, wie sie diesen im virtuellen Kontext verkörpern können. Dann wird auch der Kienspan von einer Hand gehalten, die der eigenen Handbewegung folgt. Erste Studien [17] legen nahe, dass zwischen dem eigenen Körperempfinden und dem „Sense of Embodiment" eines virtuellen Avatars grundsätzlich Brücken geschlagen werden können. Als Grundlage für die Gestaltung des Avatars käme, geht man nach historischer Plausibilität, nur eine Sklavenrolle in Frage, da Sklaven für die Beleuchtung der Speiseräume zuständig waren. Dass der historische Körper – als Erscheinungsbild und als Rolle – von User:innen als Kontrast zur eigenen Körperlichkeit erfahren wird, liegt nahe. Womöglich erlaubt die Möglichkeit, mit dem virtuellen antiken Körper konkrete Tätigkeiten und Wahrnehmungshandlungen auszuführen,

die soziale und historische Distanz ein Stück weit zu überbrücken.

Die freie Hand, die den Controller (= Kienspan) nicht hält, ist offen für haptische Erfahrungen der im Raum vorhandenen Objekte. Die Zielsetzung des Experiments ist, dass sich die Sinneseindrücke des virtuell Gesehenen mit dem Ertasteten verschränken und eine taktile Virtualität entsteht. Noch sind weitere Arbeitsschritte nötig, bis diese Verschränkung mehrerer Sinnesvermögen im „Virtuellen Triklinium“ reibungslos gelingt.

Virtual Reality hat sich als revolutionäres Instrument für kulturwissenschaftliche Fragestellungen etabliert [18]. Die Fähigkeit, Realitäten digital nachzubilden, eröffnet neue Sichtweisen auf historische Räume und Kontexte. Das „Virtuelle Triklinium“ ist kein starres Modell, sondern eine Kombination aus Licht-, Seh- und Verhaltenssimulationen. Die Lichtsimulation modelliert die Ausbreitung des von den Lampen abgestrahlten Lichts im rekonstruierten Raum und die Reflexion an seinen Oberflächen. Durch Modelle der visuellen Wahrnehmung werden die physiologischen Mechanismen des Sehens unter den Bedingungen eines weitgehend dunklen, nur durch die Flammen von Öllampen beleuchteten Raums simuliert. Die Bewegung in der virtuellen Realität und die Interaktion mit den Leuchtgeräten erlauben es nun, Aspekte des Verhaltens und damit verbundener Erfahrungen zu simulieren.

Während der Ausstellungsbesuche zeigten sich die Besucher:innen begeistert von der VR-Erfahrung und der Möglichkeit, einen physischen Raum virtuell zu erkunden und dank der interaktiven Elemente, vor allem der Möbel, verschiedene Perspektiven einzunehmen. Mutige oder erfahrene VR-User:innen nutzten die Chance, sich auf die Klinen zu legen und virtuell zu entspannen. Andere Besucher:innen bevorzugten klare Anweisungen. Sie hielten sich oft genau an die Arbeitsaufgabe („finde im Raum vier Lampen und entzünde das Licht“) und sie experimentierten nur auf Einladung. Die Bedeutung von Betreuer:innen, die den Usern während des VR-Erlebnisses zur Seite stehen, ist daher nicht zu unterschätzen. Erstaunlich unterschiedliche Reaktionen gab es hinsichtlich des fehlenden (Avatar-)Körpers. Fehlte einigen Besucher:innen das optische Feedback der eigenen Leiblichkeit und somit das Vertrauen in die eigene Bewegungsfähigkeit innerhalb der VR-Welt, so fanden sich andere umgehend in der körperlosen Rolle zurecht.

Der wissenschaftliche Wert dieser Technologie wurde während der Ausstellung in München durch Feedbackbögen evaluiert. Ein Schwerpunkt der freiwilligen Evaluation lag auf den Erfahrungen der Besucher:innen mit der VR und auf der Frage, wie die Ausstellung das Spannungsverhältnis, das Neben- und Ineinander von archäologischen Artefakten in den Vitrinen und digital animierten Stellvertretern in Medienstationen und VR vermittelt hat. Die Ergebnisse der Evaluation werden in die Weiterentwicklung des „Virtuellen Trikliniums“ in Wissenschaft, universitärer und außeruniversitärer Lehre einfließen.

5. SCHLUSSFOLGERUNGEN

Das Forschungsprojekt „Neues Licht aus Pompeji“ steht für eine Verknüpfung traditioneller archäologischer Methoden und moderner Technologie. Es zeigt eindrücklich, wie durch die Nutzung digitaler und immersiver Medien eine sinnliche Brücke zwischen der antiken Welt Pompejis und der heutigen Zeit geschlagen werden kann. Diese Schnittstelle eröffnet für die antiken Lichtobjekte eine neue Dimension des Verstehens, das über das traditionelle buchbasierte Studium weit hinausgeht. Die wissenschaftlich fundierte Vorgehensweise und die strengen Kriterien an Rekonstruktion und Simulation gewährleisten eine Präsentation, die sowohl akkurat als auch fesselnd ist. So steht das Projekt „Neues Licht aus Pompeji“ für eine dynamische Plattform, die nicht nur die Vergangenheit neu erlebbar macht, sondern auch den Grundstein für künftige technologiegestützte Forschungs-vorhaben zur Kulturgeschichte der Sinne in vergangenen Gesellschaften legt.

6. DANKSAGUNG

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7. LITERATURHINWEIS

Zur Ausstellung „Neues Licht aus Pompeji“ ist 2022 ein umfassender wissenschaftlicher Ausstellungskatalog [1] in deutscher Sprache erschienen und ein Begleitband [2] in italienischer Sprache.

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“Cultural heritage is our passion”

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ABSTRACT: Originals are the most important asset in information transmission.
Our society is deeply rooted in history, old documents and visual content (manuscripts, old books, old documents, papers and maps, pictures, cultural heritage artifacts, etc.) are emotional testimonies of this heritage, and stimulate people’s feelings and memories. Often, these however remain hidden to the large public: they are either kept in old storage areas that put them in conservation peril, or digitized but hardly accessible due to complex cataloguing systems, sometimes “boring” research interfaces. In addition, many items are described in proprietary systems or file formats. The consequence of this is that today users have to spend a lot of time to understand inconsistent workflow of proprietary retrieval databases or unattractive search-engine interfaces. Thus, there are billions of ancient and modern fragile documents and material preserved in memory institutions worldwide, that offer unique cultural and historical content.

1. INTRODUCTION

The participation in and engagement with culture creates value in our sector and society at large will build a highly accessible service for cultural heritage digitization and preservation which meet the licensing rights and IPR from the various content owners.
The platform will leverage the cutting-edge scientific innovation in machine learning, artificial intelligence and deep-learning algorithms for advanced curation. The long-term preservation of the digital assets will be facilitated by the integration of a format agnostic decentralized ingest platform, capable of handling various standard formats for future access and interoperability.
We want everyone to have the opportunity to participate in digital cultural heritage - to access it, to share it, to enjoy it, contribute to it and be enriched by it. We want to target in this proposal large community of users, including Europeana community, spanning from humanities researchers to the creativity industry, entertainment brokers, archivists,
art historians, graphic designers, bloggers, teachers, students, advertising and marketing, policy makers and the interested public to use valuable and economically driven solutions to facilitate and accelerate the digitization and content sharing process.

2. DIGITIZATION FOR THE FUTURE

As the world market leader in the digitization of cultural assets, Zeutschel have been delivering the highest quality, technologically advanced products to our customers worldwide for over 60 years and we are the driving force in the digitization of cultural assets. Due to these many years of experience and our worldwide history with libraries, archives and museums, we are familiar with the requirements for high-quality digitization . This understanding of industry requirements shapes our product strategy and development. For more than 20 years, our Head of Development & Technology, Mr. Volker Jansen, has been intensively involved with the measurement and evaluation of image quality. In the context of his work, intensive academic exchange at an international level is mandatory. As part of this effort, the internationally recognized UTT test charts were developed and have now found their way into the ISO 19264-1:2021 standard "Photography - Archiving systems - Imaging systems quality analysis - Part 1: Reflective originals". A working group of international experts (ISO TC42 JWG26) developed this standard. In addition to Zeutschel GmbH, well-known institutions from almost all nations (eg Metamorfoze , Danish National Library, Swedish National Archives, Cambridge

University, Library of Congress, Metropolitan Museum, National Archives, Image Engineering GmbH & Co. KG, Laser Soft Imaging AG etc.) are all represented in this working group. As well as the development of general standards, innovative methods of digitization are created as part of this cooperation and exchange.

All scanning and processing technologies should be designed to process the originals gently and in the highest quality and to treat them with the greatest care, to rule out any damage.

The fundamental aim must be to digitize each original only once, if possible, so that the content can be researched worldwide. Therefore, when using any scan system, in addition to the image content, an optimal image quality in terms of detail (resolution, scale, geometry) and tonal reproduction (brightness, OECF, dynamic range, color, noise) play the greatest role. The image quality is not only assessed on the actual image, but also on test charts which are digitized on the system under identical conditions. A software-supported measure of the image quality can then be determined in these scans.

The methods used are described in international ISO standards and relevant technical guidelines. These include the classification of the measurement results in defined quality levels. Subsequent manual correction using image processing should only be necessary in exceptional cases. Therefore, in addition to the selection of the right scanning system, the competence of the scanning employees is key for the optimal results.

The best “tool” is worth nothing if the employee working with it does not have the necessary qualifications, both in operating the systems used and in dealing with archive materials. Due to our work with highly sensitive, historical templates and valuable art collections, knowledge of the principles of conservation when dealing with media of all kinds is a matter of course for all of our employees. One of the most important components for working with cultural assets is therefore the continuous training of employees with regard to dealing with and handling fragile and valuable documents, as well as behavior in the vicinity of archival media. We therefore not only offer these training courses for our employees, but also offer them to all interested parties and create video tutorials on the relevant topics. The final content of these tutorials comes from active participation and regular exchanges with the relevant specialist standard and quality committees.

In addition to well-trained employees the scanning hardware technology used is also key for the "perfect" digital copy - whenever necessary, contact-free processing must be used, which can still deliver the highest possible quality as a result. The photographic process of reprography has proven particularly useful for this and not only offers the advantage of increased quality and depth of field, but with the appropriate choice of perspective, a three-dimensional recording and compensation of the curvature of the original can also take place . Furthermore, the light exposure plays an important role in the processing of light-sensitive originals: depending on the imaging principle, a low exposure is achieved by short sequential illumination or a low illuminance.

Our proposal goes toward the participatory practices, standards, platforms, tools and guidelines best practice recommendations to encourage, stimulate and help communities (private and public sectors) to actively being engaged, participate and collaborate in a digitization and preservation practice.

Building partnership, encouraging stakeholders, private and public institutions to get involved in this initiative also through crowdfunding and crowdsourcing activities, creating networks of users, involving and stimulating various class of citizens to join our proposal is the earth of our project to make it financially sustainable and attractive to the industry too.

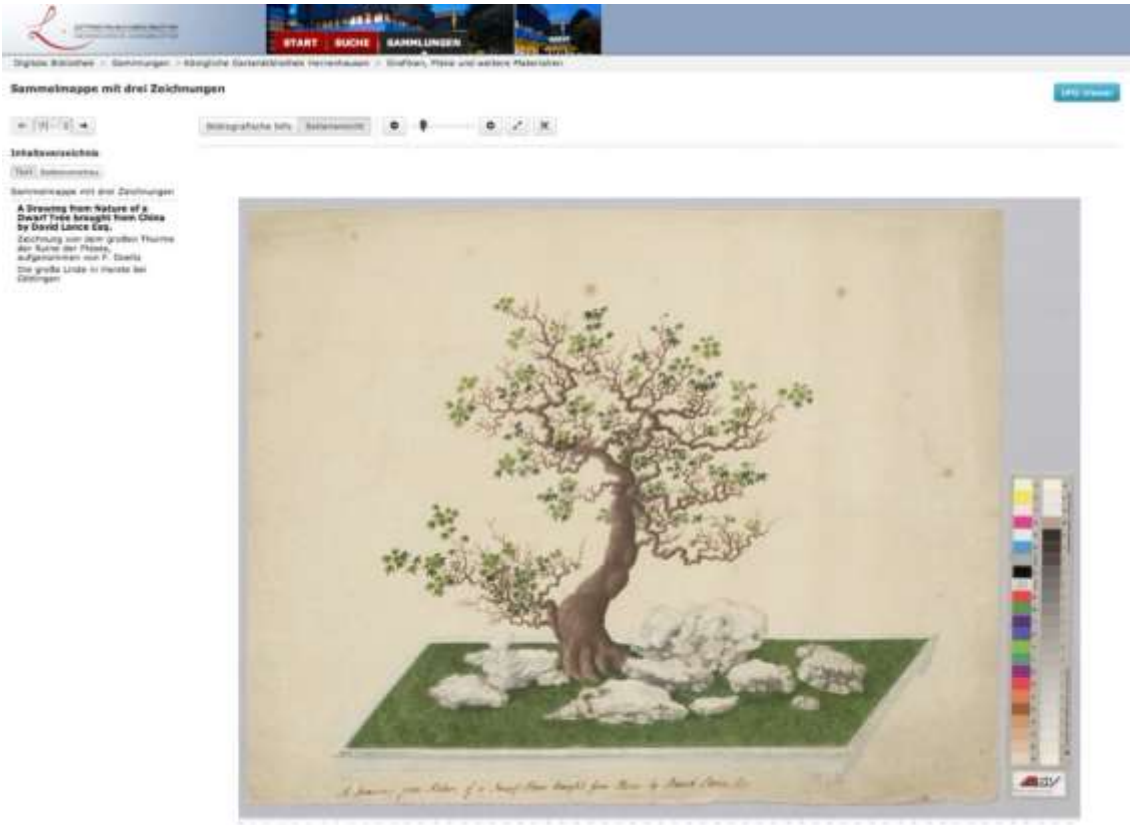
3. CONCLUSION

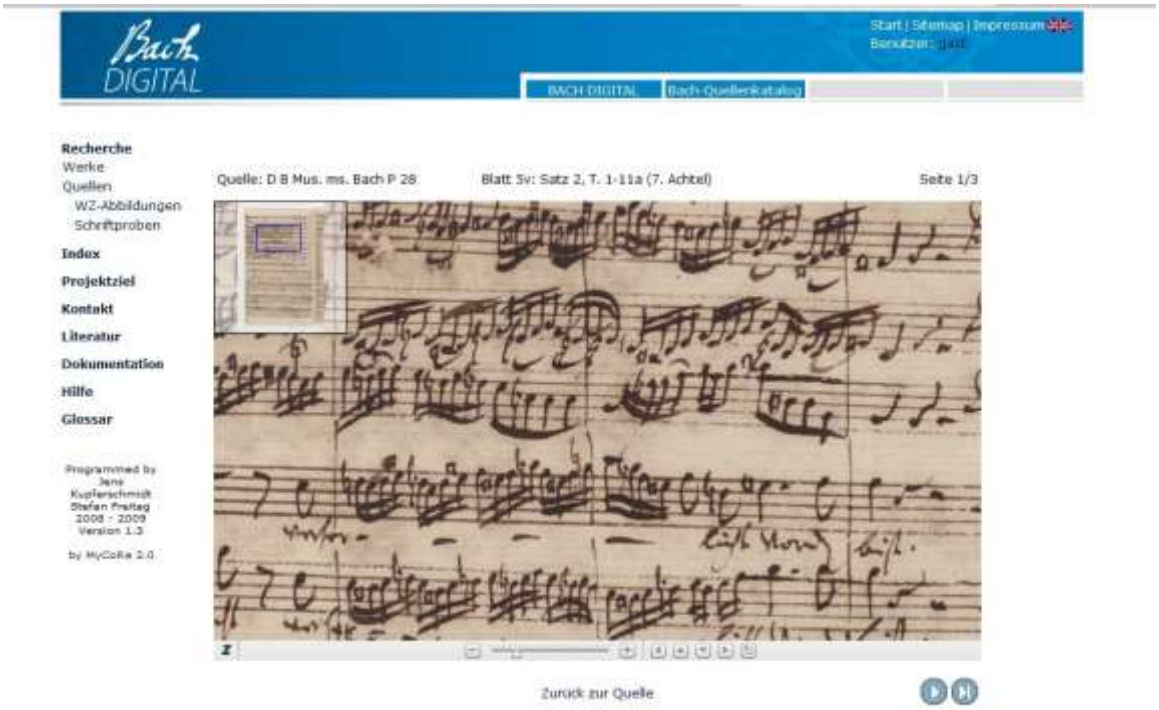
This initiative will facilitate and boost further the aggregation and harmonization of old and new content and will stimulate, facilitate and encourage citizens, private and public institutions to digitize their content in a more efficient way.

The aim it to make more visible and accessible digital content laying in the national repositories, facing obstacles of different catalogue and descriptive schemas, different languages, different organisation of collections and themes for searching. Our approach will work on the digital formats producing new contents and new description and will facilitate the use of these historical valuable contents by

the new social networks approach and mechanisms enlarging extremely the potential user target arena.
All of these points inspire and influence us as Zeutschel in our daily work and we do our part to preserve unique cultural assets and to secure art and knowledge for future generations.

Below some examples of the art work captured through Zeutschel's technology:

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Seite 1/3
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EVA Berlin

EVA Berlin 2023 Conference
30. November – 01. December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Künstliche Intelligenz in Museen – Erschließung von Sammlungsbeständen mithilfe von KI

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KURZDARSTELLUNG: Das Projekt „Künstliche Intelligenz in Museen (KIM)“ wurde initiiert, um in einer Machbarkeitsstudie zu evaluieren, inwiefern Künstliche Intelligenz bei der Generierung von Metadaten in Museen genutzt werden kann. Hierbei wurden gut erfasste Münzsammlungen aus Museen als Trainingsobjekte gewählt, da hier die Digitalisierung zum jetzigen Zeitpunkt schon sehr weit fortgeschritten ist und somit ausreichend Daten vorliegen um die KI erfolgversprechend zu trainieren. Die Demo-Anwendung „Recoinnaissance“ findet zu neuen Digitalisaten die ähnlichsten der bereits vorhandenen Münzen und liefert auf dieser Basis Vorschläge für Metadaten des neuen Digitalisats, so dass die Verschlagwortung während der Inventarisation der musealen Objekte zukünftig effizienter und automatisiert vonstattengehen kann.

1. EINFÜHRUNG

Museen sammeln und bewahren das kulturelle Erbe und verfügen über komplexe Sammlungsbestände mit zahlreichen Kulturschätzen. Dabei besteht die Herausforderung, diese langfristig bewahren und sichern zu können und gleichzeitig für die Nachnutzung zugänglich zu machen. Die Objekt-Digitalisierung sichert den virtuellen Erhalt bei realen Zersetzungserscheinungen. Um die Sammlungs-bestände weiterhin für Forschungs- und Vermittlungszwecke zugänglich zu machen, reicht die Erstellung eines Digitalisats jedoch nicht aus. Es bedarf der Verschlagwortung der Digitalisate, um die Objekte auffindbar und nachnutzbar zu machen. Diese Verschlagwortung ist mit einem hohen Arbeitsaufwand verbunden, da die Informationen einzeln recherchiert und händisch eingegeben werden müssen. Aufgrund der oft eingeschränkten personellen und finanziellen Ressourcen ist dies für Museen kaum leistbar. Aus diesem Grund wurde das Projekt „KI in Museen“ durch verschiedene Partner initiiert, um in einer Machbarkeitsstudie herauszufinden, inwiefern KI bei der Generierung von Metadaten genutzt werden kann.

Für diese Machbarkeitsstudie wurden Münzsammlungen aus KENOM und dem NUMiD-Verbund mit 31 Partnermuseen und Hochschulen als Trainingsobjekte gewählt, da die Digitalisierung in diesem Bereich weit fortgeschritten ist, bei der Metadatenerfassung gleichermaßen das LIDO-Schema (Lightweight Information describing Objects[2]) genutzt wird und somit genügend Daten für das Training der KI vorliegen.

2. HAUPTASPEKTE

Das Projekt wurde gemeinsam durch die Verbundzentrale des Gemeinsamen Bibliotheks-verbundes (VZG) und Dataport AöR in die Wege geleitet. Für die Durchführung des Projekts wurde ein Konsortium bestehend aus dem Landschaftsverband Süd-niedersachsen, den niedersächsischen Museen, der my.worX GmbH sowie der Programmfabrik Berlin gegründet. Hintergrund ist die zunehmende Notwendigkeit Sammlungsbestände in Kultureinrichtungen zu

digitalisieren, die auch von den entsprechenden Ministerien unterstützt und vorangetrieben wird.

Das erkannte Problem ist der Zerfall von originalen Objekten im musealen Kontext. Durch natürliche oder anthropogene Katastrophen und das zeitliche Voranschreiten der natürlichen Zersetzung Originale ist die Digitalisierung ein Hauptaspekt der Langzeitarchivierung. Die Sammlungen müssen digitalisiert werden, damit diese für Forschungs-, Vermittlungs- oder Bildungszwecke zugänglich sind und bleiben. Diese Art der Aufbereitung von Digitalisaten ist manuell kaum zu bewältigen und muss automatisiert vonstattengehen.

Die Projektpartner haben in einem gemeinsamen Auftaktworkshop im November 2022 die Anforderungen und Erwartungen aller Beteiligten Institutionen von KENOM und dem NUMiD-Verbund erfasst. Für die Entwicklung der KI wurde eine Methode der Bilderkennung eingesetzt, mit der die Abbilder der Münzen verglichen und auf optische Ähnlichkeit untersucht werden können. Im Ergebnis liegt eine erfolgreiche Machbarkeitsstudie vor, für die das Demo-Tool „reCOINnAIssance“ entwickelt wurde, welches zu neuen Digitalisaten die Ähnlichsten in der Datenbank bereits vorhandenen Münzen auffinden kann. Aus den Metadaten dieser ähnlichen Digitalisate können Rückschlüsse auf die Metadaten des neuen Digitalisats gezogen werden.

Das Ziel des Projektes ist die Auswertung von knapp 130.000 Objektdatensätzen. Die Vektoren aller vorhandenen Münzobjekte liegen dabei in einer gemeinsamen Datenbank – für ein neu inventarisiertes Objekt werden die zehn ähnlichsten Bilder gesucht und durch deren bereits vorhandene Metadaten Vorschläge durch die KI erzeugt. Das Grundprinzip ist, dass das Neuronale Netz einen Vektor erzeugt, welcher die Eigenschaften des Bildes repräsentiert. Die Distanz aus den Vektoren zweier Bilder stellt dann die Ähnlichkeit dieser Bilder dar (s. Abb. 1). Hierbei gilt es zukünftig noch das Finetuning zu verbessern, da beispielsweise unterschiedliche Hintergründe zweier Bilddaten die Vorhersage als „passend“ erschweren.

***Abb. 1**: Trefferquote der Münzsuche mit KIM [1]*

Das angezeigte Ergebnis kann dann anschließend durch menschliche Expertise interpretiert und schnell ausgewertet werden. Hierbei ergibt sich sogar die Möglichkeit der lokalen Verortung mittels einer Kartendarstellung (s. Abb. 2).

***Abb. 2**: Kartenansicht der Vergleichsfunde [1]*

Das Projekt ist im November 2022 gestartet, Dataport hat die Machbarkeitsstudie durchgeführt und die KI-gestützte Infrastruktur gebaut. Das Projekt endet im September 2023 mit der Übergabe der Abschlussdokumentation.

Der Bedarf einer solchen KI-Anwendung zur Unterstützung der Generierung von Metadaten in Kultureinrichtungen ist aufgrund der Komplexität der Sammlungen hoch. Die Kombination von menschlicher Expertise und KI-Technologie ermöglicht es Museen, die Verschlagwortung ihrer Sammlungen zu optimieren und die Potenziale der digitalen Zugänglichkeit zukünftig voll auszuschöpfen.

3. ZUSAMMENFASSUNG

Die alleinige Digitalisierung von Kulturgütern ist nicht ausreichend, um die Sammlungen nutzbar zu machen. Eine aussagekräftige Verschlagwortung ist erforderlich, um das Suchen und Finden von Digitalisaten zu ermöglichen. Künstliche Intelligenz bietet eine Lösung, um diese Aufgabe auch bei großen Sammlungen bewältigen zu können, wobei die Softwarearchitektur bewusst für die Zukunft gemacht ist.

Im Rahmen einer Machbarkeitsstudie, die in enger Zusammenarbeit mit einem Konsortium aus unterschiedlichen Institutionen durchgeführt wurde, hat Dataport eine wichtige Grundlage für die Entwicklung von KI-gestützten Infrastrukturen zur Generierung von Metadaten geschaffen. Diese Studie wurde gezielt auf die Bedürfnisse der Kultureinrichtungen zugeschnitten und legt damit den Grundstein für effektive und effiziente Arbeitsabläufe bei der Erschließung der Sammlungsbestände, die die Verschlagwortung von Kulturgütern erleichtern und den Zugang zu diesen wertvollen Ressourcen für Forschung, Bildung und die Öffentlichkeit verbessern können.

4. ZUKUNFTSVISION

Der Fokus des Projekts liegt auf Museen, grundsätzlich sind die Ergebnisse aber auch für weitere Kultureinrichtungen, wie Bibliotheken und Archive übertragbar. Die Ähnlichkeitssuche ist auf andere Stempeltyp-Objekte, wie z.B. Scheine, Briefmarken oder Siegel erweiterbar und funktioniert bei großen Bildbeständen am verlässlichsten.

5. DANKSAGUNG

Das Projekt wurde gefördert durch die Stiftung Niedersachsen, die Niedersächsische Sparkassenstiftung, die Sparkasse Göttingen, die Sparkasse Hannover, die Landessparkasse zu Oldenburg, die VGH-Stiftung sowie das Niedersächsische Ministerium für Wissenschaft und Kultur. Herzlichen Dank.

6. QUELLENHINWEIS

[1] Mischak, Lars: Ein digitaler Zugang zu Münzbeständen mittels Künstlicher Intelligenz. Künstliche Intelligenz in Museen Niedersachsen. Dataport Poster Präsentation zur Projektabschlussveranstaltung 08. Juni 2023, Hannover, 2023.

[2] CIDOC Committee (ICOM) 2021: *LIDO Schema* [online]. Online im Internet: https://cidoc.mini.icom.museum/working-groups/lido/lido-overview/lido-schema/ (Stand 2023).

KONFERENZ III | CONFERENCE III

TRANSFORM III

SESSION I

Transformationen | Transformations

Moderation: Univ.-Prof. Dipl.-Ing. Dominik Lengyel
(BTU Cottbus-Senftenberg)

EVA Berlin

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Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Can the Metaverse save the planet?

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ABSTRACT: Latest dire warnings from the UN indicate that there is a rapidly narrowing window to raise ambitions and reach defined targets in combating climate change. City policy makers recognise their responsibility for reducing the heavy toll of cities, worldwide, in generating CO2 and GHG emissions but face intractable problems in leading the way towards a solution. In this paper, I'm suggesting that the answer lies in adopting a policy of 'Building Less is More' to enable our familiar constructed world to be replaced, in part, by a parallel virtual world. The making of this virtual world (or metaverse) as a tool for interaction heralds a 'new dawn', *a different place, perhaps fantastical, perhaps where we assume bodies that are far from human*. Everybody stands to gain from an early entry to the metaverse; in a world that is not on track to meet the goals of the Paris Agreement, it's the impetus for change provided by cities' embrace of the metaverse that can save the planet.

1. HOW IT ALL STARTED

Can the metaverse save the planet? I remember asking this question during the pandemic. At one particular online meeting of Flux Artists (a group of new media artists, 3000 strong from all parts of the world, set up in the UK) I described the metaverse approaching at a speed equal to that of the planet heading towards climate disaster. The collision, when it occurred, would not be an explosion but, more, an implosion when the oncoming metaverse would prevent the devastating impact of the world's temperature exceeding 1.5°C above pre-industrial levels. People clapped. But it has taken further years of thought and research to prove that there might indeed be some mileage in my simplistic view of planetary survival.

2. FINDING AN ANSWER IS URGENT

In the light of the UN's Advanced Version of its first global stocktake (published in September, 2023), finding an answer to my question has an added urgency because the UN's document describes what is a truly damning account of global climate efforts so far:

"While action is proceeding, much more is needed on all fronts…….the Paris Agreement has led to contributions that significantly reduce forecasts of future warming, yet the world is not on track to meet the long term goals of the Paris Agreement……and there is a rapidly narrowing window to raise ambitions and implement existing commitments in order to reach the confirmed target. Achieving net-zero carbon and greenhouse gas emissions requires systems transformation across all sectors and contexts including scaling up renewable energy and phasing out all unabated fossil fuels and ending deforestation." [**1**]

It is significant that, for the first time, the UN has come out unequivocally on the side of *phasing out all unabated fossil fuels.* Previously, at COP meetings, all-country agreement on this point has remained elusive.

But there is precious little else in the report that gives any indication that exhortations 'to do better' will be heeded by all 197 countries who signed the Paris Agreement. However, one key passage in the UN's stocktake, which lays stress on the significant part that cities play in generating CO2 and GHG emissions, does indicate that there's a way out of the current *impasse*:

"The share of emissions from cities is estimated to be 67 to 72% of global emissions when using consumption-based accounting that includes indirect emissions outside urban areas." [**1**]

As a start, in examining the crucial role of cities, I'll turn towards the megacities of East Asia.

3. EMBRACING A VIRTUAL WORLD

In South Korea and China, to alleviate the difficulties of physical communication in ever-growing urban centres, local governments have been motivated to embrace Virtual Reality (**Figure 1**). The result is an 'all or nothing' approach to digital transformation which demands that South Korean workers spend all their working time in a virtual world. For instance, employees of Zingbag, a financial company, no longer need to travel to the centre of Seoul. They work virtually in a 30 storey building, Metropolis, that can accommodate up to 300 people, at any one time, on each floor. Employees working in the same virtual space can immediately communicate with colleagues whenever they want by moving their avatars. They have no need to use phones or e-mail. Instead they communicate by word of mouth. We're told that Zingbag's virtual environment has generated a more motivated workforce with a lower cost of living and a better quality of life. Certainly, in East Asia generally, the idea is catching on [**2**].

Figure 1: *View of Seoul, South Korea, where the ever increasing difficulties of physical communication in a congested city have led to workers spending time in a virtual world.*

By contrast, In the West, I can foresee that individual choice will remain a matter of paramount importance. Here, our adoption of a new post-pandemic work/life balance requires that we are given the option of deciding, for ourselves, how much time we want to spend in a virtual world. I'll call this the '50/50' approach to digital transformation. It heralds the 'Dawn of a New Everything'. In this new dawn, which is already with us in a nascent form, we can anticipate metaverse curators, new media artists and digital architects taking delight in creating *'a different place, perhaps fantastical, perhaps where we assume bodies that are far from human'* [**3**]. *David* Hockney gives us a foretaste of just such a world. In a recent London exhibition he has provided scenes of work and play projected in three dimensions. Although not yet fully immersive, they give some indication of a future virtual world taking shape alongside our normal physical world (**Figure 2**).

For the future, we will see this type of virtual world replacing, at least in part, our constructed physical world where architects and builders are responsible for more and more buildings producing bigger and bigger cities. I think you'll see where this is leading; the construction industry can play a significant part in averting a climate crisis by building less - a paradox, if ever there was one. By encompassing a 'Building Less is More' policy, cities can lay claim to becoming leaders in creating a more sustainable future. Time, then, to look at the full implications of taking such a fundamental step towards tackling climate change.

Figure 2*: In Lightroom's 'Bigger and Closer (not smaller and further away)' exhibition, London, 2023, David Hockney provides first signs of a world where you're in a different place, perhaps fantastical, perhaps with a body that is far from human.*

4. A SYMBIOSIS OF VIRTUAL AND PHYSICAL SPACE

The making of the virtual world (or, metaverse as I'll now call it) is dependent on the development of Virtual Reality (VR) as a tool

for social interaction. As with most technologies, whether VR is good or bad depends entirely on how it's used. In full-dive VR, users should be able to build their own lives as they choose, genuinely interacting with others around them and leading a meaningful and valuable life. This is a future that David Chalmers foresees when in his book 'Reality+, Virtual Worlds and Problems of Philosophy' he suggests that in the not-too-distant future, as our planet becomes increasingly ravaged and overcrowded, people will migrate more and more towards the virtual realm where we will find that:

- *Virtual worlds are not illusions or fictions or, at least, they need not be. What happens in VR really happens. The objects we interact with in VR are real.*
- *Life in virtual worlds can be as good, in principle, as life outside virtual worlds. You can lead a fully meaningful life in a virtual world.*
- *The world we're living in could be a virtual world. (Chalmers doesn't say it is, but it's a possibility he doesn't rule out.)* [**4**]

So, from this we can infer that VR can be much more than escapism; it can be a full blooded environment for living a genuine life in a first class virtual reality. The metaverse can be envisaged as a virtual world where no one spends an entire lifetime; people will be able to enter or exit as they choose. It gives promise of a world that users will apprehend with all their senses, as if they are physically inhabiting the environment and where no trace of the ordinary physical environment remains. To sum up, the metaverse can be described as a virtual world (or system of virtual worlds) in which everyone can spend time living day-to-day lives with many forms of social interaction.

In its current primitive form the signs of an ecosystem of metaverses is beginning to take shape although, as yet, it doesn't come close to realizing Chalmers' forecast of virtual worlds becoming first class realities. However, by 2026, it can be anticipated that 25% of people will spend a few hours every day in the metaverse. Whether for work, shopping, education or entertainment, a nascent metaverse is set to take our experiences online to the next level. Capgemini, one of a number of multinational firms advising companies on digital transformation, forecasts the metaverse giving rise to a new era of collaboration where:

"by replicating an office environment, people can come together in a shared virtual space that can be both informal and formal. Whether to relax in a breakout space or to present at meetings, employees can use their digital avatar to immerse themselves in a new virtual environment with colleagues." [**5**]

In the City of London, for instance, where the pandemic has reshaped the working world, employers are beginning to think about the metaverse's capability to promote not only collaboration but, also, creativity and increased productivity. Often, advised by experts in the field of digital transformation, managements are investigating the benefits of 'digital twins' as a means of transforming ways of working [**6**]. A digital twin is a virtual copy of a company's operations enabling it to insert any potential changes into a virtual version of the business, which then helps the company to identify more efficient ways of working. Approaching a digital twin in this way is valuable as a means of finding out what works and what does not without putting the business at risk. The point I'm making here is that the metaverse should not be viewed as something unknown, happening sometime in the future. The beginnings of a symbiosis of virtual and physical space already has become a reality – 'a new way of everything' that will enable cities to grasp the future now.

5. THE IMPACT OF CONSTRUCTION ON CLIMATE CHANGE

Released at the latest round of climate talks in Egypt, COP 27, the '2022 Global Status Report for Buildings and Construction' found that the sector accounted for around 37% of energy and process related CO2 emissions in 2021. It advised that:

"To reduce overall energy, the sector must improve building energy performance, decrease building materials' carbon footprint, multiply policy commitments alongside action and increase investment in energy efficiency."[**7**,**7a**]

The report also included a 'Global Buildings Climate Tracker' which showed graphically why the sector's performance was so poor (**Figure 3**). There's a big discrepancy between required progress to achieve zero carbon emissions by 2050 (the blue dotted line) and actual progress (the solid blue line) which indicates the likelihood of an ever widening gap occurring by 2050

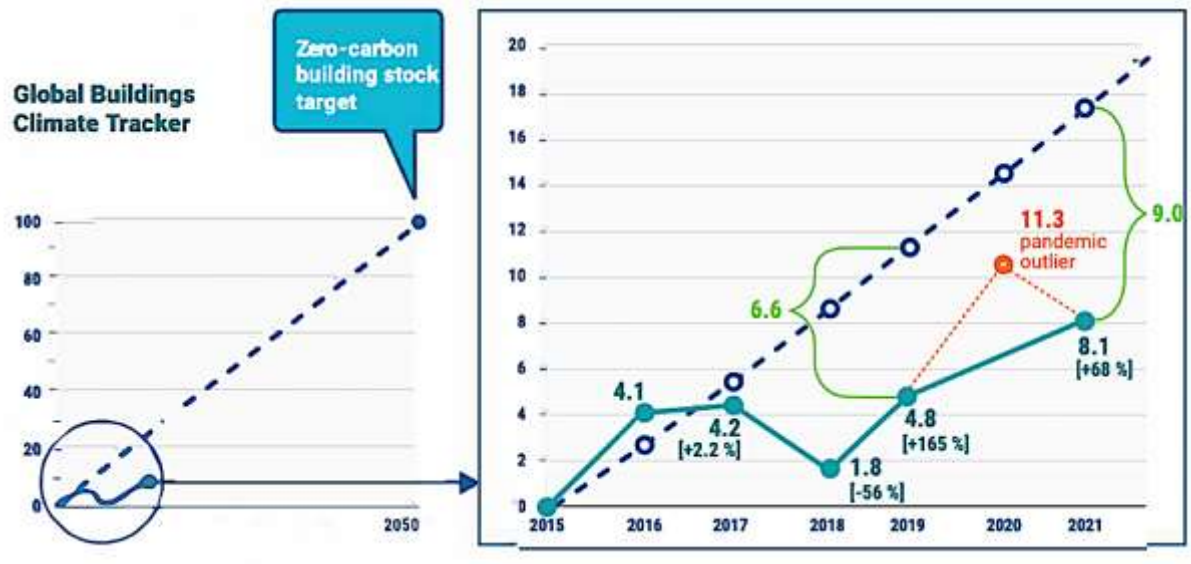

Figure 3: *Global Buildings Climate Tracker extracted from 'United Nations Environment Programme, 2022, Global Status Report for Buildings' reproduced with permission.*
Path to a zero-carbon building stock target by 2050 (left). Period between 2015 and 2021 (right).

Exhortations for the sector to improve its performance don't fall on deaf ears but there is a limit to what the construction industry can realistically achieve – and that limit is fast approaching. Building designers are well aware that the selection of building materials plays a critical part in creating a high-performance building with low operation carbon over time. For example, when designing materials for both new and retrofit construction sites, swapping a concrete based exterior wall system for a bio-based structure (eg. timber or bamboo) can greatly reduce the amount of up-front embodied carbon (as well as the ongoing emission caused by maintaining cooling systems in hot countries). Many ingenious examples of this approach can be found, worldwide, but a change of materials, in itself, will never make up for the overall poor performance of the construction industry in reaching Paris Agreement targets (**Figure 4**)/

Figure 4: *Bio-based structure (timber) is proposed for a social housing project in Milan (architects Diller Scofidio + Renfro and Stefano Boeri Architetti)*

Another, more radical, approach has to be found by giving recognition to a new symbiosis that can be formed between virtual and physical space. Only then can the poor record of construction and the built environment be brought back on track.

6. BUILDING LESS IS MORE

Already, real estate is being reimagined in the metaverse to the extent that it now offers a fast emerging but viable investment opportunity. To make this happen, digital architects are engaged in designing an entire parallel universe that seamlessly connects with our existing one [**8**] (**Figure 5**).

Figure 5: *A virtual self-governed City in the Free Republic of Liberland, a 'micro-nation' squeezed between Serbia and Croatia. No one lives there but according to Patrik Schumacher of Zaha Hadid Architects,* "The time is ripe, technologically, economically and socially, for shifting more and more of our productive lives into the metaverse".

It's a new world that enables investors and owners to create interactive spaces that

facilitate virtual contact between users anywhere. Such virtual real estate investments take place primarily on established metaverse platforms eg. [Sandbox] and [Decentraland], where the skills required to make these early forays into the metaverse involve virtual real estate management, digital architects, metaverse curators, technologists (ie, specialists in virtualization) and, significantly, new media artists to create the look and feel of customized virtual space. All involved bring a cluster of new technologies, including Artificial Intelligence, to bear on the creation and management of metaverse platforms. It's an area where invention constantly sparks invention with the skills and imaginations of all exponents stretched to the limit in giving expression to a virtual life which aims to be as good as life outside in the physical world.

There appears to be much to gain by making an early investment in the metaverse; cities taking the plunge, while having to navigate a number of associated risks, could well find themselves in a position to reap substantial financial rewards as the metaverse gains mainstream adoption in the next five years or so. Moreover, the adoption of a Building Less is More policy, if applied worldwide, could bring us back on track in reaching net zero CO2 and GHG emissions by 2050. By referring again to the UN's Global Status Report for Buildings, 2022, and the Global Buildings Climate Tracker included in that report (**7,7a**), it is possible to estimate the extent of the anticipated shortfall in reaching zero carbon building stock by 2050. This is shown below (**Figure 6)**.

The lower blue line shows how a 'Continuation of current methods for decarbonizing the building sector' ends up at a point in 2050 where only two fifths of the required CO2 and GHG emission reductions is achieved. The dotted blue line shows what has to be achieved by 2050. By adopting a 'Building Less is More' policy, as shown in red, it becomes possible to make up for lost ground. This new and potentially successful 'route to zero carbon' is achieved not only by constructing fewer buildings but, also, to a greater extent, by reduced emissions generated by a replacement virtual world – building l**ess** means gaining **more** from a fulfilling lifestyle in the metaverse.

Currently, the UN's exhortations 'to do better' in *raising ambitions and implementing existing commitments* offer little incentive for people to abandon an existing carbon-heavy lifestyle. A future that demands restrictions on travel and, maybe, a curtailed urban existence seems too dull to contemplate. For many, reluctant to take on the exigencies of climate change, there has to be light at the end of a very dark tunnel – a

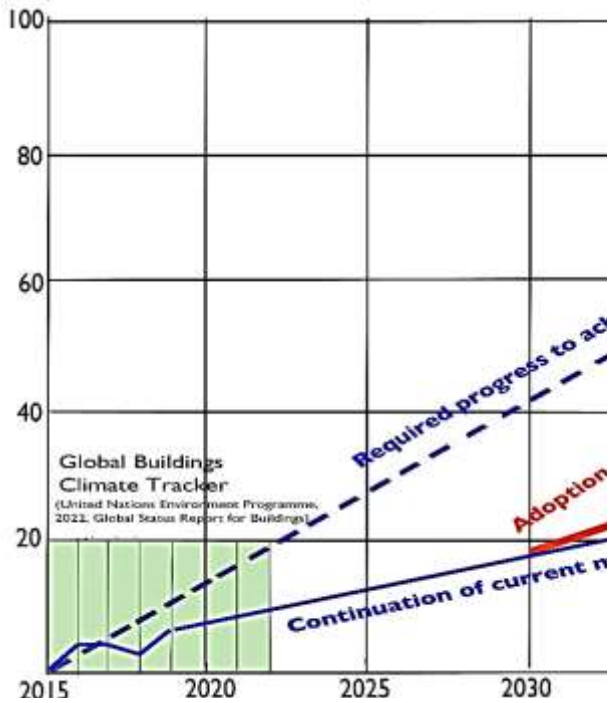

Figure 6. *Route to zero-carbon Taking the UN's Global Building Climate Tracker (Figure 3) as a start point, this revised tracker shows the path to a zero-carbon building stock target extended to 2050 (see lower blue line). As expected, it fails to achieve the required zero-carbon target. By adopting a 'Building Less is More' policy (see red line) the chance of reaching the required target is much improved.*

reason to welcome inevitable and radical change, which I'm suggesting can be provided by a 'new way of everything', a metaverse that gives promise of exciting other-worldly experiences for all, at work and play. The application of such a 'Building Less is More' policy, with all its concomitant benefits, will take some time to ramp up (ie. 2025 – 2030) but, if adopted by cities worldwide, we could expect to see signs of progress becoming evident by 2030 onwards. From then on, the take-up of the idea would need to advance exponentially towards reaching the required target by 2050.

Although non-real estate developments take place primarily on established metaverse platforms (eg.[Decentraland]), cities embracing a partly virtual future have the option of developing their own platform. As with all property development, the location of non-real estate reigns supreme and there is no better location than at the heart of a major metropolis (eg. the City of London, New York or Shanghai). In these 'superstar' cities, all hubs of commerce and centres for culture, companies and institutions from all parts of the world will be ready and willing to establish outposts which provide both virtual and physical connections. In the case of the City of London, this hybrid approach to development can be expected to both attract people back and appeal to new users. This is why I'm urging the City to take a long hard look at a way ahead that appears, at first glance, to be 'blue sky' but, on closer examination, offers a creative way of animating a 'destination city' (**Figure 7**).

Figure 7: *AI sketch by the author showing a [London Wall] platform for virtualization (ie. the City's own [Decentraland]). It will provide access for commercial and cultural organizations from all parts of the world to experience the City of London as a global hub of commerce and centre for culture.*

Before plunging into a virtual world, city policy makers worldwide will need to be confident that the carbon footprint of constructing non-real estate will represent a significant improvement over the carbon cost of physical construction. It's a subject surrounded by confusion, which is not helped by the arcane language used to describe the processes involved.

7. THE CARBON FOOTPRINT OF VIRTUALIZATION

The high quantities of energy involved in 'minting' NFTs (Non Fungible Tokens) has sent up alarm signals regarding the unsustainability of virtualization. Only a few years ago NFTs were notoriously expensive to produce in terms of energy because the mechanisms used to create them relied on a computationally costly system called 'minting', where blockchain technology, essential to the creation of metaverses, produces unique pieces of data associated with photos, videos, audio and other types of media. NFTs come in the form of avatars, artwork, music, digital creatures and HTML code, as well as plots of land in virtual worlds like [Decentraland]. Further, most NFT minters opt for the Ethereum blockchain, which requires computers – 'miners' - to take turns guessing answers to increasingly challenging mathematical problems. The key point here is that the Ethereum blockchain, representing an industry worth $195 billion, recently has made a 99.95% cut in its absolute energy use. Overnight, the sustainability movement, which previously had ignored or deplored the virtual world, recognized that it now represents a *'pixelated escape route from fragile earthly reality'*[**9**]. More than that, it might offer the only feasible escape route to a future sustainable planet.

The metaverse will continue to need very high resolution pictures, which will boost energy use even further. But, now, these increases can be achieved without compromising sustainability targets. Etherium has led the way and, now, other data centres are planning improvements in energy use that will enable them to become more environmentally friendly. Meta has committed to achieving net zero emissions by 2030. Microsoft has pledged to run its Azure cloud platform entirely on renewable energy by 2025. For the future [Decentraland], a virtual platform based on Ethereum, will be able to rely on green, clean and renewable energy. Such radical, immediate impacts on energy use can be made in the virtual world because the data on which these reductions depend are concentrated in a relatively few centres; their carbon footprints are readily identifiable. Whereas, in

the construction industry, the opposite applies; sources of high carbon emissions are located in millions of separate sites, worldwide, which explains, in part, the construction industry's dismal record in meeting sustainability targets.

8. THE CRUCIAL ROLE OF CITIES

Cities have an increasingly important part role to play in reducing CO2 and GHG emissions because, as the UN has recognised, they are mainly responsible for producing these excess gases in the first place. There's every reason for cities worldwide to acknowledge their responsibility by leading the way forward towards a solution.

The UN's assessment of cities' overall toll in generating emissions (67 - 72%) can be accounted for, in part, by the toll of the Buildings and Construction sector – see Global Status Report 2022 [**7, 7a**}. At 37%, this accounts for approximately half of cities' emissions. It comes as no surprise, therefore, that other multiple causes of emissions generated by industry (from energy use and fugitive sources), on-road transportation, railways, aviation, waterways and waste disposal, bring the total toll to around 70%. Stationary energy, as used by all these separate sectors, is one of the largest contributors to GHG emissions which, if controlled, can achieve significant emission reductions. (A stationary energy storage system can store energy and release it in the form of electricity when it is needed.) In China, for instance, where stationary energy predominates in cities with a large industrial base, Shanghai, Suzhou, Dalian, Handan and Tianjin have all succeeded in making significant progress in mitigating GHG emissions. Although such opportunities cannot be replicated to the same extent in the West, where cities have a less significant industrial base, this doesn't alter the fact that cities worldwide, by reducing emissions, can be expected to exert a fundamental impact on driving forward long-term sustainability.

The virtual world, apart from replacing, in part, the need for physical building, will have a knock-on impact on other sources of emissions. We can anticipate that lifestyle changes, occurring as a result of adopting a Building Less is More future, will be reflected gradually in the physical makeup of cities. It will take time but we can expect to see, by say 2030, clear signs of reduced emissions from institutional and commercial buildings, on-road transportation, railways, aviation and waterways. Additionally, some people who fled to the countryside during the pandemic have not returned. Is it too much to be expected, therefore, that the anticipated exponential growth of cities might be halted? Current predictions indicate that, driven by rural migration and overall population growth, 68% of the world's population will live in urban areas by 2050, compared to 55% today. Such an increase will negate any profound effort aimed at reducing the share of emissions from cities. Local governments and national governments can do much to encourage a return to pre-industrial rural living to produce fewer CO2 and GHG emissions; for many people, this migration away from urban settings would signal an improved lifestyle.

9. TAKING A LEAP INTO THE FUTURE

Technological developments, over the next 5 to 10 years, will enable city policy makers to give close attention to the nature and quality of their metaverse portfolios. The aim will be to ensure that, in a virtual world, people can experience a feeling of presence: "*you will be right there with another person in another place*"[**10**]. As far as possible, our interactions in a metaverse should replicate those we experience in our current daily lives by:

- making speech the main option for communication
- generating a sense of immersion encompassing not only Virtual Reality (VR) but also Augmented Reality (AR) and a mix between these and other forms of reality (XR)
- creating a level of embodiment where we can use our hands to manipulate digital objects and engage with a 3D virtual environment (**Figure 8)**

Taking a leap into the future requires that we should first define what to expect from a metaverse before pursuing the difficult path of making it happen. What I'm describing in this paper is not a one-size-fits-all metaverse, as I think Mark Zuckerberg might have anticipated when he changed the name of his company to Meta, but instead, a series of many separate virtual worlds all dedicated to meeting individual aspirations, where you can be in a *different place, perhaps fantastical, perhaps where you can assume a body that is far from human.* Entering such an environment for the first time will involve a process of re-worlding.

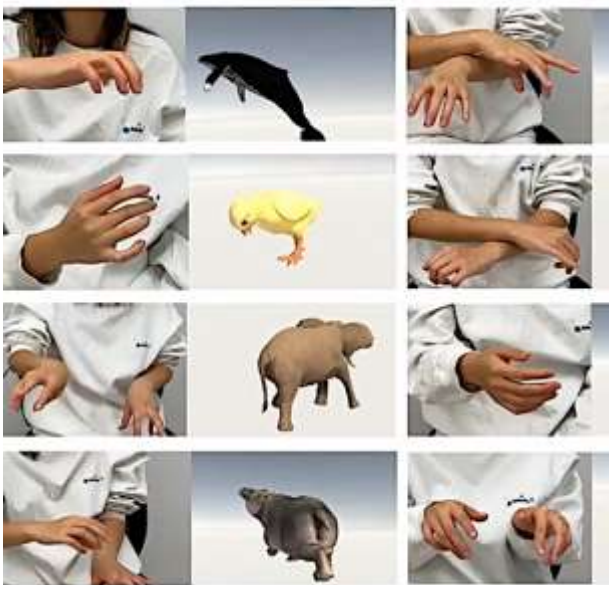

Figure 8: *Users can already gain a strong sense of embodiment in a virtual world when they control 'humanoid' avatars with their hands. (Tsinghua and Carnegie Mellon Universities).*

"Re-worlding in VR depends on the possibilities that the virtual world allows you to experience, both a feeling of social presence (the sensation of interacting and sharing the same experiences with another avatar) as well as a perception of control (degree of synchronization between user – avatar - virtual environment), both conditions mediated by the code and computing capability of the VR device with which you are accessing the virtual environment." [**11**].

For some organisations and cities not all will be new and unfamiliar in the metaverse; those that already have created a digital twin as a way of managing risk will find, in the virtual world, a way of extending an already established activity into a fully immersive 3D mirror, enabling them to test, ahead of time, the potential benefits of change. For people, at work or play, choosing to make a partial transition to the virtual world, the success or otherwise of their experiences will depend on the skill demonstrated by metaverse curators in meeting users' needs for easy access, collaboration and well-being.

All the components that will make a metaverse are almost in place. Finding the glue that will hold them together will be the key to creating a future where an ecosystem of metaverses becomes a 3D elevation of our current online world - an outcome where we can expect to encounter a more intuitive and productive way of communicating ideas. For those creating this new virtual world, there's now a Pandora's box of technologies available for producing and presenting ideas for virtualization. However, advanced technology, in itself, will never be enough; it will require art and technology to be woven seamlessly together to make the virtual world a place where we want to be [**12**]. Then, we can anticipate that all our lives will be altered forever by a mix of electromyographic sensors, volumetric holographic displays, immersive headsets, projection and tracking cameras and many other technologies still under development that collectively will provide support, stimulation, and simulations never before possible [**13**].

10. NEW PROBLEMS, NEW SKILLS

As technologies are developed, which are capable of extending processes of digital transformation into a virtual world, success will depend, as it does in the physical world, on paying close attention to the well-being of people. In creating a metaverse, people's needs must be kept firmly in mind by the metaverse curators, digital architects and new media artists involved. Together, they have a god-like part to play but must ensure that a tendency for capriciousness (a common trait in deities) is replaced by respect - respect for people's freedom of action and ability to carry out their tasks effectively. Further, all the various creators of virtual worlds must remain constantly aware of people's differences and the multiplicity of their needs to ensure that:

- The adoption of a 50/50 approach to digital transformation enables people to feel as **comfortable** in the virtual world as in their more familiar physical environment. (It's

through giving close attention to ergonomic factors that comfort can be achieved.)

- A sense of order emerges from the expression of **diversity** in the virtual world, where many new opportunities for the expression of differences will exist - for instance in people's choice of avatars.
- A freedom of expression is available in the virtual world, which **compensates** for time spent away from a more familiar physical world. (Experiences of flying and teleportation can add excitement and a sense of everyday adventure, far exceeding anything available in the physical world.)
- **Communication** via speech is the first option in the virtual world with less reliance on emails, text messages and written posts on social media as in the physical world.
- A seamless transition between the virtual and physical worlds enables effective **collaboration** with colleagues not only locally but, also, throughout the world. (Control of entering and exiting the virtual world is in the hands of all personnel via a range of VR devices.)
- An organisation's extension into the virtual world is seen as a way of contributing to people's **self-esteem** as they make their own way into a new virtual world, which offers extraordinary opportunities for self-actualization and advancement.

Attention to all these issues, social, behavioural, technological and psychological will enable people's fear of the unknown to be tempered by the 'intrinsic rewards' they gain from experiences in the virtual world. No two metaverses will ever be the same. Metaverse curators, responsible for processes of digital transformation, will find they have to delve well below the surface of their client organisations (cities, companies or institutions) to obtain a clear set of objectives, before translating these into a metaverse.

But, who are these metaverse curators; although I've used the term throughout this paper, as yet, they exist only in name. Once discovered as real people, I see their future role extending the word 'curating' to cover not only the content of a virtual world but also its impact on people from a behavioural and psychological point of view. No simple task but new problems require new skills and it's the role of the metaverse curator which will ensure that life in a virtual world can be as fulfilling as life outside in the physical world.

11. CONCLUSION: THE VALUE OF CONJECTURE

My suggestion that the metaverse offers a way of stemming our seemingly unstoppable drive towards climate disaster must be regarded as a conjecture - a conjecture which provides a gleam of hope that we can counteract the UN's gloomy predictions. The current dire performance of the global construction industry in reducing CO2 and GHG emissions pinpoints the need for radical action – action as proposed in this paper for cities, worldwide, to adopt policies of 'Building Less is More' where building **less** means gaining **more** from a fulfilling life in the metaverse.

When Bill Gates, in his book 'How to Avoid a Climate Disaster' [**14**] tells us that to find a solution *we'll need biology, chemistry, physics, political science, economics, engineering and other sciences*, he's missing out the other 50%. What is now required is a way forward where the two great ways of knowing, understanding and discovery - art and science - become harnessed together as never before. A blurring of the boundaries between art, the humanities and science has been happening for the last 50 years or so to the extent that, now, a 'code of the collective', as George Steiner calls it, is poised to create a 'new way of everything' [**15**}.

If my conjecture has validity, the spark for collective action will be ignited by cities, worldwide. As prime generators of CO2 and GHG emissions, some cities already have acknowledged their responsibility for leading the way forward, but it won't be easy. Far from it; as Jeremy Green, a developmental biologist explains:

"It is precisely the limitations of what a model or conjecture can do that gives it value. If you cannot make your model match the data, one of them must be wrong and you have something to learn. The process of bridging that gap provides the value and excitement of new discovery."[**16**]

I can see that, initially, a collective approach might not be completely successful in tackling each and every aspect of a process which, inevitably, must change our lives forever. However, with adjustments to the conjecture as work proceeds, a policy of 'Building Less is More' holds promise that, **in a world that is not on track to meet the goals of the Paris Agreement, it's the impetus for change provided by cities' early embrace of the metaverse that can save the planet.**

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The Agency of Image in an Age of Urban Re-Imagination

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ABSTRACT: This essay delves into the multifaceted realm of visualization for Urban Design, presenting cities as intricate canvases of boundless opportunity and perpetual evolution. Acknowledging the imprecision within a diffuse context, the essay emphasizes the value of rendering in both localized and broader urban conditions. Specifically, it contends that perspectival image-making frequently deployed in singular architecture and landscape design commissions should be appropriated to address urbanism at the scale of entire cities.

Traditionally reliant on objective tools, contemporary urban conditions challenge urbanism to adopt more nuanced and responsive visual representation. Digital tools, mainly 3D modeling and rendering, empower urban images that go beyond physical truths to reveal conceptually enlightening meaning. These images capture the intricate interplay of scales, engaging diverse audiences and transcending linguistic and cultural barriers.

Images serve as a universal language, inherently open to various interpretations. The dynamic nature of urban development accommodates the potential for compelling images to play a pivotal role in shaping perspectives, influencing decisions, and documenting changing cityscapes. As society grapples with numerous complex challenges, the image emerges as a powerful tool to convene experts and amateurs, fostering collaboration and dialogue. The development of urban images, a nuanced process involving historical research, interpretation, technological advancements, and strategic sharing, becomes indispensable in shaping perceptions and fostering understanding as cities evolve.

1. INTRODUCTION

The past generation of urbanization has led to a baffling paradox. Cities have developed clear identities without ever establishing legible plans for landing on them. In effect, cities have become the way they are through a combination of external circumstances, intuition, and naïveté. At a macro level, heritage cities like New York, Paris, and Tokyo remain largely static. Of course, development happens piecemeal, but the past three decades of urbanization in established cities have been akin to an eclectic process of coloring within the lines rather than wholesale urban redefinition. Even new cities (Shenzhen, Dubai, Las Vegas) exist as a proliferation of an identifiable unit across one or several lengthy urban spines, thus expanding without truly maturing beyond their initial identity. Even the most heavily planned cities, Beijing, for instance, exhibit a sense of unnerving contrast when trying to negotiate the disassociations arising from the juxtaposition of old and new. However, urbanism can no longer shoot from the hip. In the wake of a global pandemic, all while numerous societies are

negotiating how to arrive at spatial equity, and somewhere along the course of a global climactic crisis, urbanists are focused on re-imagination. It is necessary to ponder how did our cities get here and how we may point them in the right direction.

Let us start with the duality between process and outcome. If we consider this moment in history, especially in the field of Urban Design, examining this dialectic between the practice and product holds immense value for the future of our world and society. One does not need to think hard to trace the many issues of our day to 20th-century urban outcomes. For example, one particularly noticeable artifact of 20th-century development is automobile-focused urban formations that tie large populations to the continuous consumption of fossil fuels. If you need a car to navigate the city, then why not live large in a house of your own? Parking to house those cars? Sure, we can have that too, even if it means using space that would better house people in need or simply leaving it empty to preserve the natural environment. The multiplying effects of this lifestyle-guided urbanism are unbending and ripple over history from the American dream of a benign picket fence to an excess of single-family homes, followed by a sub-prime mortgage crisis-induced global recession, and landing finally with our current generational cost of living conundrum.

While most existentially pressing, the warming climate is only one of society's many concerns. However, as seen in the line of consequences above, outcomes of specific urban design directions lead directly into other areas of imbalance in addition to climate - namely, society and economy. Addressing these three areas of concern requires expertise in disparate fields. Nevertheless, recognizing their interconnected nature does not require deep familiarity with either. The following question emerges: how do we create space where inherently different yet related issues are addressed in coordination?

Cities are the setting where issues compound to the most considerable degree. Climate vulnerability, hollowed-out urban cores, heritage building, and suburbanism are but a few arenas where the challenges facing our natural, social, and economic environments face off in the urban realm. It is natural for urbanists of the moment to ponder if something went amiss during the prior urbanism, planning, and design processes that yielded the frameworks for today's cities. On the one hand, we should not deride the decisions of past times without acknowledging the gift of our twenty-twenty hindsight. However, much work still needs to be done for a better future while the margin for error seems ever-limited relative to generations past.

The world's population will continue to grow, estimated at another 2 billion people over the next 30 years. Most of that growth will center in and around cities. Granted, we are already amid unprecedented global growth as we toil to handle present challenges and look blearily forward to an uncertain future. It is both pragmatic and productive to consider how we envision the ramifications of our urban design decisions better to accept responsibility for future outcomes in our present moment.

Figure 1: *Rising Tides and Towers, San Francisco, Alex Yuen and Dylan Gibbs*

2.1 THE COMMONALITY OF IMAGE

The *image* has forever been at the center of urban design. To enact urban aspirations, one must first visualize them. This precise role has been central to the activities of designers (architects, landscape architects, and, since the second half of the 20th century, dedicated urban designers). The images these groups produce,

usually at the behest of a fee-paying client, are then used to galvanize support, marshal resources, and unlock authorization for the project to proceed.

Modernism mobilized the image to highlight progressiveness in the design fields. Filling a need for built environments that could unlock new ways of life in the wake of both World Wars, in addition to the practical need to reconstruct environments destroyed through conflict, the architectural wing of the international Modernism movement saw an opportunity for a novel future for cities. Led by such genuinely innovative minds as Le Corbusier, Frank Lloyd Wright, Oscar Niemeyer, Kenzo Tange, Peter and Allison Smithson, Fumihiko Maki, and many others, the broad coalition of architects and urbanists developed a vast array of responses to the fundamental need of the mid-century moment. Central to the movement was establishing urban pieces and wholes that uplifted the human condition for a more stable, functional, and comfortable society. Corbusier's sketches for the Parisian *Plan Voisin* were bold in their architectural moves but nuanced in depicting new lifestyles supported by transformative urban operations.

Figure 2: *Perspective for a Plan Voisin, Paris, Le Corbusier, 1925*

Now, we find ourselves decades into the 21st century, having experienced many benefits of the modern city. Nonetheless, an increasingly popular and appropriate critique of Modernism gathering in the movement's wake is its impulse to deploy the image to demonstrate novel and exciting outcomes above all else. Many modernist plans were agnostic or ignorant of the underlying cost of supplying such grand visions. Of course, financial cost is usually most immediately consequential for any project's stakeholders, such as the client, investors, and the government. However, what is quickly coming into focus, although it has been forever evident, is the inherent complexity involved when operating at the scale of the urban design project (as in any large building, open space, or master plan). In such cases, stakeholders are as numerous as those who will visit the site over the project's lifespan, taxpayers affected by the project, and groups living in the margins and excluded from any decisions that still affect them. Furthermore, an ever more critical anthropogenic perspective would reveal the cost of pouring tons of concrete, sealing over acres of permeable land, and requisitioning steel from a continent over to have an effect well beyond the human population of a project's immediate surrounds.

Urbanization is our species' largest project. It is multi-scalar and multi-dimensional. It has no singular author but endless participants who shape cities, suburbs, and landscapes. This diverse cast of characters frequently inhabits the very spaces they collectively shape. This natural irony often influences the actions taken on the city, making them highly personally motivated. Given the pluralism of perspectives, experiences, and outlooks that affect how a city changes, where do we find common ground? Urban design is a contested art, but convening power is imperative to unite disparate actors and create progress. Thus, we return to the image for its ability to attract a broad audience, galvanize energy around a condition, and synthesize disparate considerations through a common perspective.

2.1 DEFINING IMAGE

Designers are adept at creating a host of image types, including drawings, renderings, diagrams, and sketches. Specifying the role of different image types and their agency towards depicting urban conditions seems critical.

Drawings are a designer's primary professional instruments of service. All drawings are images, but not all images are drawings. Specifically, drawings are vector-based and have been since the dawn of the architectural profession and continue to be so after the near complete adoption of digital drafting within the industry. In a vector image, two points form a line. Multiple lines represent walls, windows, columns, and doors. The organization of these elements constitutes a building. One may represent cities through an analogous visual

hierarchy, with each element shifting in scale downwards while maintaining a consistent relationship between the individual parts and the combined whole.

Drawings are generally produced orthographically - as two-dimensional representations of physical space. Plans, sections, elevations, and axonometrics utilize parallel projection. In such drawings, no lens length and resulting foreshortening of the subject's dimensions would arise from any distance between the viewer and the object. We all perceive the world in perspective, but these drawings serve a critical function by unambiguously representing spatial relationships between elements. By removing perspective, parallel drawings render a space objectively. As such, they often serve as legally binding documents like construction drawings and urban plans. In such cases, drawings are not up for interpretation.

In addition to the traditional elements of a drawing set, designers have often produced perspectives. These images depict the experience of space. They reflect how one would perceive the area or object the parallel drawings illustrate. Those with a good hand can draw or paint these perspectives, and many contemporary designers continue to do so. If done precisely, this involves establishing a horizon line and vanishing points followed by a series of construction lines forming a perspective grid.

Like many aspects of life and work, the introduction of the computer to design changed the game. Digital software now allows for the construction of perspectival views of an object instantaneously. 3D modeling software, such as Mcneel's Rhino, has become ubiquitous in the design professions. Such programs add a third dimension to the act of 2D drafting. Points still form lines, and lines form shapes. However, now, one can extrude, loft, or pipe shapes to create objects with depth and volume. In order to view these objects in three dimensions, the computer calculates a perspective and translates the view to the screen. The designer can exert complete control over the angle and lens length of the view. Moving quickly from parallel to ultra-wide angles, desk-bound designers have an omnipotent telephoto setup that any photographer could only fantasize about deploying in the field.

Figure 3: *Urban Isolation on a Slope, Hong Kong, Yuen and Eric Lee*

While the adjustable lens-length attribute is a default function of design software, it has opened up a new possibility for perspective to feature prominently in work of many scales. The primary consequence of this feature is the proliferation of computer renderings. Unlike a vector-based drawing, a rendering is a raster image, meaning it is a series of dots, each of which is a single color, that compose a larger image when assembled. Where a drawing tends to be rational, a rendered image can exhibit emotion, tone, and attitude.

Paradoxically, computers produce raster images in a hyper-rational manner. Parallel to working with the geometry and camera in the software, objects receive assigned material attributes, and light sources are established in the scene. In combination, material, light (or a lack thereof), and perspective create elements in a visual formula that the computer calculates. Light emitted from the included sources bounces off objects in various ways depending on the geometry and its material qualities (matte, reflective, translucent, red, baby blue) before a virtual lens receives it. This process is all handled digitally through a multitude of calculations. The computer then collates the results into rendering, translating digital values into the character of the image's pixels. The whole endeavor aims to emulate how lenses, from cameras to the human eye, would perceive the scene if it existed in the physical world.

The world primarily regards renderings as objects of outcomes. Consider when a designer receives a commission to design a building, a park, or an urban plan. Their mission is to deliver a vision, and while they will spend weeks, months, or even years ideating, sketching, modeling, and workshopping internally, the first public outcome is a rendering of what the project will be. The rendering may result from a dirty process of back and forth, breakthroughs, and failures in the design process. However, it symbolizes the clarity and coherence necessary for pushing the project toward realization. It also often exists alongside a set of objective, parallel-projected line drawings - plans, sections, diagrams, and details - that deconstruct projects into comprehendible segments that are, in turn, shared with consultants, contractors, and municipalities for comment and refinement. And yet, it is the perspective image that the project relies on to receive approval, either from a broad public or, in many cases, from a narrow group of power holders seated in corporate or governmental authority. In the high-stakes game of building big things, the right image can authorize a project, while the wrong one could be a death knell.

There is a good reason why the rendered image is well suited to sell a project. Plans and sections are not intuitively legible to vast swaths of the public. On the other hand, the viewer does not need training in reading raster images, for this image type reflects how the non-disabled already perceive the world with their visual senses. However, the rendered image's adopted role as a marketing tool has negatively affected its perception. Renderings are manipulatable, unlike line drawings, which are measured and drawn to scale. They are susceptible to editing or blurring when depicting attractive but less truthful renditions of the work may be advantageous. In a typical case of urban airbrushing, it is not uncommon for a junior designer to receive direction from the powers above them to make a building look slimmer by stretching its proportions in the rendering despite such measurements differing from construction drawings, which dictate the appearance of the eventual real thing.

In the era of widespread computer adoption, design faces a challenge: 3D modeling and its accompanying rendered images lack the tactile friction that was once inherent in traditional design processes. Through software, designers assemble form without consideration of mass or gravity. Designers swiftly assign materials to space without considering cost, availability, or sourcing. Moreover, everything can then be beautified in post-processing through the immeasurable capabilities of Photoshop. The rapidity and intensity of deadlines prevalent in design culture and business curtails the ability to produce methodically as projects reach the finish line. Subsequently, choices made during final design sprints often yield images that overpromise outcomes and under-consider the real pressures facing the space the image depicts.

Figure 4: *Tokyo Alley, Nana Komoriya*

Architectural representations, whether in drawings or digital renderings, introduce a complex interplay of truth and artifice. While capable of concealing flaws or presenting an idealized version of a project, these depictions often focus on showcasing polished, perfected states. This motivation is stereotypically at the politician or developers's behest and the taxpayer's expense for the largest of works. The prevalence of lens flares, reflections, and other embellishments in 3D renderings can be perceived as artful strategies to divert attention from design shortcomings, providing momentary satisfaction without thoroughly examining spatial considerations.

A "post-digital" movement has emerged in response to these pitfalls, reasserting the importance of drawing in architecture and related design fields. However, this self-referential trend poses limitations to design's audience and is principally a reaction against the perceived technocratic nature of digital rendering tools. This rejection may stem from the steep learning curve associated with digital rendering, reflecting broader insecurities within design disciplines regarding the representation of their work and the value they contribute. However, it also comes at the wrong time, when advances in hardware and software make rendering faster, easier, and more accessible. Concurrently, the proliferation of screens and the explosion of social media has yielded a rapid transformation of society writ large into one thirsting for visual stimulation. The design community must be cautious of movements within the design fields to abandon the responsibility to represent experiences, whether due to post-digitalism or the disruptive consequences of generative AI. It would be hard to recoup agency once such a responsibility is abandoned.

Figure 5: *Seoul Essence, Madison Kim*

2.2 REPRESENTING THE CITY

Distinguished by its unparalleled scope, Urban Design is an unparalleled discipline, uniquely poised amidst design fields. The city, conceived as an intricate and boundless creative endeavor, epitomizes a project of limitless complexity and perpetual evolution. Unlike a specific design intervention, urban action requires a perspective acknowledging the imprecision of operating within a diffused context. Where the act of rendering seeks out idiosyncrasy at localized scales of design, the technique remains equally valuable when studying and, in turn, presenting broader conditions relative to the subject of the urban condition.

Cities are recognizable. We live in them. Without knowing them formally, we become intimate with them through the developed familiarity of the quotidian. In the case of certain cities, we first experience them in film and social media before ever stepping foot within their physical limits. They each have an uncharted character, a look and feel, a way of being, and an essence that is impossible to document precisely. In 1960, one man attempted to create a framework for urban legibility when American Urbanist Kevin Lynch detailed what he called *The Image of the City* in a book of the same name [1]. Lynch recognized that cities have identifiable features that structure their experiential qualities. The

clarity of this structure defines a city's ***imageability***. Lynch acknowledged the five key elements of imageability: paths, edges, districts, nodes, and landmarks. Nevertheless, this structure for urban understanding had limitations that related directly to how Lynch represented the cities he was studying.

Kevin Lynch was an urban planner who studied imageability through plan drawings. Critically, for the time, such elements could be mapped on a city plan without advanced graphic techniques or tools. To this day, mapping remains an invaluable arrow in the urbanist's quiver. The advent of GIS, or Geographic Information System, enables the layering of spatial data sets. When deployed effectively, the technology offers potentially transformative insights into the geographic interplay of apparent or latent urban features. However, the scale and perspective of such maps are suited to document circumstances rather than conditions. Like the measured drawings introduced prior, maps are vessels for representing objective data but are not suited for projecting nuance, tone, and atmosphere. While high-level urban decision-making and strategy benefit immensely from light cast on such circumstances through critical cartography, understanding the experience within a given space around such considerations is at the essence of everything related to the urban.

Urbanism has traditionally favored objective tools such as maps, diagrams, and drawings, eschewing rendered, perspectival images. Historically, urbanists have needed to simplify the complexity of cities into legible mediums due to the immense scale of urban environments and the limitations of analog tools. However, the unmistakable vastness and dynamic nature of contemporary urban subjects introduce a paradox in representation. After acknowledging the impossibility of perfectly encapsulating something as large and ever-changing as a city, a liberating realization arises that perfection is not a requisite. Instead, authors can redirect their focus towards distilling spatial conditions into visual composites, allowing for a more nuanced, alluring, and responsive approach to capturing the essence of urban landscapes.

In contrast to dynamic and uncontrollable cities, specific architecture or landscape commissions demand representational techniques bound by the project's scope. When addressing a stand-alone design project like a new building or public space, visual representation must take the viewer from zero to one. That is to say, the designer deploys tools to manifest a space for an audience that has only existed prior as an idea in the designer's mind. The image inherits an understood physical, cultural, or social context when engaging with the city. The image does not need to tell the viewer that Bangkok is tropical, Sydney is by the water, and Cairo is dusty before encountering it. While the scale of the urban subject is immeasurable, depicting these cues allows the author to engage with a city's design amid its unceasing transformation. Doing so is also an act of documentation and research with an element of empathy. Developing synthetic urban images requires a keen awareness of the situation beyond what is already popularly understood.

Figure 6: *Milan in Four Scales, Keeley Chism*

As in photography, the value of such images is not in their ability to represent a context realistically. Today, one may take out their phone and shoot a photo or refer to Google Earth if accuracy is paramount. Instead, the value of the generated urban image is in its capacity to synthesize the relational qualities of urban space into a perspective. Such qualities include the physical nature of the space, from its materiality to its lighting to its climate. It also

encompasses how the space is occupied and the types of activity it engenders, ranging from the expected to the surprising. Powerful details can exist across various scales and dimensions. Leaves on the ground connote autumn. Condensation on windows elicits humidity. Regarding taxis, yellow means New York, red signifies Hong Kong, and black stands for London or Tokyo. A work can elicit a valuable sense of authenticity that simultaneously grounds the image with clarity, credibility, and depth by depicting essential details about a place.

Digital tools empower urban image generation. For one, they accommodate the combination of disparate spatial data, including GIS shape files, topographical contours, and 3D building models into one scene. Once one establishes the scene's setting, one can manipulate it to enhance the agenda of the image. Unlike processes tied to 2D drawing, Modeling software can transform urban conditions based on the author's decisions. Formal manipulation of urban fabrics can radically restructure latent hierarchies in both visually mesmerizing and conceptually enlightening ways.

In Christoper Nolan's sci-fi thriller, *Inception*, [2] Ariadne is a talented architect in training recruited to design *dreamscapes* - the settings found in others' dreams - in which the rest of the characters operate. Occupying a dream for the first time, Ariadne finds herself in the familiar urban fabric of Paris. When told she has complete creative control over her surroundings, she begins to ponder. "My question is, what happens when you start messing with the physics of it all?" Ariadne wonders, at which point the city of Paris begins to fold and twist in on itself. The buildings, people, and objects on the street remain familiar, but their direct physical relationship to one another changes dramatically. Urban images have a similar potential to establish visions of a city that are not physically true but revealing.

Figure 7: *Beyond the Strip, Daytona Beach, Kevin Robishaw*

In addition to the ability to formally manipulate cities, digital design tools enable the quick and efficient establishment of perspectives for scenes. Height, angles, and lens lengths can be adjusted instantly, saving the need to launch a drone or gain access to a specific building floor for the perfect vantage point. This consistent modeling, framing, and shooting method is lifted directly from architectural visualization. Architects like Ariadne, landscape architects, and urban designers trained in such techniques and spatial thinking are fortuitously suited for engaging with urban imaging. However, unlike traditional "archviz" which is deployed most frequently for an audience of design competition jurors or the prospective homeowner holding a sales brochure for a condo, urban images are unsolicited. Although devoid of specific patrons, such images derive influence from their expansive communicative reach.

Figure 8: *A Talw of Two Busses, San Francisco, Yuen and Gibbs*

2.3 THE POWER OF THE IMAGE

Imagery is powerful because it is consumed much like our everyday visual experiences of the world. Unlike a drawing, perspective imagery is inherently open. It is open to interpretation from multiple angles, each reading containing its own value. Imagery is open. As Umberto Eco established in his 1962 book, Open Work is the type of creative product that is inherently open to various interpretations and understandings. Urban images should be open to confront various issues facing cities while at the same time remaining legible to numerous perspectives and levels of urban expertise. Writing, a highly refined form of image, has limitations. For one, a reader must be literate in the language, presenting a significant barrier to the work's recognition by a broad audience. Conversely, images can show without the need to tell.

From a neurological perspective, reading and viewing images activate different parts of the brain. Language processing is predominantly a responsibility of the left hemisphere. The cognitive process involved in reading involves recognizing syntax and semantics and, in turn, forming a coherent mental *image* of the text itself. On the other hand, viewing images engages the visual cortex at the back of the brain. Although the cognitive strain involved in reading text versus interpreting images varies from person to person, the sequence in which one analyzes information in each process contrasts. Text comprehension only yields meaning through language processing. Images present the vision initially, allowing the viewer to further react to the subject analytically, emotionally, or intuitively. The diversity of responses to images, as well as the medium's accessibility, presents profound potential for image-based urban analysis to supplement or replace traditional written thought on urbanism.

Images function as a universal language, communicating ideas without explicit verbal articulation. Tools that can speak without traditional language are invaluable for a society that is ever more affected by the strains present in the urban environment. In an era marked by an increasingly anti-intellectual societal reality, the power of images to demonstrate without telling becomes a poignant reminder, especially for those immersed in the sheltered spaces of academia, government, and high-design culture.

This visual language has the unique ability to transcend linguistic and cultural barriers. In specific contexts, the decision to write in one language over another has profound consequences for who can read the work and how it is received. For instance, consider the contrast in a message when a writer works in Catalan instead of Spanish, Cantonese versus Mandarin, or any colonial script instead of an indigenous tongue. Working through images allows the author to bypass such implications and instead focus on the character of the piece's content. Furthermore, powerful imagery calls for the layering of meaning in clever and defiant ways. In contexts where censorship stifles communication and creativity, the image can show what words cannot say.

Figure 9: *Hong Kong 2047, Yuen and Lee*

Beyond their communicative role, urban images emerge as a potent tool for collaboration. When focusing on the city's dynamic and uncertain conditions, images go beyond mere documentation and projection, serving as a foundation for vibrant discussions. Furthermore, the increasingly open nature of images in the digital age enhances collaborative endeavors. The democratization of image creation by advancements such as real-time rendering and generative AI and subsequent dissemination through the internet empowers a broader spectrum of individuals to convey ideas visually and others to respond in turn. The internet was supposed to be the world's forum, but tweets and clips are not suitable for building dialogue. As society faces its most complex challenges, especially concerning the future of the built and natural environment, the image demonstrates a capacity to convene a wide-ranging set of experts and amateurs around any critical perspective.

Images wield a unique power in capturing the intricate interplay of scales that define urban design. What sets urban design apart from other forms of environmental design is its engagement with many scales, from the intimate details of domestic spaces to iconic skylines. Complexity in urbanism deepens as it grapples with multifaceted dimensions such as economic, political, cultural, temporal, social, and environmental factors. Describing the intricate relationship between scale and dimension with mere words proves challenging. However, a robust image, skillfully composed, can seamlessly integrate diverse scales and dimensions within its frame, unveiling the latent structures connecting these elements. The outcome captivates our visual senses by appealing to our intrinsic familiarity with a place or cities in general. It provides a swift and comprehensive understanding, compellingly conveying the intricate influences shaping the urban fabric.

2.4 DEPLOYING URBAN IMAGES

In the dynamic realm of urban development, creating compelling images plays a pivotal role in shaping perspectives, influencing decisions, and documenting the ever-evolving cityscape. This intricate process exists across four interconnected stages: Consumption, Interpretation, Production, and Sharing.

The historical trajectory of image development spans from the birth of photography to the digital age, resulting in vast archives that encapsulate the essence of cities. Digitization has transformed these images into easily accessible references from various human endeavors such as design, journalism, social media, cinema, photography, art, and literature. Recognizing the multitude of experiences reflected in urban images necessitates understanding the groups creating them while considering those whose voices may be absent. A preliminary precedent-based research phase is critical to understand the frontier of vision that the image sits on. The choice of urban subject, how it has been depicted, and why it was captured are necessary questions to interrogate when developing an understanding of precedent.

The interpretative phase seeks to uncover latent urban conditions, bridging the physical and intangible aspects of the city: buildings, grids, and infrastructure impact economic, social, ecological, and historical systems. In the wake of global challenges, images serve as diagnostic tools, revealing conditions that demand attention and intervention. Furthermore, images must resonate with the zeitgeist, connecting with or countering visual movements across many realms, be it conventional media, social media, or political messaging.

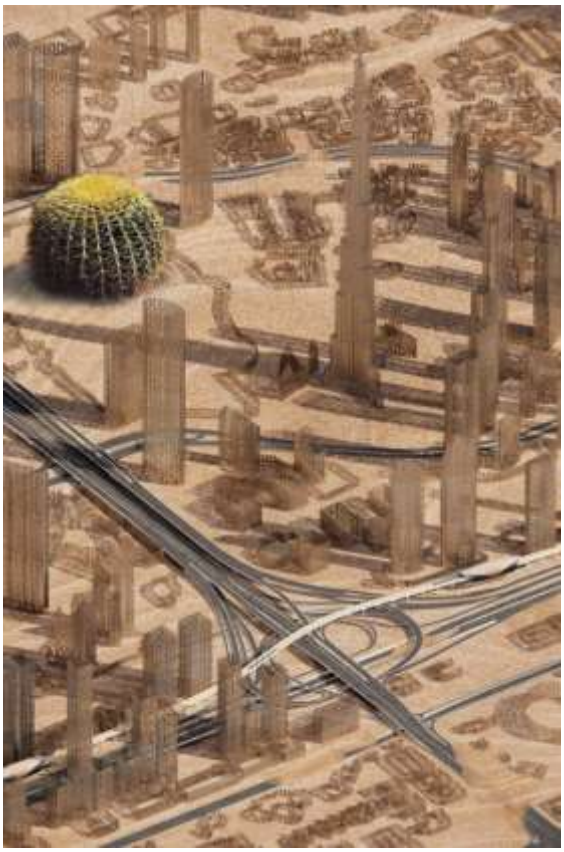

Figure 10: *Highway Urbanism, Dubai, Abdukarim Umarov*

An image may capture many subjects but cannot respond to every pressure, limitation, or question. Strong urban images match a conceptual agenda with a visual perspective. They are direct in their approach but open in their interpretation.

Production of urban images involves a synthesis of perspective, light, and material, with contemporary tools making this process more accessible than ever. Advancements in rendering technologies, such as real-time rendering, open-source 3D assets, and ever more user-friendly interfaces, have democratized image creation. Early computer renderings were gaudy and awkward things. Even now, they can be uncanny, resembling the real thing up to a certain point, after which the

image feels artificial. Nevertheless, every medium, from cinema to photography to electronic entertainment, has gone through similar growing pains. As the industry evolves, lessons learned from past experiments, increased audience education, and a broader societal understanding of processes contribute to continuously improving image quality and potency.

In an era of increasing skepticism towards expertise, images emerge as a powerful means of universal communication. Accessible and shareable, images provide a soft entry point to complex urban issues, transcending linguistic and educational barriers. Furthermore, they provide an object around which discussion may occur, focusing all parties' attention on what they see in the image rather than what they see in each other. The internet is a powerful platform for discussion, albeit as an arena where competition for attention is intense. Nevertheless, it allows images to enter popular culture, allowing urban narratives to resonate with communities beyond the cloistered domains of design and urbanism.

The development of urban images is a nuanced process that transcends mere visual representation. It involves navigating historical archives, interpreting complex urban conditions, harnessing recent advancements in modeling and rendering technology, and strategically sharing images to engage broad audiences. As cities continue to evolve, the role of images in shaping perceptions and fostering understanding may become indispensable.

3. CONCLUSION - THE MOMENT

In 1990, a young Indian architect by the name of Rahul Mehrotra put forth an apparent provocation for the field of urban design in an essay he penned titled "Making Legible City Form." [3] In it, Mehrotra observed that India's rapid post-colonial growth and transformation had yielded "fragmented, random, and highly illegible urban structures." One noted cause cum consequence of such a reality was the disentanglement of the professional responsibilities of architects and planners. While planners focused on unpacking quantitative analysis to propose high-level urban distributions, architects were obsessed with the idiosyncrasies of building design within the limits of a plot. The lack of connectivity between policy and design led to an inconsistently considered urban fabric. Mehrotra believed realigning this slippage in pursuit of legibility was the responsibility of urban design. Mehrotra acknowledged that urban design involves a host of actors, yet there remains a need for a unifying force around which teams can assemble. He writes, "To achieve this, targets must be established - possible images of what the various efforts might produce. This is where projections and simulations are invaluable, for they establish a tangible goal."

Citing Kevin Lynch elsewhere in the essay, Mehrotra pragmatically advocates for creating images to fix cities that lack coherent imageability. He did so thirty years after Lynch defined the term, as cities modernized and the prospect of digital power in the design fields could be anticipated but had not yet been fully felt. Our society is one generation removed from Mehrotra's writing and two from Lynch's. While the cities we inhabit, study and work on remain essentially the same in name, the circumstances that apply pressure when we do so are vastly different from those previously facing the two authors. Sixty years ago, 3 billion people lived on earth. Where design and urbanism lacked technical ability, the fields benefited from the immense opportunity to build due to post-war reconstruction, industrial modernization, the retreat of empire, and nascent globalization. Mehrotra wrote from a milieu of relative even urbanistic opportunity and capability. In the subsequent thirty years, the global population had nearly doubled to 5.3 billion humans. Digitalization was imminent, and economic liberalization was about to be unleashed after the recent end of the Cold War.

Our current moment is different. Cities are saturated. Either they are too sparse, too hot, too wet, too inefficient, too crowded, too banal, too expensive, too divided, or too old. Rich and poor countries are struggling to house a global population that surpassed 8 billion in 2023. There are many issues and many voices. However, robust and accessible technology, bountiful data, and the ability to share information rapidly and broadly offer a path toward goal-defining urban images. Designers should head up the creation of these images. While distinct individuals will author the outputs, the inputs will be drawn from all across society - from scientists to sociologists, photographers, activists, and beyond. The

internet gives the designer access to their perspectives to be synthesized and layered into graphic material and the means to send the visual back out into the world to be reacted to and follow up action. In this moment of many concerns, the image has emerged as a vital agent in defining our urban futures.

4. ACKNOWLEDGMENT

Aside from the independent work of the author, the image presented here were created by students at the Harvard University Graduate School of Design as participants in the project-based seminar, “The [New] Image of the City, which has run since the spring of 2022. Any replication of the work embedded must be properly credited to the authors.

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EVA Berlin

EVA Berlin 2023 Conference
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Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Vom Museum der Dinge zur Erzählung von Menschen

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KURZDARSTELLUNG: Die Möglichkeiten der digitalen Transformation erlauben die Erweiterung des Museums in einen umfassenden Informationsraum. Begleitet wird diese Entwicklung nicht nur durch Prozesse der Kontextualisierung und Dekolonisierung sondern auch durch zunehmende Zweifel an der „Aura“ des Originals.

Damit wird die Frage aufgeworfen, ob das Sammeln physischer Objekte eine zwingende Notwendigkeit für die Existenz des Museums als Gedächtnisorganisation darstellt oder ob nicht vielmehr die menschliche Tätigkeit als Voraussetzung für die Existenz und Betrachtung von Objekten stärker in den Fokus der Museumsarbeit zu rücken wäre.

Die Provenienzforschung hat gezeigt, dass die Rolle von Personen als Subjekte in den räumlichen und zeitlichen Zusammenhängen ihrer Tätigkeit im konventionellen Museum zu wenig Beachtung fand. Die Modellierung der „Person“ (E21) als „Actor“ (E39) im „CIDOC Conceptual Reference Model“ erlaubt eine systematische Fortentwicklung der Museumsdokumentation unter verändertem Blickwinkel zum Beispiel in den Bereichen Forschung, Restaurierung, Vermittlung und Ausstellung. Gemeinsam mit den Erzählungen in Herkunftsgemeinschaften und überlieferten Texten könnte dies der „Anfang von etwas anderem“ werden und die Erzählung vom Museum als Gedächtnisorganisation fortschreiben.

Kurzlink: https://0cn.de/MuseumDingeMenschen

1. KONSERVATIVE GEDÄCHTNISORGANISATION „MUSEUM“

„Vielleicht ist dies das Ende des klassischen Museums des 19. Jahrhunderts und der Anfang von etwas anderem.“ (Benedicte Savoy) [1, S. 59]

Als eine der Wurzeln des „klassischen Museums des 19. Jahrhunderts“ kann heute die im 18. Jahrhundert beginnende Sammeltätigkeit im Zeitalter der europäischen Expansion[2] gelten, die im Laufe des 19. Jahrhunderts ausgehend von der in humanistischen Gelehrtenkreisen populären Sammelleidenschaft stetig anwuchs[3, S. 80] um sich schließlich um 1900 zu einem „regelrechten Sammelhype“[3, S. 79f.] auszuweiten. Gleichzeitig ist es eine „relativ junge historische Erscheinung“,[Vom Objektraum zum Informationsraum: 4, S. 3] Kulturerbe im weitesten Sinne anhand von gesammelten Gegenständen in einer Gedächtnisorganisation „Museum“ systematisch für die kulturgeschichtliche Forschung zu bewahren,

um deren Ergebnisse dann öffentlich auszustellen und dem Publikum zu vermitteln.

Die scheinbar fortschrittliche Erweiterung der Museumsaufgaben des Ausstellens und Vermittelns durch öffentlich zugängliche Museumswebseiten zeigt bei genauerer Betrachtung diese Gedächtnisorganisation im Vergleich zu Bibliotheken[vgl. 5] als deutlich konservativ.[vgl. 6] So ähneln zum Beispiel die „Sammlungen Online“[7] der Staatlichen Museen zu Berlin eher der erweiterten Auflage eines papiernen Katalogs mit besseren Möglichkeiten des Nachschlagens als einem grundlegend neuen Zugang zu einem Informationssystem auf verschiedenen Ebenen. Obwohl mit der Bildungsplattform des Museums für Islamische Kunst „Islamic Art“[8] einige digitale Vermittlungsangebote prototypisch neue Wege angedeutet werden, fehlt bereits hier die umfassende Vernetzung von Sammlungsobjekten mit inhaltlichen Konzepten ebenso wie die Verknüpfung mit anderen Sammlungen oder Informationsangeboten.[vgl. 9]

Der Eindruck verstärkt sich beim Blick auf den Stand der digitalen Transformation im größeren Maßstab. Die in vielen Bereichen erst am Anfang stehende Kulturgutdigitalisierung[vgl. 10] hat unter anderem auch zur Folge, dass Möglichkeiten für Museen, die Zugänglichkeit ihrer Sammlungen zu verbessern und neue Einnahmequellen aus der Nutzung von Digitalisaten zu erschließen,[11, S. 57] nicht genutzt werden können.[vgl. auch 12: „Die digitale Transformation schafft vollkommen neue Verwertungsmöglichkeiten, die auch von Museumsorganisationen genutzt werden können.“] Während in den Bibliotheken bereits seit über einem Jahrzehnt die Auswirkungen neuer Kommunikations- und Kollaborationsmethoden auf die Beziehungen zu den „Nutzern“ untersucht werden,[vgl. 13] bleibt in vielen Museen das Potential der „Freien Inhalte“[14] und die damit verbundene Erweiterung des digitalen Publikums noch häufig ungenutzt.[11, S. 56f.] Gleichzeitig steht das „althergebrachte Expert*innenverständnis“[12, S. 10] einer Begegnung mit „Besucher*innen“ in einer teilhabenden Wissenskultur im Wege.

Äußere Erscheinungen wie das Festhalten an den Prinzipien des Ausstellungs- und Bestandskataloges sowie die beschriebene Vernachlässigung des digitalen Publikums zeigen das Beharrungsvermögen der Gedächtnisorganisation „Museum“. Die Herausforderung des notwendigen und tiefgreifenden Wandels[15] [vgl. 16] wird an Beispielen aus den digitalen Geisteswissenschaften deutlich.

1.1 WIKIDATA UND KULTURELLES ERBE

Die ansteigende Nutzung[17] von Wikidata[18] durch Kulturerbe-Einrichtungen als verknüpfte Datenquelle (LOD)[19] gibt Anlass zu der Frage, ob Museen ihrer Verantwortung für kulturelles Erbe auch dadurch gerecht werden, dass sie die Ergebnisse ihrer Arbeit ebenfalls derart vernetzungsfähig aufbereiten. Der derzeitige „Mangel an Museumsknoten“[9] deutet leider eher auf eine verneinende Antwort hin.

Um dies zu ändern, bedarf es zunächst der Neuorganisation der Informationen über Sammlungsobjekte auf der Grundlage eines semantischen Datenmodells,[20] das sich nach dem CIDOC-CRM[21] als Standard für das Kulturerbe richtet. Die dann möglichen Aussagen über Eigenschaften von Sammlungsobjekte mit eindeutigen Identifikatoren und die Modellierung von Beziehungen erlauben nicht nur semantische Eindeutigkeit und sammlungsübergreifende Vergleichbarkeit, sondern besitzen auch die Anschlussfähigkeit als „Linked Open Data“ (LOD). Die Nutzung der genannten Elemente wie Objekt (item), Aussage (statement), Eigenschaft (property) und Beziehung (relationship) macht Wikidata zu einem vernetzbaren und hochflexiblen Informationssystem, das auf vielfältige Art und Weise abgefragt[vgl. 22] werden kann.

Auf der Grundlage semantischer Modellierung[vgl. 23] mit Hilfe des CIDOC-CRM werden in der Archäologie „Linked Open Data“ (LOD) bereits als Mittel zur Verbindung verteilter Datenquellen und zur Ermöglichung von Quervergleichen genutzt, gleichzeitig dient Wikidata in diesem Bereich zunehmend als offene Wissensplattform für die Erstellung und Verteilung von LOD.[24] Ähnliche Bestrebungen gibt es auch im Archivwesen.[25]

1.2 RETTUNGSPARADIGMA, SAMMELHYPE UND ÜBERFORDERUNG

Die eingangs bereits erwähnte Steigerung der Sammelleidenschaft in Verbindung mit dem

sogenannten „Rettungsparadigma“[3] wird häufig mit Adolf Bastian, dem prominenten Gründungsdirektor des Museums für Völkerkunde in Berlin, in Verbindung gebracht:

Mit lautem Weck- und Warnruf trat er Jahr und Jahr für das Sammeln bei den dahinsterbenden Naturvölkern ein: „der letzte Augenblick ist gekommen, die zwölfte Stunde ist da! Dokumente von unermesslichem, unersetzlichem Wert für die Menschheitsgeschichte gehen zugrunde. Rettet! rettet! ehe es zu spät ist.[Karl von Steinen in der Gedächtnisrede auf Adolf Bastian: 26, S. 248]

Der Rettungs- und Bewahrungsgedanke war weit über die Ethnologie hinaus auch in anderen wissenschaftlichen Disziplinen verbreitet, ja das Sammeln überhaupt kann als ein bürgerliches Massenphänomen gesehen werden, so dass heute die Sammlungen in unterschiedlichsten Typen von Museen darauf zurückgehen.[3, S. 90] Auch wenn in der Ethnologie das vermeintlich „ideale Ziel des Sammelns, […] materielle Stammesmonographien zu erstellen“[27, S. 35] gelegentlich noch verteidigt wird, zeigt schon die Beschränkung auf materielle Objekte das grundlegende Problem: alle immateriellen Aspekte der bedrohten Kulturen blieben unberücksichtigt. Die Auffassung, dass materielle Objekte als alleinige Quelle es erlauben, kulturgeschichtliche Forschung zu betreiben,[vgl. 3, S. 93] ist wohl in einem engen Zusammenhang mit Erscheinungen wie der „imperialistischen Nostalgie“, der „Krise der europäischen Moderne“ und schließlich der Zurschaustellung nationaler Überlegenheit in den großen Nationalmuseen zu sehen.[3, S. 92–94] Die ernüchternde Folge für die Forschung in solchen Sammlungen hat Flower Manase so formuliert: „You have the objects, we have the knowledge.“[zit. nach: 3, S. 99]

In großen Museen, deren Sammlungen anderen Wissenschaftsdisziplinen zugeordnet werden, mögen sich die Folgen der „Sammelwut“ etwas anders gestalten, doch führen auch hier die schiere Masse an physischen Sammlungsobjekten und der Bewahrungsgedanke dazu, dass sich die immer noch wachsenden Bestände und die dadurch erforderlichen Maßnahmen der Bestandserhaltung auf die Museumsdokumentation[28] auswirken und konservative Haltungen der Beschäftigten im Museum stärken.

Auf eine umfassende Erforschung der Ursachen für die konservative Grundhaltung in vielen Museen und den verzögerten Beginn der digitalen Transformation muss hier verzichtet werden. Es drängt sich jedoch der Eindruck auf, dass die dominierende Rolle des Bewahrungsgedankens in nicht unerheblichem Maße dafür sorgt, dass eher die Folgen der Überforderung des objektzentrierten Systems „Museum“ akzeptiert werden, als neue Orientierungen ins Auge zu fassen.

Einige Beispiele müssen hier genügen, um die Überforderung des heute vorherrschenden Typs eines Museums zu verdeutlichen, das in den physischen Sammlungsobjekten sein alleiniges Gravitationszentrum sieht.

- Bereits 2013 bezeugte der Generalinspekteur der Smithsonian Institution öffentlich unzureichende Bestandskontrollen und Konservierungspraktiken sowie unvollständige und ungenaue Bestandsverzeichnisse.[29, S. 29f.] Obwohl die Museumsorganisation 2022 eine aktualisierte Richtlinie zur Verwaltung von Sammlungen in Kraft setzte, in der hohe Ansprüche an Informationen über die Sammlungen und die Bestandsverzeichnisse formuliert werden,[30, S. 14–16] sind kritische Stimmen nicht verstummt, die unvollständige Sammlungsdokumentation und Personalmangel beklagen.[“Repatriation is time consuming and difficult because some parts of the collection lack complete documentation and because there is only a small staff to handle the many requests […]”, 31]

- Die tieferen Ursachen für einen in diesem Jahr erst festgestellten Verlust von Sammlungsobjekten im Britischen Museum sind aus der offiziellen Pressemitteilung[32] nicht zu erschließen. Dass es sich um „nicht kategorisierte Gegenstände“[“uncategorized items”, 33] handelte und damit wohl auch Probleme bei der Dokumentation der Museumssammlungen[“important questions about security, record keeping and funding priorities”, 34] sichtbar wurden, hat in der öffentlichen Diskussion zu grundsätzlicher Kritik an der institutionellen Kultur des Museums geführt.[“disfunctional institutional culture”, 35]

- Dass Probleme der Museumsarbeit in engem Zusammenhang mit Personal- und

Finanzmangel stehen und daher wohl kaum kurzfristig gelöst werden können, zeigen die Strukturempfehlungen des deutschen Wissenschaftsrates zur Stiftung Preußischer Kulturbesitz (SPK), zu der auch die Staatlichen Museen zu Berlin (SMB) gehören. Für die gesamte SPK wurde 2020 festgestellt, dass hinsichtlich der Informationstechnik und der digitalen Transformation die Stellenpläne „den Anforderungen eines modernen Archiv-, Bibliotheks- und Museumsbetriebs“ nicht mehr genügen.[36, S. 22] Für die SMB werden außerdem unter anderem in den Bereichen der Bestandserhaltung und der Sammlungsdokumentation fehlende Personalkapazitäten genannt, so dass die Museen „kaum in der Lage (sind), ihre Verantwortung gegenüber der Öffentlichkeit wahrzunehmen“.[36, S. 22] Der Umstand, dass Museen fast ausschließlich mit ihren Ausstellungen in dieser Öffentlichkeit wahrgenommen werden,[vgl. 37] hat zur Folge, dass konkrete Probleme in der Bestandserschließung und -pflege selten bekannt werden. Für das Museum für Islamische Kunst, das mit seiner Sammlung zu den SMB gehört, wurde 2018 nach Angaben im Museumsdokumentationssystem festgestellt, dass 17628 Datensätzen, die 40734 bearbeiteten Objekten entsprechen, noch 51785 aufzunehmende Objekte gegenüberstehen (Abb. 1).[38, S. 2, 18]

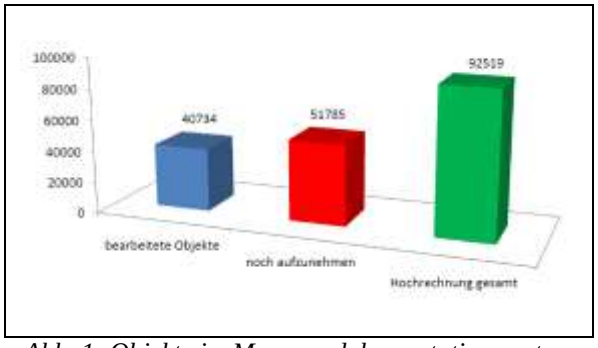

Abb. 1: Objekte im Museumsdokumentationssystem (Museum für Islamische Kunst, Berlin)

Abschließend darf hier ein Beispiel dafür nicht fehlen, dass auch die Nutzung digitaler Werkzeuge und Methoden keine Garantie für die nachhaltige Nutzung von Informationen über die Sammlungsobjekte bietet, wenn nicht genügend Personal zur Verfügung steht. So ging eine umfassende digitale Darstellung der Dauerausstellung des Museums für Islamische Kunst verloren, die nicht nur die Phase nach der Vereinigung der Sammlungen in den 1990er Jahren dokumentierte. Mit der Schließung des Museums im Südflügel der Pergamonmuseums 2023 endete auch die Geschichte der Ausstellung des Museums in diesem Teil des Pergamonmuseums, die in ihrer wesentlichen Struktur seit 1932 erhalten geblieben war. Obwohl noch vor der erfolgreichen Publikation der Ergebnisse des Projekts[39] auf die erforderliche Langzeitarchivierung hingewiesen worden war,[vgl. unter Weiterentwicklung: 40] sind die Daten heute nicht mehr verfügbar.

1.3 GRÜNES MUSEUM

Wer weiß, ob es in 100 Jahren überhaupt noch eine Gesellschaft gibt, die unsere Museen besuchen kann oder will? (Stefan Simon)[41, S. 37]

Auf einen weiteren Aspekt der Überforderung von Museen mit großen Sammlungen physischer Objekte kann hier nur kurz eingegangen werden, obwohl er vielleicht die größte Bedrohung für diese Gedächtnisorganisation – wie wir sie kennen – darstellt. Dabei sind es nicht nur das Rettungsparadigma und der Bewahrungsgedanke in Verbindung mit dem unbewiesenen Glauben kulturgeschichtlicher Forschung an das Alleinstellungsmerkmal[42] materieller Objekte als unverzichtbarer Quelle mit der „Aura des Originals“, die ein Umdenken erschweren. Auch der technische Fortschritt in der Klimatechnik in Verbindung mit den rasanten Veränderungen im Bereich der Restaurierung sorgt dafür, dass der ökologische Fußabdruck der Museen „ihre ureigene Mission, die nachhaltige Bewahrung des kulturellen Erbes, zu unterlaufen droht“.[41, S. 61]

2. HERAUSFORDERUNGEN

2.1 REAURATISIERUNG ODER KONTEXTUALISIERUNG?

Zu der geschilderten Überforderung von Museen im Bereich der Museumsaufgaben des Sammelns und Bewahrens, deren Bewältigung die Voraussetzung für die darauf aufbauenden Aufgaben Forschen, Ausstellen und Vermitteln ist, kommen weitere Herausforderungen hinzu. Mit Dekolonisierung und gewachsener Bedeutung der Provenienzforschung gehen für die Museen auch andere Veränderungen einher, die in nicht unbeträchtlichem Maße auf Prozesse

der digitalen Transformation zurückzuführen sein dürften.[vgl. z.B. 43, S. 143]

Unzweifelhaft ist dies der Fall bei der Kontextualisierung,[44] die auf der Grundlage einer immer dichteren Vernetzung von Daten und Informationen unter anderem im WorldWideWeb den „Informationsraum Museum“[Informationssystem Museum: 45, S. 6f.] quantitativ und qualitativ ständig erweitert. Deutlich sichtbar wird dies, wenn Sammlungsobjekte „Bezugspunkte innerhalb von Netzwerken“[46, S. 46] der Forschung werden. Damit verschiebt sich gleichzeitig die Bedeutung der Sammlungsobjekte vom Gravitationszentrum der jeweiligen musealen Sammlung zur Quelle intrinsischer und extrinsischer Daten für den „Informationsraum Museum“, der über die Verknüpfung mit Normdaten[47] sowie die Standardisierung nach dem CIDOC-CRM als „Linked Open Data“[19] verfügbar gemacht werden kann (Abb. 2).

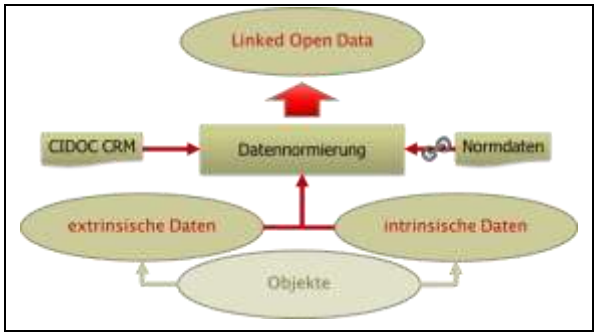

Abb. 2: Informationssystem Museum

Es ist sicher kein Zufall, dass diese Entwicklung nicht nur durch zunehmende Zweifel an der „Aura des Originals“[vgl. 48] begleitet wird, sondern man diese sogar als „bildungsbürgerliches Konzept“,[49, S. 40] „gefälschte Aura“, „Reauratisierung“ und vom Museum bezweckte Inszenierung bezeichnet.[50] [vgl. Original, Abbild und Information: 4] Etwas nüchterner betrachtet könnte Kontextualisierung als Versuch gesehen werden, mit Hilfe der neuen Werkzeuge und Methoden digitaler Transformation die Verluste an Informationen zu ersetzen, die bei der Herauslösung der Objekte aus ihrer ursprünglichen Umgebung zwangsläufig entstanden. Dabei kann dann aus allen vorhandenen extrinsischen Daten in Verbindung mit den intrinsischen Daten, die am Objekt selbst ermittelt werden können,[51, S. 2f.] ein digitaler Zwilling[52] entstehen, dem durch die wachsende Vernetzung des „Informationsraumes Museum“ – auch mit Ergebnissen von „Citizen Science“[vgl. 53] – weitere Daten und Informationen hinzugefügt werden können (Abb. 3).[vgl. Informationsraum und digitaler Zwilling: 45] Es gälte dann, die Museumsaufgabe des Bewahrens (zunächst auch) auf den digitalen Zwilling als „Substrat eines Objektes“[49, S. 43] auszudehnen.

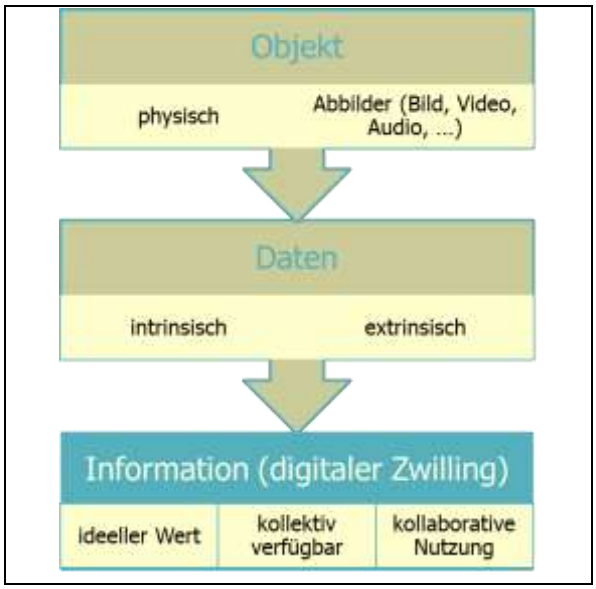

Abb. 3: Digitaler Zwilling eines Sammlungsobjekts

2.2 PROVENIENZ, DEKOLONISIERUNG UND RESTITUTION

Im Rahmen der Debatten über Dekolonisierung und Restitution ist die Quellenlage der sammelnden Institutionen ebenfalls kritisch beleuchtet worden. Dies betrifft neben fehlender institutionenübergreifender Erfassung von Objekten auch Standards für die inhaltliche und formale Strukturierung von Dokumentationen sowie das „Nicht-Wissen in der Sammlungsdokumentation“.[54, S. 265–267] Die wechselhafte Geschichte von Museumssammlungen mit Umorganisationen und Verlagerungen sei hier beispielhaft als einer der Gründe genannt, die eine systematische und zuverlässig nutzbare Bestandsdokumentation verhinderten.[55, S. 259]

Welche Rolle in der Museumsdokumentation spielen dabei die Namen von Personen, ihre verlässliche Identifizierung und zeitgeschichtliche Einordnung? Auch hier sind bereits kritische Fragen öffentlich erörtert worden.[vgl. 56] Sie reichen von anonym gebliebenen Sammlern oder Leihgebern über die Hintergrundinformationen zu Vorbesitzern bis zum schillernden Spektrum der Rollen, die ein- und dieselbe Person spielen kann: Forscher, Händler, „Völkerkundler“ und Trickser.[57]

Diese kritische Sicht zeigt gleichzeitig einen Anknüpfungspunkt für die veränderte Prioritätensetzung bei der Sammlungsdokumentation, wenn ein fehlender „Orientierungsmaßstab zur Notation von Personendaten“[54, S. 275–278] als Erschwernis für die Provenienzforschung genannt wird. Ein weiteres Argument für die Konzentration auf Personen sind die positiven Erfahrungen auf diesem Gebiet in den Naturwissenschaften.[„Wikidata“, 58]

2.3 PERSONEN STATT OBJEKTE

Ein Museum muß jederzeit ausnahmslos und genau wissen, für welche Gegenstände es [..] verantwortlich ist und wo diese sich befinden. Um seine definierten Funktionen lückenlos erfüllen zu können, muß ein Museum [..] über sämtliche Informationen verfügen, die mit diesen Gegenständen zusammenhängen.[59, S. 9]

An der aktuellen Provenienzforschung wird sichtbar, dass die Rolle von Personen als Subjekte in den räumlichen und zeitlichen Zusammenhängen ihrer Tätigkeit im konventionellen Museum bisher zu wenig Beachtung fand. Richten Museen den Fokus ihrer Arbeit stärker auf Personen, ermöglichen sie gleichzeitig die Vernetzung mit anderen gesellschaftlichen Bereichen, wenn sie Daten über Personen liefern, die bisher wenig oder gar nicht als Sammler bekanntgeworden sind. So ließ sich z.B. anhand der Abbildungssammlung des Museums für Islamische Kunst ermitteln, dass der als „Seeteufel“ bekanntgewordene Felix Graf von Luckner (GND: 118574809)[60] islamische Kunst sammelte.[„Ereignismodellierung in der Praxis“, 45] Im gleichen Museum ist Paul Erich Kirmse (GND: 1269920588)[61] als Vorbesitzer[62] von islamischen Glasfenstern bekannt. Über die zahlreichen Wirkungsorte, die von ihm bekannt sind (Abb. 4), könnten weitere Angaben in Archiven[vgl. 63] für die Anreicherung von Provenienzdaten ermittelt werden.

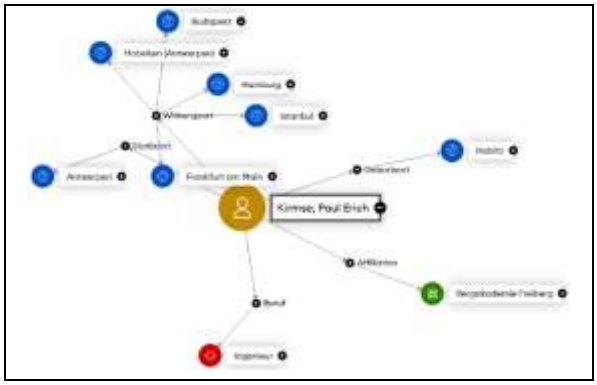

Abb. 4: Wirkungsorte von Paul Erich Kirmse

In den digitalen Geisteswissenschaften ist die Bedeutung von Personendaten für die Forschung schon vor mehr als einem Jahrzehnt erkannt worden.[vgl. 64] Folgerichtig hob die Initiative zur Schaffung einer digitalen Forschungsinfrastruktur für die Geistes- und Kulturwissenschaften („Digital Research Infrastructure for the Arts and Humanities“, DARIAH-DE) ein von der Berlin-Brandenburgischen Akademie der Wissenschaften entwickeltes Personendatenrepositorium (PDR) bei der Anwendung und Nutzung von Normdaten besonders hervor.[65, S. 27]

Personen spielen in der gesamten Geschichte von Museumsobjekten eine entscheidende Rolle, denn alle für Menschen interessanten Aspekte der Museumsaufgaben Sammeln, Bewahren, Erforschen, Ausstellen und Vermitteln sind mit konkreten Personen oder Gruppen verbunden. Als Ausgangspunkte für weitere Untersuchungen sind hierbei die gegenwärtig in den Museen tätigen Personen besonders wichtig, weil Informationen über sie schneller zu ermitteln und durch bereits digital verfügbare Daten leichter zu verarbeiten sind. Hinzu kommt, dass sie als besondere Wissensträger gleichsam die Schamanen[vgl. 66] des industriellen Zeitalters sind, die als Vermittler zwischen der inneren Museumswelt und der Öffentlichkeit agieren. Wie die (Kultur-)Historiker an den Universitäten überliefern sie Geschichte(n), wobei die Objekte gewissermaßen als „Gedächtnisstützen“ der Vermittlung und ihrer Anschaulichkeit dienen.

2.3.1 DIE DEMASKIERUNG DES MUSEUMS DURCH ERFASSUNG SEINER SCHAMANEN

Folgt man einer Theorie des Zusammenhangs zwischen den Begriffen „Person“ und „Maske“,[vgl. 67] so spielen die Menschen in ihren Beziehungen mit Museumsobjekten verschiedene „Rollen“. Der Perspektivwechsel von der Objektbeschreibung zur Erfassung handelnder Personen setzt die Betrachtung dieser Personen (E21 im CIDOC-CRM) als Akteure (E39) im Rahmen einer Aktivität (E7 als Unterklasse von „Ereignis“ E5) voraus, die durch Zeitspanne (E52) und Ort (E53) näher beschrieben werden kann. Die Vorteile dieser ereignisorientierten Modellierung[vgl. 68, Fig. 1, 2 (Version 7.2.2)] (Abb. 5) anstelle der objektzentrierten Datenstruktur sind nicht nur bereits hervorgehoben worden,[69, S. 40] sondern es gibt mit der Entwicklung des „Linked Art Data

Model“[70] auch die Verbindung eines semantischen Datenmodells mit dem Konzept der „Linked Open Data“.

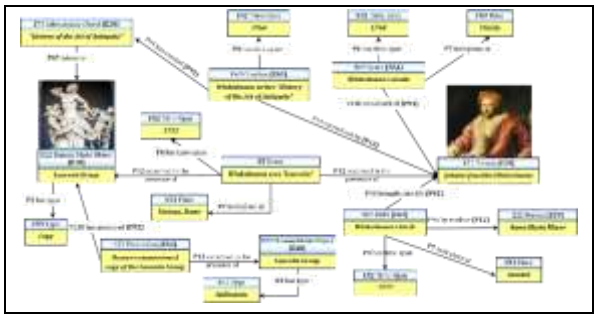

Abb. 5: Eventmodellierung im CIDOC-CRM

Die Umsetzung solcher Prinzipien in der Museumsdokumentation erlaubt deren systematische Fortentwicklung unter verändertem Blickwinkel zum Beispiel in den Bereichen Forschung, Restaurierung, Vermittlung und Ausstellung. Gemeinsam mit den Erzählungen in Herkunftsgemeinschaften und überlieferten Texten könnte dies der „Anfang von etwas anderem“ werden und die Erzählung vom Museum als Gedächtnisorganisation fortschreiben.

2.3.2 PERSONEN ALS AKTEURE UND VERNETZUNGSKNOTEN

Dabei wird erkennbar, dass es eigentlich nicht die Museumsobjekte sind, die der Erforschung von „Menschengeschichte“ dienen, sondern dass die „Objektgeschichte“ von Menschen gemacht und bestimmt wird und dass diese Objektgeschichte während der (Auf-)bewahrung im Museum ständig weiter geschieht.

Wie die Qualität der Beschreibung von Rollen, die Personen bei den jeweiligen Ereignissen im Zusammenhang mit den Objekten spielen, Forschungsergebnisse und ihre Bewertung beeinflussen, wird unter anderem in folgenden Bereichen deutlich:

- Da alle extrinsischen Daten von einem „Beschreiber“[51, S. 2] stammen, ist es von Bedeutung, wer eine bestimmte Aussage getroffen hat. Dies betrifft zum Beispiel die Motive konkreter Personen für das Sammeln, Bewahren oder Erforschen von Museumsobjekten, die für Bewertungen und Vergleiche von Ergebnissen dieser Tätigkeiten ins Gewicht fallen.

- Provenienz: „Die Erforschung der Erwerbungsumstände, der beteiligten Personen und Institutionen, ihrer Netzwerke, Motive und Methoden trägt zu einem tieferen Verständnis nicht nur der Objekte, sondern auch der Erwerbungspolitik der Museen und der Institutionengeschichte bei.“[71, S. 2]

- Bei der Datierung von Medien sind nicht nur die Fotomotive (einschließlich fotografierter Personen) bedeutsam, sondern auch Daten zu den Fotografen. Herausforderungen sind zum Beispiel vererbte Fotografenateliers, bei denen Vater und Sohn den gleichen Namen führen.

Werden Personendaten miteinander verlinkt, können daraus – in Abhängigkeit von der Informationsdichte und -qualität – weitere Erkenntnisse abgeleitet werden. Gleichzeitig entstehen so „Kategorien für die Bewertung von born-digital Quellen, die an der Grenze zu einer Philosophie des Vertrauens stehen“,[72, S. 30] mit denen zum Beispiel neue Maßstäbe für die Verifizierung und Gewichtung von Forschungsdaten möglich werden – vor allem im Bereich der „Citizen Science“.[vgl. “Who digitizes and controls digital collections?”, 73]

Eine in den Naturwissenschaften bereits seit längerem erfolgreiche Anwendungsmöglichkeit sind die Zitationsnetzwerke, die Publikationen und Zitate aus ihnen verknüpfen. Solche Netzwerke lassen sich anschließend zum Beispiel mit dem DOI-System[74] auswerten und visualisieren (Abb. 6)[75].[76]

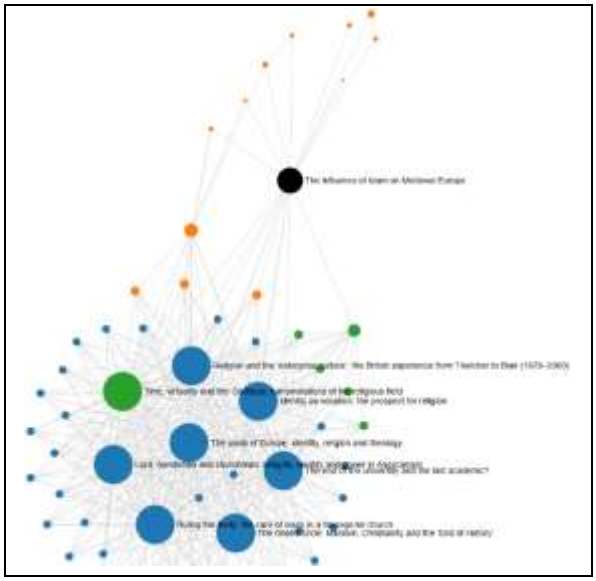

Abb. 6: Citation Graph

Weitere Auswertungen vernetzter Personendaten können Rückschlüsse auf fehlende Daten

erlauben und damit zum Beispiel Identifikationsmöglichkeiten bieten, wenn Namen in Quellen unvollständig überliefert sind. Auch wissenschaftssoziologische Erkenntnisse lassen sich gewinnen, sofern genügend Daten über die Personen vorliegen (Abb. 7).

Abb. 74: Wissenschaftssoziologische Informationen[77]

Mit der Modellierung der Personen-Metadaten anhand des CIDOC-CRM als Forschungsaktivitäten ließe sich schließlich auch die Verknüpfung mit Archivdaten herstellen und so eine weitere Gedächtnisorganisation anbinden. Da Archive bereits seit langem die Namen ihrer Nutzer aufzeichnen, bieten sich damit weitgehende Möglichkeiten einer nachträglichen Digitalisierung.

Allerdings sind hier auch Hindernisse zu berücksichtigen, die bei der eindeutigen Identifizierung von Personen als Voraussetzung für die Normierung auftreten können. So ist zum Beispiel im Museumsdokumentationssystem der Staatlichen Museen zu Berlin ein Antiquitätenhändler verzeichnet (PER ID 100978), der sowohl als „Mohammad Yeganeh“[78] als auch „Manūčihr Ǧamālī“[79] bibliothekarisch erfasst wurde. Erst die Verknüpfung der Bibliotheks- mit Archivdaten[vgl. 80] und die Nutzung weiterer Quellen[81] ermöglichte die Bestätigung der Identität. Da wiederum die in Museen vorhandenen Informationen über Personen dazu beitragen können, solche Hindernisse zu überwinden, sollte der biographischen Forschung und der Publikation ihrer Ergebnisse mehr Aufmerksamkeit geschenkt werden. Wie die Arbeiten von Jens Kröger[82] über Kurt Erdmann[83] und Carl Johan Lamm[84] zeigen, gibt es hierzu bereits gute Ansätze. Doch zweifellos sind zu wenig Daten über Personen im Zusammenhang mit Museumsobjekten überhaupt öffentlich zugänglich, geschweige denn als „Linked Open Data“ veröffentlicht. Für die Forschung im Museum bedeutet dies natürlich auch, sich „auf die Auseinandersetzung mit Methoden und Konzepten der Datenwissenschaften einzulassen“.[85, S. 59]

Da die Wissenschaftlerinnen und Wissenschaftler in den Museen heute bereits die Forschungsgeschichte von morgen schreiben,[86, S. 71] sind gleichzeitig die Voraussetzungen dafür zu schaffen, dass ihre eigenen Personendaten und Forschungsaktivitäten nicht nur beliebig dokumentiert werden, sondern ereignismodelliert erfasst sind. Mit ORCID[vgl. 87] oder der „BibSonomy Genealogie“[88] seien zwei Werkzeuge genannt, die hierzu genutzt werden können.

Es bietet sich an, die Qualitätsstufen der Nutzung von Personendaten in Anlehnung an die Entwicklung des „World Wide Web“ zusammenzufassen:

- 1.0: **Personen** wird die Veröffentlichung von Informationen über sich selbst und andere ermöglicht.
- 2.0: Mit der **Kollaboration von Personen** findet ständig der Wechsel zwischen den Rollen von „Sender“ und „Empfänger“ statt.
- 3.0: **Semantische Methoden und Werkzeuge** verbinden die Begriffssysteme von Individuen zur Verständigung zwischen Personen und ermöglichen die **maschinelle Verarbeitung**.
- Die Verknüpfung der komplexen Informationen über Museumsobjekte in deren digitalen Zwillingen[vgl. „Der digitale Zwilling“: 4] mit den **„digitalen Zwillingen“ von Personen** gestattet sowohl die Erforschung der Interaktion von Personen als auch der Aktivitäten im Zusammenhang mit den Museumsobjekten.

2.3.3 PERSONEN UND IMMATERIELLES KULTURERBE: ERZÄHLENDE ÜBERLIEFERUNG

„[…] was man ſchwarz auf weiß beſitzt, Kann man getroſt nach Hauſe tragen.“[89, S. 121]

Der Schüler, der im „Faust“ diese sprichwörtlich gewordene Meinung äußert, wird von Goethe nicht gerade als jemand geschildert, dem eine gelehrte Zukunft bevorsteht. Es darf also vermutet werden, dass der Dichter selbst seine Zweifel an der Schriftlichkeit hatte. Kein Zweifel dürfte daran bestehen, dass die „mündliche Nachrichtenform“[„Kurze Übersicht über die Entwicklungsgeschichte des Nachrichtenwesens“, 90, S. 4–7] in der menschlichen Geschichte länger die beherrschende Rolle spielte

als alle moderneren Übermittlungsmethoden für sprachgebundene Informationen.[vgl. auch 91]

Trotzdem spielt in den Gedächtnisorganisationen Archiv und Museum die mündliche Überlieferung nur eine untergeordnete Rolle. Sowohl die schriftliche Fixierung von Sprache als auch die Konservierung von Sprache und Tönen mit technischen Mitteln sind nicht ohne die Lösung der unmittelbaren Beziehung der denkenden Person zum verdinglichten Resultat ihrer Handlung (z.B. Schreiben, Sprechen oder Singen) möglich – ähnliches gilt für Filmaufnahmen. Dagegen bleibt die kontinuierliche erzählende Überlieferung ein von den Beteiligten ständig in Gang gehaltener Prozess durch die Einbeziehung der hörenden und sehenden Empfangenden, die dann wieder zu Sendenden werden.[vgl. das ähnliche Prinzip der Brechtschen Radiotheorie und des Web 2.0, 92, S. 25f.] Die sich daraus ergebenden Chancen für Museen, die den Fokus von den Sammlungsobjekten zu handelnden Personen verschieben, können wohl kaum überschätzt werden.[vgl. 93]

Der von der Notwendigkeit des Sammelns[94, S. VIII] materieller Kulturgüter so überzeugte Gründungsdirektor des Museums für Völkerkunde in Berlin, Adolf Bastian, klagte 1881:

[…] jetzt hallt uns auch dort, auf allen Seiten ein „zu spät" entgegen, da die Träger der unverfälschten Traditionen bereits im raschen Aussterben begriffen sind und das, was sie durch lange Ueberlieferungen bei sich fortgepflanzt hatten, eine Art in der Erinnerung aufbewahrte Bibliothek, mit dem letzten des Stammes begraben wird.[94, S. IX]

Ironischerweise besuchte ihn gleichen Jahr König David Kalākaua[95] während seines Aufenthalts in Berlin – der Monarch, dessen Regierungszeit als *First Hawaiian Renaissance* gilt.[96, S. 38f.] Zu Ehren König Kalākauas wird heute jährlich beim „Merrie Monarch Festival" mit dem hawaiischen Hula[97] das wichtigste Kulturerbe Hawai'is als „lebendiger Prozess der Rückgewinnung der kulturellen Souveränität" sichtbar.[98] Damit widerlegt die Überlebensfähigkeit eines indigenen Kulturerbes auf der Grundlage mündlicher Überlieferung und erzählender Tanztradition nicht nur die These von der Unverzichtbarkeit materieller Objekte als kulturgeschichtlicher Quelle. Werden zum Beispiel beim Hula verwendete Instrumente von Sammlern aus ihren funktionellen und spirituellen Zusammenhängen gerissen, verlieren sie darüber hinaus wesentliche Merkmale ihrer Existenz als kulturelle Zeugen.

2.3.4 KI'I KIHAWAHINE

Ein Beispiel dafür, dass der „nivellirende Einfluss unserer modernen Cultur"[99, S. 130] die erzählende Überlieferung in Hawai'i nicht vollständig auslöschen konnte, ist das Standbild (ki'i)[100] der Göttin Kihawahine (Abb. 8), das Eduard Arning am 11. Februar 1887 im Berliner Museum für Völkerkunde vorstellte.[101, S. 137] Heute befindet sich dieses Standbild in der Ausstellung des Ethnologischen Museums im Humboldt Forum.[Ident.-Nr. VI 8375, 102] Im Zusammenhang mit der weitgehenden Zerstörung von Lāhainā im August 2023 wurde nicht nur in einer Sendung des öffentlichen Rundfunks in Hawai'i[102] sondern wenig später auch in Kalifornien[103] die Rückgabe dieses Kulturerbes thematisiert.

Abb. 8: Ki'i Kihawahine

Während eines Besuchs von Kumu[etwa: Lehrer*in als Quelle von Wissen, vgl. 104] hula Lorna Kapualiko Lim und Kumu hula Michelle Kaulumahiehie Amaral am 1. September 2023 in der Ozeanien-Ausstellung im Humboldt Forum war der Verfasser Zeuge einer zeremoniellen Begegnung mit Kihawahine, die eindrucksvoll die Auffassung bestätigte, dass Museumsobjekte wie Subjekte agieren, weil sie „als von Menschenhand geschaffene Begleiter des sozialen und individuellen Lebens" entstanden.[105, S. 11] Ein sich im gleichen Raum aufhaltender Schüler, der diese Begegnung ebenfalls beobachtete, antwortete auf die Aufforderung seines Lehrers, mit der Klasse weiterzugehen: „Nein, ich bleibe, das hier ist wichtiger." Dieses emotionale Verständnis für die Besonderheit eines solchen Vorgangs in einer Museumsausstellung kann vielleicht damit erklärt werden, dass dieser Schüler die Erschütterung

der beiden Kumu hula gespürt hat, die von Josephine Ebiuwa Abbe, Choreografiedozentin an der Universität von Benin City, so beschrieben wurde:

„Ihr schaut und bewundert, und das dürft ihr natürlich. Aber als ich in Berlin war, da war es so: Die Afrikaner im Raum erschauderten bei der Begegnung mit den Stücken, da waren auch Tränen. Sie erfassten — ganzheitlich — ihren Wert, holistisch, verstehen Sie? Ihr studiert, nehmt das Äußere wahr, und es gefällt euch, uns auch. Aber es ist das Innere, das uns erschüttert und das ihr nicht sehen könnt."[106, S. 53]

Eine solche „Respiritualisierung" und die Betrachtung der „Objekte" als kulturelle „Subjekte"[vgl. „Objekt, Subjekt oder beides?", 107, S. 55f.] dürfte nur im Rahmen der Herkunftskulturen mit den in ihnen denkenden und handelnden Menschen möglich sein. Dazu könnte die Gedächtnisorganisation „Museum" über die bisherige Kontextualisierung hinaus ihren Beitrag mit der Rückgabe der Kulturgüter und der Bereitstellung aller Informationen als „Linked Open Data" leisten. Für die Museumsaufgaben des Ausstellens und Vermittelns können Kopien und Nachbildungen verwendet werden, da „nicht so sehr die Authentizität, als vielmehr das physische Vorhandensein der Dinge im Ausstellungsraum für die Beförderung der historischen Imagination entscheidend ist."[48, S. 246] Außerdem ermöglichen digitale Reproduktionstechnologien heute so detailgetreue Nachbildungen, dass sogar im Falle eines Verlustes wesentliche Merkmale erhalten bleiben können.[108, S. 2]

2.3.5 ALEPPO-ZIMMER

Die Chancen für wesentliche Erkenntnisgewinne bei einem Perspektivwechsel hin zu Personen und ihren Aktivitäten können am Aleppo-Zimmer[109] im Museum für Islamische Kunst als einem weiteren Beispiel verdeutlicht werden. Bisher wurden die Informationen zu diesem bedeutenden Kulturerbe auf der Grundlage eines statischen Wissensbegriffs sowohl in der Dauerausstellung[„Dauerausstellungen und dynamisches Wissen", „Der digitale Zwilling", 4, S. 310, 313] vermittelt als auch in „Sammlungen online" präsentiert. Der Annäherung an das Ausstellungsstück im Museum waren aus konservatorischen Gründen durch eine Absperrung Grenzen gesetzt und die Kontextualisierung durch alte (Text und Grafik) sowie neue (Audio und Video) Medien erforderten hohe kognitive Anstrengungen bei den Besuchern.

Nach der Schließung der Dauerausstellung im Südflügel des Pergamonmuseums im Oktober 2023 ist das Aleppo-Zimmer bis zur Eröffnung der neuen Dauerausstellung im Nordflügel nicht zugänglich. Da für diese neue Präsentation keine Nachbildung geplant ist, werden wohl auch zukünftig Besucherinnen und Besucher die Atmosphäre eines syrischen Empfangsraumes vom Anfang des 17. Jahrhunderts nicht direkt räumlich und haptisch erfahren können.[vgl. 48, S. 247f. über den Nachbau einer ägyptischen Grabkammer]

Die Annäherung an das Kulturerbe und seine vielfältigen Verbindungen zu verschiedenen kulturellen Aspekten kann jedoch auch erleichtert werden, wenn zum Beispiel die wichtigsten Veröffentlichungen und deren Autor*innen den „Knowledge Graph" für das Aleppo-Zimmer mit wenigen Personen[„Museumsobjekte im Vergleich", 9, S. 112f.] ergänzen. Hierfür wurden in Wikidata die Publikationen von

- Christian Ewert (GND: 130629359),
- Julia Gonnella (GND: 1053820968),
- Claudia Ott (GND: 120939142) und
- Kassem Toueir (GND: 126345058X)

hinzugefügt. Der „Knowledge Graph"[110] zeigt nun diese Veröffentlichungen als Verknüpfung mit dem Aleppo-Zimmer (Abb. 9).[111] [vgl. auch 112]

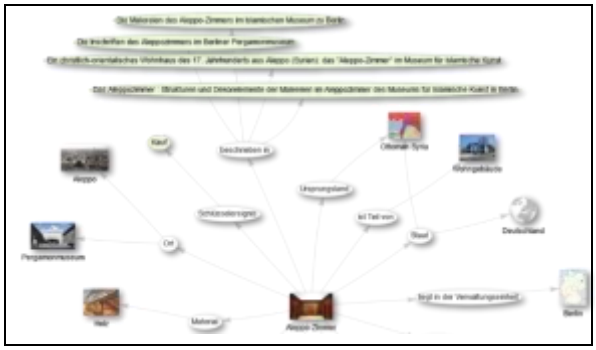

Abb. 9: Knowledge Graph mit Publikationen

Die wissenschaftliche Veröffentlichung der Inschriften des Aleppo-Zimmers[113] als „Wikidata-Item" Q123234756 beinhaltet die Information, dass Claudia Ott deren Autorin ist. Gemeinsam mit den in der deutschen Nationalbibliographie[114] verknüpften Informationen (Abb. 10) und weiteren „Linked Open Data" lassen sich Forschungsstrukturen model-

lieren, die die Auseinandersetzung verschiedener Personen mit dem kulturellen Erbe „Aleppo-Zimmer“ zeigen und damit weit über die üblichen Beschreibungen von Museumsobjekten hinausgehen. Vor allem aber wären solche Teile eines „digitalen Zwillings“ auch eine Ressource für Menschen, die keinen Zugang zum physischen Museumsobjekt haben.

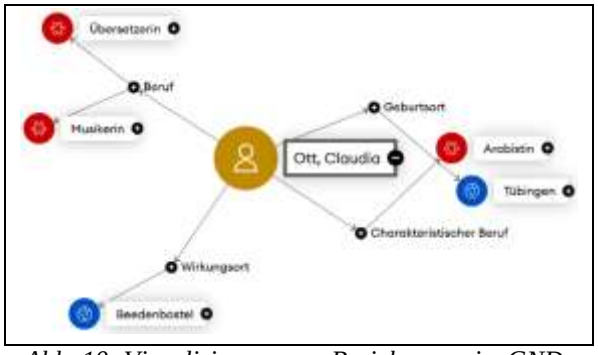

Abb. 10: Visualisierung von Beziehungen im GND-Explorer[115]

3. SCHLUSSFOLGERUNGEN

1. Wenn die „Wertschätzung von Originalen als Mittel sozialer Distinktion […], mit dem die über *kulturelles Kapital* verfügenden Schichten ihren Geschmack beweisen und sich von den weniger privilegierten Gruppen abgrenzen“,[48, S. 185f.] in den Museen nicht mehr als Voraussetzung für das Bestehen als Gedächtnisorganisation gesehen wird,[vgl. „Diskussion der Ergebnisse der Untersuchung“, „Implikationen für die Praxis“, 48, S. 243–249] können für alle Museumsaufgaben neue Perspektiven und Möglichkeiten erschlossen werden.

2. Die Befreiung von Museumsobjekten aus bestehenden Besitzverhältnissen durch Dekolonisierung muss keinen Verlust für die Gedächtnisorganisation „Museum“ darstellen, wenn die (Re-)kontextualisierung konsequent mit Mitteln und Methoden der digitalen Transformation vorangetrieben wird. Sowohl die eigenen analogen und digitalen Informationssammlungen (z.B. Archive, Fotoarchive, Abformungen oder Modelle) der Museen als auch externe Quellen sind dabei zu nutzen, um in der jeweils höchsten Digitalisierungsklasse[„Digitalisierungsklassen und -anforderungen aus fachwissenschaftlicher Sicht“, 10, S. 18–23] zu digitalisieren und als „Linked Open Data“ bereitzustellen.

3. Die Konzentration auf die Informationen über die Objekte und die Einbindung der Museen in global vernetzte Informationsstrukturen hat nicht nur das Potenzial, personelle und finanzielle Kapazitäten freizusetzen, sondern bietet gleichzeitig die Chance, die unnötige Konkurrenz[vgl. „Universität contra Museum? Ein kompliziertes Verhältnis“, 116, S. 311–313] zwischen Museums- und Universitätswissenschaften zu beenden.

Das Fazit könnte frei nach Loriot[117, S. 298: „Ein Leben ohne Mops ist möglich, aber sinnlos“] lauten: Ein Museum ohne Objekte ist möglich und sinnvoll.

4. DANKSAGUNG

Für anregende Diskussionen und Hinweise danke ich Andreas Bienert (https://www.wikidata.org/wiki/Q119568949) und Frank von Hagel (http://www.isni.org/0000000024032454).

Mit „Mahalo nui loa“ danke ich meinen Lehrerinnen und Lehrern in Hawai‘i, namentlich Kumu Ehulani Stephany, Kumu Frank Ka‘anana Akima, Jonathan Kaleikaukeha „Kimo“ Lopez (†), Kumu Lorna Kapualiko Lim, Lynda Saffery und Kumu Michelle Kaulumahiehie Amaral, die mir Einblick in hawaiische Traditionen ermöglichten.

5. LIZENZ, ABBILDUNGEN UND LITERATUR

5.1 LIZENZ

5.2 ABBILDUNGSNACHWEIS

Abb. 1 Objekte im Museumsdokumentationssystem (Museum für Islamische Kunst, Berlin): „Stand der Dinge“, von Jacqueline Neuner [CC BY-SA 3.0 (https://creativecommons.org/licenses/by-sa/3.0/)]

Abb. 2 Informationssystem Museum, Abb. 3 Digitaler Zwilling eines Sammlungsobjekts: Thomas Tunsch [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0/)]

Abb. 4 Wirkungsorte von Paul Erich Kirmse: https://explore.gnd.network/gnd/1269920588/relations

Abb. 5 Eventmodellierung im CIDOC-CRM: „Figures and Diagrams“, CIDOC CRM, https://cidoc-crm.org/figures, Fig. 2 (Version 7.2.2)

Abb. 6 Citation Graph: „Citation Graph: The Influence of Islam on Medieval Europe“, https://citationgraph.org/graph/8f19d0fa7d74aace.

Abb. 7 Wissenschaftssoziologische Informationen: „Burchard Brentjes“, https://wikidata.metaphacts.com/resource/wd:Q1010297

Abb. 8 Ki‘i Kihawahine: „Kihawahine“, von Claudia Obrocki [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], https://id.smb.museum/object/996611

Abb. 9 Knowledge Graph mit Publikationen: „Aleppo Room (Q1240477)“, Wikidata Query Service [CC BY-SA 4.0 (https://creativecommons.org/licenses/by-sa/4.0)], https://scholia.toolforge.org/topic/Q1240477.

Abb. 10 Visualisierung von Beziehungen im GND-Explorer: „Ott, Claudia“, https://explore.gnd.network/gnd/120939142

5.3 LITERATURHINWEIS

Soweit möglich wurden alle Online-Ressourcen im Internet Archive gesichert und können bei Bedarf mit Hilfe der „Wayback Machine“ (https://archive.org/web/) abgerufen werden.

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SESSION II

Digitale Gemeinschaft | Digital Community

Moderation: Dr. Thomas Tunsch
(Kustos | Museum für Islamische Kunst | SMB)

EVA Berlin

EVA Berlin 2023 Conference
30. November – 01. December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Computer 3D Models in Visual Arts Education - Some Experiences from Croatia

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ABSTRACT: This pilot research was referred on the application of computer 3D models in the field of visual arts education in Croatia. It was conducted in 2022 in Split, and involved a total of 145 participants. In the first phase, we introduced school students to computer 3D models in the teaching of visual culture and fine arts. In the second phase, we examined students' attitudes towards the application of computer 3D models in the process of teaching various art courses. The measuring instrument consisted of two questionaries. With the first one, general data about participants was collected, and with the second one attitudes about use of computer 3D models in the teaching process was examined. The results indicated that students have a high interest in using 3D models for teaching. Furthermore, they also indicated statistical significance in some of the respondents' answers concerning their gender and age.

1. INTRODUCTION

In today's everyday life, various digital technologies are prevalent, and their most numerous consumers are children and youth. Therefore, Croatian professor and educator Matijević [1] believes that alongside traditional school, there is also a digital school present today, which significantly occupies the free time of young people. Therefore, digital media have a significant impact on education, perhaps even greater than the influence of traditional schools. On the other hand, computer science professor Newport [2] advocates for digital minimalism because he believes that all of us, especially children and youth, are exposed to the excessive influence of digital technologies and the use of various applications that divert our attention from many aspects of real life, which can ultimately have a negative impact on an individual's mental health. Nevertheless, we believe that in today's time, it is impossible to eliminate digital technology from our everyday lives. It helps us in many ways, and the youngest users need to be continuously educated about its advantages and limitations. Matijević states [3] p. 41, that "today's students do not like to be forced into participation in didactic scenarios in which they are not active and expect constant changes in teaching media, locations, and learning strategies." Therefore, we believe that certain forms of digital technologies need to be integrated into the teaching process in many subjects and at all educational levels to encourage students to engage in active and independent learning. For example, the research results of Teplá et al. [4] demonstrate that the use of 3D models and animations, or dynamic visualizations, had a positive impact on motivation, active

participation in the teaching process, and understanding of the educational content among science students (Biology, Chemistry and Geology). Moreover, some recent studies in medicine and forensics confirm the effectiveness of using computer 3D models in the education of medical students and forensic anthropology students [5,6].

The field of visual arts education [7] is suitable for the use of digital media, a promotion also emphasized by the current Curriculum for the subject of Visual Culture in primary school and Fine Arts in secondary school [8], which has been in effect in the Republic of Croatia since 2019. To achieve specific educational outcomes within one of the curriculum domains and develop students' competencies in the field of information and communication technology, it is necessary to apply a digital medium in teaching and learning. The use of digital media, specifically computer 3D models, in teaching various educational content in the field of visual arts education enables students to achieve better and clearer visualization, modernizes the teaching process, and makes it more interesting for students. Furthermore, a few researchers emphasize that teaching students how to use computer programs that allow them to create their own 3D models can stimulate the development of their spatial intelligence. The research conducted by Benzer and Yildiz [9] is particularly interesting because they proved that computer-aided 3D modelling can improve the spatial abilities of students (future IT teachers) and positively influence their attitudes about the implementation of 3D modelling in teaching. This can significantly help their future students to develop spatial abilities as one of the key skills needed in the 21st century and for their success in the STEM, STEAM field. Suman [10] points out that experimental studies have shown that students' spatial abilities can be improved at all levels of education, the most successfully in the lower and upper grades of primary school, then in secondary education and at colleges, and with slightly less success in adults. Diezmann and Watters [11], in their long-term research on children's spatial abilities, conclude that they are related to advanced drawing and painting abilities. It follows from this that through the subject Visual Culture, the spatial intelligence of children and young people can be encouraged through certain activities. Comparing different approaches to designing an art curriculum for primary schools, Edwards, Caldwell, and Heaton [12] advocate connecting traditional artistic expressions (drawing, painting, modelling) with digital technology, because today's students live in a time where digital and virtual are intertwined with realistic.

2. 3D TECHNOLOGY IN VISUAL ART EDUCATION

2.1 COMPUTER 3D MODELS IN THE TEACHING OF VISUAL CULTURE AND FINE ARTS

In the teaching of visual arts, 3D technology can be used in the teaching and learning process, which we will present in a few examples from our teaching practice where we introduced school students to computer 3D models in the teaching of visual culture in primary school and fine arts in secondary school (The implementation of 3D technology in teaching visual culture and fine arts was carried out by Vana Mardešić as a student in 2022 during her professional-pedagogical practice in the Master's program in Visual Culture and Fine Arts at the Arts Academy, University of Split).

One of the ways to implement 3D technology in art classes can be teaching students in using computer programs that will allow them to design their own 3D models. Such a modern approach is particularly acceptable in the implementation of some teaching topics, especially in the field of architecture, sculpture, and design. With the various possibilities offered by the program, many artistic and compositional elements and terms related to a certain teaching topic can be explained in a modern and interesting way.

For the application of 3D technology in the implementation of selected teaching topics in the seventh and eighth grade of the Kman-Kocunar elementary school in Split, it was necessary to organize the lessons in an IT classroom so that students could have access to computers. Blender, a computer program for 3D modelling, was previously installed on all available computers. After a short introduction to the teaching topics, students were introduced to the basics of using the program and navigating the interface and were shown the tools within the program that can be used for modelling. The students followed with interest and very quickly understood how to use the program. Each of the teaching topics was realized in 90 minutes, i.e., two class periods. Even though two students used one computer,

each student was able to create an independent artwork.

Seventh grade students had the task, while thinking about the proportions of the human face, to create a 3D model that represents a caricature, within the "Together we are different" teaching topic, with the "Portrait and self-portrait" subtopic. The motive of their digital work could be a person they know personally, a famous or imaginary person. The students were very motivated and active during the creative process, they collaborated, exchanged, and upgraded their knowledge, discovering something new and unusual.

Figure 1: *Seventh grade students' works - caricatures created in the computer program Blender*

Their art solutions, created using digital technology, are interesting, creative, and original. Some of the art works, caricatures, are shown in Figure 1.

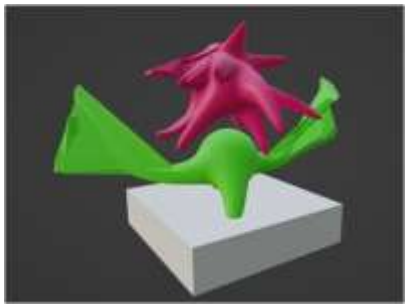
Eighth grade students had the task of designing a public sculpture/monument in the 3D program, using the contrast of shapes, surface textures or colours, within the "Art and Community" teaching topic. Although this task was more complex than the previous one, carried out in the seventh grade, due to the addition of colour and texture, it gave the students more creative freedom, therefore they showed a significant interest in using the 3D program. Some of the students independently explored the possibilities, found advanced solutions, and showed an unexpected willingness to discover, navigate and learn independently within the program they were using for the first time. Figure 2 shows some of the artworks, student proposals for public sculptures.

Often, students in the seventh and eighth grade of primary school lose interest in the contents of the Visual Culture subject. There is a lack of motivation and interest in participating in creative tasks. The reasons are multiple. Despite this fact, students in the final grades of primary school, who had the opportunity to get acquainted with a new, unusual, and challenging medium, showed significant interest in the art process, active learning of 3D programs, collaborative learning, peer-evaluation, and self-evaluation. Also, they exceeded our expectations in the skill of using the computer program Blender, which they encountered for the first time.

With the minimal intervention of the student (V. Mardešić) who organized and coordinated active, mostly independent, and collaborative learning, they were able to create three-dimensional works of art virtually skilfully and resourcefully.

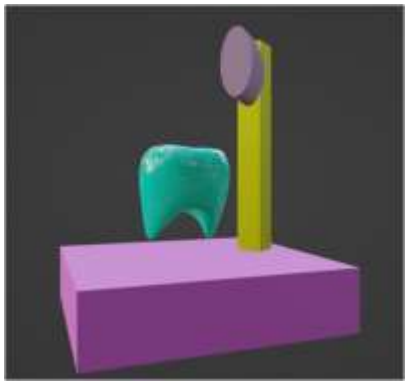
The use of 3D technology in the teaching of visual arts in secondary schools, particularly in high schools (as well as in the teaching of numerous theoretical courses in art and art history departments, as well as art history studies), is primarily focused on teaching content. The possibilities of applying 3D technology in education are significant. Many 3D reconstructions and models are readily available on several well-known, free, and

accessible websites [13]. During the conducted teaching topics “Elements of Form in Sculpture” and “Palace” in the first and second grade of the 3rd and 4th Gymnasium in Split, V. Mardešić enriched the presentations with 3D animations and 3D rotating models, explaining the subject matter in the fields of sculpture and architecture.



Strange Plant

Ballerina



Tooth and Brush

Figure 2: *Eighth grade students' works - public sculptures created in the computer program Blender*

For example, when showcasing and introducing architecture through 3D models and animations, it is easier to immerse students in the spirit of the era in which the architecture was built, as well as the methods and sequence of construction. This method of presenting, introducing, and interpreting significant architectural works allows students to have a more immersive experience because they can perceive the architectural object or complex in a three-dimensional manner, like how they would experience it *in situ*. Furthermore, by utilizing digital technologies in the teaching process and departing from the traditional approach to teaching and interpreting architecture using images, photographs, floor plans, and drawings, students become more interested in the subject matter and gain a better understanding of the teaching content. The implementation of 3D rotating models is also beneficial in teaching topics related to sculpture, as their three-dimensional virtual models provide a more comprehensive experience compared to a few static photographs of a selected sculpture. Even in the teaching and learning of subjects related to painting, it is sometimes desirable to enable students to take a virtual tour (with the help of 3D technology) of one of the world's museums.

It is unquestionable that a complete experience of an artwork occurs in the direct encounter of the recipient with the artwork. Nevertheless, the indirect experience of a painting, sculpture, or architectural piece made possible by virtual 3D technology has a positive educational and developmental impact on students, while simultaneously modernizing the teaching process.

2.2 STUDENTS’ ATTITUDES TOWARDS THE APPLICATION OF COMPUTER 3D MODELS IN THE TEACHING OF VARIOUS ART COURSES

In the second phase of the pilot research, we examined students’ attitudes towards the application of computer 3D models in the process of teaching the visual culture, fine arts, and various art-historical courses at the higher level, both for the educational purposes and the encouragement of spatial abilities. The measuring instrument consisted of two questionnaires. With the first one, general data about participants was collected, and with the second one we examined students’ opinions and attitudes about use of computer 3D models in the teaching process through six questions that contained the Likert assessment scale. The latter was analysed using the chi-squared test and the two-proportions z-test methods.

In the research, 145 participants took part, of which 47 (32.4 %) were primary school students, 61 (42.1 %) were secondary school students, and 37 (25.5 %) were college (arts

academy) students. Of these, there were 57 (39.3 %) male participants, 84 (57.9 %) female participants, while 4 (2.8 %) participants chose not to disclose their information. The participants ranged in age from 13 to 46 years (M=16.94; SD=4.41).

The data were collected in Split, in the period from March to July 2022, in two primary schools (Kman-Kocunar Primary School, Lokve-Gripe Primary School), two secondary schools (3rd Gymnasium of Science and Mathematics, 4th Gymnasium - Marko Marulić) and at the Arts Academy of the University of Split.

The questionnaire on the use of computer 3D models in teaching contained a total of six statements/questions which are:
Q1 In previous visual art education, teachers used computer 3D models in teaching to explain the subject matter.
Q2 I understand the space shown in a 3D model better and easier than the one shown in a 2D picture.
Q3 When a teacher uses a computer 3D model for interpreting graphics, it motivates me to pay more attention in class.
Q4 The material presented through a computer 3D model is more interesting to me.
Q5 I wish that in the future, 3D computer models will be used in teaching.
Q6 I would like to learn how to design 3D computer models in an appropriate program / I want to have additional education in that field.

The participants expressed their agreement or disagreement with the stated statements on a 5-point Likert scale, and they responses are shown on the Figure 3.

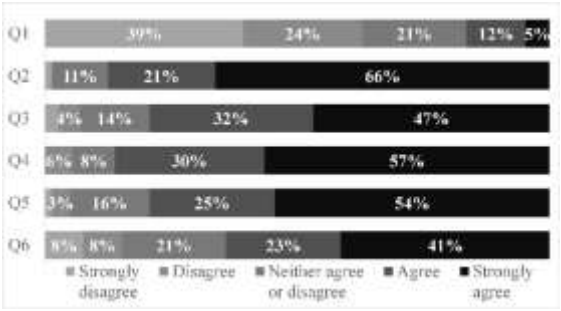


Figure 3: *Student's responses to six statements/questions (Q1-Q6) from second questionnaire*

Although number of randomly selected examinees from schools and higher education institution was small, the results indicated that 79 % of them expressed interest in using the 3D models in art classes (Q5), and more than 80 % said that monitoring and understanding teaching content was eased using computer 3D representations (Q3; Q4). Furthermore, 87 % of examinees believed that they had better, and easier understanding of space presented by the 3D model in comparison to the 2D image presentation (Q2) and 64 % of examinees would like to learn to design computer 3D models and have additional education in this field (Q6). Moreover, 63 % examinees believed that teachers in the previous visual art classes have not used computer 3D models (Q1). The results indicated that students have high interest in using computer 3D models for teaching different subjects in the field of visual arts education. Furthermore, the results show that in their previous education, a small number of teachers used computer 3D models in teaching.

In this article, we briefly presented the results related to the attitudes of students from the second research questionnaire, while their comprehensive analysis and discussion were presented in the previous paper, which is in the process of publication [14].

Furthermore, we were interested in whether the gender and age of the participants have a significant influence on their attitudes related to the use of computer 3D models in the field of visual arts education. Therefore, we statistically analysed the obtained results using the chi-squared test and the two-proportions z-test methods.

2.2.1 THE INFLUENCE OF GENDER ON STUDENTS' ATTITUDES

The chi-squared analysis of students' attitudes showed a deviation for the gender variable in the first and third research questions, Q1: In previous visual art education, teachers used computer 3D models in teaching to explain the subject matter, and Q3: When a teacher uses a computer 3D model for interpreting graphics, it motivates me to pay more attention in class.

In the first question (Q1), the attitudes of males deviate more from the expected responses compared to females, and this deviation falls within the negative spectrum. The response to question Q1 is extremely negative, with a predominant presence in the strongly negative part of the Likert scale. When analysing by gender, the two-proportions z-test showed a

significant deviation for the strongly negative and neutral parts of the Likert scale, reflecting the significantly more negative attitude of males compared to females. The male participants expressed significantly stronger disagreement with the statement regarding the previous use of computer 3D models in the field of visual arts education, as graphically represented on the Figure 4.

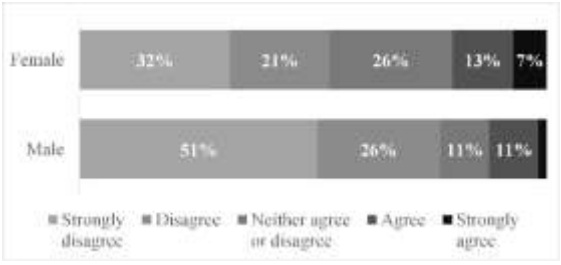


Figure 4: *Female and male responses to the first statement/question (Q1) from second questionnaire*

In contrast to the predominantly negative attitude expressed by the participants in the first research question, the overall attitude of the respondents related to the third research question (Q3) is positive, with a predominant presence in the strongly positive segment of the Likert scale. In this question as well, the attitudes of males deviate more from the expected responses compared to females, in the sense that they are less positive than the attitudes of females. The two-proportions z-test showed a difference in the positive part of the Likert scale, which is also evident on the Figure 5, with females having a more positive attitude than males regarding the stimulation of motivation and attention when using computer 3D models in the teaching of various art courses.

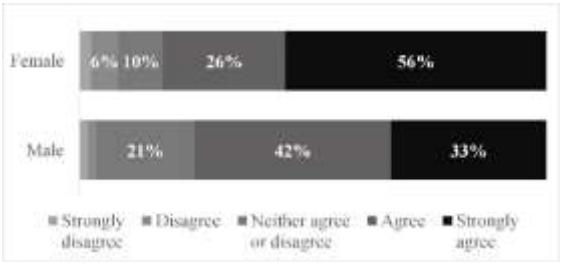


Figure 5: *Female and male responses to the third statement/question (Q3) from second questionnaire*

2.2.2 THE INFLUENCE OF AGE ON STUDENTS' ATTITUDES

The chi-squared analysis of students' attitudes concerning the variable of age revealed differences in their attitudes in the first research question, Q1: In previous visual art education, teachers used computer 3D models in teaching to explain the subject matter, and the sixth research question, Q6: I would like to learn how to design 3D models / I want to have additional education in that field.

Secondary school students' attitudes related to the first research statement/question (Q1) deviate the most from the expected responses, and the two-proportions z-test indicates the most significant change in the moderately positive part of the Likert scale, in the sense that their positive attitude has been reduced compared to others. Consequently, secondary school students have the most pronounced negative attitude towards the use of computer 3D models in their previous visual arts education compared to the other two groups of participants, as shown on the Figure 6. This could suggest that secondary school teachers used computer 3D models to a lesser extent in their previous teaching of Fine Arts compared to elementary school and college teachers.

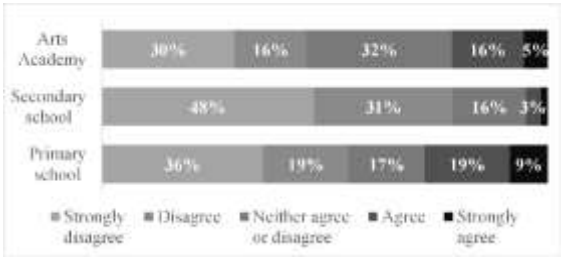


Figure 6: *Student's responses to the first statement/question (Q1) from second questionnaire concerning their age*

Furthermore, the attitudes of students from the Arts Academy regarding the sixth research statement/question (Q6) related to the desire for additional education in the field of designing computer 3D models deviate the most from the expected responses. The two-proportions z-test shows significant deviations for the strongly negative and strongly positive parts of the Likert scale. The negative attitude of the Arts Academy students is reduced compared to other attitudes, while the positive attitude is strengthened. As a result, the attitude of students from the Arts Academy is extremely positive compared to the other two groups of participants, which is evident on the Figure 7. We can conclude that such an attitude is expected because of their mature age and professional curiosity towards the application of new digital technologies in the field of fine arts and visual art education.

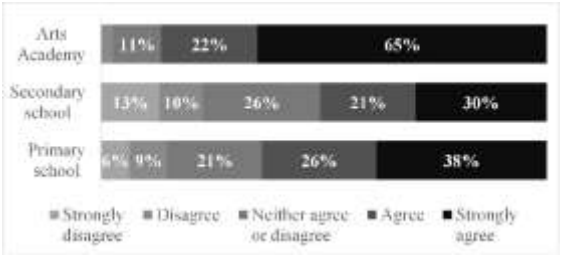


Figure 7: *Student's responses to the sixth statement/question (Q6) from second questionnaire concerning their age*

3. CONCLUSION

In this article, we presented the results of a pilot study that aimed to examine the attitudes of students of different ages (elementary school, secondary school, and college, i.e., Arts Academy students) regarding the implementation of computer 3D models in visual arts education. The results point out that students have high interest in using computer 3D models for teaching different subjects in the field of visual arts education. Furthermore, they also indicated statistical significance in some of the respondents' answers concerning their gender and age.

The significant interest shown by students in using and utilizing computer 3D models in visual arts education should have a positive impact on teaching practice. Teachers of all subjects within the visual arts education should use computer 3D models in their teaching and should be trained for this purpose. Implementation of the 3D technology in the teaching of Visual Culture, Fine Arts and many art-historical courses at higher education institution would modernize the teaching process, enrich the teaching content, make it more interesting to students, and positively impact promotion of their visualisation and spatial abilities.

4. ACKNOWLEDGMENT

We express our gratitude to all the students who voluntarily participated in this research.

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New technologies, new narratives, new experiences
Stories between exhibiting and AI

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ABSTRACT: This paper focuses on the relationship between new technologies, contemporary art and exhibition methods and questions how AI can demystify creativity and suggest alternative developments and uses. It studies a specific case study, the exhibition *Another World* of Christopher Kulendran Thomas, organized between October 2022 and January 2023 by the Institute of Contemporary Art (ICA) in London and the KW Institute for Contemporary Art in Berlin. *Exploring* the creative, social and political potential of new technologies, the show focused on the liberation war of Tamil Eelam, an autonomous territory in Sri Lanka (the artist's birthplace). Blurring the boundaries between historical research and fiction, online data and personal experience, the artist created video installations and paintings to explore primordial questions regarding identity, nationality and creativity and to portray an alternative, utopian reality. Eventually, the paper highlights how today's new technologies and the consequent aesthetic and phenomenological experience can be exploited to structure an alternative political and philosophical thought.

1. INTRODUCTION

Between October 2022 and January 2023, the Institute of Contemporary Art (ICA) in London and the KW Institute for Contemporary Art in Berlin presented the first major exhibition of British-Tamil artist Christopher Kulendran Thomas.

Titled Another World, the exhibition showed the creative and socially active potential that an alternative approach to technology can offer. It focused on the liberation war of Tamil Eelam (1983-2009), the artist's birthplace and an autonomous territory born as a response to the discrimination, persecution and purges against the Tamil minority within the former British colonial island, Sri Lanka. In the 1980s, during the civil war, this state was self-governed by a revolutionary movement which, in the early years of the World Wide Web, used the Internet to coordinate a globally distributed parallel economic system among the Tamil diaspora. Precisely, from the mid-1990s [#], the LTTE began to explore the heuristic potential of the Internet. They used it to add dimension to the issues of belonging, information, and human rights, to create an independent network of information and spaces for debate, to manage a parallel and autonomous economic system and to finally shape sustained nationalist ideologies. Eventually, the Internet has made it possible to spread the Tamil utopia on a global scale, cultivating the feeling of a nation and thus building a real community within a virtual state. Despite this political and social involvement, the military conflict between Tamil and the Sri Lankan government ended in 2009 with the disappearance of the autonomous state and the flight of thousands of people.

The artist, together with longtime collaborator Annika Kuhlmann, started from this collective and at the same time personal history by asking himself a simple question: "How do you tell the story of the losing side of a conflict when history has already been written by the winners?". The exhibition was designed to answer this question and, implicitly, to suggest new ways to blur the boundaries between reality and fiction, not in an attempt to establish a hierarchy or make a judgement, but rather to experiment with new forms of sociability that can be concretely put into practice.

[#] The destruction of the state resulted in the closure of all websites and social platforms dedicated to it and, therefore, the loss of the archive and, ultimately, the erasure of collective memory. On this topic, see (Ranganathan, 2010).

2. "OUR HISTORY HAS BEEN ERASED, WHY NOT REINVENT IT?"

The main work of the entire exhibition was the imposing video installation, *The Finesse* (2022), which organized two sculptures representing Tamil ceremonial dresses on the sides of five monolithic mirrored screens onto which a video created for the occasion was projected and on which the public sometimes reflected, at irregular intervals, thus merging in a sort of architectural and visual hallucination. As such, the installation actively participated in the implicit contents enunciated by the video, thus becoming a critical parameter of the work. The film articulates the narrative power of technology by combining archival footage with AI-generated processes to blur the lines between historical and fictional research, to induce further horizons, other interpretations, and different consequences and to give life to an alternative reality that seems to ask whether network technology can create a true utopia or perhaps another story.

The video portrays the region of Tamil Eelam, presenting it as a sort of utopian self-sufficient community dedicated to cooperation, through the apparently logical succession of real or fictional clips where archive videos, CGI avatars, scientific politics and clips of pop culture (specifically, the most viewed clips from TikTok or YouTube) alternate accompanied by music or interviews. Depending on the temporality of the visit, one may come across videos of the forest planted by the Tamil liberation movement during the civil war as a sustainable source for a self-sufficient society, or other clips, such as those created using Unreal Engine and Generative Pre-trained Transformer 3 - GPT3 (a game software from 3D computer graphics) which instead depict areas of the forest made inaccessible by the archaeological task force of the Sri Lankan government. Others clips then showed Tamil Tiger propaganda videos from the 1990s, in which a soldier, while travelling through the Tamil jungle, clarifies the value of decentralized information systems and the ironies of Western democracy, illustrating ideas about a new self-sufficient state in which artists work for collective liberation rather than individual expression. Within this succession of clips, there were then AI-generated "deep fake" videos showing the avatar of Kim Kardashian (an American media personality) describing the devastating effects of social media on our society and identity; and another one presenting the Tamil dancer and director Asmina Thirunavukarasu intent on sharing her thoughts on the diaspora during a bus trip: "Being Tamil, she says, means understanding reality as fiction"; "Our history has been erased, she continues, why not reinvent it?".

In the succession of these clips, between real and fictitious images, the film often and suddenly stops at different moments and without apparent logic, which nevertheless seems to rhythmically suggest the need for cognitive reflection, the need to take a break and think about what one has just seen or heard. At particular intervals, the screens, therefore, turn off to give the audience time to incorporate and embody thoughts, but at the same time, to appear what they ultimately are, i.e. five black and monolithic steles that rise in front of the people reflecting their image together with the forest projected behind them. The interruption of the video thus allows the individual's body, implicated and wrapped in a sort of electronic jungle, to emerge into a new idea of collective, shared, possible and at the same time utopian reality.

While the starting point of the exhibition has been the question regarding the way in which one can tell the story from the losing side without being subjugated by the winning thought, the subsequent question that the work seemed to raise is rather how we can inspire constant changes and allow for of another ending. "How can we radically give shape and life to new narratives?" The answer lies in the way the film is processed and shaped, that is, in a video that is never the same twice. The film

indeed is continuously renewed within a process of self-generation through algorithms, thus giving shape to an infinite and always different video.

Blurring the boundaries between historical research and fiction, online data and personal experience, collective temporality and fictional timeline, the artist explores primordial questions regarding identity, nationality, human rights, but also creativity and speculative narratives and, above all, he portrays an alternative reality. In particular, he examines how art, architecture and technology may today be able to probe the capabilities of new technologies, to build a new community feeling based on other non-capitalist systems and to shed light on decentralized societies like that of Tamil. Eventually, *The Finesse* traces the attempt of the Tamil liberation movement to imagine a cooperative economy based on renewable energy, common ownership and mutual coordination, but also to discuss mistakes made or supposed and then focus on the broader questions arising from the failure of utopia. The particularity of the artist's intervention also lies, above all, in his capability to include the spectator within a simple installation but at the same time capable of suggesting an emotional dimension and inducing a reflection that goes beyond simple aesthetic enjoyment.

Around this main work, a series of other projects have corroborated the contents implemented by the artist. The video *Being Human* (2019), for instance, once again makes use of the combination between the architecture of the work, engaged thought, and the holistic potential of AI to suggest different scenarios. For the installation of this video, the room was divided into two parts by a transparent glass wall as wide as the room (which therefore prevented access to the second part) on which another film was projected. In this case, *Being Human* mixes the story of how Thomas Kulendran's uncle prefered to stay in Sri Lanka, rather than escape, to establish a human rights centre, with monologues on the paradox of politics (between protection and repression) or on contemporary art and the concept of authenticity, argued most often by avatars that like the painter Oscar Murillo or Taylor Swift ("pretending fake behaviour is the only way to be real"), and also by a young Tamil artist who he travels on a train to his father's hometown, discussing the influences of analytic philosophy and Kant's immanence on identity and art.

The peculiarity of this installation is, once again, its rhythm. With greater force compared to the first installation, in this case, the visual rhythm was intertwined with moments of lucidity (of thought), whereby the video disappeared, soft lights came on, and the screen became transparent, allowing a glimpse of the behind the scenes, that is, revealing the second part of the room, blocked by the wall, set up with sculptures and paintings. Immersed in darkness, the audience experienced once again their presence. The moment of detection, the moment of light, when it is thus possible to see the behind, where the work reveals its presence and the public experiences the impossibility of sight, is, therefore, the climax of the entire installation. Of even more interest is the choice of pictorial works that the artist creates using machine learning algorithms that focus on the art-historical influences of the Western canon on the post-civil war Sri Lankan art world, thus revealing the ambivalent relationships and consequences of a colonial imaginary devoid of historical identity. Furthermore, these are not simple prints of paintings created by algorithms but paintings on canvas created by the artist's studio on the basis of artificial images, which, therefore, call into question the issues of authorship, attribution and appropriation - topics that are dear to the artist since his first experiments - and which find a link with the issues raised by the CGI avatar present in the *Being Human* video which states: "simulating similar behaviour is the only way to avoid having to do it seriously".

These paintings also join another work started in 2013, *When Platitudes Become Form*, for which the artist began purchasing works from contemporary art galleries in Sri Lanka and then inserted them into the international market of current Western art through a hybridization process. More precisely, the artist purchases works that have experienced real success in the new regional contemporary art market that has developed in Sri Lanka in the last ten years, just after the end of the civil war in 2009, and then integrates them into new works, through a process of collage, manipulation or simple juxtaposition. Both for the paintings created starting from images generated by an algorithm and for this latter work, it is a question of interacting with the influence of colonialist aesthetics through processes of translation, appropriation, positive destruction, and creative speculation in a way to reveal the long-term effects that colonial regimes have had on art in postcolonial nations.

3. INHABITING THE BORDERSCAPE

Exploring the defeat of the revolutionary struggle for Tamil independence, the exhibition not only highlighted the possibilities offered by technological innovation in inducing, creating and suggesting new holistic narratives but also addressed political and social issues, probing non-hierarchical forms of self-government. It was a question of staging largely untold, handed down and hoped for stories of that liberation movement and its possible legacies that, therefore, become the projection of the challenge that the artist undertakes, that is, "how to tell differently". The artist's creative approach also reveals how AI can demystify creativity and suggest alternative, socially and politically engaged developments and uses. Above all, the artist never lets fiction overtake reality but instead suggests an alternative way to observe the border, to experience its temporality, the radicality, that is, of a border that is often blurred, but still present: an inhabitable *borderscape* (Rajaram, Grundy-Warr, 2007; Brambilla, 2015).

Beyond the geopolitical context in which the concept is defined, the borderscape must be understood here from an empirical and abstract point of view, as" […] a fluid field made up of a multitude of negotiations, claims and counter-claims", and above all as a "contact zone" in which it is possible to find, as suggested by Mary Louise Pratt, "[…] subjects […] constituted in and by their relations between them" (Pratt, 2008, 8). Thus defined, within our context of studies, the notion of borderscape suggests the narrative utopia implemented by Christopher Kulendran Thomas. A border that no longer appears as an imaginary line that divides, but rather as a gray area, a variable space, a hybrid site in which "conventions are not yet established and still up for negotiation" (Bishop, 2023, 37), an uncharted and "unclaimed territory that exposes the prejudices and attitudes of our culture, as well as the way we practice architecture" (Borasi, 2019, 18). A no-man land.

It is, therefore, a multivalent concept that evokes both its limits and its very content. However, the understanding of this gray area is variable, depending on whether one looks from inside it or from the outside. In this sense, the borderscape refers, almost by contrast, to the idea of a permeable border in motion. Neither a space that unites nor a distance that separates two opposing shores, the border is here understood as a contained volume, a procedural and autonomous space to be explored. The concept of borderscape can thus be considered as a dynamic and flexible transition process, a *borderscaping*, within which a series of negotiations between subjects (animate or inanimate, visible or invisible) determines the emergence not only of what lies beyond the border but above all of what is found inside and which the semiotician Jurij Lotman (2009) would define as possible passionate and unpredictable enunciations that leave room for the "most varied discards and the most complex dialogues".

The example of Kulendran Thomas, therefore, seems to fit into the epistemological turning point that sees art increasingly reaching the discursivity of stories and social problems and echoing the new "ecology of knowledge" (Boaventura da Sousa, 2007) for which artistic practices are understood more as places of knowledge production in which "intellectual technologies" (Goody, 1977) manifest themselves thanks to new visual writing techniques. More precisely, these new practices insinuate themselves within the decolonial theory that proposes not a destruction or deconstruction of knowledge and discourses but rather its decolonization. New imaginative geographies, or rather, third spaces (Soja, 1996) that explore the multiple senses of the idea of line, border, edge, understood as liminal space (Turner, 1969), spaces "of otherness, of comparison and of identity mixing, spaces also of coupling of the real and the imaginary, spaces, above all, crossing the binary logics of modernism to move towards a multiplicity, other spaces created by difference, towards a revised spatiality, which, starting from this difference, elaborates new places for the struggle and the construction of interconnected communities of resistance" (Westphal, 2008).

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Where past and future meet: Artificial intelligence and the art museum

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ABSTRACT: Museums seek new ways to engage, enchant and educate audiences. In the future, Artificial Intelligence will play an increasingly important role in audience-orientated digital learning and engagement offers as well as in scientific terms as a research companion for museum curators. Now first steps in this direction are being taken in small experimental projects as for example in the AI project presented here "The *Infinite Loop* ring". It is a joint project between artists and art museums. AI can inspire artists interested in interrogating the past, working along similar lines as museum curators do in processes of data gathering and interpretation. "The *Infinite Loop* ring" shows how (art) historical museum collections can be used for new artistic questions and demonstrates the development potential of museum artefacts. At the same time, curators and artists can enter into an exciting new dialogue with visitors with the help of such creative, forward-looking projects.

1. INTRODUCTION

Museums and artists both seek new ways to engage, enchant and – maybe even educate audiences engulfed and numbed by endless images. This shared goal makes museums and artists natural partners in their quest to understand and preserve the past. With Artificial Intelligence, a new partner has arrived on the scene, which supports the creation of new artistic content that dazzles and inspires people, and becomes a gateway to engaging with historic collections.

Globally, museums have long added digital programming to their Learning and Engagement offers. Artificial Intelligence has a role to play in this that, as of yet, is in its infancy. In addition, AI is becoming a powerful research companion for museum curators in all types of museums – from art and culture to natural history and technology – especially when large numbers of objects (= data sets) need to be analysed and compared in a short period of time. Given that many national collections comprise hundreds of thousands if not millions of items, Artificial Intelligence's potential for museum management and research appears to be almost limitless. To the best of the authors' knowledge, now first steps in this direction are being taken in small experimental projects. It will be fascinating to see how museums use AI for their core objectives of collecting, preserving, for researching and interpreting our material culture in five, or even ten years' time.

For artists interested in interrogating the past, AI can be an inspiration along similar lines using the same processes of data gathering and interpretation. The key difference lies in the creative process of selection and refinement, which eventually leads to a new work of art. Such works can be important in a museum context: as part of the interpretation or, indeed, as a new item in the collection.

2. THE PROJECT: THE *INFINITE LOOP* RING

Glasgow-based German jewellery artist Silvia Weidenbach and digital artist Jon Emmony from London work in different fields, but both merge traditional artistic techniques with cutting-edge technology. As the world of blockchain technology and NFTs creates a new arena of experience and ownership of art and design, they have discovered Artificial Intelligence as a tool to break down boundaries in their creative processes. Their jewellery project *Infinite Loop* first started in 2021 and thus used digital photography of rings, spanning over 3,000 years of human creation, as a starting point for the creation of an entirely new, futuristic design. They included objects from three museum collections: the Staatliche Antikensammlungen Munich, the Germanisches Nationalmuseum (GNM) Nuremberg, and The Alice and Louis Koch Collection at the Swiss National Museum, Zurich. Digital images of these historic items of jewellery were used to train an AI, which developed its own unique understanding of the meaning of materiality, form, and features in these pieces. Once this process of learning was complete, the AI began its own journey of creation, showing the human artists infinite new rings that feel familiar yet somehow distant. Through discussions around materiality (how does one convert pixels into something tangible?), gemstones that spoke to the iridescent, ever-changing properties of the digital were selected. This translation of a digital object into a physical one was expanded upon by also creating a hologram of the final ring – exploring a midway point between 'real' and digital: an object that almost felt like it could be touched. This in-between space allows for new types of objects to be created and experienced.

2.1 ANTIQUITY REIMAGINED

The starting point for the *Infinite Loop* project was Silvia and Jon's fascination with historical jewellery paired with their desire for a contemporary-futuristic exploration of design processes. At the heart of their work with ancient masterpieces of jewellery lies a deep respect for the quality of their design and making. The Greek, Etruscan and Roman gold jewellery on display in the Staatliche Antikensammlungen Munich demonstrate their makers' extraordinary level of craftsmanship, technical skills and creativity. Necklaces, finger- and earrings, bracelets and robe pins tell us about the wishes, dreams and realities of their makers' lives. They bring today's audiences closer to their time and culture of origin.

The invention of the intricate technique of granulation (fig. 1) is comparable to today's groundbreaking technological innovation of AI. Granulation had revolutionised goldsmithing in ancient times and remained a key technique for a very long time. Its beginnings date back to the 4th millennium B.C.: even the Sumerians were already familiar with this technique. The art of granulation then reached its peak in the Etruscan period.

Figure 1: *Golden disc earring with granulation, from Vulci, 500 BC, Staatliche Antikensammlungen Munich. Photo: R. Kühling*

But how did it work? The ancient goldsmith cut gold wire into small pieces. The resulting gold shards were melted into minuscule balls in a crucible with charcoal powder at about 1,100 degrees Celsius. These were then neatly separated by size using sieves. After that they were chemically soldered to the surface of the piece of jewellery. For this purpose, the goldsmith coated the base with copper carbonate, so-called gold glue (ancient Greek: *chrysokolla*). During subsequent heating, the beads bonded with the base material without melting. One had to work quickly. The artistry lay in the exact arrangement of the patterns. The purity of the material was important, with a fineness of at least 900 parts per thousand. The revolutionary thing about granulation was the discovery of the chemical reaction, i.e. the "chemical solder", which made it possible for the spheres to adhere [1].

Subsequently, jewellery with granulation decoration was produced throughout the Greek-populated world of the Mediterranean. A good example is the finger ring with granulated decoration from around 150 B.C. (fig. 2) on display at the Staatliche Antikensammlungen, which Silvia and Jon included in their project.

Figure 2: *Golden finger ring with granulation and glass stone, from Greece, 150 BC, Staatliche Antikensammlungen Munich. Photo: R. Kühling*

However, knowledge of the granulation technique was gradually lost in ancient times. It was not until the beginning of the 20th century that jewellery was made again that – in terms of technical accomplishments – could stand in comparison with its antique models. Today we have reached a next step when we see how AI has dealt with the ancient technique of granulation.

2.2 FROM HAPTICS TO MOVEMENT: FIRST STAGES OF *INFINITE LOOP*

In Munich, the project went through two stages in spring and summer 2022: a digital workshop and a first live presentation of the video [2] created with the help of AI in a museum room of the Staatliche Antikensammlungen.

First, the video was shown on April 1, 2022 as part of the Digital Workshop "Beyond the *Infinite Loop*. Dimensions of Artificial Intelligence in Art and Art History" [3] and put up for discussion. The workshop aimed at artists, curators and a general audience was co-hosted by the Staatliche Antikensammlungen and the Germanisches Nationalmuseum (GNM) and was the first public dialogue between the past and future of jewellery-making.
In the first section, three artists currently working on art projects with AI from different disciplines (Tom Furse, Artist and Musician, London; Jon Emmony, Digital Artist, London; Silvia Weidenbach, Jewellery Artist, Glasgow) contributed their experiences and perspectives. They presented their works *Infinite Loop* and *Dialogue*, which were created in the interaction and dialogue between 'human and machine'. It explored what happens in such an – unpredictable – interaction and what new ways of seeing the world emerge.

In the second section, scholars offered historical perspectives based on their current work. Their case studies highlighted how art and crafts have always given rise to innovations and inspired their makers. Astrid Fendt (Senior Curator, Staatliche Antikensammlungen and Glyptothek Munich) and Heike Zech (Deputy Director, Head of Decorative Arts, Germanisches Nationalmuseum Nuremberg) discussed this in their lectures on "*The art of granulation – 'AI' in antiquity*" and "*Nuremberg Renaissance silver: innovation between art and craft*". Beatriz Chadour-Sampson (London based jewellery historian and consultant for the Alice and Louis Koch Collection at the Swiss National Museum Zurich) explored how a profitable link between art and historical knowledge works in her lecture "*The finger ring, a defined form with an incredible wealth of interpretations*". Stephanie Heinecke (Communication Studies, Hochschule Fresenius University of Applied Science Munich) explained the significance of AI today at art and media colleges and universities in her lecture "*AI – buzzword or game changer? Implications for higher education and working life*". Elke Katharina Wittich (Head of Zentrale Einrichtung für Weiterbildung / Central Institution for Continuing Education, Leibniz Universität Hannover) showed in her lecture "*Arts and the Machine – Humanities, Artificial Intelligence and the Question of Connectivism*" [4] perspectives that can open up in the interplay between art and AI.

In the museum itself, the video *Infinite Loop* was on show from July 5-10, 2022 [5] as part of the international Munich Jewellery Week [6] (fig. 3).

Figure. 3: *Poster of the video* Infinite Loop, *which was on show in Staatliche Antikensammlungen Munich from 5-10/7/2022 as part of the international Munich Jewellery Week.*

It was projected onto a wall in the so-called treasure chamber in the basement of the Staatliche Antikensammlungen in the midst of the display cases with the Greco-Roman gold jewellery (fig. 4).

Figure. 4: *The video* Infinite Loop *was projected onto a wall in the so-called treasure chamber of the Staatliche Antikensammlungen in the midst of the display cases with the ancient gold jewellery. Photo: S. Weidenbach*

This is where the visual interplay and confrontation with the antique originals that had been made available to the AI took place (fig. 5). For the first time, it was possible to test the added value of the idea and visualisation of a ring created using AI on the basis of models from the past in front of visitors to a historical jewellery exhibition. The video served the most diverse areas of interest and expectations of museum visitors. On the one hand, in a 1:1 comparison, the templates for the video could be extracted from the moving image and compared with the still objects in the display case. While the latter carry the age value and the aura of the original, the newly created ring, which can be seen in the video, refers to the future of jewellery design and the revolution of our habits of thought concerning the production and design of jewellery. Overall, the video encouraged reflection on the meaning, aesthetics and technology of jewellery then, now and in the future.

Figure. 5: *Visual interplay and confrontation of the video* Infinite Loop *with the antique originals that had been made available to the AI. Photo: S. Weidenbach*

For visitors to the Staatliche Antiken-sammlungen, it was the first time they experienced the museum room traditionally known as the "Treasury" in a completely different ambience (fig. 6). The semi-dark ambience in which the museum showcases with the jewellery are staged along the walls was broken up by the fast-moving images of the video intervention projected onto the wall between the showcases. The visitors' first

attention inevitably fell on the new ring, created by means of AI, and its process of creation. The antique pieces of jewellery initially receded into the background, but on second glance, they came to the fore in terms of their great relevance to Silvia and Jon's newly created ring.

Figure. 6: *Thanks to the video* Infinite Loop *visitors could experience the museum room in a completely different ambience. Photo: S. Weidenbach*

2.3 PROCESS AS MESSAGE: *INFINITE LOOP* AS NEXT STEP IN CRAFTS INNOVATION

From Munich, the project travelled to the Germanisches Nationalmuseum (GNM) where it was on temporary display in the refurbished galleries dedicated to *Crafts and Trades. 1500-1900* [7]. These galleries showcase the museum's rich collection dedicated to traditional trades, their customs and products which includes the superb heritage of Nuremberg's famous craftspeople. They speak to the so-called mysteries of the trades and give an insight into a pre-industrial way of producing every day and luxury items. While especially the silver vessels created by the city's masters for a European élite still dazzle, the processes behind their creation often remain hidden. The individual piece runs a risk of being overlooked among the multitude of treasures on display, and the always-limited means of on-site interpretation. Modern curation can deal with this – by reducing the number of items on display, by offering additional layers of interpretation for diverse audiences online, and also by employing a state-of-the-art gallery design and lighting to help visitors find and understand key pieces. In order to highlight the continuity of trade and craftsmanship in particular, contemporary objects and images are paired with their historic counterparts. Silvia's and Jon's *Infinite Loop* thus became the companion to a display on teamwork from a historical perspective which explored design and making as distinct parts of the creation of an object. They could stem from the same person, but more often than not were the result of a prolonged collaboration of specialists. The use of AI to create the *Infinite Loop* is but a logical and innovative extension of the pool of collaborators.

The display highlighted the process of creation in three sections (fig. 7). The first section asks how Silvia and Jon were able to engage in a dialogue with their non-human collaborators – the AI, as well as the historical rings of the three collections – and what interfaces and intermediary instances had to be created for the different entities to work together successfully. The starting point were a few examples of the GNM's historical rings from the 15th to the 17th centuries that were involved in the project.

Figure 7: *The* Infinite Loop *display case in the galleries dedicated to Crafts and Trades. 1500-1900 at the Germanisches Nationalmuseum in Nuremberg. Photo: V. Suchy*

In order for the AI to process these historical rings, they first had to be converted into digital information – i.e. they had to be digitally photographed (fig. 8). Photography therefore represents the first step of abstraction and digitisation. To make the display readable and understandable for visitors, however, the digital images had to be reconverted to analogue print-outs. This small curatorial decision to exhibit

the photos as prints and not, for example, on an additional screen reveals one of the greatest challenges in exhibiting virtual media and algorithmic processes within the framework of more 'traditional' galleries: Often banal reasons like the lack of wall-space, technical equipment or even power-outlets limit our possibilities.

Figure. 8: *Digital image of a golden finger ring with enamel and green glass stone from the object-database of the GNM, 16th/17th century, Germanisches Nationalmuseum Nuremberg. Photo: M. Runge*

Cube-shaped paper-sculptures, whose form alludes to pixels, together with the video mentioned above, shown on a screen next to the display case, visualise the operating principles of the AI as it merges the digital images together and creates an ever-flowing, constantly changing and evolving kaleidoscope of new ring-designs. At the end of the first section, the hologram created by Jon and Silvia served as a bridge between the digital and the material form.

The second section dealt with the process of determining the form and materiality of the *Infinite Loop* ring. Out of the unending flux of ring-designs created by the AI, one was selected and several enlarged experimental models were 3D-printed in different colour-gradients. The de-materialized quality of the AI's ring-design offers endless possibilities of colour and materiality. Therefore, these qualities had to be selected consciously by Silvia and Jon. This is a crucial and particularly interesting point in the design process: Here, the human actors with their specific, conscious form of creativity take over from the AI. This is also the point where the intersection between human and artificial intelligence becomes most tangible.
In order to do the dynamic, futuristic qualities of the design-process justice, first attempts were carried out with the element bismuth – an element characterised by its iridescent rainbow colours and its crystalline staircase-structure. However, bismuth soon proved to be too brittle for the desired carving-technique, so that Silvia and Jon quickly switched to labradorite – an equally iridescent yet more sturdy mineral with a blueish, metallic shimmer. In the display, two pieces of bismuth and one of labradorite illustrate the trials and errors of the quest to give a physical form and quality to the non-material designs of the AI (fig. 9).

The next step was to print true-to-scale 3D models. The print data could in turn be used by the Pauly company in Idar-Oberstein to mill the finished ring from a piece of labradorite using a CNC (Computerized Numerical Control) milling machine. In the display, a set of diamond cutters represents this automated process.

Figure. 9: *Pieces of labradorite (left) and bismuth (right). Photo: V. Suchy*

The final section of the display consisted of the *Infinite Loop* ring itself (fig. 10). The ring thus stood at the end of a meandering path from its analogous source material through the digital realms of the algorithm and back to its material form (fig. 11). The main aim of the display was to showcase the steps that were taken by both, human and non-human actors, the decisions that had to be made along the way, and the processes that led to the finished *Infinity Loop* ring. The ring itself became a powerful materialisation of

the collaboration between human and non-human entities.
The biggest challenge in developing the display was the question of how we could give the hidden work of the algorithm a material and presentable form without taking away the specific qualities of the digital. In this respect, curating the display posed somewhat similar challenges to the ones that arose during the creation of the *Infinite Loop* itself.

The *Infinite Loop* has proven to be an innovative display which enabled the GNM to engage in meaningful conversations with its visitors. Especially during guided tours, deep discussions about the possibilities and dangers of AI, the future and importance of the crafts, and the nature of creativity itself came up. Here, the topicality of the subject certainly played into the museum's hands: Shortly after the display was opened in autumn 2022, ChatGPT went live, and a few months later deceptively real looking, yet AI-generated images of Pope Francis in a puffer jacket went viral.

Figure. 10: *The* Infinite Loop *Ring. Jon Emmony and Silvia Weidenbach, 2022. Photo: GNM.*

Both events sparked great enthusiasm and sometimes even greater panic in public discourse about AI and its impact on art, culture, and even human civilisation.

Figure. 11: *The* Infinite Loop *ring as focus and ending point of the display showcasing the collaborative journey of its production. Photo: V. Suchy*

3. CONCLUSION

"The *Infinite Loop* ring" is an experimental joint AI project between artists and art museums. It shows how collections can be used for new artistic questions and demonstrates the development potential of museum artefacts. It also opens up new ways of engaging in dialogue with the audience. The historic rings at the foundation of *Infinite Loop* spanned 3,000 years of human creativity, craftsmanship, and collaboration. They convey the wishes, dreams, and realities of their creators and tell us a great deal about their particular times and cultures. What does *Infinite Loop* tell about us?

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SESSION III

Intelligente Partnerschaft | Smart Partnership

Moderation: Freya Schlingmann
(Referatsleitung Digitale Museumsdienste | SMB)

EVA Berlin

EVA Berlin 2023 Conference
30.November – 01.December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

REINTERPRETING ARTISTS' SELF-PORTRAITS THROUGH AI DERIVATIVE CREATIONS

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ABSTRACT: Over recent years, the use of artificial intelligence (AI) in the field of Art History has garnered growing interest. Many academic publications on this relatively recent topic explore the role of AI in the analysis of huge datasets and digitised art collections, according to specific research or curatorial questions, while others address AI as a theme or a tool for contemporary artistic practices. This paper presents an alternative approach, considering generative AI as part of an interpretative methodology based on derivative images created with text prompts that specifically request a reinterpretation of a particular artwork, without adding any stylistic or contextual modifiers. Focusing on the iconic Self-Portrait (in a red coat) by the Portuguese painter Aurélia de Souza, the aim of this study is to discuss how images produced with different text-to-image AI generators may not only illustrate some of the features highlighted in Art History studies, but also foster new questions and readings of the same artwork.

1. INTRODUCTION

Reinterpretation has always been a key topic in Art History, not only for scholars and curators but also for the artists themselves. In view of their biographical relevance and subjectivity, artists' self-portraits tend to be especially fertile in terms of curatorial and creative readings. Explored in numerous exhibitions and publications, the interest in self-portraits has expanded greatly with the increasing digitisation and online circulation of art museum collections and, more recently, with the development of artificial intelligence (AI).

Over the past three decades, an exponential growth has been seen in the number and diversity of scientific publications addressing the intersection between Art History and digital technology. In line with Lev Manovich's "Database as a Symbolic Form" (1998) [1], many authors have studied the ways in which art databases and digital tools have paved the way for new methodologies in Art History and museum studies. As insightfully noted by Johanna Drucker in her vision of Digital Art History as a possible autonomous discipline, the paradigm shift does not reside solely in the use of new digital tools but, above all, in the new approaches and ways of thinking that have emerged with digital processes [2]. This is also evident with the increasingly frequent incorporation of machine learning (ML) processes in Art History, for instance, to identify and sort artworks according to specific criteria or to conduct innovative comparative analyses. In fact, ML models can "reveal connections and links between artworks that might otherwise not have been fully legible, or only incompletely accessible" [3]. As Drimmer and Nygren observe:

"There is, however, an important distinction between recent (and anticipated) applications of

AI and earlier instantiations of Art History's adoption of computation. Whereas earlier work largely used digital tools for the purposes of information management or to ask questions adjacent to the works of art (in other words, in generating and analysing what could be considered a work's context), we are seeing the first efforts at aiming AI at the work itself, that is, the use of computer vision as an analytical lens placed on the object" [4].

At the same time, advances in AI-based systems for image production also pose new challenges to art historians, curators and artists. In the last two years several AI text-to-image generators - such as Midjourney, Stable Diffusion, Runway, DALL-E and Microsoft Bing Image Creator - have emerged and rapidly become extremely popular. Besides opening a new and exciting chapter in the History of Digital Art, AI image generators are having a wider impact on contemporary culture at large, also fuelling the debates on authenticity, copyright and the ethical use of technology. According to Juan Martín Prada, these ML models mark "the beginning of a new phase of visual culture in which a large part of the images produced will have their origin, to a greater or lesser extent, in these types of AI-based generative systems or, at least, will have been edited using some of these new technologies" [5].

Against this background, the methods and criteria adopted for the study of artists' self-portraits are being critically reviewed. Today, art historians and curators benefit from an unprecedented opportunity to easily access online art collections and databases, where they can find other works that, for different reasons, can be compared to a specific case-study. Such comparisons typically include works by the same artist or by other authors, who lived in the same period or had similar interests and artistic practices. Additionally, a comparative analysis can consider existing reinterpretations of a painting by artists from different generations. In fact, through appropriation, re-contextualisation and recreation processes, derivative artworks offer new perspectives on the original, building alternative narratives upon the initial creation [6]. Today, with AI image generation tools, the range of comparative hypotheses can be further extended through the creation of speculative images that could somehow exist, but do not, in online art archives [7].

Focusing on a specific case study – Aurélia de Souza's *Self-Portrait* (c. 1900), also known as *Self-Portrait in a Red Coat* – this paper examines how, in parallel with derivative works created by contemporary artists, images produced with generative AI tools can also shed light on less evident or less studied aspects of this masterpiece of Portuguese modern art. Drawing on both a literature review and a set of experiments performed in 2023, using three AI image generators – Aitubo, Microsoft Bing Image Creator and DALL·E 2 – this paper contrasts the descriptions found in fundamental bibliography on Aurélia de Souza's painting with the images generated by AI as a response to text prompts specifically designed for this study.

2. AURELIA DE SOUZA'S ICONIC SELF-PORTRAIT

Figure 1: *Aurélia de Souza, Self-Portrait, c. 1900. Oil on canvas, 45 cm x 36 cm. Museu Nacional de Soares dos Reis, Porto [8]*

Born in Valparaíso, Chile, Aurélia de Souza (1866-1922) was one of the few women to be recognised as one of Portugal's great painters of the second half of the nineteenth century [9]. In 1869, when her family returned to Portugal, they settled in Quinta da China, a farm on the banks of the river Douro, which would become the setting and studio for many of her paintings and photographs [10]. At the age of 16, she took up drawing and painting classes with António

da Costa Lima, a former disciple of Roquemont, and painted her first self-portrait in 1889 [11]. She later studied at the Porto Academy of Fine Arts and at the Julien Academy, in Paris, an independent art school where she attended courses by J. P. Laurens and B. Constant. Aurélia de Souza's artistic training was also marked by her trips and visits to museums during this period, not only in France, but also in Belgium, Germany, Italy and Spain. This was also when (c. 1900), she painted her famous *Self-Portrait* (in a red coat), which is unanimously considered a masterpiece of Portuguese art from the turn of the century.

This painting, which belongs to the collection of the Soares dos Reis National Museum, in Porto, was listed as a National Treasure in 2006. Over the last two decades, Aurélia de Souza has garnered critical acclaim and this particular work has been a prominent feature in various exhibitions and publications. Studied by Portuguese art historians from different generations, such as José-Augusto França, Raquel Henriques da Silva, Maria João Lello Ortigão de Oliveira, Adelaide Duarte and Filipa Lowndes Vicente, among others, the year 2000 marked a turning-point in the internationalisation of this self-portrait with its appearance in the exhibition *1900: Art at the Crossroads*, co-produced by the Royal Academy of Arts, in London, and the Solomon R. Guggenheim Museum, in New York. More recently, exhibitions such as *On Portraiture from Life* (2018), *All I want – Portuguese Women Artists from 1900 to 2020* (2021) and *Life and Secret. Aurélia de Souza 1866-1922* (2022) have re-centred this painting under the general framework of Portuguese contemporary art and within the scope of Aurélia de Souza's unique career.

The literature around her *Self-Portrait* (in a red coat) highlights the frontality and psychological intensity of the representation [12], which denotes a new interest for introspection and "self-awareness that emerged in the first decades of the twentieth century" [13]. Some authors further elaborate on the psychological dimension of the painting, referring to the tension between presence and absence [14] or between a restrained femininity and a masculine austerity [15]. Regarding the physical features of the sitter, some descriptions mention the severe head with reddish hair [16], the light blue eyes and the enigmatic gaze, while others refer to the pale tone of Aurélia's skin against the dark background and the explosive energy of her red coat [17]. José-Augusto França pays particular attention to the symmetrical composition, defined "by the high neckline of a blue blouse with yellow braids, with an amber pin [...], vertically along the parting of the hairstyle, the nose [and] the middle of the closed mouth" [18]. This symmetry is only interrupted by the concealed button fastening of the red coat. Filipa Lowndes Vincente and other authors also explain the affinity of this representation with photographic images used by the artist as a preparatory process for some of her paintings [19], namely portraits.

In parallel with academic and curatorial studies, Aurélia de Souza's *Self-Portrait* has also been the object of research and creative reinterpretation by contemporary artists, such as Albuquerque Mendes, Noé Sendas and Susana Mendes Silva. Such projects provide alternative insights into this iconic painting, as they recontextualise some of the aspects already studied by art historians and, at the same time, raise new questions by exploring different media (e.g. photography, performance) and establishing connections with other topics, works and authors.

Considering that "a derivative work is one which is not only based on a previous work, but which also contains sufficient new, creative content to entitle it to its own copyright" [20], this paper subscribes to the idea that derivative experiments can provide fresh perspectives on the original. However, the notion of derivative art has become a topical issue with the recent developments of AI image generators. In her book *Computational Formalism: Art History and Machine Learning*, Amanda Wasielewski describes AI-generated portraits as metarepresentations, explaining that:

"An AI-generated portrait can also be considered a type of composite image in that it draws its form from a multitude of images to create a new, single image that shares characteristics with these multiple sources. […] Whereas GAN is a far more complex process than simple photographic compositing, the algorithm cannot create anything truly new that is not related to the input that it is given. So, although the algorithm does create a completely new (and often unexpected) image, this image is always related in some way to the contents of the database" [21]

Hence, and since AI generated images are intrinsically derivative and composite, this paper seeks to investigate the potential contribution of such images to a broader study of Aurélia de Souza's *Self-Portrait*. Do they illustrate the main features highlighted by art historians and curators? Do they suggest any links with other works by the painter? Do they unveil any relevant particularities of her creative process?

3. REINTERPRETING AURÉLIA DE SOUZA'S SELF-PORTRAIT THROUGH AI GENERATED IMAGES

In order to respond to these questions, several experiments were conducted between July and November 2023 using three different AI image generators: Aitubo, Microsoft Bing Image Creator and DALL·E 2. The use of these three tools sought to compare images with different content and expression, despite being generated from the same text prompts. As observed by Jonas Oppenlaender, "today, beautiful and intriguing digital images and artworks can be synthesized from textual inputs ("prompts") with deep generative models" [22], which have been trained with massive datasets including millions of images available on the web.

Online guides and manuals for AI art generators usually emphasise the importance of prompt design, explaining that, in order to attain the best results, the text prompts should give simple, clear and detailed instructions [23]. In spite of their limited length, when using these AI tools for an artistic work, an effective "prompt should include specific descriptions, shapes, colours, textures, patterns and artistic styles. This allows the neural networks used by the generator to create the best possible visuals." [24]

Nonetheless, as the purpose of this study is not to develop a creative process based on Aurélia de Souza's painting, but rather to formulate a new hypothesis of interpretation, the prompts were limited to the essential idea of generating interesting derivatives. In order to minimise the author's interference in the production of such images, the prompts focused on the objective of creating a new visual interpretation of the original painting using generative AI, without any creative or visual inputs. Following this criterion, no photographs were uploaded to serve as a basis for the production of the AI images and no reference to artistic languages, techniques, background colours or visual effects was directly provided. The process began with very short prompts to which further details about the original painting were gradually added, such as the date or the reference to the red coat, which were introduced in some experiments as a modifier of the main prompt (see Table 1). It is important to note that the same prompts were repeated in all three AI image generators.

The following pictures correspond to the author's curatorial selection from a total of 82 images especially created for this paper. With Bing Image Creator the more generic prompts – i.e. "A new version of the self-portrait of the Portuguese painter Aurelia de Souza" and "A contemporary image inspired by the self-portrait of the Portuguese painter Aurélia de Souza" – produced a significant number of interesting results (see Table 1). The relevance of these images lies both in the consistent, yet sometimes subtle, similarities with the original and in the clues they may provide about the painter's creative process.

Figure 2: *Image generated by Bing Image Creator for the prompt "A contemporary image inspired by the self-portrait of the Portuguese painter Aurélia de Souza". Helena Barranha, 01.08.2023.*

This can be observed, for example, in Figure 2, which appears to be very similar to a scan of a vintage portrait photograph, taken in a studio, in the early twentieth century. The red, although present, is attenuated by the pattern of the blouse fabric and by the sepia tone that dominates the entire composition, also changing the colour of the sitter's eyes. Marked

by the frontality and symmetry that characterise Aurélia de Souza's self-portrait, this image allows the observer to deduce that there is a connection between the artist's work and photographic techniques. Indeed, and as explained by several art historians, the painter used photography as a means to investigate self-representation and arrive at the final painting [25].

Figure 3: *Image generated by Bing Image Creator for the prompt "A contemporary image inspired by the self-portrait of the Portuguese painter Aurélia de Souza". Helena Barranha, 01.08.2023.*

In the bibliography on Aurélia de Souza, the use of photography as part of the creative process is also associated with another famous self-portrait in which the painter represents herself as Saint Antony (c. 1902). A second image created with the same AI tool and the same prompt (Fig. 3) reveals intriguing resemblances with that painting, highlighting the triangular shape of the face and the slender figure of the painter. While this picture illustrates the Symbolist ideal of androgyny [26], other AI images (Figs. 4 and 5) evoke the painter's interest in transvestite representations, namely as in the aforementioned *Self-Portrait* as Saint Antony [27]. Although both images were created with the same prompt – "A new version of the self-portrait of the Portuguese painter Aurelia de Souza" – their expression is considerably different, revealing how DALL·E tends to generate less conventional images. It is also interesting to note that, even though the prompt did not include any reference to colours, in both cases the presence of red flowers creates a vibrant contrast with the rest of the composition.

Figure 4: *Image generated by Bing Image Creator for the prompt "A new version of the self-portrait of the Portuguese painter Aurelia de Souza". Helena Barranha, 02.11.2023.*

Figure 5: *Image generated by DALL·E 2 for the prompt "A new version of the self-portrait of the Portuguese painter Aurelia de Souza". Helena Barranha, 21.10.2023.*

Another series of experiments with more detailed prompts, including the date of the original painting and the reference to the red coat, led to equally diverse results. Such additional inputs, especially the red coat, ensured a closer similarity to the original painting (Figs. 6 and 7). Nevertheless, some of the results were quite surprising and, once again, DALL·E produced the most intriguing images.

Figure 6: *Image generated by DALL·E 2 for the prompt "A recreation of the self-portrait of the Portuguese painter Aurélia de Souza, dating back to 1900, also known as self-portrait in a red coat". Helena Barranha, 21.10.2023.*

Figure 7: *Image generated by Bing Image Creator for the prompt "A re-creation of the iconic self-portrait in a red coat of the Portuguese painter Aurélia de Souza (1900), with the same eyes as the original". Helena Barranha, 08.08.2023*

A variation of the same prompt, with a reference to Aurélia de Souza's eyes, also led to curious results (Fig. 7). Although many of the descriptions found in Art History literature underline the rigid symmetry of the Self-Portrait, on closer examination a slight difference between the painter's blue eyes may be noted. Interestingly, this is one of the facial features to emerge in different images generated with AI that may encourage the observer to explore the painter's work, in order to understand why. In fact, in other self-portraits, particularly the one in a blue blouse (n.d) [28], Aurélia de Souza highlights the asymmetry of her eyes.

With Aitubo the results obtained for the various prompts were more repetitive and, in most cases, less relevant than with the previous two AI image generators. In fact, the pictures created with Aitubo attest the visual specificity of this tool and its effectiveness for creating Pixar-styled images [29] that seem to belong to an animated film. A good example of these animation aesthetics is the image generated using only the link to the Wikipedia article on Aurélia de Souza as a prompt (Fig. 8).

Figure 8: *Image generated by Aitubo using only the link to the Wikipedia article on the painter as a prompt:https://pt.wikipedia.org/wiki/Aur%C3%A9lia_de_Sousa. Helena Barranha, 31.07.2023.*

4. CONCLUSION

As shown in the previous section, although the prompts used in the three AI image generators were exactly the same, the results were surprisingly diverse, thus proving that even when these tools are based on the same technology, as is the case of Microsoft Bing Image Creator and DALL·E 2, the visual output can be considerably different. The following table synthesises a qualitative assessment of the results obtained with the different prompts and AI image generators. This evaluation was made by the author based on curatorial criteria, such as the possibility of establishing a consistent relationship between the derivative image and the original or the existence of features that allow or invite the observer to discover relevant aspects of Aurélia de Souza's creative process.

Prompts	AI Image Generator		
	Aitubo	Bing Image Creator	DALL·E 2
A new version of the self-portrait of the Portuguese painter Aurelia de Souza	***	****	*****
A contemporary image inspired by the self-portrait of the Portuguese painter Aurélia de Souza	**	*****	**
A derivative artwork based on the self-portrait of the Portuguese painter Aurélia de Souza c. 1900	***	****	***
A recreation of the self-portrait of the Portuguese painter Aurelia de Souza c. 1900	***	****	***
A recreation of the self-portrait of the Portuguese painter Aurélia de Souza, dating back to 1900, also known as self-portrait in a red coat	***	****	*****
A recreation of the iconic self-portrait in a red coat of the Portuguese painter Aurélia de Souza (1900), with the same eyes as the original	**	****	****
Link to the Wikipedia article on the painter: https://pt.wikipedia.org/wiki/Aur%C3%A9lia_de_Sousa	*****	*	*

Table 1: *Relevance of the images obtained for each prompt, from ***** (highly relevant) to * (irrelevant). Curatorial assessment made by the author according to the objectives of this study, 2023.*

The research conducted for this paper aimed to investigate the ways in which images created with AI can expand perspectives on an artwork. Considering that "how computers 'see' images is fundamentally different from how humans process image data" [30] and that these derivative images are created through algorithmic associations between the original and other sources, it may be concluded that these images can effectively indicate new ways of looking at a given painting. Unfortunately, the current lack of transparency in generative AI does not enable an identification of the sources selected and processed among the millions of digital items used to train the machine learning model. Thus, it is impossible to decipher why certain images reproduce visual and cultural stereotypes while others are less conventional.

The study of an artist's self-portrait through the production and analysis of AI generated images is still a largely unexplored subject which, as argued throughout this paper, proves to be interesting when observing it from a different angle or finding other layers of meaning. From a curatorial point of view, this methodology of derivative comparison opens alternative possibilities for interpretation, study and associative display. Moreover, from an educational perspective, AI generated images can provide an effective means of engaging students in the study of a particular artwork by fostering autonomous discovery, as well as the development of detailed observation and visual comparison skills. In fact, the automated creation of digital images derived from an artist's self-portrait can actively motivate the interest of students in different levels of education in Art History, inviting them to identify the uniqueness of a certain artist, as well as to understand the specific features of an artwork and its underlying creative process.

Finally, and more importantly, this methodology can contribute to the current debates around the role of AI in shaping contemporary visual culture by addressing the increasing ambiguity between digitised originals and born-digital derivative works and also issues of authenticity, copyright and the politics of image appropriation and reuse. In doing so, this approach can fuel critical and creative thinking, thus contributing to promote visual and digital literacy.

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Promised too much? AI in use in the image archive of the ETH library

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ABSTRACT: With 3.6 million photographs – from the period between 1860 and today, the Image Archive of the ETH Library in Zurich is one of the largest historical image archives in Switzerland. Since 2021, the Image Archive uses artificial intelligence for content-based image indexing, in addition to intellectual indexing, and for the translation of metadata. Users benefit from additional research options. The automatically generated tags are closer to everyday language and go into more detail. The Image Archive uses autotagging in a complementary way: It does not replace the intellectual work with the subject headings but complements it. Although the autotags produced good results on average, a quality check was initiated. After analysing 75% of the autotags, the deletion rate was around 50 to 70%. While the computing time is considerable, the financial effort is negligible. In view of the initial processing, which took over 16 months, the question arose as to whether the computational effort required to generate the autotags was worthwhile at all. An online survey provided insights into the acceptance of the autotags on the one hand and the research techniques of the users on the other.

1. INTRODUCTION

The Image Archive of the ETH Library in Zurich with 3.6 million photographs and other image documents from the period between 1860 and today is one of the largest historical image archives in Switzerland. The thematic collection focuses on image holdings directly related to the Swiss Federal Institute of Technology (ETH) Zurich, such as architecture and construction sciences, engineering sciences, natural sciences, computer science or earth and environmental sciences. Image material from organisational units of ETH Zurich, from private individuals or institutions with a direct connection to ETH Zurich are taken over, as are image holdings and archives from external bodies (private individuals, organisations, foundations, companies). In addition to the collection development, digitisation, indexation, and archiving are the classic tasks of the ETH Library's Image Archive. Classic data generation in the Image Archive is a multi-stage process that includes inventory, formal and content-related indexing with subject headings. Additional forms of data generation such as crowdsourcing and georeferencing help to improve data quality and utilisation.

Since 2006, the Image Archive has been operating the web-based image database "E-Pics Image Archive" (https://ba.e-pics.ethz.ch) for indexing and dissemination; this is part of E-Pics, the ETH Zurich platform for photographs and image documents (https://www.e-pics.ethz.ch/). Behind it is the digital asset management system Canto Cumulus with the web frontend AWP. Around 930,000 images are publicly accessible on E-Pics Image Archive. Most of these published images can be downloaded free of charge in various resolutions since the introduction of the Open

Data Policy [1] in March 2015. The image archive licenses those images whose rights of use are held in full by the ETH Library with Creative Commons BY-SA 4.0. These images can be used freely for scientific, private, non-commercial, and commercial purposes, provided the correct image credit is given, and must be passed on under the same conditions if they are modified.

2. IMAGE RECOGNITION WITH ARTIFICIAL INTELLIGENCE

Automatic image recognition using artificial intelligence (AI), or object and pattern recognition in image materials, has been a topic in computer science since the end of the 1950s. However, it is only in the last ten years or so that image recognition has made significant progress using new technologies, such as deep learning with the help of *convolutional neural networks.*

However, for software to be able to learn itself in deep learning processes, a corpus of data must be available that is manually labelled by humans in machine-readable form beforehand. For example, objects within the image can be surrounded with *bounding boxes* and these regions can then be tagged. The image contents are divided into concepts (e. g., "cat"). To train the software, around 500 to 1000 representative images of a concept are necessary. For good training data, for example, not only pictures of black cats on green grass are needed, but a wide variety of cats in different settings and postures (see picture examples). The categorised data is then used to train the computer vision software or the artificial neural network. Large amounts of images with as many concepts as possible are necessary. The most important database or "pre-trained" dataset is ImageNet with over 14 million images and over 20 000 concepts. In deep learning models, the algorithms generate both the programme codes and a set of rules (model) without human programming. If new data is added to the algorithm, it can now evaluate it and "continue learning".

This means, in simple terms and illustrated with example images from the image archive, the following: With the training image of a cat in a classical posture as input, the algorithm would eventually be able to recognise and correctly categorise the image of the "sleeping cat" as a concept "cat".

Since the tagging of training data always represents the perspective of the person tagging an image, gender or cultural bias can occur in the context of these procedures, a phenomenon that is recognised and discussed by both cultural studies research and computer science [2], [3], [4], [5].

***Figure 1**: Input "Cat". Photo: Josef Schmid. ETH Library Zurich, Image Archive, http://doi.org/10.3932/ethz-a-001002487*

***Figure 2**: Input "Sleeping cat". Photo: Josef Schmid. ETH Library Zurich, Image Archive, http://doi.org/10.3932/ethz-a-001002485*

3.1 IMAGE RECOGNITION WITH CLARIFAI (AUTOTAGGING)

The computer vision software "Clarifai" could be integrated in the backend of the image database Cumulus as an autotagging plugin in February 2021. The plugin was developed by CDS Gromke for Cumulus.

Using automatic image recognition, the image contents are analysed and textual autotags are output as a result. The process is called "autotagging". The following settings can be made in the "Autotagging Control Panel" in Cumulus:

– Model ("Autotag Model"): possible models are "General" and the more specific "Wedding", "Travel", "Food" and "Apparel".

– Colour ("Autotagging Colour"): Extract up to eight main colours.

– Classification (“Autotagging Classi-fication”) of sensitive content.
– Facial recognition (“Autotagging Face”): Face, age, culture, gender.
The Image Archive uses the general model “General”, which is suitable for historical image material and provides good results. For the colour images, the “colour” function is additionally activated, which extracts the main colours from the image and can be used in the web frontend as an additional “Colour selection” filter during the search. The recognition process per image takes an average of 20 to 30 seconds.
Finally, Clarifai’s autotags are output in an alphabetical list. Over the entire stock, this resulted in a list of around 4600 automatically generated tags in the E-Pics Image Archive, starting with “scavenger” (“Aasfresser”) and going up to “cypress wood” (“Zypressenholz”). The autotags are part of the categories in the web frontend. By default, they are called “Keywords” and can be searched conveniently in the category search slot, just like all other categories.
In the first example, the results from Clarifai are discussed and contrasted with the keywording from the professional staff.

Figure 3*: Keyword “write”. Photo: Unknown, ETH Library Zurich, Image Archive, http://doi.org/10.3932/ethz-a-000014639*

The image illustrates an example of the advanced image research options. Specifically, a “teaser image” was sought for a Wikipedia workshop. On the off chance "write" was entered, the autotag with the same name was found with about 1000 hits. With conventional keywords, a comparable image would not have been found without considering possible writing contexts. In this image, for example, the old library system ETHICS in the catalogue room of the ETH library was keyworded. The man writing was not relevant for the keywording. The autotags, on the other hand, produce further interesting results. From “concentration” – which probably means the concentration of the person writing – to the interpretation that the setting takes place in a “company”. However, “laptop” does not accurately identify the technology historically; laptops were not in common use until the 1990s. Here, the more generic keyword “information technology devices (computers)” is advantageous.

The full metadata for example “write”:
Unknown: Zurich, ETH Zurich, Main Building (HG), Main Library, Catalogue Room, ETHICS online query, 15.04.1986 (Ans_01693-005, http://doi.org/10.3932/ethz-a-000014639).

Autotags: office, computer, adult, inside, concentration, laptop, man, people, furniture, writing, desk, technology, company.

Subject headings:
– People in Context / Education + Science + Culture / Archive + Library.
– ETH Zurich / Building / ETH Zentrum / Main Building (HG) / ETH-Bibliothek / Katalogosaal / ETHICS.
– Objects + machines / instruments + devices / information technology devices (computers).
– Switzerland / Zurich, Canton / Zurich, City / Zurich-Oberstrass.

The second example shows one of the approx. 120 colours that have beautiful names such as Dark Slate Grey, Fire Brick or Medium Orchid.

Figure 4: *Colour selection “Fire Brick” (screenshot E-Pics Image Archive)*

3.2 CLARIFAI: ERROR ANALYSIS AND CORRECTION OF AUTOTAGS

The Image Archive does not make corrections to the autotags at image level or in the alphabetical list of keywords. The majority of autotags are nouns, but verbs and adjectives also occur. There are both concrete ("waste bin", "eagle farm", "African elephant", etc.) and abstract concepts that require interpretation ("reject", "abstraction (philosophy)", "absence", etc.).

After the first run, 4600 tags were generated. These tags were initially left as they were. Although the autotags produced good results on average, a quality check was initiated after initial feedback from users and our own spot checks. The autotags were analysed and corrected according to the following criteria:

Lower/upper case: 671 duplicates were removed by merging tags with different spellings; it is also noticeable that the hits of these duplicates are different and have little overlap. A whitelist has been created.

Visual analysis: The remaining 3,914 autotags were visually analysed to identify errors. The analysis yielded the following results:

– Correct assignment: tags were correctly assigned, and the added value is high (e. g., "Schlagzeuger"/"drummer").

***Figure 5**: Autotags are almost consistently correct: "drummer" (screenshot E-Pics Image Archive)*

– Partially incorrect: Tags were partially incorrect, but the pattern was recognisable (e. g., "Abakus"/"abacus").

– All incorrect: Tags were assigned completely incorrectly, and the pattern was also recognisable ("Béchamel"/"bechamel", "Verbrechen"/"crime"), the tags were deleted.

– Incorrect tags with hits under 10 images or tags not relevant to ETH were deleted.

***Figure 6**: Autotags are almost consistently incorrect: "crime" (screenshot E-Pics Image Archive)*

In addition, the following error types were identified:

– Translation errors: In some cases, tags were translated incorrectly. For example, the English tag "relief" (plastic representation in art) was translated as "Erleichterung" ("relief"). In other cases, the tags were not translated and only make sense when you see the images: "rock" was corrected to "Felsen" or "real" was corrected to "property/Liegenschaft".

– Reinforcement of prejudices: In some cases, tags were used that could reinforce prejudices against certain groups or groups of people. For example, the tags "sexy", "blonde" to describe female persons were used. These tags were deleted.

After analysing 75% of the tags, the deletion rate was around 50 to 70%. A blacklist has been created. Analysing errors and correcting autotags is an important step in improving the quality of the data. This avoids incorrect or misleading information and makes the data usable for further processing.

The use of AI was not conceived from the outset as a replacement for intellectual hierarchical keywording. The present results confirm this premise. AI does not replace intellectual indexing, at best it complements it. Indexing captures the central motif, whereas tagging "dissects" the entire image down to the smallest details. The subject headings tree is partially contextualised, i. e., there are subject headings for individual buildings such as the buildings of the ETH or for people such as Albert Einstein. Clarifai's autotags, on the other hand, do not give out specific persons or buildings such as the Eiffel Tower. Eiffel Tower images receive the generic "tower" and at most "landmark". In the Image Archive, the images will therefore in future be both manually tagged and indexed using AI.

4. AUTOTRANSLATE WITH DEEPL

A long-standing desideratum was also fulfilled with AI. Since mid-March 2022, it has been possible to integrate the AI-based translation software DeepLPro in the backend of Cumulus and have the selected metadata fields “Title”, “Description”, “Contained in” (for report titles and the like) and “Comments” translated by machine. For this purpose, the corresponding metadata fields had to be newly created in the backend (e.g., “Title (English)”), a specific record view set had to be set up and a trigger to start the automatic translation had to be defined. If users change the language to English in the web frontend, the machine-translated metadata is displayed and searched. The contents of tabular metadata fields (colour, shape, physical description, etc.), the categories and the field names have been bilingual for a long time. With the online launch of the English translations in August 2022, the “Original title” field, which has been kept in the background since 2018, was also displayed online for the first time. In the original title, the title is reproduced in its original state as it was recorded during the inventory. The metadata of the Image Archive is very “volatile”, mostly due to the countless comments from volunteers (crowdsourcing). The field original title is displayed in both language versions so that after later revisions it can be at least partially understood which parts of the title have been changed. In the case of misleading or unclear machine translations, it is therefore possible to refer to the original.

*E*xample in German with English translation
Title:
– Aarburg, Brückenschlag zwischen Bifang-Kupferschmied und Ruttigerhof.
– Aarburg, bridge building between Bifang coppersmith and Ruttigerhof.
Description:
– Fertigstellung des westlichen Endes der Brücke.
– Completion of the western end of the bridge.
Contained in:
– [Pontoniere, 1914-1915]. 3 Alben mit 198 Bildern (alle digitalisiert).
– [Pontooniers, 1914-1915]. 3 albums with 198 pictures (all digitized).
Comments:
– Thomas Pfister: Aarburg, Brückenschlag zwischen Bifang-Kupferschmied und Ruttigerhof. Fertigstellung des westlichen Endes der Brücke.
– Thomas Pfister: Aarburg, bridge between Bifang-Kupferschmied and Ruttigerhof. Completion of the western end of the bridge.

At the moment, DeepL is one of the best translation programmes on the market [6]. For the most part, DeepL provides good translations of the Image Archive’s metadata. Aerial photographs and architectural photographs, which make up a considerable proportion of the inventory, are mostly structured according to the relatively simple scheme “place, district, street, building”.
The following cases, on the other hand, turned out to be problematic:
– Place names are translated incorrectly, e.g., Brunnen as “Fountain”, Baden as “Bathing” or Speicher as “Memory”.
– Geographical abbreviations such as “v. S.” [from the south], “v. N. O.” [from the north-east] and Swiss terms such as ARA (sewage treatment plant) are not recognised.
Another hurdle is that each language must be translated individually. For this, they must first be identified, because the metadata do not contain fixed fields for the designation of the language of the catalogue record, such as in MARC-21 format field 008.

5. EFFORT, COSTS, AND INCOME

The machine indexing procedures were used for the initial processing of the digital data as follows:
Autotagging
– Computing time/image: 20 to 30 seconds
– Initial processing: February 2021 to May 2022
– Number of target days for 24-hour operation: 340
Colour
– Computing time/image: two seconds
– Initial processing: May to July 2022
– Number of target days for 24-hour operation: 14
Autotranslate
– Computing time/image: six seconds
– Initial processing: May to December 2022
– Number of target days for 24-hour operation: 74
Since the application of these processes on the production servers is very resource-intensive, so that the performance of both the back end and the web front end is negatively affected, the image analysis can only be carried out after work, and the autotranslate only after 10 p.m. or at the weekend. The processes must be started manually. A total of 428 days (including weekends) of pure computing time were

necessary for the initial processing of all images with the three methods mentioned.

The costs are calculated per action in autotagging, the model “General” and the action “Colour” are each one action. For example, 500 colour images cost USD 1.20. Around one million images tagged with an action cost a total of USD 1,176.

The cost of the autotranslate is calculated according to the number of translated characters. The approximately one million images processed generated around 103 million translated characters and cost EUR 2,073.

While the computing time is considerable, the financial effort is negligible. In view of the initial processing, which took more than 16 months, the question arose as to whether the considerable time-consuming computing effort – not to mention the manual starting of the computing process every evening – to generate the autotags is worth it at all. Are the autotags generated by AI used by the users and if so, how?

An online survey was conducted in May 2022 to obtain information on the search strategies of users in the web frontend of the E-Pics image archive [7]. 1,206 people such as users, crowdsourcers and employees of GLAM institutions were contacted by e-mail. The response rate was 16.5% with 199 completed questionnaires. As was to be expected, almost all respondents used the Google-like keyword search in the central search slot. Half of the respondents also use the second and newer category search slot. Every third person uses the subject headings regularly and almost every fourth person has at least tried them. Overall, the subject heading search is well accepted and actively used. Only 16.6% of respondents do not use or no longer use the subject headings. Already 15 % of the respondents use the new keywords (autotags) regularly and about 25 % of the respondents have already tried them or discovered them thanks to the survey. The benefit of content indexing is recognised and appreciated by most users. Overall, subject headings and keywords are seen as helpful. The somewhat provocative statement that there is no need for subject headings and that keyword searches would suffice was affirmed by a third of respondents. A quarter of the respondents find the subject headings very helpful because they structure the content well. The question of whether users are aware of the difference between subject headings/autotags and keywords was answered by 44.4% with “yes”, 39.8% with “no”. For 15.8%, this distinction does not play a role.

6. CONCLUSION

Thanks to the autotags/keywords, users have an additional research option: the tags are closer to everyday language and go into more detail. New and possibly unexpected search results are possible.

The Image Archive uses autotagging in a complementary way. It does not replace the intellectual work with the subject headings but complements it. After initial feedback from users and our own spot checks, it was decided that a quality check of the autotags would be useful. After analysing 75% of the tags, the deletion rate was around 50 to 70%. A blacklist has been created. Analysing errors and correcting autotags is an important step in improving the quality of the data. This avoids incorrect or misleading information and makes the data usable for further processing.

As could be shown, the time required for calculation is very high. For the initial processing, 428 days would have been necessary in a 24-hour operation. The processes must be initiated manually in each case. Since the application of these processes on the production servers is very resource-intensive and the performance of both the back end and the web front end is negatively affected, the AI is only operated outside office hours. Measured against this, the financial expenditure is low.

It is to be hoped that models for historical images will also be trained in the future. The image archive's collection of over one million images would be a good start for turning library archives into AI training data, as the Royal Library of Sweden is currently doing [8].

Although IFLA published a “Statement on Libraries and Artificial Intelligence” [9] in September 2020, there is still no debate on ethical guidelines for AI in GLAM institutions.

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May (A)I help you? – AI-based dialogues in the museum

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ABSTRACT: Social robots aim to provide assistance across diverse applications through seamless natural language communication. The effectiveness of this communication largely hinges on the sophistication of the underlying dialogue system technology within the robot. To assess the practicality and reception of a social robot serving as a museum guide, we deployed a Furhat robot at the Ocean Museum Germany, OZEANEUM, Stralsund. Based on a partly standardized questionnaire with N = 141 participants, we analyzed user expectations and the perceived performance of social robots in the public service contexts. The study shows that users expect a proactive conversational design that leads to informative dialogs that are backed up by extensive knowledge about the museum and museum topics in the broadest sense. Concerning turn-taking, it becomes clear that the question-answering interaction strategy, which is typical of many commercial robots, does not match the expectations of fluid and natural communication that are set by the anthropomorphic design.

1. INTRODUCTION

Social robots are increasingly prevalent in public spaces, including areas such as retail, hospitality, theme parks, and museums [1]-[3]. Yet, despite their expansion, these robots face significant challenges, especially in public service environments where they encounter a broad spectrum of users with diverse expectations and perceptions. Ensuring their interactive behavior appears natural in these open-ended settings requires more than just advanced technical infrastructures. It also depends on understanding the users – specifically, their expectations of, and experiences with such systems. Grasping the nuances of these multifaceted users and their diverse expectations and behaviors is essential in designing social robots for public spaces. This was highlighted in a recent evaluation at the OZEANEUM Stralsund, which is part of the Ocean Museum Germany, where visitors interacted with a social robot connected to an Artificial Intelligence (AI)-driven dialogue system, underlining the dual importance of grasping both, technical and societal demands, to design social robots capable of intuitive and natural interactions with users.

2. RELATED WORK

The development of social robots is at an inflection point. Nowadays robots are increasingly being deployed across the service industry [4], spanning all sub-industries like retail [5], travel [6], or hospitality [1] with increased frequency.

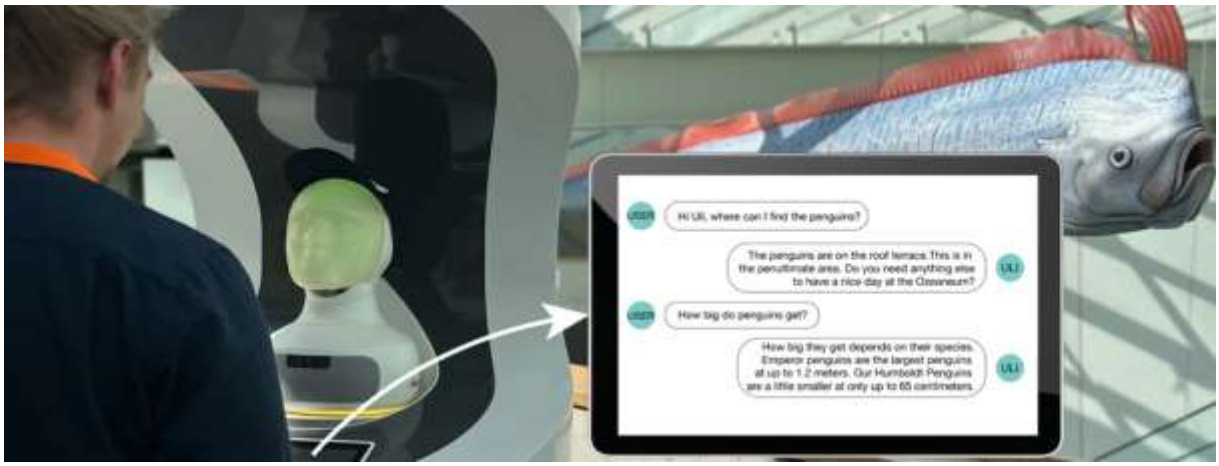

Figure 1 Interaction with the 41cm tall social robot head Furhat with an illuminated mask system at the OZEANEUM Stralsund. The robot head is mounted on a housing, which includes a display to show a manual and transcribed dialogue during interactions. Source: Ana Müller, Cologne Cobots Lab, CC-BY-NC SA 4.0

As social robots find roles in various real-world scenarios, it has become evident that laboratory studies may not always provide the most reliable method for developing and evaluating such systems, especially when these systems are designed for Human-Robot Interaction (HRI). Finally, research outside the laboratory offers invaluable insights into the dynamic nature of HRI that is crucial for the success of robots in genuine, everyday environments [7]. Consequently, cultural institutions, like museums, have emerged as promising venues for the research and development of social robotic systems, and over the past two decades, numerous attempts have been made to deploy social robots in museum settings [8]-[10]. Robots have already been used to greet visitors, provide information, and augment exhibitions [11], [12] and some early efforts have been made to enhance interaction abilities (e.g., showcasing emotions with robots [8]). However, more recent implementations have prioritized navigation over interactive capabilities (e.g., [13]). Nonetheless, a comprehensive understanding of user expectations in HRI is vital, as it not only influences the interaction capabilities of social robots but also impacts the broader social acceptance of robots in public spaces.

3. MATERIALS AND METHODS

The field study with the social robot was conducted from the 8th to the 19th of May 2022 at the OZEANEUM Stralsund, a natural history museum dedicated to the marine environment of the northern seas and one of the most visited museums in Germany. The museum addresses a wide audience, including experts, the general public, and families. Throughout our field study, 11,334 people visited the exhibitions (M = 944.5, SD = 323.12 per day).

The experimental setup consists of a Furhat robot head from Furhat Robotics (see Fig. 1) paired with a dialogue system running on a back-end server. The dialogue system architecture follows a task-oriented pipeline, with rule-based dialogue management as the central component [14]. The interaction is based on a question-answer paradigm, following a mixed-initiative strategy [15], where both the robot and the human participant could take turns initiating parts of the conversation. The agent was tested at two positions of the exhibition, i.e., the beginning and end of the tour.

The primary objective of our study was to delve into the user experience and expectations during situated interactions in a real-world setting. To enrich our understanding of Human-Robot Interaction (HRI) in such real-world scenarios, we employed semi-structured questionnaires, collecting feedback from N = 141 participants regarding their encounters with the social robot.

The questionnaire was conducted with both people who interacted with the robot (n = 121) and non-interacting visitors of the museum (n = 20), to obtain diverse feedback on the agent. Data were collected in open-ended questions asking participants why they did – or did not – interact with the robot and suggestions for future capabilities. The interviews were

Table 1 CATEGORIES AND SUBCATEGORIES OF QUALITATIVE USER FEEDBACK AND DESCRIPTIVE DATA FROM ANALYSIS

Categories and Subcategories	Explanation	stop interaction	future agent	not-interacting
Back-End	**This is the category for areas of technical improvement.**	**40**	**108**	**-**
Understanding	The system needs a better understanding of user utterances. This can be due to various technical reasons, e.g., a not well-functioning speech-to-text synthesis (STT), but also to ambient noise (environment) or the user (e.g., speaks too softly) or the interplay of all aspects.	10	20	-
Knowledge	The system needs more or detailed knowledge.	15	44	-
Conversation Design	The system's conversation design and style needs improvement.	4	19	-
Initiative	The system needs to show more initiative during interactions.	-	7	-
Features	The system needs additional features (e.g., entertainment functions (for kids), different languages).	2	18	-
Annoying Features	Some certain features of the system were annoying.	2	-	-
Error	An error occurred during the interaction - or at least the user believed it was an error.	5	-	-
Fast	The system needs to process user utterances and answers faster.	2	8	-
Front-End	**This is the category for everything that addresses the front-end.**	**6**	**41**	**-**
Appearance	The front-ends appearance leads to downside effects.	4	6	6
Voice	The voice used is not profitable.	1	10	3
Purpose Unknown	The robot's purpose needs to be communicated via additional media	1	5	-
Place	The robot must be placed somewhere else in the exhibition.	-	2	-
Mobility	The robot needs mobility capabilities e.g., a navigation function	-	6	3
Personality	The robot should have its own personality, i.e., not only provide infos.	-	2	-
Personalized	The robot must adapt depending on individual users.	-	4	-
Human-Like	The robot should be more human-like.	-	1	-
User	**This is the category for aspects that depend on individual users.**	**64**	**2**	**14**
Go On	User wanted to leave the museum or go on to visit exhibitions.	49	-	5
No Question	User stated he had no (more) questions to ask.	14	-	4
Not Interested	User not interested at all.	1	2	3
Other Users	Other Users were around, or the system was already in use	-	-	2
Completed	**This is the category for interactions that were completed.**	**9**	**13**	**-**
Win	Interaction successfully completed.	7	4	-
Ok	Interaction completed.	2	9	-
Other	Feedback can't be categorized within defined categories.	-	6	-
		119	170	20

conducted in German and subjected to a deductive-inductive coding analysis. Table 1 shows the defined categories and subcategories with an explanation and descriptive data resulting from the analysis. The sample consisted of N = 141 randomly selected visitors of the museum. The average age of the sample was 40 years (SD = 20.42, N = 131, 10 missing) ranging from 12 to 81 years, and a balanced gender distribution (62 females, 73 males, 1 diverse, 5 missing). Our study had a diverse group of participants in terms of education, occupation, and age. Unlike studies in tech-focused museums, not all participants here had an interest in technology or robotics, resulting in diverse and critical feedback. For instance, participants had mixed attitudes towards AI (Slider 0 (reserved) - 100 (open): M = 37.63, SD = 30.05). Some had never used personal assistants like Siri and Alexa, while others frequently used them (n = 58). Based on users' self-assessment, users typically were able to express three utterances (M = 2.92, SD = 1.474) during the interaction with the agent.

4. RESULTS

As outlined in Sec. 3, the responses from both users and non-users were classified into distinct (sub)categories. The categories – **Back-End, Front-End, User, Interaction Completed** – offer initial insights into why users stopped interacting with the agent and shed light on potential areas of improvement. In the following sections, the categories are discussed considering their subcategories and the descriptive results (see Tab. 1).

A. Analysis from User Category

Personal or individual reasons were the primary causes for the termination or non-occurrence of interaction with the agent.

Besides the descriptive statistics of all categories presented in Tab. 1, the results of the **User** category are displayed in Fig. 2. This sunburst graphic presents exemplary user statements from all (sub)categories. The subcategories for interacting users reveal that 49 users wanted to move on, while fourteen had no more questions, and four lost interest in the interaction. The cause of this lost interest – whether personal, technical, or situational – is unclear. The reasons for not having any more questions may be agent-dependent and/or dependent on its interaction behavior. Ten users reported a successful, natural end to the interaction.

Non-users provided specific reasons for not interacting with the robot. However, these statements are conveyed similarly (Fig. 2 and Tab I). Users either wanted to move on (n = 5), were not interested in technology (n = 3), or had no questions to ask (n = 4). In addition, the presence of other people (i.e., other visitors) at the test site was also a deterrent for some. A few noted a general disinterest in technology and therefore offered no suggestions.

While the **User** category does not offer explicit action strategies to improve agents in public spaces, the feedback provides implicit insights into requirements. For example, in responses to why they "stopped talking to the robot" many users framed their answers in a question-answer format, stating they had no (more) questions. This indicates that a reactive conversation style may not be the optimal fit for a museum setting. A proactive conversation strategy, emphasizing informing users about specific topics, might be more suitable.

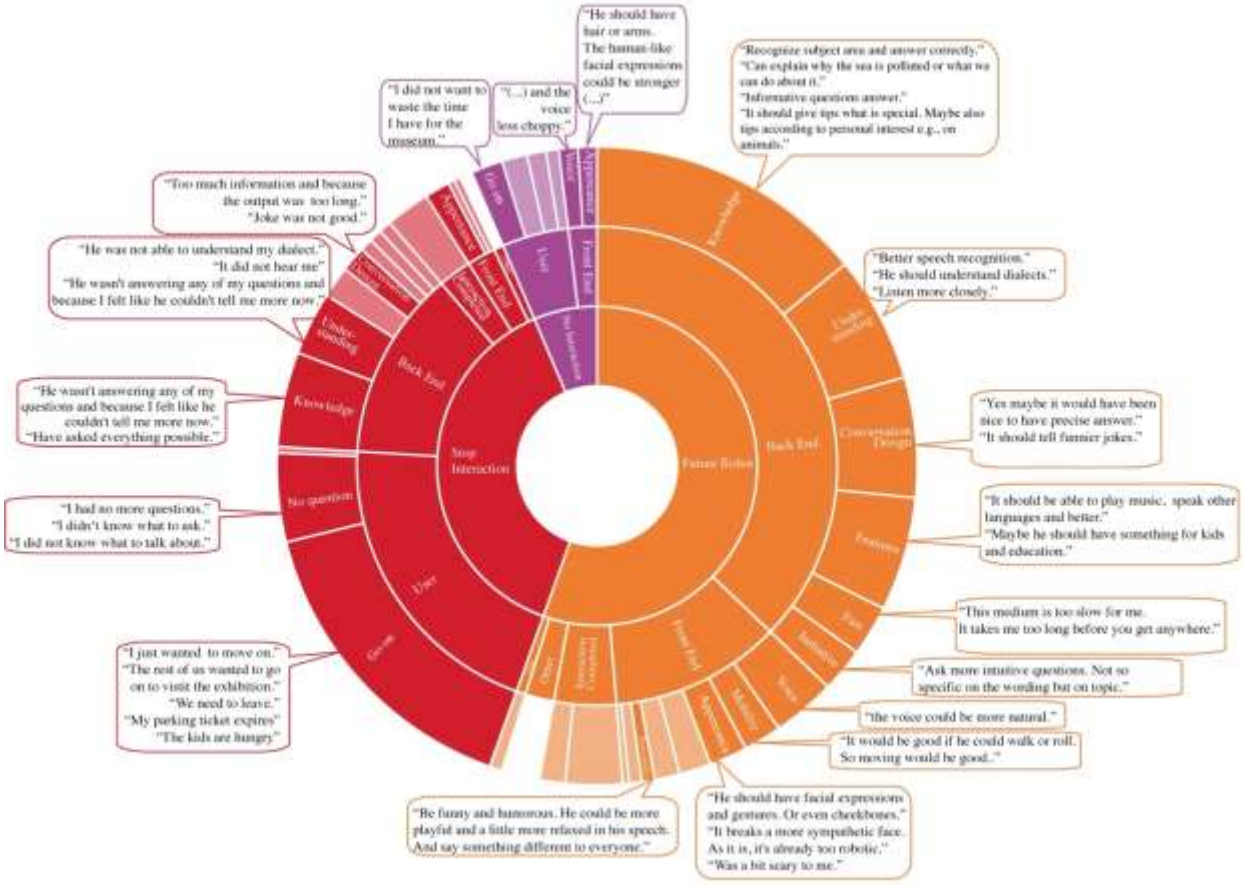

Figure 15 Sunburst graphic to illustrate the categories along with subcategories to highlight the diversity of user statements. The inner circle shows the question, the middle circle the category of each statement, and the frequency associated with the respective qualitative question. The outer circle visualizes the corresponding subcategories in matching colors. Subsequently, quotes from the participants are added in the margin as examples. For parts of the circle with a weaker color, no example statement was added, because they were short and self-explanatory. Descriptive Data of those subcategories can be found in Tab. I

B. Analysis from Back-End Category

Unlike the **User** category, the **Back-End** category provides insights into user expectations and thus for future improvement strategies. Both reasons for ending interactions (n = 40) and suggestions for a prospective agent

(n = 108) are categorized under this heading, as depicted in Tab. 1 and Fig. 2.

Five Participants noted that they ended the conversation with the system after errors occurred. However, the system logs did not register any serious back-end errors during those interactions. This discrepancy is revealing, as it indicates that users might interpret certain events to be as serious, leading them to believe that further interaction with the system is not possible.

The subcategories Understanding and Knowledge highlight potential areas of improvement that encourage users to have longer interactions with a future agent. For example, one user stated, “I stopped talking to that one because he did not understand me. Where I specifically asked about the [whale]skeletons , I still got an answer to fish.”. Another said, “He wasn’t answering any of my questions and because I felt like he couldn’t tell me more now”. Issues with Understanding are also evident in comments like: “He didn’t even answer me. He should probably be able to listen better.” or “A future robot should answer specific questions professionally”. At this point, it is crucial to emphasize that Understanding is not necessarily to be understood in the technical sense, but rather in the overall perception of the users and that various technical reasons can lie behind a poor perception of Understanding performance. On the one hand, users could track the recorded dialogue on the display (Fig. 1), and minor errors in the recording, e.g., due to loud ambient noise, were interpreted as poor comprehension (even if they still resulted in a correct response). Furthermore, we observed turn-taking challenges because users started talking before the agent entered listening mode (signaled by Furhat’s lighting in yellow Fig. 1). Yet this aspect was also summarized by users under poor understanding (i.e., malfunctioning Speech-to-Text). Moreover, in group interactions, the robot struggled to identify the speaker or whether the statement was directed at it. Users' feedback emphasized the importance of a comprehensive knowledge base as a fundamental need that is decisive for successful communication.

One user pointed out: “[I stopped] because I wasn’t getting anywhere, and I was embarrassed. It was funny but also an inhibition because I was talking to a machine.”. Feedback for future robots echoed these sentiments. Observations frequently showcased interactions where users sought specific information, like the depth of the Baltic Sea or the size of whales and polar bears. In the latter case, the agent incorrectly answered the size of penguins because that was the only available answer about the size of an animal in the database. Such user feedback underlines the importance of a robust knowledge database and a well-functioning Understanding.

Suggestions also include enhancing the agent’s Conversation Design. For example, users wanted the agent to be more initiative, have improved small talk capabilities, or undergo overall communication modifications. Some felt the conversation should be more engaging, suggesting that the agent should be more proactive, and transparent about its functions.

Our observations also showed that the users make statements during the conversation such as “that’s interesting” or answer the system to a joke with “hahaha” and ask counter-questions to certain statements of the agent. From a technical point of view, better dialogue management is necessary. Achieving this requires implementing various conversational strategies, such as small talk or explanations. However, it remains to be evaluated what level of conversation management strategies are appropriate, as not all users appreciate lengthy explanations from the agent.

Detailed feedback with concrete suggestions was also mentioned in the development of new features. These included the ability to play music, children’s functions like quizzes, barge-in function, and short-term memory for previously mentioned topics. Users also wanted the integration of the connection of external data sources and the capability to recognize and understand different languages and give prompt replies “using more natural phrases.”. Especially the barge-in function can lead to a more natural HRI since it refers to a feature that allows users to interrupt the system while it is speaking. This can be important for creating a more natural and efficient conversational flow, as it mimics human-to-human interaction where one party can interject or respond while the other is still speaking. Lastly, the processing speed, i.e., the time that elapses until the answer is given (ranging from 0.5 to 1.3 seconds,

depending on the length of the utterance), was addressed in the *Fast (answers)* subcategory. The latter is especially challenging in noisy environments where the agent's listening ability is compromised.

C. Analysis from Front-End Category

Similar to the **User** and **Back-End** categories, the sunburst graphic illustrates aspects of the **Front-End** category using sample user statements (Fig. 2). While the **Front-End** did not heavily influence users' decisions to terminate interactions, feedback indicated that there is still notable room for improvement. Although the number was comparatively small, some users expressed a desire for a differently designed front-end – one that is mobile, navigable, has a distinct appearance, or utilizes a different voice. A subset of users (n = 5) felt that the agent's purpose needed clarity especially when distinctions between it and functions of agents like Siri and Alexa. The purpose of the robot, depending on its use case, as an in-depth informational system about the exhibition or as an entertainment system, seemed ambiguous to these users. Besides leveraging additional media to illustrate the agents' purpose in a specific use case, two users – who encountered the agent at the beginning of the tour – suggested relocating the agent within the exhibition, noting they had fewer questions at this early stage of their visit. One of those users summarized: "I'm here for the first time and you're so impressed by the architecture and the whole presentation and you're at the beginning of the tour and - as it is at the beginning - you don't have a lot of questions yet. You want to let it sink in and then questions can arise.".

5. CONCLUSIONS AND FUTURE WORK

This paper presents a study on the expectations of social robots in real-world settings, executed using a Furhat Robot at the OZEANEUM Stralsund, Germany. The study encompassed N = 141 participants: n = 121 interacted and n = 20 were interviewed without interaction. Museums, like many other applications of social robots in public spaces, contain an inherent service element. Visitors anticipate assistance from human staff members, either for organizational matters like navigation or to clarify queries about displayed content. This expectation is also given in HRI and reflected in the results of this study.

Users anticipate the robot to possess expansive knowledge, tackling service-related questions, like navigating the premise and location-specific queries (e.g., finding a restroom, checking for barrier-free paths, or depositing personal belongings).

Moreover, they expect the robot to engage in small talk and act as a fountain of knowledge about the exhibition, transcending mere information dissemination. Users crave more precise and detailed agent responses and access to external data sources. However, in real-world settings, system operators want to ensure that only correct and controlled answers to preserve their reputation. Balancing these needs is challenging since external data sources and manual data of training both are not infallible. Despite this, the manual creation of training data is time-consuming and influenced by the developer's demographics, making it hard to cover all questions. Although, the vast amount of knowledge needed for good system performance makes a database connection mandatory. The Cologne Cobots Lab (TH Köln) future work therefore focuses on a distributed knowledge generation system to guarantee site-specific knowledge and quality answers. This system integrates a use-case-specific handcrafted knowledge base, supplemented by a Large Language Model (LLM) like ChatGPT (OpenAi), ensuring ethical considerations and appropriate answer length. In addition to having access to a comprehensive and reliable knowledge base that ensures accurate responses, users also anticipate that the system will correctly interpret and understand their inquiries (e.g., through functioning Natural Language Understanding and Speech-to-text) and be able to answer them quickly and above all correctly. However, several interacting factors are important, which can influence the success of the dialogue - even independently of the correct answer. The example of users asking about polar bears and receiving a response about penguins highlights the importance of understanding user expectations and communication behavior. Users often assumed that the system misunderstood them acoustically, even if there were no errors in the speech-to-text or natural language understanding. Instead, misunderstandings often occurred due to turn-taking issues, such as users starting their questions while the system was still processing or pausing in the middle of a question. To improve the system's performance, it is important to account for these natural communication behaviors and develop strategies to better understand user intent. The

Cologne Cobots Lab is working on the improvement in turn-taking with a Furhat Robot through various strategies. Since we aim to connect our back-end to different front-ends (e.g., other social robots and a digital agent), we also align these strategic considerations with the transferability to other front-ends, with very different possibilities in terms of gestures, facial expressions or visual presentation on an additional tablet. These strategies include using symbolic colors for the listening state and using user feedback to predict turn-taking.

In conclusion, several determinants were identified that might hinder system interaction, including the necessity for a vast knowledge base, miscommunication during turn-taking, challenges managing groups, and individual user reasons. These insights indicate enhancing the system's natural language processing capability, broadening its knowledge base, and refining group interaction methods could uplift user experience and engagement levels. Additionally, pinpointing the exact meaning behind participants stating the robot did not comprehend them is crucial. Besides, it's essential to discern why users might opt to cease interaction, offering invaluable insights for refining social robot design and functionality to more adequately meet public service needs.

Limitations

A limitation of the study is that participants were aware that it was a research project and not a finished product, which could have influenced their responses but also potentially motivated them to be especially critical. Additionally, the use of free-text answers in the survey may have introduced variability in the data. To improve this, audio recordings could be used while still ensuring data protection standards are met. These recordings could be transcribed into text offline. Our research objective is to connect subjective data from questionnaires and observations with objective data from the agent itself and analyze system logs to determine which components are responsible for interaction errors. We also aim to investigate the reasons and preferences of users, such as the perceived quality of conversation design and front-end factors like the voice used and the appearance of the Furhat Robot, which may affect interaction.

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WORKSHOP I

Tactile Museum Project:
Using 3D printed tactile artifacts for creating inclusive experiences in museums

Moderation: Vicente Gascó Gómez

EVA Berlin

EVA Berlin 2023 Conference
30. November – 01. December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Tactile Museum Project. Using 3D printed tactile artifacts for creating inclusive experiences in museums

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ABSTRACT: This workshop paper investigates the role of 3D-printed tactile artifacts in enhancing inclusion and multi-sensorial experiences in museum exhibitions for individuals with visual impairment and tactile learners. Museums traditionally cater to sighted visitors, leaving those with visual impairments at a disadvantage due to limited tactile and auditory interactions. The paper presents a methodology and case studies case where 3D printing technology was employed to replicate selected museum pieces, allowing tactile exploration by visually impaired individuals. The methodology includes digitization considerations of museum pieces, 3D modeling, along with design and fabrication considerations. The initiative's success is measured by the positive response of visually impaired participants who visited the museum, with 93% satisfaction reported, signifying the effectiveness of 3D-printed tactile aids in museum settings. These findings advocate for the widespread adoption of such technologies to create inclusive cultural environments, suggesting a transformative impact on museum experiences for those with visual impairments.

1. INTRODUCTION

In this workshop, we present a series of case studies as part of ongoing research on the use of 3D-printed tactile artifacts to create more inclusive and multi-sensorial experiences in museums. Museums are institutions that serve as custodians of humanity's collective heritage. They collect various types of materials, artifacts, and/or specimens of historical, scientific, artistic, and cultural significance. Some of them are made available in the form of permanent displays, curated collections, or temporary exhibitions.

Traditionally, museums have been designed for sighted visitors in both architectural and exhibition design. This visual-centric design approach is evident in how objects are displayed. Museum experiences are often structured around viewing the objects and reading accompanying descriptions in the form of placards next to the objects. Additionally, there is also a technical reason. Many museum artifacts are delicate and require conservation measures that limit physical interaction, thus inadvertently excluding those who rely on tactile or auditory engagement.

Visual impairments are one of the most difficult to address in the museum world [1]. It is currently estimated that there are 253 million people worldwide who are blind, partially

sighted, or have low vision [2], up to 2.2 billion people have near or distant vision impairment [3], and the number is increasing. Eye diseases cause limitations in everyday life that can lead to exclusion from cultural and social life. Many museums are not adapted to serve people with visual impairments although such adaptations are relatively inexpensive. It does not require the construction of special driveways or any major architectural changes. Challenges are more associated with a lack of technical preparation, proper labelling, qualified personnel, [4], and a lack of tactile representations of museum objects.

Curators and designers must consider how to translate visual information to other mediums that can be understood through other senses such as creating replicas or interpretative models that accurately represent the original objects along with integrating assistive technologies such as audio descriptions, or Braille labels. This often requires a multidisciplinary approach, incorporating insights from educators, accessibility experts, and the communities the museums aim to serve.

Additive manufacturing, better known as 3D printing, offers a cost-effective and accessible means of translating visual information to tactile form. 3D printing is a process of creating three-dimensional objects from a digital file by successively layering materials until the object is complete. Unlike subtractive manufacturing which cuts away material, additive manufacturing adds material layer by layer, which can lead to less waste and material efficiency.

These 3D printers have also become increasingly cheaper due to advancements in technology, increasing competition, expiring patents, and open-source designs [5]. The rise of 3D printing also had a profound effect on the evolution of user-friendly and affordable 3D modeling software that allows non-experts to create custom products to meet their needs. The widespread adoption of these technologies holds significant promise for individuals with visual impairments, who have historically faced considerable barriers due to the high costs of assistive devices.

Two-dimensional images can be converted into raised outlined images or tactile graphics using computer-aided design (CAD) software. Three-dimensional objects can also be replicated using 3D CAD or can be directly scanned using a 3D scanner to generate 3D models. The CAD models can then be inexpensively printed out in physical form using a 3D printer [6]. Several museums are already taking advantage of these processes to create and have tactile objects available to visitors. In 2019, the Naturalis Biodiversity Center used 3D scanning and 3D printing to create a replica of an unusually complete t. rex dinosaur skeleton in collaboration with the Japanese Dinosaur Museum. The 3D-printed replica has been on display at the Japanese Dinosaur Museum since October 2021 [7].

At the University of Maine and the Hudson Museum, a team of composite artists and research engineers used 3D printing technologies to pioneer a proof of concept for collection replications, repatriations, and educational purposes. A 19th-century frog clan helmet—an artifact of cultural patrimony dating back to the late nineteenth century—that originally belonged to the Tlingit and Haida Indian Tribes of Alaska was replicated and then repatriated to its original roots. [8] In 2019, digital artists Matt Smith and Anders Rådén recreated four of Boccioni's destroyed works by using a combination of vintage photographic material and 3D printing for the exhibition, "Umberto Boccioni: Recreating the Lost Sculptures" at London's Estorick Collection of Modern Italian Art [9].

The Smithsonian Museum in Washington DC currently runs one of the most ambitious digitization programs in the world. More than five million specimens and objects have been digitized and shared online for everyone to see or even download. Anyone in the world could download a 3D model and replicate it with a 3D printer for personal enjoyment or educational purposes. [10] Projects like this have far-reaching implications that not only benefit the visually impaired and tactile learners but also democratize access to culture and education, offer more readily available resources to educators, and benefit cultural preservation and research. The Smithsonian also partnered with IF/THEN to create 120 life-size 3D-printed statues of a diverse coalition of contemporary women STEM innovators and role models leading a variety of fields, from protecting wildlife, and discovering galaxies, to trying to cure cancer [11].

These examples reflect a growing trend among museums to welcome diversity and inclusion through the innovative use of CAD and 3D printing technologies. Many museum guidelines mention the importance of appealing to multiple senses such as the use of tactile objects and comprehensive audio descriptions such as the Smithsonian Guidelines for Accessible Exhibition Design [12]. The aim of this workshop is to develop a methodology for projects that consider using 3D CAD technologies to prepare copies of historical, cultural, or artistic value intended to be used by people with visual impairments and tactile learners. This work presents case studies that used 3D modeling, CAD software, and FDM (fused deposition modeling) 3D printers to create such objects for museums in Puerto Rico. The objects were used for initiatives such as staff training, making exhibits more interactive and accessible for the visually impaired, promoting creative engagement, and inclusivity workshops.

2. DESIGN AND FABRICATION METHODOLOGY

The procedure for replicating museum objects with 3D printing can be quite complicated, it involves (1) digitizing the object either by 3D modeling or 3D scanning, (2) digital post-processing might be needed to ensure a correct representation of the original object, (3) preparation and slicing for 3D printing, and (4) material selection and fabrication [13]. A pipeline methodology was developed with the intention of streamlining the process to ensure quality and consistency.

The methodology includes the following steps:
A. Initial assessment
B. Digitization and 3D modeling considerations.
C. Design considerations for 3D printing
D. Fabrication and validation

Stage A. An initial assessment of the object to be replicated should include answers to the following questions:
- Determine what design elements make the object unique. This could include materiality, intricate details, textures, colors, and artist's intentions.
- Does the scale make it tactile inaccessible? Is it too big so the replica needs to be scaled down or is it too small, so the replica needs to be scaled up?
- Do we have access to the object? Can it be moved so it can be 3D scanned? Is it better or more affordable to 3D model it based on CAD drawings and/or using photography?
- What makes it unique? What physical elements are important for tactile recognition?

Stage B. Source or prepare the information needed for digitization and CAD modeling. Images, dimensions, and blueprints can be enough to accurately digitize a physical object using 3D modeling and computer-aided design (CAD) software.

Stage C. Additional refinement or modification might be needed to ensure that fine details are printable. Modifications could also be determined based on educational emphasis or to highlight tactile interpretation. Just as with any manufacturing process, there are several fundamental elements relevant to successfully 3D printing an object. The most important of these include feature sizes, fabrication orientation, and support structures (Table 1) [14].

Design Feature	Minimum tolerance
Supported walls	≥ 0.8mm
Unsupported walls	≥ 0.8mm
Support angle	≤ 45°
Embossed / engraved details	≥ 0.6mm wide & 2mm high
Horizontal bridges	≤ 10mm
Holes	≥ 2.0mm
Connecting / moving parts	≥ 0.5mm difference
Minimum features	≥ 2.0mm
Pin diameter	≥ 3.0mm

Table 1: *Designing for 3D printing design feature tolerances.*

Stage D. Fabrication of a prototype for testing and validation in collaboration with subject matter experts. Choose an appropriate 3D printing material that reflects the desired tactile qualities and durability. Consider color, texture, and weight. Print a prototype and check for any issues in the replication process. Adjust the model or print parameters if necessary. Obtain feedback from the visually impaired community on the usability of the model.

3. CASE STUDIES

The case studies presented next were developed for the Museo de Arte y Diseño de Miramar, Spanish for Miramar Museum of Art and Design (Santurce, Puerto Rico). In September

2019, MADMi took on the challenge of creating a comprehensive educational program that allows visually impaired individuals to enjoy better access to its collection using tactile experiences, 3D models, representative materials, auditory descriptions, Braille materials, enlarged print, and guided tours.

Educators, specialists in visual impairments, and subject matter experts worked together to select works that would be part of the tour for people with visual impairments. Works that could be experienced tactilely, those that would require permission from their owners to be included in the tour, those that would need to be represented in 3D, and those that could only be described audibly were selected. About 30 works were chosen to be part of each tour.

Of those 30 chosen works, four needed to be replicated using 3D printing technology:
- Case study 1: Pink house façade: MADMi is hosted in a historical building known as Pink House. Built in 1913 in the French Neoclassical Revival style, it is part of the diverse architectural presence of the Miramar neighbourhood and so, a 3D printed replica of its façade was requested.
- Case study 2: Hydraulic tiles: a composition of four hydraulic tiles which together form a pattern, in representation of Pink House's original restored tilework.
- Case study 3: Stained glass window: a representation of a stained-glass window designed by architect Antonin Nechodoma.
- Case study 4: Esperanza: an interpretation of a grasshopper-like insect known as Esperanza.

Fig. 1: Pink House facade (left) and its 3D printed replica (right).

3.1 Pink House 3D printed tactile facade case study development.

Stage A. Initial assessment.

The 'Casa Rosada' (Spanish for Pink House) is a French Neoclassical Revival style building built in 1913 in Miramar, Santurce in Puerto Rico, and which currently hosts the museum as seen in Figure 1. Key findings include:
- Roof slope and façade ornamentations are key aesthetic elements that make this building unique. Since it's a building, the replica model needs to be scaled down.
- Architectural elements and ornamentation should be simplified for proper printability of the model.
- The main color is pink which is also part of the museum's branding.

Stage B. Digitization and 3D modeling considerations
- Architectural blueprints were available. Can be used along with photos and site visits for accurate representation. The model was done utilizing computer-aided design (CAD) software, Autodesk Fusion 360.

Stage C. Design considerations for 3D printing
- Model orientation should print with the façade facing upwards in relation to the 3D printer's built platform. Printing the model upwards would result in windowsills, doors, and architectural elements becoming overhangs and requiring support materials. This could introduce inaccuracies or a rough surface finish into the model. This issue is avoided when printed with the façade facing upwards.
- Architectural ornamentation should be simplified to comply with FDM 3D printing fabrication tolerances. No design features should be below 0.8mm in size [15].

Stage D. Fabrication and validation

Prototype fabrication was performed on a Prusa Research MK3S+ 3D printer using PLA plastic filament with a diameter of 1.75mm and using parameters depicted in Table 2. Research has been done to validate PLA-type filament plastics as ideal for 3D printing materials for individuals with visual impairment [16]. The prototype was assessed by visual impairment specialists and cleared for use in the guided tours.

Printing parameters	Value
Print resolution	0.2mm
Infill	20%
Wall thickness	1.2mm
Top thickness	1.0mm
Bottom thickness	0.8mm
Print time	14h 36min
Printing temperature	215°C
Build plate temp.	60°C
Print speed	60mm/s
Supports	None needed

Table 2: *Printing parameters for case study 3.1*

Fig. 2: MADMi's hydraulic tile (left) and its 3D printed replica (right).

3.2 Hydraulic tiles 3D printed representation case study

Stage A. Initial assessment

Hydraulic tiles were created in the mid-1800s in Spain and widely used in Europe and America. Are entirely produced by hand using cement-based raw materials and are highly customizable from colors and geometric patterns. As part of MADMi's efforts of restoration, the Pink House's original hydraulic tylework, as seen in Figure 2, was completely restored and is considered of great architectural value. Key findings included:

- Since hydraulic tiles are made by hand, they include minor imperfections and variations in their tone [17].
- A set of four tiles creates a matching geometric pattern.
- Design is determined by geometric patterns and colors.

Stage B. Digitization and 3D modeling considerations

- Design can be easily digitized tracing a photo with vector-based graphic design software. This was done using Adobe Illustrator and turned into a raised 2.1D model by importing the digitized image to CAD modeling software.
- Four different hydraulic tiles were traced to reflect their minor imperfections.
- Different raised thicknesses based on color could be used to isolate geometries for tactile discovery.

Stage C. Design considerations for 3D printing

- Model orientation works as is for fabrication.
- Model can be printed at a 1:1 scale.

Stage D. Fabrication and validation

All four tiles' prototypes fabrication was performed on a Prusa Research MK3S+ 3D printer at a 1:1 scale using PLA plastic filament with a diameter of 1.75mm using parameters as seen in Table 3. The prototype was assessed by visual impairment specialists and cleared for use in the guided tours.

Printing parameters	Value
Print resolution	0.3mm
Infill	15%
Wall thickness	1.2mm
Top thickness	1.2mm
Bottom thickness	0.9mm
Print time	8h 17min
Printing temperature	215°C
Build plate temp.	60°C
Print speed	60mm/s
Supports	None needed

Table 3: *Printing parameters for each tile in case study 3.2*

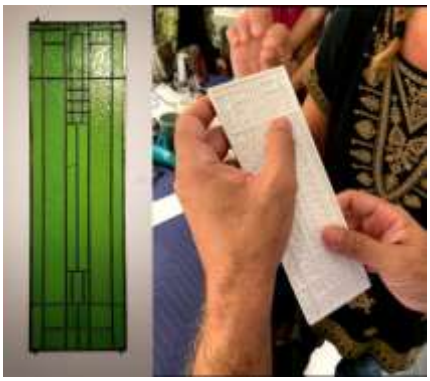

Fig. 3: Nechodoma's stained glass window (left) and its 3D printed replica (right).

3.3 Stained glass window 3D printed tactile representation case study.

Stage A. Initial assessment

The museum object is a stained-glass window designed by architect Antonin Nechodoma as seen in Figure 3. Key findings included:

- Window design consists of a green-colored stained window mounted on an aluminum frame.
- The glass features a refracted pattern and texture that dominates most of the window's design features.

Stage B. Digitization and 3D modeling considerations

- Design can be easily digitized by taking measurements and using CAD software.
- Modeling the glass texture is a must for the tactile representation of this artwork.
- CAD model should be scaled down although simplification of design features might not me necessary for fabrication.

Stage C. Design considerations for 3D printing

- Although both the aluminum frame and textured glass can be seen in both the front and

back of the window, the model should feature a flat back to avoid overhangs.
- Model can be printed at a 1:4 scale.
Stage D. Fabrication and validation
Prototype fabrication was performed on a Prusa Research MK3S+ 3D printer at a 1:4 scale using PLA plastic filament with a diameter of 1.75mm using printing parameters as seen in Table 4. The prototype was assessed by visual impairment specialists and a higher printing resolution was deemed necessary to better represent the texture of the stained glass. A second prototype was fabricated with new printing parameters.

Printing parameters	Value
Print resolution	0.30mm
Infill	25%
Wall thickness	0.8mm
Top thickness	1.0mm
Bottom thickness	0.8mm
Print time	11h 41min
Printing temperature	215°C
Build plate temp.	60°C
Print speed	60mm/s
Supports	None needed

Table 4: *Printing parameters for case study 3.3*

Fig. 4: Esperanza bug (left) and its 3D printed replica (right).

3.4 Esperanza bug 3D printed tactile model case study
Stage A. Initial assessment
An 'Esperanza' is a four-legged grasshopper-like bug as seen in Figure 4. Key findings included:
- Its green color and body features are its most recognizable elements.
- The model needs to be as anatomically correct as possible.
- Legs and antennas could be an issue due to thin dimensions.
Stage B. Digitization and 3D modeling considerations
- Design can be digitized using reference images and modeled using digital sculpting-style 3D modeling software such as Z-Brush.
Stage C. Design considerations for 3D printing
- Legs and antennas will lead to fabrication issues. Legs could be made thicker, in the case of antennas, it might be best not to include them in the model.
- The bottom of the model needs to be flattened for fabrication purposes.
- Support will be needed to do overhangs in the legs and parts of the body.
Stage D. Fabrication and validation
Prototype fabrication was performed on a Prusa Research MK3S+ 3D printer at a 4:1 scale using PLA plastic filament with a diameter of 1.75mm. Several iterations of model modifications and printing were needed due to the legs breaking during fabrication or being deemed too fragile during evaluation. For the final prototype, PET plastic filament was used due to its better mechanical properties when compared to PLA. Thicker wall thicknesses and slower printing speeds were used to improve printability and model strength as seen in Table 5. This final version was assessed by visual impairment specialists and cleared for use in the guided tours.

Printing parameters	Value
Print resolution	0.20mm
Infill	30%
Wall thickness	1.6mm
Top thickness	1.0mm
Bottom thickness	1.0mm
Print time	17h 33min
Printing temperature	235°C
Build plate temp.	90°C
Print speed	45mm/s
Supports	Yes

Table 5: *Printing parameters for final iteration of case study 3.4*

4. EVALUATION

A total of 167 participants visited the museum during the tours. Of that total, 43 had a visual impairment. Among them were 20 men, 19 women, and 4 who preferred not to identify. There was representation from all age groups, except for those between 16-19 years old. One participant identified as being between 10-15 years old, five between 20-29, seven between 30-39, eight between 40-49, seven between 50-59, five between 60-69, and ten participants were over 70 years old. When asked about their visual condition, 35% identified as blind, 37%

as legally blind, 21% as low vision, and 7% did not share their visual information.

Among the participants, 77% had never taken part in a specialized tour for people with visual impairments, while 23% had participated in at least one. When asked about tactile art experiences, 51% had experienced art tactilely, 44% had their first experience on the day of the tour, and 5% did not answer the question.

Participants had the opportunity to evaluate the 3D printed tactile replicas (as seen in Figure 5 and Figure 6) and share their experience and satisfaction through a questionnaire after completing the tour. 81% were completely satisfied with their experience, 12% were satisfied, while 2% were neutral and 5% were dissatisfied with their experience. 98% of the participants would return, and 2% would not. Moreover, 100% of the participants would recommend this tour to other people with visual impairments.

Participants asked to improve descriptions of the works and possibly include a person with visual impairments to conduct the tour. Nearly half of the participants asked for more activities like these, and one person mentioned wanting to have an exhibition that presented the works of people with visual impairments.

Due to 93% of participants expressing satisfaction, the education program along with the 3D printed tactile replicas were considered a success and now are part of the museum's permanent collection.

Fig. 5: *Visually impaired visitors evaluate 3D printed the hydraulic tiles replica. Image courtesy of MADMi.*

Fig. 6: *Visually impaired visitors evaluate 3D printed Pink House façade. Image courtesy of MADMi.*

5. CONCLUSION

The implementation of 3D-printed tactile artifacts in museums, as demonstrated by the case studies at MADMi, has proved to be a significant step towards creating more inclusive, multi-sensorial experiences for visually impaired individuals. The integration of these tactile replicas within the museum setting addresses the previously unmet need for multi-sensory engagement in exhibitions. With 93% of visually impaired visitors expressing satisfaction with the tactile replicas, the case studies and methodology presented in this workshop provide a replicable model that can be adapted to various contexts.

The careful consideration of each artifact's unique characteristics in the replication process highlights the importance of a meticulous and empathetic approach to the creation of tactile experiences. With 3D printing technologies becoming more affordable and accessible, museums now have the means to diversify their offerings and create educational programs that cater to individuals with visual impairments among other needs. The overwhelmingly positive feedback from participants of the specialized tours at MADMi, as well as their suggestions for further improvements, underscores the value and potential for growth in such initiatives.

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WORKSHOP II

Algorithmen zur Erstellung und Bewertung visueller Bildersortierungen

Moderation: Prof. Dr. Kai Uwe Barthel

EVA Berlin

EVA Berlin 2023 Conference
30. November – 01. Dezember 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Algorithmen zur Erstellung und Bewertung visueller Bildersortierungen

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KURZDARSTELLUNG: Da die Menge visueller Daten ständig wächst, wird die Organisation von Bildern immer wichtiger. Menschen können komplexe Einzelbilder leicht verstehen, aber sie haben Schwierigkeiten, große unsortierte Bildsammlungen zu durchsuchen. Dieses Problem tritt z.B. in Archivrecherchen oder der Suche nach Bildern auf. Wir berichten hier über ein durchgeführtes Nutzerexperiment, das zeigt, wie sortierte Bilder die Suche und Übersicht über große Bildmengen erleichtern. Eine neue Metrik ermöglicht die Vorhersage der Benutzerwahrnehmung bei sortierten Bildmengen. Außerdem wird ein extrem schneller Algorithmus für hochwertige visuelle Sortierung vorgestellt. Es wird gezeigt, wie die Kombination von Bildsortiertechniken mit Bildgraphen die explorative visuelle Erkundung extrem großer dynamischer Bildbestände ermöglicht.

Abb. 1: *256 IKEA-Küchengeräte, links in zufälliger Reihenfolge, rechts nach Ähnlichkeit sortiert*

1. EINFÜHRUNG

Obwohl Menschen komplexe Bilder schnell erfassen und verstehen können, haben sie Schwierigkeiten, viele Bilder auf einmal zu erkennen. Dieses Problem besteht bei der Suche nach Bildern in Fotoarchiven oder nach Produkten auf E-Commerce-Websites. Hier gestaltet sich die Suche oft sehr schwierig, wenn die Menge der relevanten Ergebnisbildern sehr groß ist. Da auf einem Bildschirm nur 10 – 20 Bilder gleichzeitig wahrgenommen werden können, ist oft ein endloses Scrollen durch unstrukturierte Listen notwendig, um das gesuchte Bild oder Produkt zu finden.

Menschen können Bilder leichter erfassen, wenn sie sortiert angezeigt werden. Abbildung 1 zeigt 256 IKEA-Küchengeräte, auf der linken Seite in zufälliger Reihenfolge, auf der rechten Seite nach Ähnlichkeit sortiert. Sucht man ein bestimmtes Bild, besteht im unsortierten Fall nur die Möglichkeit, die Bilder zeilenweise zu "scannen". In der sortierten Anordnung lässt sich schnell die passende Region identifizieren, in der dann gezielt gesucht werden kann.

2. MENSCHLCHE WAHRNEHMUNG SORTIERTER BILDER

Im Januar 2022 führte die Visual Computing Gruppe der HTW Berlin ein Experiment zur Bewertung von Bildsortierungen durch. Dabei konnte gezeigt werden, dass Bilder in sortierten Anordnungen viel schneller gefunden werden. Mehr als 2000 Teilnehmer haben am Experiment teilgenommen. Die Ergebnisse wurden in einem Fachartikel [1] veröffentlicht, hier seien die Motivation, die Durchführung und die Ergebnisse des Experiments kompakt zusammengefasst.

Das Ziel des durchgeführten Experiments bestand darin, herauszufinden, inwiefern Menschen durch geeignete Sortierungen von Bildern in der Lage sind, mehr Bilder auf einmal zu erfassen und wie dadurch die Zeit zum Finden der Bilder reduziert werden kann. Konkret ging es um folgende Fragen:

- Welche Arten von Bildsortierungen empfinden Menschen als angenehm und hilfreich?
- Wie kann die Qualität einer visuellen Sortierung, wie sie von Menschen empfunden wird, objektiv gemessen werden?
- Welche Verfahren sind am besten geeignet, um effizient Sortierungen zu erstellen, die den Präferenzen der Menschen entsprechen?

2.1 SORTIERUNGSPRINZIP

Was bedeutet eigentlich "sortieren"?
Bevor die im Experiment ermittelten Antworten auf die oben genannten Fragen vorgestellt werden, soll zunächst das Prinzip einer Sortierung anhand eines einfachen Beispiels erläutert werden. Sollen die Zahlen 6, 5, 2, 8 und 3 nach ihrer Größe sortiert werden, bedeutet dies, dass diese Zahlen so anzuordnen sind, dass jede Zahl größer als die vorherige ist.

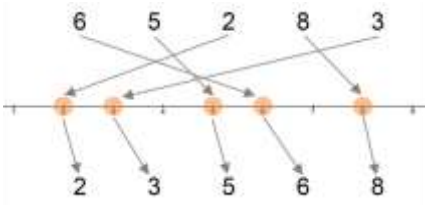

Abb. 2: *Sortierung von fünf Zahlen*

Generell gibt es für n Objekte $1 \cdot 2 \cdot 3 \cdot \ldots \cdot n = n!$ (sprich "*n Fakultät*") Möglichkeiten, sie anzuordnen. Im Fall der fünf Zahlen wären das schon 120 mögliche Anordnungen, von denen nur zwei sortiert sind (aufsteigend bzw. absteigend). Für größere Mengen von Zahlen gibt es effiziente Algorithmen zur Bestimmung der Sortierung (der optimalen Anordnung).

Wie sortiert man Bilder?
Sollen Bilder sortiert werden, ist nicht klar, wie hier eine gute Sortierung überhaupt aussieht und wie sie zu bestimmen ist. Im Vergleich zur Sortierung von Zahlen gibt es zwei wesentliche Unterschiede: Erstens wird das Aussehen und der Inhalt von Bildern nicht durch einzelne Zahlen, sondern mittels sogenannter *Featurevektoren* beschrieben. D. h. jedes Bild wird durch einen Vektor in einem hochdimensionalen Raum repräsentiert, wobei sich Vektoren ähnlicher Bilder in der Regel nahe beieinander befinden. Zweitens werden die sortierten Bilder meist auf einem 2D-Raster angeordnet, was bedeutet, dass es Nachbarn in horizontaler und vertikaler Richtung gibt. Die Zahl der möglichen Anordnungen wächst wieder faktoriell mit der Anzahl der Bilder. Bei einer Anordnung von 100 Bildern auf einem Raster von 10·10 Bildern gibt es bereits $100! = 9{,}3 \cdot 10^{157}$ Möglichkeiten (eine Zahl mit 158 Stellen), sie anzuordnen. Angesichts einer derart großen Zahl ist es selbst mit schnellsten Computern unmöglich, alle Varianten auszuprobieren. Selbst wenn es möglich wäre, alle Anordnungen zu vergleichen, wäre nicht klar, welche am besten sortiert ist.

Um das Prinzip der Sortierung von Bildern zu verdeutlichen, kann die zweidimensionale Sortierung von Farben als Beispiel dienen. Farben werden durch ihre Rot-, Grün- und Blau-Anteile beschrieben und können somit als 3D-Vektoren dargestellt werden. Um Farben zweidimensional zu sortieren, müssen diese 3D-Vektoren einem Platz auf einem 2D-Raster zugeordnet werden. Abbildung 3 zeigt eine mögliche sortierte Anordnung von 9·9·9 (= 729) RGB-Farben auf einem 2D-Raster mit 27·27 (= 729) Positionen.

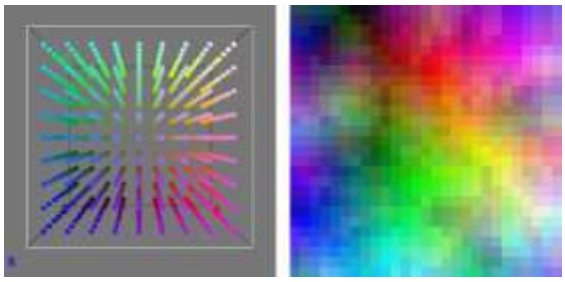

Abb. 3: *links: 729 Farben im 3D RGB-Farbraum, rechts: 729 Farben angeordnet auf einem 2D Raster*

Der Unterschied der visuellen Sortierung von Bildern im Vergleich zum oben genannten Farbbeispiel besteht nur darin, dass die Dimensionen der Featurevektoren von Bildern sehr viel höher sind. Zur Beschreibung der visuellen Erscheinung eines Bildes reichen weniger als 100 Dimensionen aus, während für die Beschreibung des Bildinhaltes Tausende von Dimensionen erforderlich sein können.

2.1 SORTIERUNGSEXPERIMENT

Verwendete Bildsets

Vor der Durchführung des Experiments haben wir Untersuchungen mit verschiedenen Bildsets unterschiedlicher Größe durchgeführt. Dabei zeigte sich, dass bei zu großer Bildanzahl einige Bilder unabhängig von ihrer Sortierung sehr schwer zu finden waren. Dies hätte bei Suchaufgaben während des Experiments sicherlich zum Abbruch vieler Teilnehmer geführt. Bei sehr kleinen Sets hingegen hatte die Sortierung der Bilder kaum einen Einfluss auf die Suchzeit, da die gesuchten Bilder meist sofort erkannt und gefunden wurden.

Im Experiment wurden vier verschiedene Sets verwendet. Das erste bestand aus 1024 zufällig generierten RGB-Farben und wurde nur zur Ermittlung der empfundenen Qualität unterschiedlicher Sortierungen genutzt. Für drei weitere Bildsets wurde zusätzlich die Zeit zum Finden von gesuchten Bildern erfasst. Diese drei Bildsets wurden so ausgesucht, dass sie einerseits unterschiedliche Such-Szenarien abbilden und es weiterhin einen signifikanten Unterschied bei der Suchgeschwindigkeit zwischen sortierten und zufälligen Anordnung gab. Das erste Set bestand aus 169 Verkehrszeichen, wie sie auf Übersichtstafeln abgebildet sein könnten. Das zweite Set bestand aus 256 Bildern von IKEA-Küchenartikeln, wie sie typischerweise auf E-Commerce-Websites präsentiert werden. Das letzte Set waren 400 Bilder zu 70 nicht verwandten Suchbegriffen, die aus dem Internet gecrawlt wurden. Dieses Set könnte eigene Fotos repräsentieren.

Abbildung 4 zeigt die vier verwendeten Sets, jeweils in der Sortierung, die von den Teilnehmern am besten beurteilt wurde.

Durchführung des Experiments

Das Experiment bestand aus zwei Teilen.

Im ersten Teil wurden die Präferenzen der Teilnehmer erfasst, indem sie Paare von sortierten Bildanordnungen betrachten und entscheiden sollten, welche der beiden Anordnungen ihnen besser gefällt. Dabei sollten die Anordnungen bevorzugt werden, die "*eine klarere Struktur aufweisen, einen besseren Überblick bieten und das Auffinden gesuchter Bilder erleichtern*".

Im zweiten Teil des Experiments sollten die Teilnehmer in sortierten Anordnungen möglichst schnell gesuchte Bilder finden. Dabei wurde überprüft, ob die von den Teilnehmern bevorzugten Sortierungen auch eine schnellere Suche ermöglichen. Darüber hinaus haben wir untersucht, wie gut sich die Suchzeit mit Hilfe der Sortierqualität vorhersagen lässt.

Untersuchte Verfahren und Qualitätsmaße

In unseren Experimenten haben wir verschiedene Methoden zur Erzeugung sortierter Anordnungen verwendet. Neben *Self Organizing Maps* (SOM) kamen *Self Sorting Maps* (SSM), *IsoMatch* und eine *diskrete t-SNE Projektion* zum Einsatz.

Abb. 4: *Die vier Testsets des Experiments: 1024 RGB-Farben, 169 Verkehrszeichen, 256 Küchenartikel und 400 Bilder zu 70 Suchbegriffen aus dem Internet*

Wir haben diese Methoden mit unseren eigenen Ansätzen *Linear Assignment Sorting* (LAS) und *Fast Linear Assignment Sorting* (FLAS) verglichen. Weitere Details zu den jeweils verwendeten Algorithmen finden sich in unserer oben zitierten Veröffentlichung. Falls möglich, haben wir für jedes Verfahren mehrere Sortierungen mit unterschiedlichen Parametereinstellungen generiert. Um auch Beispiele geringer Sortierqualität zum Vergleich zu haben, wurden auch einige schlecht sortierte Anordnungen (bezeichnet mit "low Qual.") erzeugt. Rein zufällige Anordnungen wurden nicht verwendet, da dies wieder zu Experimentabbrüchen geführt hätte, weil das Finden der Bilder häufig zu schwierig gewesen wäre.

Es gibt Maße zur Bewertung von 2D-Sortierungen, aber es gibt keine Untersuchungen, die zeigen, wie gut diese die von Menschen wahrgenommene Qualität widerspiegeln. Diese Qualitätsmaße vergleichen die Abstände der Featurevektoren im Hochdimensionalen mit den resultierenden Abständen der Bilder auf dem 2D-Raster. Üblicherweise werden die Kreuzkorrelation bzw. die normalisierte Energiefunktion verwendet, die sich jedoch beide sehr ähnlich verhalten, weshalb wir nur die letztere verglichen haben. Wir haben ein neues Maß namens "*Distance Preservation Quality*" (DPQ) zur Bewertung von 2D-Sortierungen vorgeschlagen.

Empfundene Sortierqualität

Die nächste Abbildung 5 zeigt einen Screenshot des ersten Teils des Experiments. Allen Teilnehmern wurden 16 Paare von Sortierungen gezeigt und sie sollten jeweils entscheiden, ob sie die linke oder die rechte Sortierung bevorzugen oder beide für gleichwertig halten.

Abb. 5: *Screenshot des 1. Teils des Experiments*

Um eine mögliche Beeinflussung der Ergebnisse durch unsinnige Bewertungen auszuschließen, wurde in jedem Experiment ein Paar mit extrem unterschiedlicher Sortierqualität angezeigt. Wenn ein Teilnehmer bei diesem Paar die deutlich schlechte Sortierung bevorzugte, wurden seine Entscheidungen für alle Sortierungen verworfen. Insgesamt wurden 32 Sortierungen für das Farbset und jeweils 23 Sortierungen für die drei Bildsets untersucht. Entsprechend der Fußball-Bundesliga, wo es mit 18 Mannschaften $18 \cdot 17 = 306$ Hin- und Rückspiele gibt, was 153 unterschiedlichen Paarungen entspricht, gab es hier beim Experiment 496 mögliche Paare für das Farbset und jeweils 253 mögliche Paare für die drei Bildsets.

Zur Auswertung aller Vergleiche wurde ein ähnliches Verfahren wie beim Fußball angewendet, wo ein Spiel mit einem Sieg, einer Niederlage oder unentschieden enden kann. Beim Vergleich zweier Sortierungen erhielt die bevorzugte Sortierung einen Punkt. Wenn beide Sortierungen als gleichwertig bewertet wurden, erhielten beide einen halben Punkt. Im Gegensatz zum Fußball, bei dem es pro Saison zwei Spiele zwischen zwei Mannschaften gibt, wurde jedes Sortierungs-Paar mindestens 35 mal von unterschiedlichen Teilnehmern bewertet. Aus diesen Bewertungen wurde für beide Sortierungen einer Paarung jeweils die durchschnittliche Punktzahl ermittelt. Diese beiden Punktzahlen, die in Summe 1 ergeben, beschreiben, in welchem Verhältnis die eine Sortierung besser als die andere bewertet wurde. Für den Gesamtvergleich aller Sortierungen wurden ihre erhaltenen Punktzahlen aus allen Paar-Vergleichen addiert.

Ein Qualitätsmaß, das die Sortierqualität bewertet, sollte möglichst stark mit der Qualitätsbewertung der Nutzer übereinstimmen. Abbildung 6 zeigt den Zusammenhang (die Korrelation) der durchschnittlichen Nutzerbewertung der Sortierungen (User Score) im Vergleich zu den beiden untersuchten Qualitätsmaßen. Hierbei steht E'_1 für die üblicherweise verwendeten "normalisierten Energiefunktion" und DPQ für die von uns vorgeschlagene "Distance Preservation Quality". Die Symbolfarben repräsentieren die verschiedenen Sortierverfahren.

Die beiden Abbildungen zeigen, dass unser neues DPQ-Maß eine höhere Korrelation mit den Nutzerbewertungen aufweist, was bedeutet, dass es besser geeignet ist, die von Menschen empfundene Sortierqualität vorherzusagen.

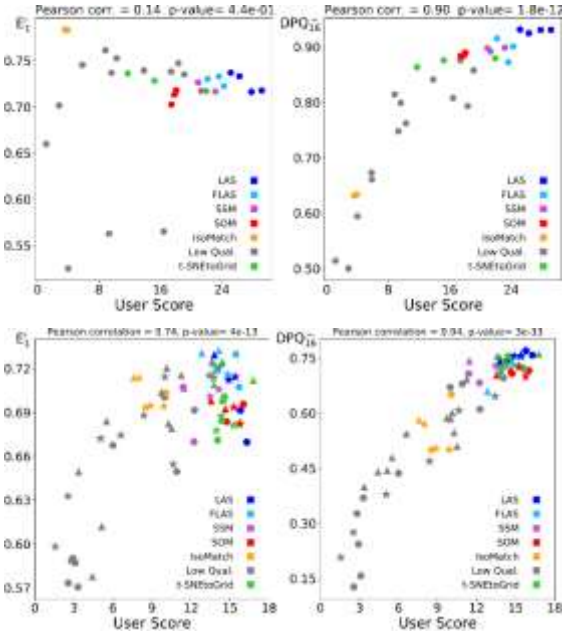

Abb. 6: *Oben: Sortierungen der 1024 RGB-Farben: Korrelation zwischen Nutzerbewertungen und der normalisierten Energiefunktion (links) bzw. unser Distance Preservation Quality (DPQ) (rechts). Man erkennt links z.B., dass von Menschen besser bewertete Sortierungen von der "normalisierten Energiefunktion" als schlechter angesehen werden. Die Werte der DPQ (rechts) hingegen steigen bei besser bewerteten Sortierungen. Unten: Sortierungen der Bildsets: Korrelation zwischen Nutzerbewertungen und normalisierter Energiefunktion (links) bzw. unser Distance Preservation Quality (rechts). Die Symbolformen kennzeichnen die Bildsets: Verkehrszeichen* (⬢)*, Küchenartikel* (▲) *und Internet-Bilder* (★)*.*

Suchzeiten

Im zweiten Teil des Experiments (Abbildung 7) wurden den Nutzern verschiedene sortierte Anordnungen gezeigt, in denen jeweils vier zufällige Bilder zu finden waren. War ein Bild gefunden, wurde sofort das nächste angezeigt. Die verwendeten Sortierungen waren dieselben wie im ersten Teil des Experiments.

Abb. 7: *Screenshot des 2. Teils des Experiments*

Natürlich hängt die Schwierigkeit, Bilder zu finden, stark von den gesuchten Bildern ab, da einige Bilder auffälliger sind als andere. Darüber hinaus unterscheiden sich die Teilnehmer in ihren Suchfähigkeiten. Bei nur wenigen Versuchen könnten diese beiden Aspekte die Ergebnisse erheblich verfälschen. Insgesamt wurden jedoch mehr als 28.000 dieser Suchaufgaben durchgeführt. Das bedeutet, dass für jede Sortierung mehr als 400 Suchen für jeweils vier Bilder durchgeführt wurden. Durch diese hohe Anzahl wurden sowohl die unterschiedlich schwierigen Suchaufgaben als auch die ungleichen Fähigkeiten der Teilnehmer ausgeglichen.

Abbildung 8 zeigt die Verteilung der Suchzeiten der 23 unterschiedlichen Sortierungen für das Set der Verkehrszeichen (Traffic Signs) und der Internet-Bilder (Web Images). Die Medianwerte der Suchzeiten für die verschiedenen Sortierungen sind als farbige Markierungen dargestellt. Auch hier zeigt sich die stärkere (negative) Korrelation der Suchzeiten mit unserem DPQ-Maß im Vergleich zur normalisierten Energiefunktion.

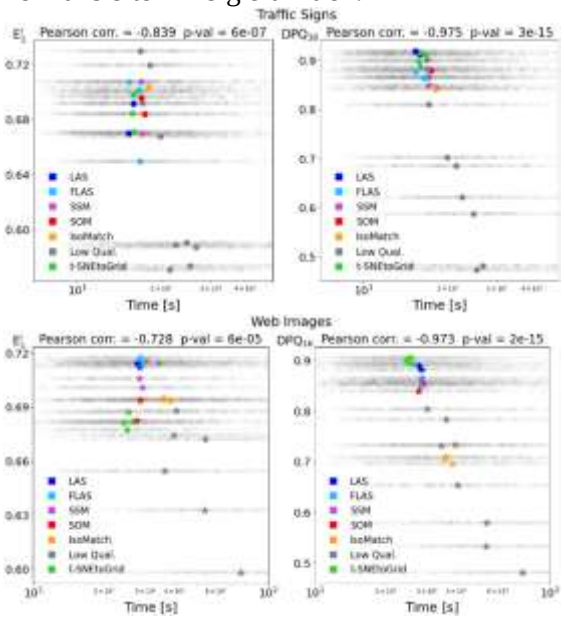

Abb. 8: *Korrelation der Medianwerte der Suchzeiten mit normalisierter Energiefunktion (links) und unser DPQ (rechts)*

Beim Vergleich der Sortierungen, die eine hohe Suchgeschwindigkeit ermöglichen, mit denen, die besonders gut bewertet wurden, zeigte sich ebenfalls eine starke Übereinstimmung. Jedoch war es für ein schnelles Finden wichtiger, dass alle ähnlichen Bilder sehr nah beieinander angeordnet waren, auch wenn die globale Anordnung der Sortierung dadurch etwas schlechter bewertet wurde.

2.1 VERGLEICH SORTIERVERFAHREN

Der letzte Schritt bestand darin, ein besseres Verständnis für die Leistungsfähigkeit der unterschiedlichen Sortierverfahren zu erlangen. Da die Laufzeit stark von der Hardware abhängt, dienen die angegebenen Zeiten nur als Vergleichswerte. Da die Distance Preservation Quality eine hohe Korrelation mit den Nutzerpräferenzen aufweist, wurde sie verwendet, um die Sortierqualität der Algorithmen in Abhängigkeit von der benötigten Rechenzeit zu vergleichen.

Abbildung 9 zeigt für die untersuchten Verfahren die erreichte Sortierqualität im Verhältnis zur benötigten Rechenzeit bei Variation der Verfahrensparameter. Bei kleineren Datensätzen wie den 256 Küchenartikel-Bildern bietet unser FLAS-Verfahren den besten Kompromiss zwischen Qualität und Rechenzeit. LAS und t-SNE können geringfügig höhere Qualitäten liefern, sind dabei aber 10- bis 100-mal langsamer. Für die 1024 zufälligen RGB-Farben erzielten unsere LAS- und FLAS-Verfahren die höchsten Sortierqualitäten.

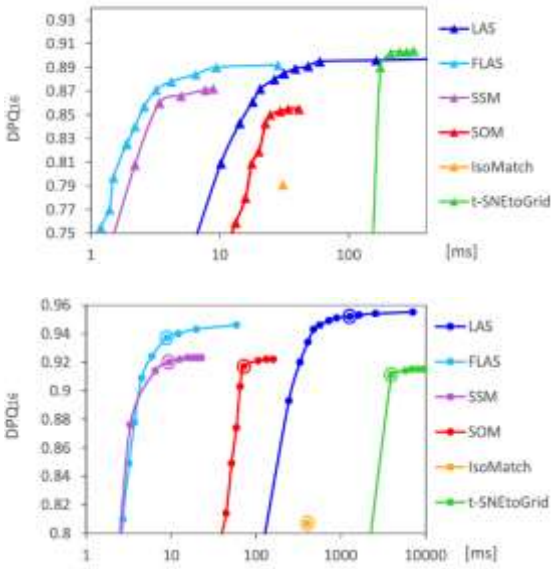

Abb. 9: *Mittlere Sortierqualität (DPQ) im Vergleich zur mittleren Laufzeit für unterschiedliche Parametereinstellungen für die Sortierungen der 256 Küchenartikel-Bilder (oben) und den 1024 RGB-Farben (unten)*

Eine weitere Untersuchung bestand darin, zu überprüfen, wie sich Qualität und Rechenzeit für unterschiedlich große Bildsets verhält. Hierbei wurden die Parametereinstellungen gewählt, die mit den ◉-Markierungen in der letzten Abbildung gekennzeichnet sind. Während SOM, SSM, LAS und FLAS bei mehr Bildern eine bessere Sortierung generieren können, wurden bei t-SNE und IsoMatch die Sortierungen schlechter (Abbildung 10).

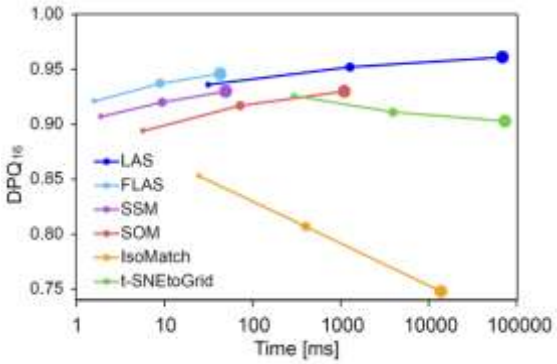

Abb. 10: *Die mittlere erzielte Sortierqualität in Abhängigkeit von der benötigten Rechenzeit für 256 (●), 1024 (●) und 4096 (●) RGB-Zufallsfarben für die unterschiedlichen Sortierverfahren.*

3. ZUSAMMENFASSUNG

Insgesamt waren wir mit den Ergebnissen des Experiments sehr zufrieden, da die zuvor gestellten Fragestellungen klar beantwortet werden konnten. Es hat sich gezeigt, dass Menschen in sortierten Anordnungen Bilder deutlich schneller finden können. Bei der Analyse von Bildsortierungen, die Menschen als angenehm und hilfreich empfinden, zeigte sich, dass eine hohe lokale Ähnlichkeit der benachbarten Bilder wichtiger ist, als das globale Erhalten der Ähnlichkeitsbeziehungen aller Bilder. Weiterhin hat sich bestätigt, dass unser Vorschlag für eine neue Qualitätsbewertung von Bildsortierungen erheblich besser als bisherige Verfahren die von Menschen empfundene Qualität widerspiegelt. Es wurde deutlich, dass unsere vorgeschlagenen Sortierverfahren LAS und FLAS qualitativ hochwertige Sortierungen erzeugen können und FLAS dabei auch sehr effizient ist. Darüber hinaus bieten unsere Verfahren eine Vielzahl von Optionen, um die Sortierungen zu beeinflussen, wie beispielsweise die feste Positionierung bestimmter Bilder oder die Möglichkeit andere Layouts als rechteckige zu verwenden (siehe Abbildung 11).

Das FLAS-Verfahren (zusammen mit einem Bildergraphen) ist so schnell, dass es möglich wird, Millionen von Bildern visuell zu explorieren. Navigu.net ist ein Beispiel eines solchen visuellen Bildexplorationstools (Abbildung 12).

Abb. 11: *Links: Sortierte Fahnen, mit fester Position der amerikanischen Flagge unten in der Mitte. Rechts: 2404 RGB-Farben in Form eines Herzens sortiert.*

Abb. 12: *navigu.net Visuelle Exploration von Millionen von Bildern*

[1] Barthel, K.U., Hezel, N., Jung, K. and Schall, K. (2023), Improved Evaluation and Generation Of Grid Layouts Using Distance Preservation Quality and Linear Assignment Sorting. Computer Graphics Forum, 42: 261-276. https://doi.org/10.1111/cgf.14718

WORKSHOP III

Initiativen, Verbundprojekte und Kooperationen für die Kultur

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Kunstgewerbemuseum (Museum of Decorative Arts)
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Tracing and Telling: Exploring collection holdings through graph-based narratives

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ABSTRACT: Cultural collections have transcended the boundaries of physical showcases and storage cabinets, evolving into intricate digital webs of interconnected data. The research project Restaging Fashion aimed to expand the possibilities for experiencing the linkages in digitized cultural heritage, focusing on the visualization of collection holdings related to the history of garments. Through graph-based narratives, the project investigated the complex interplay between the linear – and at times tentative – art historical discourses and the non-linear explorations of associated cultural heritage data. The resulting visualizations have been designed with the aim to allow for curated and dynamic exploration of the collection along research essays and their interrelated graphs.

1. INTRODUCTION

"Restaging Fashion - Digital contextualization of vestimentary sources" has been a three-year research and digitization project, funded by the Federal Ministry of Education and Research and situated at the Urban Complexity Lab [1] at the University of Applied Sciences Potsdam. Researchers from interface design, information science, and art history collaborated to represent fashion history and its sources from a linked data and information visualization perspective. The methodological approach in dress research of juxtaposing sources is being represented in the digital realm by connecting multimodal fashion sources through semantic relationships within and in between items." (see Fig. 1).

Figure 1: *Garments depicted on paintings are semantically tagged and linked*

The Berlin based publishing couple Franz and Frieda von Lipperheide gathered a collection of paintings, miniatures, relief sculptures, photographs, prints, drawings, almanacs and costume books as well as secondary literature while traveling in Germany, Austria, Italy and Switzerland in the late 19th century. This collection was and still is among one of the largest collections of sources worldwide with

regard to the history and use of fashion, costume and regional dress.

The donation of this vast collection to the state in 1892 resulted in the emergence of the Lipperheide Costume Library, which opened in 1906 next to the Arts and Crafts Museum in a separate library building. Today the Lipperheidesche Kostümbibliothek - Sammlung Modebild is housed in the Art Library (Berlin State Museums). The separation of Berlin during the aftermath of World War II also caused the splitting of the collection. While the prints and drawings as well as the literature were available for researchers, the collection of over 600 paintings and miniatures has not been displayed up to this day.

The Restaging Fashion project conserved, digitized and cataloged the paintings collection in terms of its clothing-historical content and source value. This was supplemented by 1000 selected prints and drawings from the Lipperheide collection. The selected depictions are perceived as contextualizing as well as complementing pictorial sources, enriching each other. Furthermore, a total of fifteen historical garments from the textile collection of the Germanisches Museum in Nuremberg serve as material evidence. The textile items span from 1600 to 1815 and range from the early modern doublets to a chemise dress from the early 19th century. The data capturing process involved 3D scanning and photogrammetry and they are now viewable and navigable as 3D objects. Archival documents on the history of the painting and miniature collection situate the collection objects in the historical context of the 19th century and document the genesis of the collection, its first presentation, its division after World War II as well as its reunification at the Berlin Kulturforum after the fall of the Berlin Wall. In addition, exemplary historical text sources have been selected for completing the source triad of image-text-dress and exemplifying the methodological approach of the project.

Restaging Fashion draws on visual, documentary, and material evidence, sources that are connected and communicated through the means of information visualization. The proposed visualization hence showcases paintings and miniatures alongside prints and drawings from the same collection, as well as textual and archival sources and material evidence provided by digital 3D objects of historic garments.

2. MODELING PREVIOUS AND ONGOING RESEARCH DATA

A significant part and core component of Restaging Fashion has been the documentation of the artworks and garments as well as the modeling and maintenance of the created research data, which then forms the basis of the resulting visualizations. The structural data that was generated followed specific modeling principles that enable semantic enrichment. Based on these premises, the Conceptual Reference Model of the International Committee for Documentation (CIDOC CRM) [2] was selected as the core model for the representation of the collection items. CIDOC CRM is being used extensively in the cultural sector, e.g. at the Rijksmuseum Amsterdam, the Germanisches Nationalmuseum Nuremberg, and the British Museum in London, and allows for representing cultural objects, their history, life cycle and relationships, due to its event-driven approach.

In order to choose a platform for cataloging and publishing the collected data and images, aspects and requirements such as open source, documentation and a lively coding community were taken into account. Omeka S [3] provided these requirements and the possibilities to further extend it. Omeka S became the primary platform for artifact documentation and provides an interface for establishing relationships between objects and concepts within the framework of Linked Open Data (LOD). At the same time, it offers the possibility to incorporate additional ontologies that would enrich and precisely describe the primary sources. The first step was then to migrate an already existing research database, which had been developed in a previous project at the Berlin Cluster of Excellence *Image Knowledge Gestaltung*.[4] When starting with the data generation process in Restaging Fashion the framework chosen for the description of the art works proved to be complex, unclear as regards the selection of object entities and properties in a structure that appeared to be nestled and complex. CIDOC CRM's extensive list of concepts made it challenging to distinguish between some of them, whereas at the same time they were not adequate for a more pragmatic approach. The difficulty in adopting its classes in combination with the granular approach that linked data

necessitated made data input cumbersome (an example of the granular approach in linked data representation can be seen in Fig. 2). As a result, some decisions had to be made, which would enable a more user-friendly approach in relation to cataloging and information presentation.

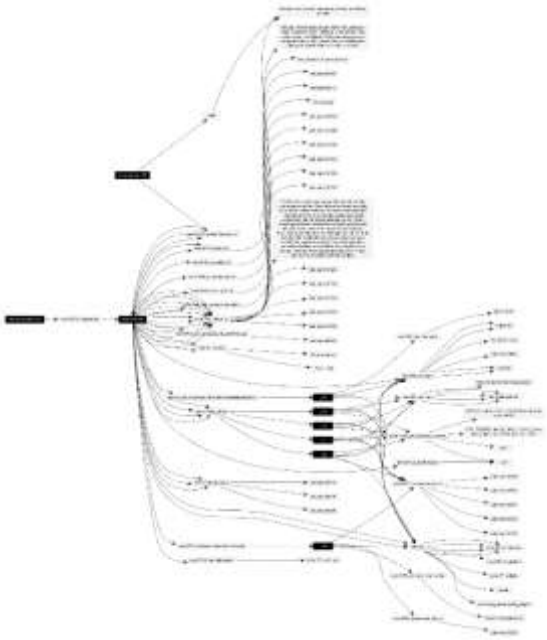

Figure 2: *Screenshot ReFa data model, see https://observablehq.com/@sinanatra/cidoc-crm*

In this regard, data curation emphasized the need for simplicity while at the same time ensuring precision to sufficiently characterize the collection. Properties that represented relationships too exhaustively were replaced by terms from other ontologies. As a consequence, CIDOC CRM was enriched by the use of other systems, especially Dublin Core [5] and Linked.Art [6]. Moreover, for some relationships local properties were implemented, whereas for the description of concepts the Simple Knowledge Organization System (SKOS) [7] was used. In terms of simplicity, readability, and time management, textual descriptions (with literal values) were preferred, in cases where more granular linking of entities (e.g., inscriptions or dimensions) and their properties would impede data input and visualization.

Furthermore, the data created were to be accessed alongside research essays that described and contextualized the artworks and their relations. Despite the rich semantics and the extensive representational capabilities of linked data, it was important for the project that the structure of the data would be readable by both humans and machines, raising the awareness that the contemplative and reflective nature of art history discourse, often disseminated in narratives, could not adequately be replaced by an extensive network. In this regard, an effort was made for a detailed representation of cultural data, while at the same time reducing complexity and focusing on the visual representation of the information.

3. DESIGN PROCESS

Data visualization projects are often initiated on the basis of an existing dataset, which may need to be prepared and analyzed before being visualized. In contrast, this research project provided for a parallel and interconnected process of data modeling and creation, closely coupled with the design and prototyping of visualization. Since the beginning of the project, several prototypes and experiments, in the form of Observable Notebooks, have been made, in order to test the appropriate representation of the information.

3.1 PROTOTYPING METHODOLOGY

Initial efforts focused on the correct semantic structure of the data: from processing and visualizing semantic triples, to verifying the correct import of data in Omeka S. Simultaneously, the data modeling and the vocabularies used in the project have been visualized to carry out quantitative analyses. Visually representing vocabulary structures and associated artworks (see Fig. 3), helped in understanding how to enrich the descriptions of items, while visualizing ontologies facilitated a more precise semantic description of artworks.

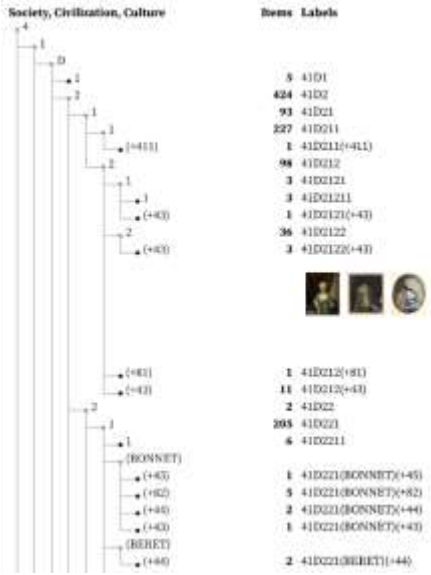

Figure 3: *A hierarchical visualization of the Iconclass notation used and their relative items in the collection*

Several different approaches were tested out to display the collection. From showing it in its entirety, based on similarities between paintings (see Fig. 4), to representing it on a temporal scale, to scaling up to a single painting and telling stories based on the connections it draws.

Figure 4: *Painting and miniatures sorted by visual similarity*

Finally, the focus centered on the visual juxtaposition of essays and graph visualizations for better representing the art historical discourse and giving access points to navigating the collection (see Fig. 5). Further prototypes were created to test how to combine essays and graphs. Both from a technical point of view: how to simultaneously write an essay by creating connections with the elements of a database, and from a visual point of view: at what level of granularity to represent a network that potentially allows thousands of connections?

Figure 5: *An early prototype of the ReFa Reader*

Early versions combined textual elements and graph representations, allowing the multiple connections between objects to be visualized. The network showed an overview of the material but did not allow further exploration of the collection. The curation of space is limited because the algorithms used to design the networks push and pull objects based on the strength of their relationships. Objects with more relationships would be central, while those with fewer relationships would be pushed away. This would produce a visual clutter, where the understanding of overall structural relationships would become very difficult [8]. Instead, by following the footsteps of the information flaneur [9] and perceiving the network from a local perspective, further prototypes were created. Starting from a term or phrase mentioned in a text and opening up a graph of relations from it allows for more editorial possibilities both in terms of essay writing and in terms of the resulting graph of connections.

3.2 TRACING & TELLING

Based on structured and semantically enriched data, the visualization exposes the data relationships in a graph-based setting in direct connection with introductory essays, giving the viewer the possibility to learn about art and fashion history as well as discover contextualized vestimentary sources. The iterative and collaborative design process, conducted through a series of co-design workshops with participants' backgrounds ranging from the digital humanities to interface design, has been centered around the question of how to convey the artworks, their rich interrelations, and relevant research. Despite an intricate modeling structure, it seems that some discourses remain "unrepresentable" [10]. The chosen reference model allows a detailed description of objects. However, regarding the representation of the ongoing research process, it is not always necessary (or feasible) to make all observations machine-readable. Instead, the priority is to present information in a way that is accessible to other researchers, avoiding the need for extensive formalization [11]. Mapping the results of art historical research into a data model based on a sequence of facts or on circumstantial evidence can quickly lead to a densely interwoven system that is neither satisfactory nor readable. To represent tentative observations or art historical argumentation threads, it was opted to design a prototype that provides access to the collection holdings via curated entry stories. Through such stories one can grasp the meaning of the artworks by following the art historical account, while at the same time relationships between artworks are shown in a graph-based environment.

Deviating from the common "Overview first" approach [12], it is possible to follow the narratives and iteratively build an understanding of the collection or dive deeper into the collection by navigating the adjacent graph. Moreover, based on the idea that a collection should not only be accessible and navigable via different modes of granularity

[13] but should also provide an introduction to the genesis of the collection and its artworks, a curatorial selection of essays, which address specific artworks, themes, and connections from the collection, is also showcased.

Following the notion that networks are also maps that act as instruments for navigation and representation [14], a curated approach to the design of the graph has been employed. The positioning of nodes suggests possible directions to explore the collection, interlacing texts with further information [15]. The viewer can delve into specific entities by clicking on them and thus opening up a new graph of relations to other entities. The generated graph comprises the core component of the interface and enables open-ended exploration. At the same time, artworks mentioned in the essay are highlighted, providing their visual representation in high resolution along with their related metadata.

Figure 6: *Screenshot of an essay in the ReFa Reader*

The proposed visualization concept, namely the *ReFa Reader* (see Fig. 6) [16], serves not just as a hybrid medium for the communication and exploration of fashion histories, but can be arguably used to experience digitized cultural collections in other domains, too. By combining the linearity of the narrative form with the topology of graphical nodes and edges, the prototype demonstrates the viability of the visualization concept that can be adapted to other data sources beyond the scope of fashion history. Potentially, formulating stories within collection visualizations allows for a more contextualized approach. Handing this tool to researchers from different disciplines and backgrounds could lead the way to more pluralistic readings of cultural collections in general.

4. CONCLUSION

One central premise of this research was that "[t]he use of computer supported, interactive, visual representation of data [can] amplify cognition" [17], which underlines the epistemic function of information visualization. However, linked open data is often hidden in collection interfaces. The semantic interconnectedness within a cultural collection is rarely used to stage narratives and pursue open-ended exploration. Even rarer is the integration of storytelling into exploratory collection visualizations. This research investigated the potential of interweaving linear description of art and fashion history with the non-linear exploration of the respective cultural heritage data.

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"Come one, come all(?)" Engaging Users of the German Digital Library

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KURZDARSTELLUNG: Seit April 2023 ist das neugestaltete Portal der Deutschen Digitalen Bibliothek online. Mit derzeit über 50 Millionen Objektnachweisen und ca. 19 Millionen Digitalisaten aus rund 700 Kultur- und Wissenseinrichtungen ist die Deutsche Digitale Bibliothek Deutschlands größter öffentlicher Aggregator offener GLAM-Daten. Wie genau wird die Deutsche Digitale Bibliothek genutzt und welche Nutzergruppen gibt es? Kann das Portal den spezifischen Anforderungen verschiedener Nutzergruppen gerecht werden? Oder bleibt die „Sammlung für alle" am Ende doch eine „Sammlung für niemanden"? In unserem Vortrag setzen wir uns mit Fragen rund um die Nutzerorientierung auseinander und diskutieren diesbezügliche Potentiale und Strategien in einem Umfeld rasant fortschreitender Digitalisierung und technischer Neuerungen. Dafür stellen wir die Resultate des 2023 abgeschlossenen Projektes „Nutzerorientierte Neustrukturierung der Deutschen Digitalen Bibliothek" vor und skizzieren die allgemeinen Herausforderungen von Vermittlungsarbeit rund um Bildungsarbeit, digitalen Tools zur interaktiven Datennutzung und Citizen Science.

1. EINFÜHRUNG

Im April 2023 wurde das neugestaltete Portal der Deutschen Digitalen Bibliothek veröffentlicht. Der Relaunch ist ein wichtiger Schritt für die Weiterentwicklung der Deutschen Digitalen Bibliothek als zentraler und nutzerfreundlicher Zugang zu digitalisiertem Kulturerbe in Deutschland [1]. Gegründet im Jahr 2009 von einem Kompetenznetz von 13 deutschen Wissens- und Kultureinrichtungen, vernetzt das Portal seit nunmehr über zehn Jahren digitalisierte Bestände, macht diese über ein zentrales Webportal für die Öffentlichkeit frei zugänglich und fungiert dabei als nationaler Aggregator für die *Europeana*.

Darüber hinaus ergänzen sparten- und themenspezifische Subportale das Angebot: Das Archivportal-D bietet Zugang zu digitalisiertem Archivgut und Informationen zu Archiven [2], das Deutsche Zeitungsportal ermöglicht eine Recherche in Millionen von Zeitungsseiten aus vierhundert Jahren deutscher Geschichte [3], und das Portal Sammlungsgut aus kolonialen Kontexten schafft Transparenz gegenüber Objekten aus kolonialen Kontexten in deutschen Kultur- und Wissenseinrichtungen [4].

Nach einem anfangs noch recht überschaubarem Datenbestand, waren die letzten Jahre von enormem Wachstum geprägt: Immer mehr Einrichtungen in Deutschland digitalisieren ihrer Bestände und teilen diese über die Deutsche Digitale Bibliothek. Mit

derzeit bereits über 50 Millionen Objektnachweisen und ca. 19 Millionen Digitalisaten von rund 700 Kultur- und Wissenseinrichtungen ist die Deutsche Digitale Bibliothek Deutschlands größter öffentlicher Aggregator offener GLAM-Daten. Dieser Prozess wird sich in den kommenden Jahren noch weiter beschleunigen.

Doch gerade angesichts solch schnell steigender Bestandszahlen stellt sich die Frage nach der Nutzung und Vermittlung des digitalisierten Kulturgutes: An wen richtet sich das Angebot und wie wird das Portal tatsächlich genutzt? Welche Nutzergruppen und *use cases* sind zentral? Welche Anforderungen an *usability* und *webdesign* bestehen, um die Erwartungen der Nutzer*innen zu erfüllen? Welche Strategien und Formen von Vermittlungsarbeit sind zielführend? Welche Herausforderungen und Potentiale ergeben sich mit Blick auf technische Innovationen im Bereich von digitalen 3-D Modellen und künstlicher Intelligenz?

Neben der konstanten Weiterentwicklung der technischen Infrastruktur und des Netzwerks der datenliefernden Kultureinrichtungen werden in den kommenden Jahren Nutzerorientierung, Anwendungsszenarien und Vermittlungskonzepte stärker in den Fokus rücken. Die über das Portal verfügbaren Bestände bergen dabei vielfältige Nutzungspotentiale, die über jenes als reines „Nachweisportal“ hinausgehen – etwa in den Bereichen von Forschung, Kulturvermittlung und Bildung sowie für die kulturinteressierte Öffentlichkeit.

Gleichzeitig birgt der spartenübergreifende Charakter und die offene Anlage der Deutschen Digitalen Bibliothek aber auch eine große Herausforderung: Kann das Portal gleichzeitig den Anforderungen der unterschiedlichen Nutzergruppen gerecht werden? Oder sind Datenstruktur, *user interface* und Präsentation zu unspezifisch und bleibt das „Portal für alle(s)“ am Ende ein „Portal für niemanden“?[5]

Im vorliegenden Beitrag gewähren wir einen Einblick in die Kulturvermittlung der Deutschen Digitalen Bibliothek. Im ersten Teil präsentieren wir dafür die Konzeption und Resultate des 2023 abgeschlossenen Projektes „Nutzerorientierte Neustrukturierung.“ Darauf aufbauend diskutieren wir im zweiten Teil die Perspektiven der Vermittlungsarbeit rund um kulturpolitische Bildungsarbeit, digitale Tools zur interaktiven Datennutzung und Citizen Science. Dabei verorten wir unsere Überlegungen im Spannungs- und Aktionsfeld soziodigitaler Transformationsprozesse.

2. DAS PROJEKT „NUTZER-ORIENTIERTE NEUSTRUKTURIERUNG“

Zwischen 2020 und 2023 wurde das Projekt „Nutzerorientierte Neustrukturierung des Portals der Deutschen Digitalen Bibliothek“ von der Beauftragten der Bundesregierung für Kultur und Medien mit 5,6 Millionen Euro aus dem „Neustart Kultur“- Programm gefördert.

Das Projekt verfolgte mit insgesamt neun Teilprojekten das übergeordnete Ziel, die Nutzungspotentiale für Zielgruppen und die diesbezügliche Vermittlungsarbeit auszubauen und weiterzuentwickeln. Die vier zentralen Zielgruppen der Deutschen Bibliothek sind 1) Lehrer*innen, 2) Forscher*innen, 3) Kulturvermittler*innen sowie 4) die kulturinteressierte Öffentlichkeit.

In einer übergreifenden Nutzungsstudie zu Beginn des Projektes und anschließenden Vernetzungsprojekten mit Einrichtungen aus den Bereichen der jeweiligen Zielgruppen wurden deren spezifische Nutzungserlebnisse und -bedarfe evaluiert.

Für den schulischen Bildungsbereich wurde deutlich, dass ein besonderes Potential vor allem in der Vielfalt der verfügbargemachten kanonischen und nicht-kanonischen Objekte sowie deren rechtssicherer Nutzbarkeit liegt. Gleichzeitig wurde jedoch die große Masse an Informationen im Portal als potentiell überfordernd bewertet und eine Hilfestellung bei der Reduktion der Objektvielfalt auf eine überschaubare Auswahl an thematisch und didaktisch geeigneten Objekten ins Gespräch gebracht.

Im Bereich Forschung wünschten sich Wissenschaftler*innen für die Suchfunktion verbesserte Filter- und Sortiermöglichkeiten sowie niedrigschwellige Möglichkeiten zur (Nach-) Nutzung der Daten in Software-Anwendungen. Vertreter*innen von kleineren Kultureinrichtungen – etwa Heimat- oder Geschichtsvereine – identifizierten das Portal als hilfreiches Werkzeug für lokale Geschichts- und Kulturprojekte. Dabei wurde das Potential

für Citizen Science-Projekte unterstrichen. Im Bereich der kulturinteressierten Öffentlichkeit wurde das Portal als nützliches Recherche-Instrument für vielfältige private Interessen bewertet, wobei das Thema Familienforschung herausstach.

Aus den eruierten Anforderungen der verschiedenen Nutzer*innengruppen ergaben sich Handlungsaufträge für die Neugestaltung des Portals, die im Projekt umgesetzt werden konnten. So wurde die Suchfunktion grundlegend überarbeitet: Zu nennen sind hier beispielhaft neue Navigationswege, neue bzw. weiterentwickelte Filtermöglichkeiten, simultane Filtersetzung oder Suchmöglichkeiten für redaktionelle Inhalte des Webportals. Ebenso wurde das Web- und Navigationsdesign des Portals grundlegend überarbeitet und zielgruppenspezifische Nutzungs-Tutorials erstellt.

Des Weiteren konzipierte und erarbeitete das Projektteam neue narrative und themengeleitete Sucheinstiege und Angebote für das Webportal. Dies erfolgt etwa über kuratierte Dossiers, die mit Artikeln, Bildergalerien, Spielen und virtuellen Ausstellungen den Einstieg in das Portal attraktiv gestalten und themenbezogen die Vielfalt an Beständen in der Deutschen Digitalen Bibliothek präsentieren. So eröffnet sich den Nutzer*innen ein niederschwelliger Überblick über die breitgefächerten Kulturgüter, die in der Deutschen Digitalen Bibliothek verfüg- und erlebbar sind.

Neben der nutzer*innenorientierten Neugestaltung des Portals wurden im Rahmen des Projektes auch langfristige Kooperationen mit Partnerinstitutionen angestoßen, die eine Nutzung und Nachnutzung der Daten über die Deutsche Digitale Bibliothek hinaus ermöglichen – etwa durch Lernplattformen, auf denen Lernende und Lehrende direkt mit den digitalisierten Kulturobjekten aus den Beständen der Deutschen Digitalen Bibliothek arbeiten können.

Um die Angebotsvielfalt der Deutschen Digitalen Bibliothek zu erhöhen und die im Portal präsentierten Bestände zu diversifizieren, wurden im Projektkontext außerdem Digitalisierungsvorhaben von Kultur- und Wissenseinrichtungen finanziell gefördert. Deutschlandweit haben mithilfe dieser Förderung insgesamt 60 Einrichtungen über 500.000 hochwertige Digitalisate von Kulturobjekten produziert und in die Deutsche Digitale Bibliothek eingebracht. Dabei wurden hochauflösende Fotos angefertigt, die die Nutzungsqualität im digitalen Raum signifikant erhöhen.

In der Summe konnte mit der Evaluation der zielgruppenspezifischen Bedarfe, der Neugestaltung des Webportals mit Erarbeitung umfassender redaktioneller Inhalte und der Initiierung von langfristigen Kooperationsprojekten die Nutzerorientierung der Deutschen Digitalen Bibliothek klar weiterentwickelt werden. Gleichzeitig brachte das Projekt die Erkenntnis, dass in verschiedenen potentiellen Nutzergruppen divergierende Perspektiven auf und Anforderungen an das Portal bestehen und der generelle Bekanntheitsgrad des Portals zielgruppen-übergreifend nach wie vor weiter zu steigern ist. Damit steht die zukünftige Vermittlungs- und Outreach-Arbeit vor der Herausforderung, mit begrenzten Ressourcen den Weg in Richtung einer stärkeren generellen Nutzerorientierung und zielgruppenspezifischen Ausrichtung weiterzugehen.

3. KULTURVERMITTLUNG UND OUTREACH-ARBEIT

Die Kulturvermittlung und Outreach-Arbeit der Deutschen Digitalen Bibliothek basiert auf verschiedenen Säulen und ist eng verknüpft mit der übergreifenden und zielgruppenspezifischen Öffentlichkeitsarbeit, die etwa Messeauftritte, Anzeigenschaltung und Publikationsaktivitäten in (Fach-)Periodika sowie – nicht zuletzt – eine breite Social Media-Präsenz umfasst.

Ein zentrales Standbein bilden die regelmäßig von der Online-Redaktion auf dem Portal veröffentlichten redaktionellen Beiträge: Hier behandeln in thematische Dossiers gegliederte Artikel, Bildergalerien und Spiele anhand von ausgewählten Objekten historische, politische und kulturelle Themen und geben so Einblick in die Breite und Tiefe des Bestandes der Deutschen Digitalen Bibliothek. Ziel ist, durch das Kuratieren von vielfältigen und spannenden Objekten die Bestände der Deutschen Digitalen Bibliothek für ein breites Publikum erfahrbar zu machen und zu einer weiteren explorativen Suche einzuladen.

Das Angebot an redaktionellen Beiträgen wird derzeit durch die Übersetzung von

ausgewählten Inhalten in Leichte Sprache erweitert. Ebenso im Aufbau befinden sich kuratierte „Quellensammlungen“ für den Schulunterricht, die – angelehnt an aktuelle Lehrplanthemen – handverlesene Primärquellen aus der Deutschen Digitalen Bibliothek zusammenführen und Lehrer*innen als Grundlage für ihre Unterrichtsgestaltung an die Hand gegeben werden.

Im Bereich der redaktionellen Inhalte kommt dem Format der virtuellen Ausstellungen eine besondere Stellung zu. Die Deutsche Digitale Bibliothek bietet mit der Software DDBstudio ein kostenlos nutzbares Tool für das Kuratieren und Publizieren von digitalen Ausstellungsprojekten an, die auf dem Portal veröffentlicht werden. Kultur- und Wissenseinrichtungen können dank DDBstudio so mit digitalen Beständen virtuelle Ausstellungsprojekte realisieren – ein Angebot, das breit genutzt wird: Derzeit sind bereits ca. 200 virtuelle Ausstellungen auf dem Portal veröffentlicht. Der Service und die Software von DDBstudio werden konstant weiterentwickelt, um mit technischen Entwicklungen im Bereich der Präsentation von digitalen Kulturobjekten Schritt zu halten – etwa im Bereich von 3-D Modellen und interaktiven Karten.

Einen weiteren Vermittlungsansatz im Kontext der redaktionellen Inhalte des Portals bilden Beiträge mit experimentellen Vermittlungsansätzen, die ein aktives „Machen“ aus den Beständen demonstrativ herausleiten. Hier werden Objekte aus dem Bestand mit konkreten Nutzungsfällen verknüpft und vorgestellt. Dabei können gerade ungewöhnliche, teils abwegig anmutende Nutzungsideen kraft ihrer Plakativität besonders aussagekräftig sein. Das Nachbacken von historischen Brotrezepten oder die Erstellung von digitalen Schriftsätzen und Grafiken auf der Basis von historischen Dokumenten und Bildern werden mithilfe kurzer Video-Tutorials anschaulich präsentiert. Dabei gilt es zu vermitteln, dass die DDB inspirativer Ausgangsort für vielfältige Projekte sein kann – ein Vermittlungsanliegen von zielgruppen-übergreifender Relevanz.

Der redaktionelle Bereich zielt also auf die stetige Weiterentwicklung des Portals der Deutschen Digitalen Bibliothek. Über die reine Funktion des Nachweisportals hinaus soll die Webpräsenz als interessanter digitaler Ort mit hoher genuiner Aufenthaltsqualität gestaltet werden und einen auf intuitives Entdecken ausgerichteten Zugang ermöglichen. Besonders der Bereich 3D-Anwendungen wir hier in Zukunft neue Möglichkeiten für die Vermittlungsarbeit eröffnen. Erste 3-D Modelle von Kulturobjekten sind bereits im Portal verfügbar.

Neben der über das Portal stattfindenden Vermittlungs- und Outreach-Arbeit steht der Bereich der Nachnutzung der aggregierten Daten *jenseits* des Portals über die API. In der Vergangenheit war in diesem Kontext der Hackathon „Coding da Vinci“ ein wichtiges Projekt, an dem die Deutsche Digitale Bibliothek beteiligt war. Zwischen 2014 und 2022 realisierte „Coding da Vinci“ regelmäßige Kultur-Hackathons, in deren Rahmen kreative Software-Anwendungen mit offenen Kulturdaten erarbeitet wurden – etwa aus den Beständen der Deutschen Digitalen Bibliothek. Einen weiteren Anwendungsbereich der API bilden derzeit Lernplattformen, die Objekte aus dem Bestand der Deutschen Digitalen Bibliothek in ihre Angebote integrieren. Hier kooperieren wir etwa mit der Lernplattform „wir-lernen-online.de“, die vom gemeinnützigen Verein *edusharing* betrieben wird. Greade was die zielgruppenspezifische Vermittlungsarbeit angeht, bieten Kooperationsprojekte mit Einrichtungen aus den jeweiligen Bereichen, die die Daten der Deutschen Digitalen Bibliothek über die API (nach-)nutzen, großes Potential für die Zukunft – etwa für Forschungs- und Citizen Science Projekte.

3. SCHLUSS

Vor uns liegt das viel zitierte digitale „Age of Abundance“, das einen exponentiell wachsenden Zugang zu digital frei zugänglichem Wissen verspricht. Daher wird in Zukunft gerade auch die Fähigkeit zur Auswahl, Reduktion und Anwendung relevanter Wissensbestände ein wichtiges Ziel digitaler Kulturvermittlung darstellen. Ebenso müssen im Angesicht der dynamischen Entwicklungen im Bereich von virtuellen Realitäten und künstlicher Intelligenz Vermittlungsangebote auf dem Stand der Zeit gehalten werden, um den Erwartungen der Nutzer*innen entsprechen zu können. In diesem Sinne gilt es die Potentiale für die Vermittlungsarbeit der Deutschen Digitalen Bibliothek auch in Zukunft weiter auszuloten und auszubauen.

Dies geht jedoch nicht allein: Das jährliche Budget der Deutschen Digitalen Bibliothek von ca. 4,5 Millionen Euro ist vergleichbar mit dem einer Grundschule, wobei der Großteil bereits durch den Betrieb und die Weiterentwicklung der Infrastruktur gebunden ist.

Innovative Ideen und Projekte für die Weiterentwicklung der Kulturvermittlungs- und Outreach-Arbeit müssen daher auch im Austausch und der Kooperation mit externen Partnern entstehen – etwa Kultureinrichtungen, Bildungsinitiativen oder Forschungsverbünden [6]. Gerade in Projektkooperationen besteht die Möglichkeit, zielgruppenspezifische Angebote und Anwendungen zu konzipieren und umzusetzen, die gleichzeitig auch den spartenübergreifenden Charakter der Deutschen Digitalen Bibliothek zu nutzen wissen. Zentral hierbei ist der Grundsatz, die Angebote der Kulturvermittlung entlang der FAIR-Prinzipien frei zugänglich und kostenlos zu gestalten.

In diesem Sinne sehen wir das Potential der Vermittlungsarbeit auch immer in der Kooperation und im Dialog mit Dritten. So kann die Deutsche Digitale Bibliothek durch den offenen Austausch und die Zusammenarbeit mit vielfältigen Partnern auch in Zukunft wenn auch vielleicht nicht ein „Portal für alle(s)“, bestimmt doch ein Portal für „viele(s)“ sein.

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Ein gemeinsamer Datenraum für das historische Erbe Hessens

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KURZDARSTELLUNG: In 2020 standen fünf Kultureinrichtungen des Landes Hessen vor der Herausforderung die Informationen zu ihren mehr als 2 Mio. Sammlungsobjekten für die Mitarbeiterinnen und Mitarbeiter aller fünf Einrichtungen zugänglich zu machen. Über die Verbesserung der Kooperationsmöglichkeiten zwischen den Dienststellen hinaus, war ein wesentliches Ziel des Projektes, auch die Weitergabe von Informationen an Dritte in verschiedenen Datei- und Datenformaten zu ermöglichen. Die besondere Herausforderung liegt in der Vielfalt der Themengebiete der Sammlungen und der gleichermaßen großen Vielfalt der genutzten Datenbanksysteme und Datenmodelle. Um allen Anforderungen unter den gegebenen Rahmenbedingungen gerecht zu werden, wurde das System mit Hilfe des Sammlungsmanagementsystems easyDB der Programmfabrik GmbH, Berlin verwirklicht.

1. EINFÜHRUNG

In den Sammlungen der hessischen Kultureinrichtungen existieren mittlerweile recht große Bestände an digitalen Daten zu den Sammlungsobjekten. Diese Sammlungsdaten werden, oftmals historisch gewachsen, in sehr unterschiedlichen Systemen verwaltet. Dies führt zu Mehraufwand und Anpassungsschwierigkeiten bei der Zusammenführung der sehr heterogenen Datenbestände und bei der Bereitstellung von Daten für die Nutzung durch Dritte. So war im Jahr 2020 der Zeitpunkt gekommen, diese historischen Strukturen zu überdenken und für kooperatives Arbeiten zeitgemäß neu aufzusetzen.

Im Mandanten Historisches Erbe Hessen sind fünf Dienststellen verwaltungstechnisch zusammengeschlossen: das Landesamt für Denkmalpflege Hessen (LfDH), die Verwaltung der Schlösser und Gärten (SG), das Hessische Landesmuseum Darmstadt (HLMD), die Hessen Kassel Heritage (HKH) und das Museum Wiesbaden (MuWi). Neben zahlreichen anderen Aufgaben verwalten alle diese Institutionen umfangreiche Sammlungen mit mehr als 2 Mio. Objekten aus unterschiedlichsten Themenbereichen des historischen Erbes Hessens. HLMD und MuWi verfügen als Mehrsparten-Museen über Kunst- und naturhistorische Sammlungen. Die anderen Dienststellen pflegen Bestände aus dem gesamten Spektrum der Kunst- und Kulturgeschichte, von der Volkskunde über Kunsthandwerk bis hin zur Archäologie und Paläontologie.

Im Folgenden möchten wir einen Überblick über das Projekt geben und einige besondere Herausforderungen und unsere Lösungsansätze näher beleuchten

2. DIE AUSGANGSSITUATION

Den Anlass zu dem Vorhaben begründet u.a. ein Landtagsbeschluss, der vorsieht die

Sammlungen der Museen in einem gemeinschaftlichen Portal zu veröffentlichen. Ein einheitliches Sammlungsmanagement-system Institutionen-übergreifend einzuführen war jedoch aus technischen und weiteren Gründen, nicht ohne Weiteres realisierbar.

In Hessen wurde nun ein zentrales Datenbanksystem geschaffen, das die weitere Nutzung der etablierten Datenbanken der einzelnen Dienststellen gewährleistet, gleichzeitig aber erweiterte Funktionen für alle Beteiligten zur Verfügung stellt.

Zur Verwaltung der Sammlungsbestände sind bei den Dienststellen, historisch gewachsen, unterschiedliche Datenbank-Architekturen mit nicht weniger unterschiedlichen Datenmodellen in Betrieb. In diesen Bestandsdatenbanken werden etablierte Metadatenstandards und kontrollierte Vokabulare oder Thesauri nur in sehr begrenztem Umfang oder gar nicht genutzt.

Ebenso heterogen ist die Situation bezüglich der Anbindung an das Datennetz. Einige Dienststellen sind im besonders gesicherten "HessenNetz", einem landeseigenen Intranet, eingebunden, während andere ihre internen Strukturen selbst verwalten und zusätzlich kommerzielle Serviceanbieter nutzen.

Neben diesen eher technischen Ausgangsbedingungen existieren für die Umsetzung des Projektes klare Vorgaben in Bezug auf den verfügbaren Finanz- und Zeitrahmen.

2.1 RAHMENBEDINGUNGEN

Unter Berücksichtigung der gegebenen Bedingungen mit Nutzern an zahlreichen Standorten war eine Umsetzung als Web-Applikation, ohne die Notwendigkeit, Client-Software auf zahlreichen Rechnern installieren und pflegen zu müssen, klar vorzuziehen. Um die verfügbaren Ressourcen möglichst effizient zu nutzen, sollte so weit möglich am Markt verfügbare Software genutzt werden. Von Beginn an wurde festgelegt, dass die Daten im zentralen System nicht bearbeitet bzw. verändert werden sollten, damit die Integrität der Daten zu jedem Zeitpunkt sichergestellt ist. Sind Änderungen oder Ergänzungen erforderlich, so sind diese in den "Heimatdatenbanken" vorzunehmen. Anschließend sollen die aktualisierten Daten – möglichst automatisiert - neu synchronisiert werden. Besonders wichtig ist auch, dass jederzeit eindeutig erkennbar ist, zu welcher Einrichtung ein Objekt gehört. Des Weiteren müssen Objekte über den gesamten Datenbestand, idealerweise sogar global, eindeutige Identifikationsnummern (IDs) besitzen.

2.2 TECHNISCHE UMSETZUNG

Für die technische Umsetzung wurden zwei Alternativen diskutiert:

1. Eine Metasuchmaschine, die in Echtzeit auf die Bestände der Datenbanken der beteiligten Dienststellen zugreift. Eine solche Lösung ermöglicht die Bereitstellung jederzeit aktueller Informationen, ohne dass Kopien erstellt werden müssen. Diese Variante hätte allerdings erfordert, die Software für die Suchmaschine inklusive der Anbindungen an die verschiedenen Bestandsdatenbanken neu erstellen zu lassen. Unter den gegebenen Voraussetzungen, insbesondere auch hinsichtlich der unterschiedlichen Netzwerkanbindung der Dienststellen, wäre diese Variante technisch, und damit auch finanziell sehr aufwändig gewesen.

2. Eine zentrale Datenbank, in der Kopien der Daten aus den verschiedenen Dienststellen vorgehalten werden. Diese Kopien können und müssen regelmäßig aktualisiert werden. Diese Lösung bietet die Möglichkeit, die Leistung der zentralen Datenbank unabhängig von den Systemen der einzelnen Dienststellen zu optimieren. Außerdem erhalten die Dienststellen mehr Kontrolle über die Daten, die dem zentralen System übergeben werden. Durch die gewählte Art der Implementierung kann die Aktualisierung der Daten zeitlich flexibel und ohne die Notwendigkeit festgelegter Zeitabstände jeweils dann erfolgen, wenn neue oder aktualisierte Daten zur Verfügung stehen. Diese Variante bietet vor allem die Möglichkeit, kommerziell verfügbare Sammlungsdatenbanken bzw. Sammungs-managementsysteme für die Realisierung der zentralen Datenbank zu nutzen. Damit reduziert sich der zeitliche und finanzielle Aufwand für die Einrichtung des gesamten Systems.

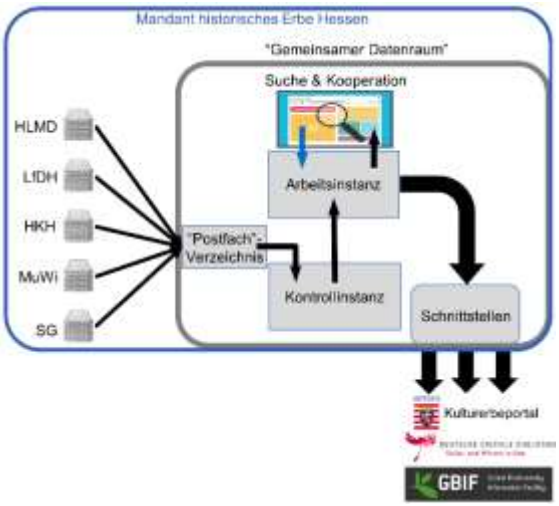

Abb. 1: *Datenflüssen im gemeinsamen Datenraum des Mandanten Historisches Erbe Hessen. HLMD: Hessisches Landesmuseum Darmstadt, LfDH: Landesamt für Denkmalpflege Hessen, HKH: Hessen Kassel Heritage, MuWi: Museum Wiesbaden, SG: Verwaltung der Schlösser und Gärten.*

2.3 FUNKTIONSUMFANG

Primäre Aufgabe des gemeinsamen Datenraums (Abb. 1) ist die Bereitstellung von Informationen über die Sammlungsbestände der beteiligten Institutionen für alle ihre Mitarbeiterinnen und Mitarbeiter. Ein direkter, ungefilterter Zugriff auf den Datenbestand von außerhalb dieser Institutionen ist nicht vorgesehen. Die wesentliche Funktion ist somit eine effiziente Suche über sämtliche digital verfügbaren Sammlungsobjekte aller involvierten Dienststellen. Darüber hinaus soll das System die Zusammenarbeit von Personen aus verschiedenen Dienststellen unterstützen, indem z. B. individuell konfigurierbare Zusammenstellungen von Objekten angelegt und gemeinsam eingesehen und bearbeitet werden können.

Die Bereitstellung ausgewählter Objektdaten für die Nutzung durch Dritte soll in standardisierten Formaten und Protokollen wie LIDO (Lightweight Information Describing Objects), Dublin Core (DC), OAI-PMH (Open Archives Initiative Protocol for Metadata Harvesting) und über eine API (Application Programming Interface) erfolgen. So wird sichergestellt, dass die Daten mit anderen Systemen und Plattformen kompatibel sind und problemlos integriert werden können. Auf diesem Weg sollen Daten z. B. an die Deutsche Digitale Bibliothek (DDB), an die Global Biodiversity Information Facility (GBIF), an das hessische Kulturgutportal, das gerade entwickelt wird, an das ebenfalls im Aufbau befindliche nationale Portal für Objekte aus kolonialen Kontexten oder an andere Fachportale und Datenaggregatoren übermittelt werden. Durch entsprechende Kennzeichnungen der jeweiligen Datensätze erfolgt die Steuerung der Freigabe von Informationen für bestimmte Empfänger.

Mit den gleichen Mechanismen können Daten auch für die Nutzung z. B. in Museums-Apps oder Online-Ausstellungen verfügbar gemacht werden.

Das System ist insgesamt so ausgelegt, dass mittelfristig Daten gemäß den FAIR-Prinzipien (Findable, Accessible, Interoperable, Reusable) zur Verfügung gestellt werden können. Durch die Bereitstellung der Daten als Linked Open Data (LOD) kann die Sichtbarkeit und Interoperabilität der Daten deutlich verbessert werden.

3. UMSETZUN DES PROJEKTES

3.1 VORARBEITEN

Im ersten Jahr des Projektes wurde unter Beteiligung von Kurator:innen und Digitalmanager:innen aus allen beteiligten Dienststellen zunächst eine Bestandsaufnahme durchgeführt und die Anforderungen an das neue System wurden ermittelt. Dies beinhaltete die gemeinsame Erarbeitung von Datenfeldlisten und anderen relevanten Details, um sicherzustellen, dass die Anforderungen aus verschiedenen Fachbereichen angemessen berücksichtigt werden. Die Einbeziehung der späteren Nutzer und Verwalter des neuen Systems sollte helfen die Akzeptanz und den Erfolg des Projekts sicherzustellen.

Nach Festlegung der Anforderungen und der Entscheidung über die Systemarchitektur wurde über eine umfängliche Marktsondierung nach einer Software gesucht, die die gewünschten Funktionen bereitstellt. Von besonderer Bedeutung waren hier die erforderliche Flexibilität in Hinsicht auf die Konstruktion des Datenmodells und die Verfügbarkeit der Protokolle für die Weitergabe von Daten.

Bei den Informationen, die das System aufnehmen kann, sind die Pflichtangaben beschränkt auf eine ID (Inventarnummer) und eine Bezeichnung für das Objekt plus einige technische Informationen. Damit soll sichergestellt werden, dass auch Objekte, für die nur minimale Informationen vorliegen, in das System aufgenommen werden können.

Darüber hinaus werden aber zahlreiche Felder für weitergehende Daten zur Verfügung gestellt, sodass Objekte mit allen Informationen ausgestattet werden können, die z. B. für eine Weitergabe an die DDB oder andere Portale erforderlich sind.

3.2 AUFBAU DES GEMEINSAMEN DATENRAUMES

Für die Realisierung des Projekts wurde ein zentrales Datenbanksystem gewählt, das Kopien der Originaldaten vorhält. Insbesondere unter den gegebenen technischen Rahmenbedingungen erschien dies als die effizienteste Lösung.
Die Datenanlieferung erfolgt in Form von CSV-Dateien über einen dedizierten Ordner auf dem Server, der nur das Schreiben, nicht aber das Lesen von Daten zulässt. In der aktuellen Version, in der das Einspielen von Daten noch von Hand durchgeführt wird, ist für diesen Zweck ein sogenannter Hotfolder der zentralen Datenbank eingerichtet. Zukünftig ist die automatische Verarbeitung der neu angelieferten Daten vorgesehen. Die dazu erforderliche Erweiterung der Software wird aktuell noch durch den Datenbankanbieter entwickelt. Dieser Ansatz bietet eine hohe Flexibilität ohne feste Aktualisierungszyklen und minimiert die technischen Anforderungen an die Systeme, die die Daten zuliefern.

Als Grundlage für das zentrale Datenbanksystem wird die am Markt verfügbare easyDB der Programmfabrik GmbH in der Version 6 verwendet. easyDB ist ein Sammlungsmanagementsystem, das bereits in zwei der fünf beteiligten Dienststellen für die Verwaltung der Sammlungsbestände genutzt wird. Es zeichnet sich durch eine besondere Flexibilität in der Gestaltung des Datenmodells aus, so dass auch thematisch sehr diverse Sammlungen, für alle Nutzer zufriedenstellend, abgebildet werden können.
Als voll ausgestattetes System für die Verwaltung großer Sammlungen bringt es alle Grundfunktionen bereits mit, wie z. B. eine bewährte Benutzeroberfläche mit Volltext- und Expertensuche, ein weit entwickeltes Rechte- und Rollensystem sowie Schnittstellen für den Datenimport und -export. Durch die Entscheidung für eine etablierte Museumsdatenbank als zentrales Element konnten Kosten und Entwicklungszeit für das Gesamtsystem geringgehalten werden, sodass eine Verwirklichung im vorgegebenen Zeitrahmen möglich wurde.
In dem gewählten Betriebsmodus werden zudem Server und Speicher vom Anbieter der Datenbank bereitgestellt und administriert. Dadurch sind keine zusätzlichen personellen Ressourcen oder Hardwareanschaffungen erforderlich.
Die Nutzung eines Systems “von der Stange” hat aber auch zur Folge, dass z. B. die Gestaltungsmöglichkeiten der Nutzeroberflächen eingeschränkt sind und bestimmte Strukturen und Prozesse im Front- und Backend nicht angepasst werden können.

Das letztlich implementierte Datenmodell ist recht einfach gehalten. Im Wesentlichen besteht es aus zwei Haupttabellen, die Informationen zu Objekten aus den Themenbereichen Kunstgeschichte und Naturgeschichte aufnehmen. Informationen zu Mediendateien, Personen und Orten werden in separaten Tabellen verwaltet. Da standardisierte Thesauri in den Quelldatenbanken nur sehr eingeschränkt bis gar nicht in Gebrauch sind, werden Daten grundsätzlich so in die zentrale Datenbank übernommen, wie sie von den Institutionen geliefert werden. Dadurch wird die Authentizität der Informationen sichergestellt und Fehler, z. B. durch automatische Konvertierung, werden vermieden.

Die Übertragung von Daten in das als “gemeinsamer Datenraum” bezeichnete System erfolgt mittels separater CSV-Dateien für die Daten zu Objekten und Medien. Die Notwendigkeit, zwei separate Dateien für Objekt- und Medieninformationen anzuliefern, ergibt sich aus den Vorgaben des gewählten Datenbanksystems beim Importprozess. Für den Import können je Sammlung eigene Feld-Zuordnungen angelegt, gespeichert und wiederverwendet werden. Dies eliminiert die Notwendigkeit einer starren, einheitlichen Struktur bei den CSV-Dateien, in denen die Daten angeliefert werden und erleichtert somit die Erzeugung der entsprechenden Exporte aus den Quelldatenbanken.

Zur eindeutigen Zuordnung der angelieferten Dateien zu den Sammlungen wird die ISIL (International Standard Identifier for Libraries and Related Organizations) im Dateinamen genutzt. Ebenso dient die ISIL in Kombination mit der Inventarnummer und der jeweiligen Systemeigenen ID zur Erzeugung zweier IDs

für jeden Datensatz, die für den gesamten "gemeinsamen Datenraum" eindeutig sind. In Kombination mit der URL des "gemeinsamen Datenraumes" ergibt sich eine global eindeutige ID.

Die Zugriffsrechte werden über ein Rechte- und Rollensystem geregelt, das ausschließlich lesenden Zugriff auf die Daten gewährt. Veränderungen der Datenbestände sind nur in den Heimatsystemen möglich und müssen über Aktualisierungen in das zentrale System übertragen werden. Dies gewährleistet die Integrität und Sicherheit der Daten und verhindert unautorisierte Änderungen im zentralen System.

4. ZUSAMMENFASSUNG UND AUSBLICK

Unser Projekt zur Schaffung eines gemeinsamen Datenraumes für die Sammlungsdaten mehrerer, thematisch sehr breit aufgestellter Kulturerbe-Institutionen, zeigt, dass ein solches, flexibel einsetzbares System auch mit überschaubaren Ressourcen zu verwirklichen ist. Das kürzlich in Betrieb genommene System bietet, basierend auf einer klassischen SQL-Datenbank mit assoziiertem Suchserver, sowohl komfortable Suchmöglichkeiten über den gesamten Datenbestand, wie auch recht komfortabel einzurichtende Wege, Daten über standardisierte Schnittstellen und Formate an andere Datenbanksysteme zu übermitteln.

Die Entscheidung, als zentrale Datenbank auf eine am Markt verfügbare Museumsdatenbank zurückzugreifen, hat sich bewährt, da dadurch bedeutender, sonst erforderlicher, Ressourceneinsatz vermieden werden konnte.

Als erstaunlich herausfordernd hat sich allerdings die Suche nach einem geeigneten Datenbanksystem erwiesen, da die Diversität der Daten sowie der zuliefernden Datenbanken eine Konfigurierbarkeit insbesondere bei der Gestaltung des Datenmodells, aber auch den Möglichkeiten zum Datenaustausch erfordert, die viele Hersteller nicht anbieten konnten.

Mit dem jetzt verwirklichten gemeinsamen Datenraum haben die Dienststellen des Mandanten Historisches Erbe in Hessen ein zukunftsfähiges Werkzeug zur Nutzung ihrer Sammlungsdaten geschaffen, das auch für weitere Entwicklungen viel Potenzial bietet.

So befindet sich aktuell eine Erweiterung des Systems in Planung, die es ermöglichen wird, zusätzliche Informationen zu einzelnen Objekten zu erfassen und dauerhaft zu sichern, ohne den originalen Datenbestand des jeweiligen Objektes zu beeinträchtigen. Damit wird es z. B. möglich, neue Forschungsergebnisse zu Objekten direkt mit diesen zu verknüpfen.

4. DANKSAGUNG

Wir möchten allen Mitarbeiterinnen und Mitarbeitern der Dienststellen des Mandanten Historisches Erbe Hessen für die sehr produktive Zusammenarbeit danken, besonders zu nennen sind hier die Digital-Manager:innen und Digital Scouts der Dientstellen. Ebenso möchten wir uns bei den Mitarbeiterinnen und Mitarbeitern der Programmfabrik GmbH für die gute Betreuung in allen Projektphasen bedanken und bei den zuständigen Stellen von HMWK und hessischem Digitalministerium für die Bereitstellung der Projektmittel.

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Normdatenportal und IKMK.net

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KURZDARSTELLUNG: Die Präsentation bietet einen Überblick über die bisher gemachten Erfahrungen im Bereich der numismatischen Objektdokumentation sowohl innerhalb des Münzkabinetts der SMB als auch im Zusammenspiel mit den universitären Projektpartner von numid.online in Deutschland und trinational im Falle von ikmk.net. Die Bedeutung und Chancen des semantischen Webs, von Normierung, Datenaustausch und konsequenter Konzeptpflege mittels des Normdatenportals bei gleichzeitiger Freigabe im WWW werden vorgestellt.

Normdatenportal und IKMK.net

Das Münzkabinett der Staatlichen Museen zu Berlin kann auf mittlerweile 16 Jahre Erfahrung und Praxis in der online-Präsentation seiner Bestände zurückblicken.
Beginnend mit einer ersten Ausgabe mittels Touchscreen in Raum 246 der 2006 eröffneten Dauerausstellung im Bode-Museum startete am 20. Mai 2007 der IKMK (Interaktive Katalog des Münzkabinetts) online mit knapp 3.000 Objekteinträgen und verschiedenen Suchmöglichkeiten mittels Freitextsuche, Schlagworte und Zeitschiene sowie angeschlossenem Emailpostfach für Besucherkommentare.
Erfahrungen in der Praxis der Datenerfassung und Dokumentation, Anforderungen der Redaktion zwecks Fehlervermeidung sowie vor allem ein Bewusstsein für die Bedeutung der Nutzung von universalen Identifikatoren und LOD führten ab 2011 zu einer durchgehenden Normierung der heute über 70 in Gebrauch befindlichen Felder und Deskriptoren, welche zudem mit Linked Open Data-Identifikatoren angereichert sind.

Bereits seit rund 10 Jahren werden die Objektdaten des Berliner IKMK auch auf nationalen und internationalen Portalen wie der DDB, museum-digital und den Themenportalen der American Numismatic Society (z. B. OCRE, Pella, Seleucid Coins u.a.) ausgegeben.
Mit dem Start des vom BMBF geförderten NUMiD-Projektes (numid.online) 2017 entstand basierend auf lokalen Instanzen des IKMK ein Netzwerk universitärer Münzsammlungen mitsamt einem gemeinsamen Portal. Die dort gesammelten Erfahrungen konnten im Mai 2021 bei der Gründung von ikmk.net, dem trinationalen Netzwerk von IKMK-Nutzern in Deutschland, Österreich und der Schweiz genutzt werden. Universitäre, städtische und staatliche Sammlungen sind hier mit ihren lokalen Instanzen des IKMK in einem gemeinsamen Verbund organisiert.
Ein wesentliches Werkzeug dieses vernetzten Arbeitens dabei ist die Nutzung gemeinsamer Normdaten, welche seit Juli 2019 auch für alle anderen Nutzer online unter ikmk.smb.museum/ndp frei zur Verfügung stehen. Damit steht seitdem ein Werkzeug für die Editierung und Anreichung einheitlicher

numismatisch relevanter Identifikatoren zur Verfügung, welches intern für die Einbindung dieser IDs in lokale IKMK und extern frei über das Normdatenportal genutzt werden kann.
IKMK.net präsentiert momentan rund 125.000 in hoher Datenqualität numismatische Objekte in rund 30 Sammlungen. Die Objektdaten werden in verschiedene Portale wie der DDB, Europeana, museum-digital sowie Typenkatalogen zur Münzprägung der Hellenistischen Könige, der römischen Republik und der Kaiserzeit, der römischen Provinzen, sowie der Regionen Thrakien, Moesien und der Troas exportiert.
Der Vortrag will einen Einblick in die Organisation der Datenstruktur und -erfassung, der Redaktionsverfahren des Berliner IKMK und IKMK.net allgemein sowie vor allem in das Normdatenportal selbst. Zudem soll die Bedeutung der Nutzung eines weiten Stammes relevanter LODs für potentielle spätere Vernetzung mit anderen Portalen verwandter und fernerer Fächer hervorgehoben werden.

Weiterführende links:
ikmk.net
ikmk.smb.museum/ndp (Normdatenportal)
numid.online (Portal), numid-verbund.de (zum Projekt)
Handreichung Dokumentation numismat. Objekte:
https://ikmk.smb.museum/eMuseum?lang=de&exhibition_id=88
Nutzerhinweise IKMK:
https://ikmk.smb.museum/eMuseum?lang=de&exhibition_id=102

Open cultural heritage projects for social and educational inclusion

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ABSTRACT

Museums, in order to successfully cope with the new, unprecedented, (post) pandemic conditions, have adopted, to a large extent, new technologies, mainly the ones of digital social networks and virtual reality, thus ending up in redefining the basic principles of museology and museography.

The rapid pace of technological developments in modern times, easily accessed by different groups of people, should also be taken into account, towards the direction of integrating information and communication technologies at all levels of education in order to achieve greater convergence between the learning experience provided from the current educational system and the experience gained outside of it.

Taking into account all the afore-mentioned, as well as one of the basic principles of constructivism, according to which learning results from the construction of cognitive structures through the acquisition of experiences and interaction with the environment, this paper proposes the development of open cultural projects to strengthen social cohesion, raise the awareness of the new generation in matters of culture and highlight new professional perspectives through education.

1. INTRODUCTION

Cultural heritage, as the cultural imprint of man's long history, shapes our collective memory. By overcoming local cultural identities, it becomes the "common place" that brings us together. [Chroni, 2018] Cultural heritage, as a key component of collective memory and social cohesion, plays a decisive role in the interaction and strengthening of relationships between the individuals of the local and global community, supporting social inclusion and, at the same time, strengthening economic regeneration. [Chroni, 2019]

The crisis of the COVID-19 pandemic, having a huge impact on society, as well as on the economy, has led to the urgent need of re-inventing the common values that connect people globally, thus rendering the phenomenon of the pandemic, a catalyst for positive changes.

The "new normal" as it has been shaped nowadays has made it clear that digital technologies point out the way, creating new models of scientific collaboration, developing innovative techniques for cultural heritage management and also proposing hybrid methodologies of social participation.

According to the *Hangzhou Declaration* on May 17, 2013, "in the face of mounting challenges such as population growth, urbanization, environmental degradation, disasters, climate change, increasing inequalities and persisting poverty, there is an urgent need for new approaches, to be defined and measured in a way which accounts for the broader picture of human progress and which emphasizes harmony among peoples and between humans and nature, as well as equity, dignity, well-being and sustainability. These new approaches should fully acknowledge the role of culture as a system of values and a resource and framework to build truly sustainable development, the need to draw from the experiences of past generations, and the recognition of culture as part of the global and local commons as well as a wellspring for creativity and renewal". [The Hangzhou Declaration, 2013]

The United Nations Conference on Sustainable Development, *The Future We Want*, at Rio de Janeiro, in June 2012, having highlighted the importance of cultural diversity and the need for a more holistic and integrated approach to sustainable development, has also enhanced cultural heritage's essential role in people's communication, social and educational inclusion, as well as in economic regeneration. [The future we want, 2012]

Open access-open data as emerged from the science sector, has very quickly emerged as a trend and practice in the field of culture as well, thus complying with the values-based approach model of cultural heritage management, emphasizing the values attributed to cultural heritage by different interest groups of people. The *Faro Convention on the Value of Cultural Heritage for Society/The Council of Europe 2005* had already proposed a more comprehensive and holistic view on the notion of cultural heritage, emphasizing the important role of people's participation and engagement in cultural procedures. [The Faro Convention, 2005]

2. MUSEUM-CULTURAL HERITAGE-SOCIETY

The concept of a *museum* is defined for the first time in 1889, by Georges Brown Goode, as "an organization concerned with the collection of teaching subjects, each of which is represented by some well-chosen sample". In 1895, he himself added that "the museum is an organization that preserves the objects that best illustrate the natural phenomena, the arts and the culture of man with the aim of enriching knowledge, enlightenment and cultural elevation". [Burcaw, 1997] On August 24th, 2022, in the framework of the 26th ICOM General Conference held in Prague, the ICOM Extraordinary General Assembly approved a new museum definition: "A museum is a not-for-profit, permanent institution in the service of society that researches, collects, conserves, interprets and exhibits tangible and intangible heritage. Open to the public, accessible and inclusive, museums foster diversity and sustainability. They operate and communicate ethically, professionally and with the participation of communities, offering varied experiences for education, enjoyment, reflection and knowledge sharing." [ICOM-Museum definition] The museum, therefore, as a multidimensional institution with a scientific, educational, social and developmental role, is at the same time an ark of collective memory. [Chroni, 2019]

According to one of the meanings of the term, which ICOFOM accepts, [ICOFOM], *museology* covers a very broad field that includes all attempts to formulate theories and critically approach the museum discipline, the common denominator of which can be defined as a specific relationship between man and reality which is expressed through the documentation of the real and can be perceived through direct sensory contact. This definition does not reject a priori any form of museum, from the oldest to the newest (*cybermuseum*), because it tends to deal with a field open to all kinds of experimentation in the museum sector. Under the latter perspective in mind, Bernard Deloche proposed the "definition of museology as museum philosophy." [Deloche, 2001]

The *museum* notion is directly connected to the notion of *cultural heritage* which plays an essential role in people's communication, social inclusion, as well as in economic regeneration. Placido Domingo, Honorary President of *Europa Nostra*, forewording the official *Report of the Cultural Heritage Counts For Europe Program*, as published in June 2015, states: "the wealth of buildings and cultural heritage, historic neighborhoods and cultural landscapes has the potential to inspire us, to enrich us and to help us cultivate a sense of belonging to a wider community." [Giraud-Labalte et al, 2015]

The preservation of cultural heritage requires documentation, monitoring, highlighting; in other words, an integrated management. A fundamental role in highlighting is operated by museums, which in recent years, by applying

new technologies, contribute decisively to the enhancement of the notion of cultural heritage and its communication to the public, thus achieving interaction with civil society, through participatory procedures.

Over the past four years, the COVID-19 pandemic crisis has deeply affected societies around the world, plunging the global economy into a deep recession. According to the 2020 *Annual Report of the United Nations Development Programme*, [U.N. Development Programme Annual Report] the devastating effects of COVID-19, the climate crisis and the growing inequality are not evenly distributed. They are, however, interrelated, and should be treated as such. In this context, the *United Nations Development Program* [U.N. Development Programme. https://www.undp.org/] is committed to strengthening and expanding its partnerships, considering that only then is it possible to contribute to the creation of a just social reality that offers dignity to all people, to ensure a healthy planet and to enable to achieve the *Sustainable Development Goals* by 2030 through a decisive decade of action. [Steiner, 2021]

The imprint of the situation is also evident in the universe of museums. The established situation is detailed in an official *UNESCO Report*, the product of a related research carried out in May 2020. The *UNESCO Report* is aligned with the *UNESCO Recommendation concerning the Protection and Promotion of Museums and Collections, their Diversity and their Role in Society*, as it emerged following the cooperation of 56 Member States in 2019, placing particular emphasis on the social role of museums in the light of the fact that "museums are vital public spaces that must be addressed to the whole of society and therefore can play an important role in the development of social bonds and cohesion, in the construction of citizenship and in the reflection of collective identities". [Mairesse, 2020]

3. NEW MUSEOLOGICAL REALITY

The *UNESCO Report* of May 2020 reveals, however, that museums have been particularly affected by the pandemic, with 90% of them closing their doors during the crisis and, according to the International Council of Museums (ICOM), more than 10% may never reopen. This initiative also seeks to understand how the industry has adapted to the restrictions imposed by the pandemic and explores ways to support affected institutions in the wake of the crisis. This report presents a first assessment of the impact of COVID-19 on the museum sector. [Mairesse, 2020]

Figure 1: *UNESCO Report of May 2020. [Mairesse, 2020]*

The International Council of Museums (ICOM) also conducted a similar survey, the second in a row, after the first one, in May 2020, and published a related Report, which resulted from the analysis of almost 900 responses from museums and museum professionals on five continents, responses which were collected between September 7 and October 18, 2020. It is important to highlight that, shortly after the survey had been completed, Europe began to experience a second wave of generalized lockdowns. The survey revealed that museums continued to strengthen their digital activities. All categories analyzed by the survey increased in a percentage of at least 15% of museums worldwide, a number that rises to almost 50% if we also take into account areas such as social media, live streaming events or online educational programs. Specifically, the percentage of museums that launched a new media channel increased for every activity examined compared to April. This ensured the continuation of the museums' operation. Museum professionals have returned to the workplace, but working from home is still widely encouraged, if not mandated. A large increase in digital visitors was observed in the period January-October 2020. [Gaballo, 2020]

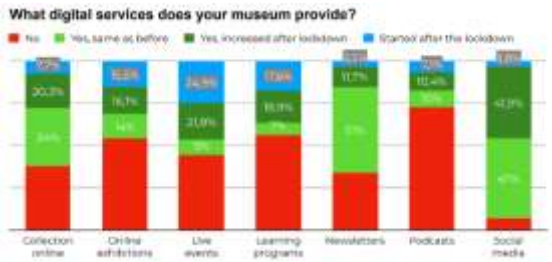

Figure 2: *ICOM Report September-October 2020.* ***[****Gaballo, 2020]*

A survey by the NEMO network [NEMO, 2021] brought to light the following: until the

pandemic was fully under control, museums faced a significant loss of income, either closed or open under security measures. Visitor levels have declined significantly and have not only challenged museums' business models and measures of success, but also necessitated new approaches and ideas to connect with their audiences and provide access to their collections in a meaningful way. In total, 600 museums from 48 countries participated in this survey between October, 30 and November, 29, 2020, the majority of which situated in Europe. The survey follows on from NEMO's original research, report and recommendations on the impact of the COVID-19 pandemic on museums, from May 2020 during the first lockdown, and seeks to further explore the different issues raised by the first research and which were discussed in the museum community. The topics were as following:

1. Consequences of income (and other) losses.
2. The new important role of digital museum products.
3. Adapted operations and preparedness during crises.

The NEMO network concludes: "**Keep museums open to the public during the crisis: Society must work together to slow the pandemic**", in the context of a persistent situation, where the risk of individual loneliness increases significantly and where public spaces for dialogue and inspiration are reduced to the minimum degree. The NEMO network recommends that museums should be opened up and be used to their potential to serve as spaces of well-being within which mental health and interaction between citizens are enhanced and supported, while also safely encouraging and stimulating all forms of learning. The same survey found that a majority of larger museums (81%) increased their digital capabilities as a result of the COVID-19 pandemic, while only 47% of smaller museums said they had. It is also interesting to note that the lion's share belongs to the social media posts. Among them, *Facebook* dominates with a percentage of 75%, followed by *Instagram*, with a percentage of 21.4%. [NEMO, 2021]

Consequently, "**Museums have no borders, they have a network**", acoording to ICOM. [ICOM]

Figure 3: *ICOM official website. [ICOM]*

The *Museum Innovation Barometer*, an ongoing research effort to analyze the state of new technologies and innovations in the museum world and to predict future trends, conducted a digital survey of museum directors and academics, cultural entities, as well as experts from different departments (IT, marketing, communication and curatorial departments) from December 2020 to May 2021. The scope of the research was global. In total, 150 individual institutions and groups of institutions have participated, allowing an insight into the operation of around 200 museums. The research explores the role of technologies and digitization before and after the outbreak of COVID-19, growth areas and strategic planning for the next three years in the areas of visitor experience, digital infrastructure, data collection as well as creating revenue. The relevant results are similar to the ones of the suerveys previously mentioned. [Mairhofer & Melo, 2021]

Regarding the framework of the digital applications chosen by the different museums: visual and audio applications prevail with a percentage of 85%, while virtual reality applications show a percentage of 21%. Digital options cover a wide range of applications: virtual tours, online art classes, do-it-yourself exhibitions, online subscriptions, virtual reality games, but also interactive online platforms. [Mairhofer & Melo, 2021]

The new reality has highlighted the COVID-19 pandemic as the great digital accelerator: digital innovation has played a key role in many cultural institutions staying active during national lockdowns. As cultural stewards, these institutions took on a new role and appealed to a public that sought connection, socialization, and educational opportunities while in isolation. They achieved this while threats of furloughs and shutdowns loomed. In addition, museums assumed a public commitment: culture supports well-being by providing public goods, building community, enhancing socialization, and giving context to lived experiences. The *Heritage Alliance's 2020 Annual Report*, "Heritage, Health and Wellbeing", confirms that heritage organizations support physical and mental health, build community cohesion and teach new skills to people at risk of social exclusion. Compared to the previous *State of Digital Transformation* survey in 2016, the percentage of respondents in logistics and digital information management roles increased in 2020, while those identifying themselves in senior management roles decreased. [Culture at a crossroads, 2020]

4. CULTURE-NEW TECHNOLOGIES-EDUCATION

The rapid rate of development of new technologies in the modern era, easily accessible to the largest part of the young population, a fact to which is attributed the high familiarity of people of an increasingly younger age with the use of electronic devices, is a factor of particular gravity: man, from a very early age acquires, as already mentioned, the highest familiarity with the concept of *digital*, especially in developed countries, a fact which has led to the emergence of the term *digital native*.

The afore-mentioned have a beneficial effect in the field of the science, however a quite negative one in the field of the humanities, where the concept of the physical object, i.e., the book, as well as the process of writing remain, nevertheless, key pillars. Consequently, the interest of the new generation in the humanities is constantly decreasing, as well as in related concepts, inextricably linked to them, such as culture, cultural heritage, collective memory.

In the scientific field of the humanities, the continuous decline observed in recent years is now worrying for the quality training of future scientists in the field in question, with the situation being reflected in the now extremely low entry grades for Humanities Schools of Higher Education.

So if we want children to re-love language and history lessons, to understand concepts such as cultural heritage, cultural identity-diversity-inclusion, to seek participation in cultural activities and consciously choose the direction of the humanities studies when they reach the threshold of Higher Education, it is necessary to re-invent the way of transmitting the corresponding information, because "when you start studying an art that does not require much from you, you will serve it with the rule of mediocrity that has been imposed on you from the beginning. And then, when you go into the classroom to teach, you'll pass it on to your students." [Theodoropoulos, 2023]

In combination with the afore-mentioned, we should also take into consideration that in several cases the imprint of time has negative consequences to cultural heritage and, therefore, to collective memory: in other words, it has an eliminating effect. Moreover, the ever-increasing distancing of the individual from the *physical*, the consequent approach to the *digital*, as dictated more and more strongly by technological evolution, [Chroni, 2012; Chroni, 2019; Chroni, 2022] as well as the bulimic prevalence of new technologies in our daily lives, it becomes often necessary to recover the memory of the urban and the natural environment [Rodríguez-Gonzálvez P. et al., 2022] and to redefine the interaction and imlication of the individual with processes of experiences directly related to the *physical*.

According to the official website of the *Hellenic National Documentation Center*, the challenge for the 21st century is not to focus on technological progress, alongside other development goals, but how to harness and use new technologies strategically as a tool for development. This is highlighted in the *Human Development Report 2001* implemented by the United Nations Development Program [NDC, 2023].

Figure 4a: *Syros Virtual Museum-Open Access. The left column shows the files that have been uploaded to the project's storage space and are available for management. The screenshot comes from the process of editing the project. Design and implementation: Athina Chroni. [Chroni, 2019]*

Figure 4b: *Syros Virtual Museum-Open Access: detail of previous image. Design and implementation: Athina Chroni. [Chroni, 2019]*

In this framework, *Syros Virtual Museum* and *Syros Virtual Museum-Open Access* have been developed as the digital products of the related Dissertation Thesis, focusing on studying and rendering the multidimensional cultural physiognomy of Syros island, Greece, [Chroni, *Syros Virtual Museum*, 2019] as well as *IASIS* Postdoctoral Research Project, [Chroni, *IASIS-IOANNINA 1430-1913* Virtual museum, 2022] focusing on the study and 3D digital approach for specific landmarks of Ioannina city, Greece, landmarks that no longer exist, in which the ever-evolving dynamic of the city has been depicted. In both cases, free software options and free online platforms with a user-friendly

interface, have formed constant reference points, thus achieving a minimization of the production costs of the related digital products, allowing and encouraging at the same time crowdsourcing and community participation, for both afore-mentioned cultural projects. Adopting media as is the image, the virtual tour of the digital visitor in an online museum, developing a website as well as cultural routes in the physical space, where, additionally, interactive QR coded informative labels for the public have been installed, are aiming to diffuse cultural information and give the lead to experiential learning. [Chroni, 2019; Chroni, 2022]

The goal is to connect the *physical* space (*tangible*) with the *digital* space (*intangible*): the interactive informative labels for the public that have been installed at the sites where once the lost landmarks of the city of Ioannina, finally acquire the dimension of *digital portals* to the virtual space, through the QR codes they carry on them, a new technology that achieves an "automated" connection with processes integrated into the everyday life of the new generation. [Chroni, 2022] Further objective, the awakening of the interest of young ages, to seek additional information, in physical libraries, on matters of a wider field of cultural topics and further explore their home place.

Figure 5a: *Screenshot of the proposed IASIS-Cultural routes project. Design and implementation: Athina Chroni. [Chroni, IASIS-Cultural routes, 2022]*

Figure 5b: *Interactive QR coded informative label for the public, installed at the Central Gate of the western arm of the wall of the Castle of Ioannina. The citizen can easily and quickly digitally scan any QR code of the label in order to enter IASIS digital environment. Photograph: Athina Chroni. [Chroni, 2022]*

Highlighting the functional role of new technologies in the direction of teaching a series of humanities courses, like history, architecture, urban planning, religion, cultural heritage management, as well as raising awareness and active participation of the new generation in matters of culture and collective memory preservation, form a milestone of the afore-mentioned cultural projects.

Ultimate ojective, to activate people's community in the direction of the participatory process in matters of cultural management. Consequently, the student is educated through experiential procedures, while at the same time re-evaluating the concept of new technologies as well as the concepts of crowdsourcing, human cooperation and active participation in culture. [Chroni, 2019; Chroni, 2022]

The successful interaction of the cultural digital tools proposed is directly related to the profile of the person involved: age, cultural orientation, emotional intelligence, social origin, political view, professional status, are only some of the factors that will significantly influence the success of the process. The goal is to exploit the possibilities of *Syros Virtual Museum* and *IASIS* Postdoctoral Research Project at all levels of education, as well as of social inclusion. [Chroni, 2019; Chroni, 2022]

At this point, the need for a strategic use of new technologies to re-invent and re-approach conventional methods of the learning process becomes clear. The multi-leveled freedom offered by a virtual museum works positively and effectively in this direction, given that it offers, to a wide and diverse public, the possibility of getting familiar with the concept and the operation of the museum. Taking into account the ease of accessibility to the digital world, especially concerning the youngsters, as well as the attraction, that the digital world exerts on the new generation in combination with the great familiarity that has been shaped until now, we can understand the important role that the virtual museum undertakes ultimately to carry out, radically changing the given, so far accepted, museological principles and approaches. [Chroni, 2021; Chroni, 2019]

5. CONCLUSION

Nowadays, multiple museums have adapted their activities in order to support virtual formats, have released high-resolution images and information material under a free-to-use license, and are organizing virtual tours of their digital collections, while also joining forces with crowdsourced online platforms such as in

the case of ICOM's collaboration with Wikimedia. Social media, a largely free mechanism for building community, spreading awareness and attracting attention, has been the obvious path to maintaining public engagement during the lockdown, [Mairhofer & Melo, 2021] proving that *people are the network*. [CISCO blogs] The catalyst of the pandemic therefore, increased the percentage of museums that now use digital tools for planning and curating exhibitions, as well as remote work, while the digital system for managing their collections was improved; [Mairhofer & Melo, 2021] at the same time, new perspectives in the educational procedure have arisen.

"The virtual museum, thanks to its connectivity and the possibility of a flexible accessibility to it, lends itself to overcoming traditional methods of communication and interaction with visitors, it does not have a real place or space and its objects and related information can be disseminated to worldwide". [Schweibenz, 2004] Actually, the *European Commission-Digital Single Market* implemented intensive policies to coordinate and finance actions that will complement the cultural policy of the Member States in the areas of digitization and online access to cultural material and digital preservation. [European Commission-Digital Single Market]

Across most of our planet, citizens experience the digital version of things in multiple ways, resulting in increasingly digital experiences and, accordingly, digital preferences. Museums, in fact, are called into noble rivalry with their competitors, which are very often digital games. For this reason, museums are now developing, in most cases, games with a serious purpose (*serious games*) which should handle the educational character of the museum in an understandable and pleasant way. [Chroni, 2019]

Accordingly, the learning process is increasingly oriented towards a wider adoption of digital media. However, no process should be developed in one-dimension. It is worth mentioning the *United Nations Report* of the year 2023, warning about the excessive use of mobile phones in schools, with one in four countries already banning them. UNESCO, the U.N.'s educational, scientific and cultural organization, has announced that there is evidence that excessive use of mobile phones is linked to reduced educational performance and that high levels of screen time have negative effects on children's emotional stability. The call to ban smartphones aims to highlight that digital technology as a whole, including artificial intelligence, should always be subordinated to a "human-centred vision" of education and never replace the real-life interaction between students and teachers. [UNESCO Global Education Monitoring Report 2023]

The post on ICOM's official website [International Museum Day] succinctly crystallizes the new landscape: "The goal of Wikimedia groups in the GLAM [**G**alleries, **L**ibraries, **A**rchives & **M**useums] field is to help memory institutions share their cultural resources with the global community through Wikipedia and related programs, making cultural heritage traceable and freely accessible to the world. Given our common goals, strengthening our collaboration and starting a new *International Museum Day Wiki*-project was the logical step for the 2021 edition, dedicated to the theme *The Future of Museums: Recover and Reimagine*."

Figure 6: *IASIS Postdoctoral Research Project Informative Leaflet. Design-development-digital processing: Athina Chroni. [Chroni, 2022]*

It is clearly a scholar's challenge to explore to what extent the *digital humanities*, as they are now called due to the extensive use of digital tools for research and teaching, [Borek et al., 2016; Fails and Kelton, 2016] can contribute creatively to the teaching of subject units concerning, for example, history or language, as well as to the development of the scientific dialogue on matters of upgrading the relationship of cultural heritage with education through interactive multimedia and online technologies.

The bet is to maintain the balance between new technologies and conventional education methods, in order that students regain contact and love for the humanities. Also, to propose new paths for social inclusion in matters of cultural heritage management. In this framework, the specific paper constitutes a brief proposal for the creative implementation of the *Syros Virtual Museum* and *IASIS* cultural

projects in educational and social inclusion processes, seeking for highlighting possibilities and constraints of the initiative.

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The Mediterranean lighthouse network: semantic decomposition between parametric modeling and ontology

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ABSTRACT: The research, net of the geometric-semantic classification of Mediterranean lighthouses, investigates the creation of a replicable valorisation methodology -in the BIM environment and in the ontological context- applied to the coastal architecture, characterized by recurring shapes and geometries. In the parametric field, the objective is to create a "design model of Italian lighthouses", through which to model volumes that are proportionate and geometrically consistent with the existing lighthouse. Through the use of ontological sciences - through the insertion of geometric, functional and compositional information- we instead want to reconnect the data and make knowledge more inclusive and usable. The use of a specific common terminology finally makes it possible to mix these two sciences, towards the creation of an inclusive onto-parametric software.

1. INTRODUCTION. THE COASTAL ARCHITECTURAL HERITAGE

It is along the coast line, the limit declaring the beginning and the end of the urban space from the coastal one -a strip of land that has always been the scene of centuries-old conflicts, myths and hope for a prosperous future- that those architectures called 'amphibious' lie, made up of foundations firmly on the ground but with a fixed gaze projecting towards the horizon. Their origin dates back to very distant times and their mutation follows one another in parallel with the progress of navigation technologies, which today are increasingly more invasive than pervasive. Despite the succession of increasingly innovative systems, capable of partially placing these architectures 'in the shade', lighthouses have represented and still represent today the main instruments for navigation, as well as constituting a huge architectural example in the context of cultural heritage.

Despite the quality and very strong architectural identity of this type of construction, it is now clear that the technological evolution of optics is the main cause of the abandonment of these architectures which, while maintaining their high symbolic and identity value, become the protagonists of a sudden and inexorable transformation of the architectural organism into a fragment of past memory. The architectural volume, in most cases, appears to be in decay, accompanied by an optic and its support system kept in perfect condition, in an extreme aesthetic contrast between function and composition, a symbol of technological progress.

In the context of the cultural heritage, of which lighthouses constitute an integral part, it is known that the issues relating to the protection of the latter are today the subject of various research aimed at the maintenance, the valorisation and the dissemination of the architectural heritage, through the use of digital devices, software and tailor-made methodologies. In this context, as supported by Dr. Sanna [1], the theme of the lighthouse, now partially gutted from its role, today requires a reevaluation, avoiding its alienation through refunctionalization, analysis and compositional study, making it is possible to understand languages and connections that have never been seen before.

The construction of material and immaterial knowledge networks becomes the starting point aimed at building a functional strategy for the valorisation and the rediscovery of these architectures. It is in this cultural context that the Mediterranean lighthouses are established, a research area with very high potential if connected to the very strong and recurring identity characteristic of this type of architectural structures, linked by a common semantics and by strong cultural and architectural relationships (fig. 1).

***Figure 1**: Lighthouses: material and immaterial connections*

2. PARAMETRIC MODELING: BETWEEN RECONNECTION AND KNOWLEDGE

As just stated, the protection of cultural heritage is today the subject of various research aimed at the maintenance, enhancement and dissemination of architectural heritage, through the use of digital expedients, software and tailor-made methodologies. BIM and ontology (AI) appear to be effective tools for improving and promoting coastal architectural heritage, through the construction of a replicable methodology of "automated" modeling and connection, through the use of semantics [2].
In order to optimize the results obtained from digital methodologies, as processes strictly linked to the peculiarities of the case study to be examined, it is therefore preliminary necessary to identify the architectural characteristics to be included, as well as the presence of material and immaterial links, elements necessary for the creation of a tailor made process.

Historical-Building Information Modeling (HBIM), based on the particular recurring geometric characteristics of lighthouses, has emerged as the most performing tool to accommodate a 'reproducible parametric methodology' in the context of Mediterranean lighthouses, based on semantics, interoperability and on reproducibility. Having established the tool through which to produce the methodology, we immediately find ourselves faced with the first problem associated with this type of process: information. It is in fact known that the initial information of the artefact, fundamental for understanding the architecture, is often heterogeneous between them: the challenge of producing methodology lies precisely in the ability to intercept the correct information to insert, identifying the relational categories, towards a created methodology customized [3].

Having considered the actual usability of HBIM as a tool for the 'reproducible' construction of digital architectural models, it appears evident that the first step, functional for the construction of the entire model, is constituted by the collection of data, the typology of which it is strictly linked to the purpose of the process to be created. In this sense, the methodology intends to make the modeling process of Mediterranean lighthouses more expeditious, through the recognition of architectural and functional data, reconnected through the parallel use of the ontology [4].

At this point it is possible to carry out the definitive identification of the constituent elements of the 'lighthouse system', and how these elements can be reported in a parametric context. The functional aspects of the architecture were identified through an in-depth reconnaissance of the archival data of the entire architectural apparatus linked to the Mediterranean lighthouses, relating to the aspects linked to visibility, range, luminous specificity, and the entire system associated with the optical system, both input and output, to and from the landscape (fig. 2).

Croazia

ID (E-)	Nome e località	Mare	Coordinate	Data	Al	Alt	F	D
3580	Faro di Babac	Mar Adriatico	43°47'24.2"N 15°23'41.4"E	1874	7	6	10	Fl (2) W 30
3595	Bestanj	Mar Adriatico	42°39'40.6"N 18°02'12.2"E	n.d.	18	6	n.d.	Fl (2) W 8s
3522	Blanca	Mar Adriatico	42°55'29.6"N 17°31'06.9"E	1885	10	10	n.d.	Inattivo
3093	Bonaster	Mar Adriatico	44°11'55.7"N 14°50'19.7"E	n.d.	12	6	n.d.	Fl W 2s
3344	Bijaca	Mar Adriatico	43°19'49.4"N 16°26'04.9"E	1881	8	7	n.d.	Fl R 3s
3226	Faro di Blitvenica	Mar Adriatico	43°37'30.6"N 15°36'28.1"E	1870	38	21	24	Fl (3) W 30s
3614 -5	Cavtat	Mar Adriatico	42°35'09.4"N 18°12'16.4"E	n.d.	8	8	n.d.	Fl (2) W 10s
2782	Faro di Cma Punta	Mar Adriatico	44°53'25.5"N 14°08'44.1"E	1873	15	9	10	Inattivo
3600	Dakoa	Mar Adriatico	42°40'22.9"N 18°03'21.2"E	1876	7	13	n.d.	Inattivo
2896	Ertak	Mar Adriatico	45°23'09.9"N 14°36'32.0"E	1875	9	5	n.d.	Fl W 2s
2744	Galiola	Mar Adriatico	44°43'42.0"N 14°10'29.4"E	1890	22	18	n.d.	Fl W 5s
3216 -4	Galijolica	Mar Adriatico	43°52'37.9"N 15°22'12.9"E	n.d.	11	8	n.d.	Fl (2) R 10s

***Figure 2**: Reconnaissance of archival data*

Once the phase aimed at in-depth knowledge of the functional data of the artefact, the connection of which is subsequently delegated to the ontological software, is completed, it is possible to undertake two paths, depending on the parametric modeling strategy to be adopted: use a default model provided by programs such as Revit -making the modeling work slower and more unique- or undertake the creation of your own model file, modifying the database structure and adapting them to your own purposes.

For the architectural typology of the lighthouse, specific categories have therefore been identified, which are present in almost all of the case studies: this is the case of the macro variables and the related micro variables. Net of the compositional and geometric study of the lighthouses present in the Italian territory, the elements 'building', 'tower' and 'lantern' were identified for the macro variables, i.e. elements present in almost all of the case studies for the element 'building' and always present with regards to the 'tower' and 'lantern' elements. The latter in turn welcome and incorporate further peculiar characteristics, defined as 'micro variables' (figs. 3, 4) and classified according to the macro variable that hosts them.

For the building element, the following micro variables were identified: the number of levels, the type of moulding, the type of opening, the possible presence of ashlar work. For the tower element the following were identified: the section in plan; the possible presence of a shelf; the presence of taper; the type of moulding; the type of windows. For the lantern element, the following micro variables were identified: the type of balustrade and the section in plan.

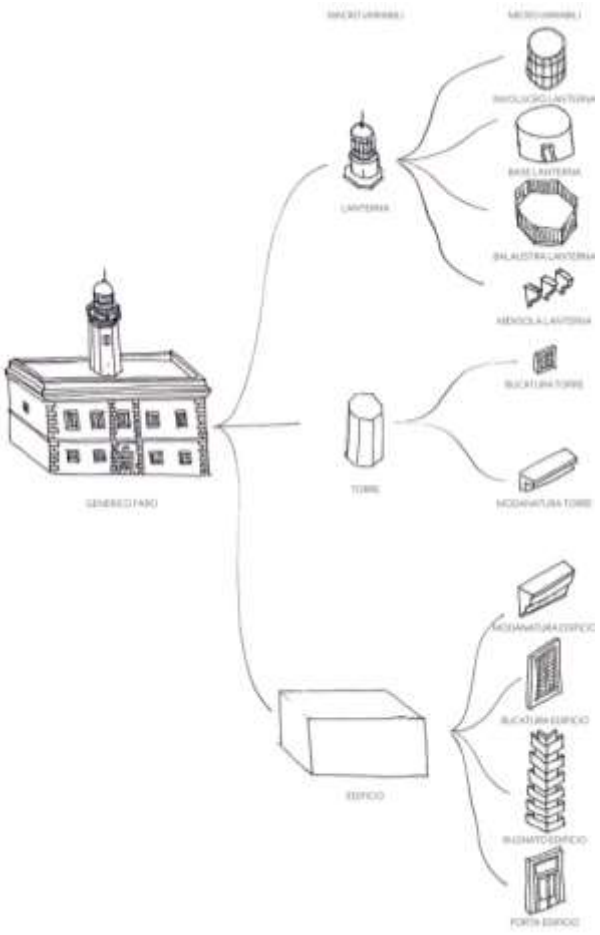

***Figure 3**: Semantic decomposition of the 'lighthouse system'.*

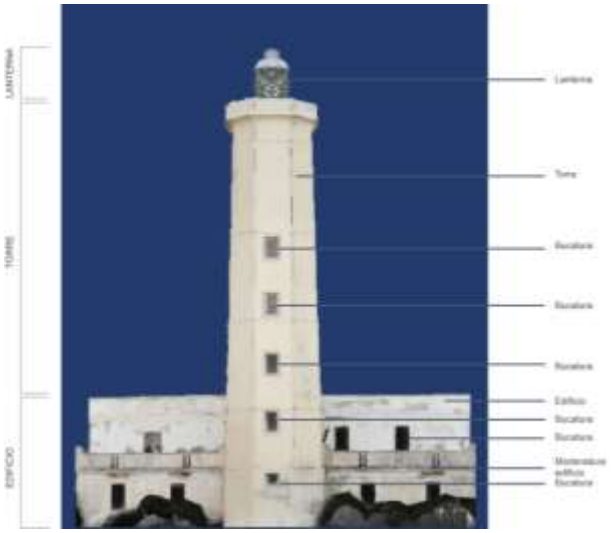

***Figure 4**: Semantic decomposition of Punta Alice lighthouse.*

This type of subdivision clearly represents the set of cases united and characterized by a reproducibility of the elements, i.e. associated by a 'genericity'. Having identified the generic variables, we immediately asked ourselves about the level of parametric detail to be obtained, as well as the most performing parametric families, capable of guaranteeing an excellent relationship between creation time, usability of the parametric family and ease of reuse.

Regarding the level of detail of the elements, the 100 and 200 type LODs, according to the American classification, and the C LODs in the Italian environment, emerge as the most effective levels for modeling aimed at the cultural valorization of the coastal heritage, evaluated by weighting the ratio time/detail. These levels of detail are, in fact, able to guarantee the representation of the main volumes and fundamental characterization elements.

It is starting from the level of detail to be obtained that we proceeded with the creation of the 'Italian lighthouse project model', in which to insert all the parametric characteristics useful for composing the geometries belonging to 90.5% of Italian lighthouses. The digital production of models of Mediterranean lighthouses appears to be an ongoing research.

The 'Italian lighthouse project model' finds its genesis in the modeling of the three macro variables -'building', 'tower', 'lantern'- through the use of the Dynamo plug-in, as the most effective solution for obtaining three solids that can be totally modified in a direct and expeditious -through the use of number sliders- in their geometric and spatial component (fig. 5).

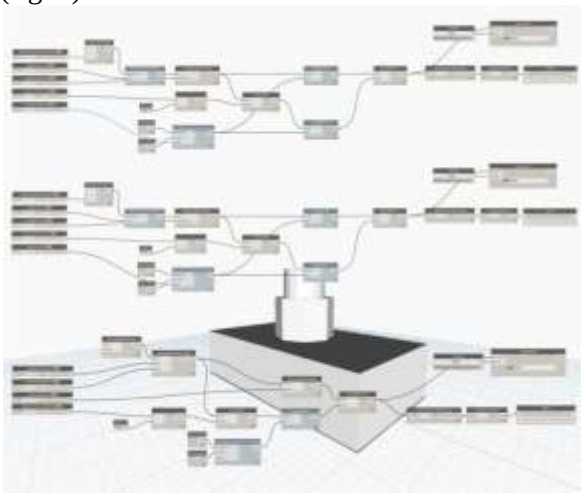

***Figure 5**: Macro variables: Dynamo script*

***Figure 6**: Overlap between parametric model and point cloud*

***Figure 7**: The Capo Colonna lighthouse: evaluation of the metric error.*

3. ONTOLOGY FOR DATA CONNECTION

The topic of ontology is configured as an extremely high-performance tool in the interoperable reconnection of functional, geometric, parametric and historical data. The entire analysis and modeling process was in fact focused on the slavish breakdown of the data, as well as on the coherent use of semantic terminologies.

This characterization makes it possible to unite, connect and enhance the parametric and ontological scope in a single workflow, linked by the identification of the unique ID element, i.e. a unique identifier that can be traced back to each element within the document Revit.

In this sense, in fact, today the mix of knowledge and disciplines through which to obtain increasingly in-depth and interactive levels of knowledge of the artefact is becoming increasingly fundamental. If on the one hand the parametric modeling of the historical heritage is configured as a possible strategy for the protection, analysis and valorisation of the artefact, it must undergo the mixture of new directions.

But why does ontology emerge as the perfect method for cataloging the semantics of cultural heritage? This is because, in fact, the ontology improves the management of data, as well as improving its implementation and interoperability, in which semantics is configured as the most effective cataloging tool [5, 6].

Ontology is the shared conceptualization of a certain domain, defined by the concepts and relationships that characterize the knowledge of the chosen domain, making it possible to organize the information already known in an intelligent way, as well as the possible assumption of new assertions, or new knowledge [7].

In the context of the 'Italian lighthouse project model', the ontology, through a semantic structuring consistent with what was defined during the parametric modeling (fig. 8), appears as the tool through which to reconnect the data, process potentially useful for identifying new assertions and similarities. With the creation of an ontology it is therefore possible to define classes, instances and semantic-historical-geographical relationships, united in a dense network composed of common data (figs. 9-11).

The ontological structuring finally makes it possible to verify the actual functionality of the methodology, through which the recurrence of parametric-semantic data can be measured in percentage, defining themselves as 'semantic recurrence cards' (fig. 12).

***Figure 8**: Ontological structuring of Mediterranean lighthouses*

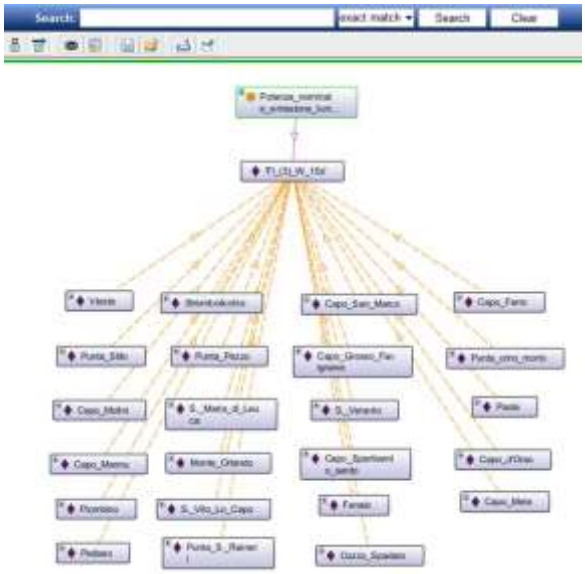

***Figure 9**: The ontology of Mediterranean lighthouses: optical connections*

***Figure 10**: The ontology of Mediterranean lighthouses: geometric connections*

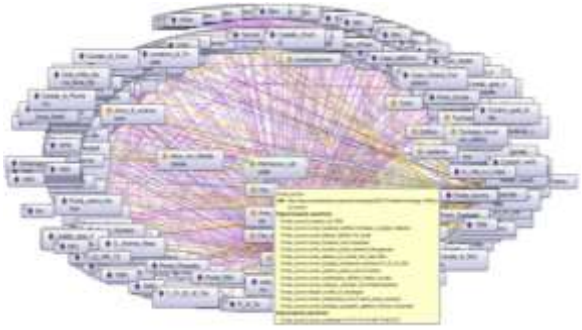

***Figure 11**: The ontology of Mediterranean lighthouses: connections*

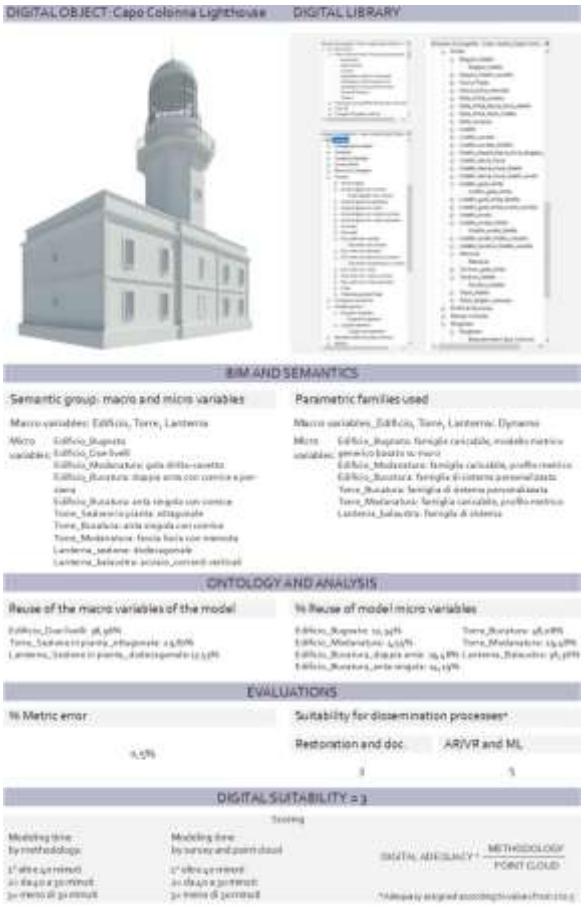

***Figure 12**: The lighthouse of Capo Colonna: semantic recurrence card*

4. CONCLUSION. PARAMETRIC POTENTIALITY AND ONTOLOGICAL KNOWLEDGE

The parametric-ontological connection is outlined as a successful strategy in the sharing and dissemination of data, even if their interchange belongs to different sciences, and therefore still difficult to use. In fact, if on one hand, the data extension is still not associable, on the other hand, the introduction of ontological data in a BIM environment would allow better management of the project in a historical environment, as it would constitute an important source of historical, semantic and geometric knowledge. Furthermore, the mixture of these two types of data would allow the connection of different buildings, in order to facilitate the use of databases for the architectural system. In the context of enhancement, however, it would be possible to create an interface capable of collecting parametric and ontological data, making them accessible to a non-specialized public through the so called "competency question". Or moreover, in the context of museum use, this type of mixing of knowledge would allow, through the creation of applications that can support both software extensions, a growing inclusiveness and accessibility of the data.

Definitely, ontology and parametric modeling can be the basis through which to generate approaches to in-depth knowledge of the artefact, analyze any new connections and facilitate the creation of a database system based on semantics and containing the mix of parametric and ontological data that can be used by specialized and non-specialist users, through unprecedented applications that can be used on smartphones.

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AUSSTELLUNG | EXHIBITION

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Digitalisierung zum Anfassen - Der responsive Waldmistkäfer

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KURZDARSTELLUNG: Wie kann man digitalisierte Objekte gehaltvoll nachnutzen? Welche Möglichkeiten bieten neue technische Ansätze, um spielerisch in Themen einzutauchen und dabei ein Erlebnis für alle Sinne zu gestalten? Im Folgenden geht es um die Entwicklung eines Demonstrators, der die Weiterentwicklung reiner Tast-Modelle zu interaktiven Steuerelementen mithilfe von KI aufzeigt und dabei Möglichkeiten für ein inklusives Museum der Zukunft präsentiert. [1]

1. EINFÜHRUNG

Ein Forschungsprojekt des Museums für Naturkunde Berlin, dem interdisziplinären Modellbauerteam werk5 und deren Schwesterfirma Interactive Scape rückt das Thema Barrierefreiheit in den Fokus und untersucht dabei innovative Ansätze, um Tastmodelle möglichst inklusiv und nutzerfreundlich zu gestalten. Im Zentrum steht dabei ein Waldmistkäfer aus der Sammlung des Museums.

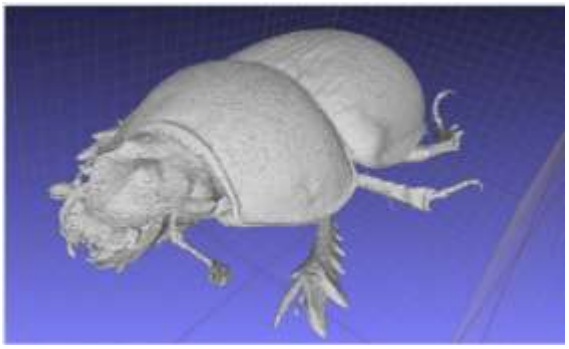

Abb. 1: *3D-Scan des Waldmistkäfers, Museum für Naturkunde Berlin*

2. HAUPTASPEKTE

Inspiriert durch das Projekt „Sammlungserschließung und –entwicklung“ des Museums sowie durch die von der Bildungsgabteilung angebotenen Tast-Erlebnistouren für blinde und sehbehinderte Personen entstand das Konzept des stark vergrößerten Käfermodells. [2] Mit Hilfe des Modells werden kleinste Feinheiten des Insektenkörpers taktil erfahrbar. Zusätzlich ist es durch spannende Audioinhalte wie Käfergeräusche aus dem museumseigenen Tierstimmenarchiv und wissenschaftliche Erkenntnisse angereichert. [3]

Basierend auf dem 3D-Modell des Waldmistkäfers, das im Mikro-CT-Labor des Museums entstanden ist, optimierte und erweiterte werk5 den digitalen Zwilling so, dass er in zwanzigfacher Vergrößerung reproduziert werden konnte. Es wurden verschiedene Materialien erprobt, die der Oberflächenbeschaffung und Haptik des Originals ähneln und häufigen Berührungen der Besucher*innen standhalten.

Abb. 2: *CAD-Planung bei werk5,*
Foto: Marc Jerusel, MfN

Um die Audio Inhalte abzurufen, statteten wir die gesamte Oberfläche des Käfers mit einer Sensorik aus, die Gesten erkennt. Durch einfaches Doppeltippen spielt das Modell passgenaue Audio-Inhalte ab. Am Käfer selbst wurden fünf Bereiche definiert und mit Audio-Inhalten hinterlegt.

Ein Prototyp ermöglichte uns, in der Entwicklungsphase die notwendigen Tests mit der Nutzer*innengruppe durchzuführen. Nach jedem Meilenstein folgte eine Workshop-Runde zur Klärung grundlegender Fragen:

- Welche Gesten sind intuitiv?
- Sind die wissenschaftlichen Inhalte verständlich und interessant?
- Sollten Inhalte gestrichen oder ergänzt werden?
- Dürfen die Texte noch länger werden?

Abb. 3: *Sensorik-Prototyp wird von einer blinden Testerin ertastet und geprüft.*
Foto: Ellen Schweizer, schweizergestaltung

Dank des Feedbacks der Nutzer*innen konnten wir das taktile Käfer-Modell immer besser an ihre Bedürfnisse anpassen und optimieren. Um das Modell inklusiv zu gestalten, gingen wir auch auf die Bedürfnisse von sehenden Testpersonen ein. Hierzu wurde das Feedback der beiden ersten öffentlichen Test-Präsentationen im Museum und der MUTEC 2022 berücksichtigt.

Das finale Exponat wurde aus dem Mineralwerkstoff Corian® in schwarz produziert. Somit kommt das Modell optisch recht nahe an das Original heran. Nur das metallische Schimmern und einige blaue, rote oder grüne Farbschattierungen fehlen.

Abb. 4: *Interaktive Lern-Station des responsiven Waldmistkäfers, Braille- und Pyramidenschrift*
Foto: werk5 GmbH

Ergänzt wird das Exponat durch eine beschriftete Sockelplatte mit Braille- und Pyramidenschrift. Das Verknüpfen visueller, taktiler und Audio-Information ermöglicht ein Lernen nach dem Zwei-Sinne-Prinzip – auch für Menschen mit Beeinträchtigung. [4]

3. ZUSAMMENFASSUNG

Unser Ziel ist ein anpassungsfähiges, intelligentes taktiles Modell, das das Potenzial digitaler Sammlungen aufzeigt und demonstriert, wie neue Technologien die Zugänglichkeit erweitern und verbessern können.

Inklusives Design ermöglicht hierbei eine neue Perspektive auf Vermittlungsarbeit, die Teilhabe, Kultur-Genuss und wissenschaftliche Erkenntnis für alle Menschen bereitstellt.

Erst die interdisziplinäre Zusammenarbeit von Expert*innen aus Museum, Handwerk und Kreativwirtschaft und Expert*innen in eigener Sache ermöglichte die Entwicklung der ersten interaktiven und inklusiven Lern-Station, deren Prinzip nun auch auf andere Exponate übertragen werden kann.

4. DANKSAGUNG

Von Seiten des Museums für Naturkunde waren Biolog*innen beteiligt, Digitalisierungs-expert*innen, die Teams des Mikro-CT-Labors und des Mediasphere For Nature Labs sowie die Bildungsabteilung und Creative Direction.

Werk5 und Interactive Scape trieben das Projekt mit ihrem Fachwissen in den Bereichen Modellbau, 3D-Druck, Sensorik und Technologieentwicklung weiter.

Expertenwissen zur barrierefreien Gestaltung steuerte Ellen Schweizer von Schweizer-gestaltung bei.

Wertvolle Rückmeldungen und Ideen kamen von einer Fokusgruppe blinder und sehbehinderter Testpersonen, die das Projekt punktuell begleiteten und durch ihr Feedback wichtige Optimierungsprozesse anstoßen konnten.

5. LITERATURHINWEIS

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Kulturgut erhalten und digital verfügbar machen

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KURZDARSTELLUNG: Wertvolle Kulturgüter bewahren und weltweit verfügbar machen. Geschäftskritische Informationen über lange Zeiträume archivieren. Gebundene Dokumente und großformatige Vorlagen einfach einscannen und kopieren. Bei all diesen Aufgaben unterstützt Zeutschel seit 1961 Bibliotheken, Archive, Banken und Versicherungen, Industrieunternehmen und Kanzleien.

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1. ZEUTSCHEL - DIE EXPERTEN FÜR BILDQUALITÄT

Das Entwicklungsteam von Zeutschel widmet sich seit langem eingehend der Messung und Bewertung der Bildqualität digitaler Bilder. Die Beurteilung erfolgt anhand verschiedener Kriterien wie Details (Auflösung, Maßstab, Geometrie), tonale Wiedergabe (Helligkeit, OECF, Dynamikumfang, Farbe, Rauschen) und Homogenität.
Um die Bildqualität zu beurteilen, werden Testcharts verwendet, die unter identischen Bedingungen digitalisiert werden. Die angewandten Methoden sind in internationalen ISO-Normen wie ISO 19264-1:2021 sowie relevanten technischen Leitlinien wie Metamorfoze und FADGI detailliert beschrieben.
Das Ergebnis dieses Prozesses ist eine kontinuierliche Überwachung der Bildqualität. Dies bedeutet, dass die Qualitätsprüfung direkt während des Scanvorgangs "on-the-fly" erfolgt. Scans, die außerhalb der definierten Norm liegen, werden sofort erkannt.
Unsere Scanner sind dafür konzipiert und ausgerichtet Ergebnisse zu erzielen, die nicht nur den internationalen Normen entsprechen, sondern diese in einigen Fällen sogar übertreffen.

2. INNOVATIVE PRODUKTE SETZEN TRENDS

Unsere Marktführerschaft gründet sich auf innovativen Produkten, die dem Markt immer wieder neue Impulse gegeben haben.

Aktuelles Produkt-Highlight sind die Scanner-Serien OS Q und OS HQ, die beim Scannen großer Formate eine bisher nicht erreichte Bildqualität und Produktivität bieten sowie die Serien OA A für schnelle und zuverlässig perfekte Ergebnisse und die Serie OS C für große Digitalisierungsprojekte, die eine kontinuierlich hohe Bildqualität bei maximaler Performanz benötigen.

POSTERSESSIONS

EVA Berlin

EVA Berlin 2023 Conference
29 November – 01. December 2023
Kunstgewerbemuseum (Museum of Decorative Arts)
Kulturforum Potsdamer Platz, Matthäikirchplatz 8, 10785 Berlin

Multi-media staging of realtime trading charts: From immersive analytics to manipulative aesthetics

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ABSTRACT: This presentation introduces the author's series of audio-visual installations and VR environments as 'gamifying' experience of financial data feeds, staged in a virtual scenery. It reflects upon gambling tendencies in the global exchanges of immaterial assets such as 'crypto currencies' or 'crypto tokens' used in 'decentralized finance' ecosystems. Trading algorithms meet emotions of greed, euphoria, and despair, representing macroeconomic value exchange as a battle for humanity's attention, causing economic resource hijacking.

1. INTRODUCTION

This work series is critically motivated by the re-emergent and growing prominence of gambling factors in global economic activities – through institutional promotion of increasingly complex investment products for unprofessional 'investor' masses, while simplifying access to the very trading processes. While political philosopher Michael J. Sandel describes several last decades as a "drift from 'market economy' to becoming a 'market society'", [1] the representation of value itself is used both for analysis and manipulation. Researcher Marcin Krawczyk states that design and aesthetics of financial charts not only 'present and reveal certain important financial information' but also 'hide what they are supposed to present and reveal '[2]. Through these represenations and interfaces, mediated by computer networks, Machine Learning and Artificial Intelligence - behaviour patterns in trader psychology merge with methods of manipulation of human attention and emotions, and are. promising control, thus, setting preconditions for unfair competitiveness for various involved actors, becoming a 'rigged game' for others.

The trading tactics and investor-attraction strategies related to various crypto-currency and crypto-infrastructure products, meme-stock trading by inexperienced 'investors', peer-to-peer loan financing, allocations of state pension funds into high-risk assets, etc., have caused legal interventions of large supervisory bodies managing legislation frameworks for investments and finance. [3]

2. MAPPINGS OF DATA INTO THE IMMERSIVE SIMULATED SENSORIUM

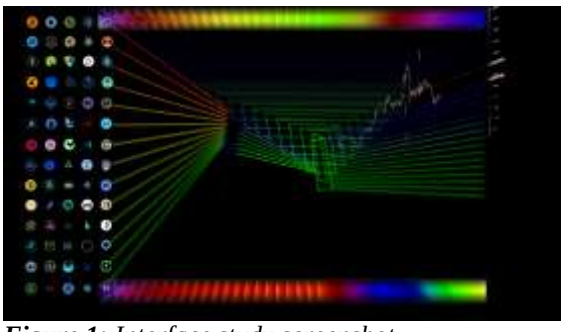

Figure 1: *Interface study screenshot*

The concepts of '360° gaze' (Stiegler, 2011) or more broadly dispositif (Foucault, 1977) are relevant how interfaces for value exchange modifies our behaviour of the 'mediated self' under the impression of surveillance [4].

This artwork series - immersive installations using 3D imagery – feature variations of speculative illustration of a dystopian 'hybrid organism' and simulated macroeco-nomic system, whose purpose is transformation of energy and resources through a behaviour and appearance that ranges from ludic (playful) and awe inducing.

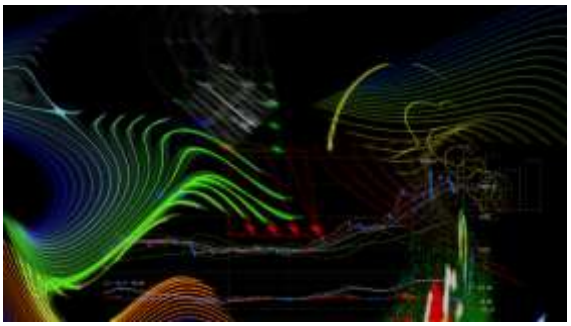

Figure 2: *Interface study screenshot*

For the installation, the data acquisition modules feed from several sources of financial trading statistics (stock- and crypto-currency exchanges, over their public Internet APIs). One iteration uses live trading activity data from various sources to create a 'virtual landscape' to observe 'passively. In other interactive iteration, visitors can make 'virtual bets' to experience growth and diminishing of their 'investment' through the cycles and complex 'monetary circuits'. Visualisation and sonification modules utilise ephemeral representations of 'placement', 'reference points' – as 'spatial anchors' in AR setting. Progressing, complexity or visitor-triggered mode-shifts induce a temporary experience of the conflation within multiple reference systems, ultimately challenging visitor's perception effort of 'sense-making', and returning back to consistent spatial arrangements, restoring the sense of order and coherence, 'flow state'.

3. CONCLUSION

Algorithmically manipulated financial trading is an arena where algorithms merge with human emotions into a global hybrid sensorium. There has been a range 3D visualization of various data sets and processes as arworks, as well as GUIs for various professional financial software products. This project however, operates within the continuum between intended usability/function and sublime 'dysfunction' as an aesthetic experience. The emerging research area of immersive analytics, which is considered a fusion of more recent developments in visualization, auditory displays, computing, and machine learning [5]. As a phenomenological effort, this work proposes a metaphor of 'simulated anisotropy' – dynamic spatial semantics beyond realistic, architectonic 3D space paradigms. Future intentions for this project may use sentiment analysis or physiological measurements, such as heart rate or galvanic skin response, to assess emotional response to the live, continuously incoming data stream. This project will evaluate experimental audiovisual design strategies dealing with complexity representations, evaluate metaphors of 'ideasthesia', which refers to the experience of emotions in response to abstract ideas. [6]

4. ACKNOWLEDGMENT

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Transformation and innovation through multimodal mediation in a Shakespeare adaptation for animated, gamified VR

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ABSTRACT: Using our ongoing project to create a gamified, animated adaptation of the lesser-known Shakespeare play *Pericles, Prince of Tyre* as an example, we reflect upon the potential that Virtual Reality (VR) offers for creating innovative and engaging educational experiences. The discussion pays particular attention to how our interdisciplinary approach to adaptation has embraced diverse forms of mediation—specifically immersive VR, gamification, animation, and motion comics—to create an experience that is engaging and entertaining yet also ultimately brings audiences back to the original text. The aim is to offer a case study through which to explore how VR might be used to appeal to 21st audiences within the wider field of education and culture.

1. INTRODUCTION

Pericles VR is an ongoing project to create a gamified adaptation of Shakespeare's play *Pericles, Prince of Tyre* for animated Virtual Reality (VR). The project is one element of a longer-term collaboration between Nanyang Technological University, Singapore, and The Shakespeare Institute at the University of Birmingham, UK, rooted in a series of practice-led research projects aiming to interrogate how works of Shakespeare might be interrogated according to the demands of immersive media.

Currently in the production stage, *Pericles VR* marks the latest stage in the play's long history of radical re-interpretation [1], leveraging upon the power of immersive media to offer first-person embodied engagement, as well as the creative potential of animation to relocate the play to a fictional setting based upon maritime Southeast Asia and recast its characters as anthropomorphic animals (Fig. 1).

Figure 1: *Line up showing 3D character models for use within immersive game levels*

The project, funded by Singapore's Ministry of Education, is particularly interested in exploring how adaptation using innovative immersive media forms might impact upon student engagement and educational outcomes when teaching works of classic literature in the 21st century classroom.

2. PERICLES FROM STAGE TO SCREEN

A lesser-known work by one of the world's most well-known and celebrated authors, *Pericles* provides an untapped source text within the existing body of VR Shakespeare adaptations, which predominantly take his most recognisable works such as *Macbeth* or *Hamlet* as their source text. Our approach to adaptation thus offers the opportunity both to redefine how Shakespeare is experienced and understood by 21st century global audiences, and to interrogate how VR as a medium might interact with pre-existing, linear stories yet also embrace its potential to offer users a sense of agency and a sense of immersion which facilitates temporal and spatial dissociation and a merging of task and self [2].

The play is considered the first of Shakespeare's late romances [3]. Its five acts follow the protagonist as he finds, loses and rediscovers his family over the course of fourteen years - a journey defined by the sea and guided by the hand of fate. In "Pericles VR," this narrative is reimagined through a series of four fully immersive game levels, connected by 2D animated cut scenes.

In these levels, players must act to unpack riddles, fight adversaries and solve problems through interactions with in-game NPCs, pop up UIs and interactive game elements. The second game element makes use of AI in the creation of a first-person combat scene in which the player, as Pericles, must defeat his competitors in a tournament to win the hand of the Princess of Pentapolis, responds to the player's movement and actions. The design of these game elements in terms of narrative is drawn from the play's original text, whilst their settings are relocated to stylised versions of Southeast Asian settings including the palace at Angkor in Cambodia (Fig. 2) and the villages of the Minangkabau culture in Sumatra, Indonesia.

Figure 2: *Screengrab of first game level, in which the court of Antioch from the original play is reimagined as the temple complex at Angkor*

Between the four game levels, the narrative of the original play is advanced by cut scenes which resemble traditional 2D motion comics, accompanied by narration using the play's original language in abridged form. Visually, these cut scenes reflect artistic styles developed within a Southeast Asian context: Cambodian temple relief carvings, Wayang Kulit shadow puppetry, traditional Thai mapmaking, and Chinese-style papercutting (Fig. 3).

These cut scenes function both to provide players with context that allows them to better understand both Shakespeare's original narrative and the way in which the immersive game levels relate to the story arch as a whole. These cut scenes are also important for the way that they offer a solution that negates the issues associated with long-term VR immersion such as nausea and vertigo, by removing the player from fully immersive participation towards static observation, albeit in a way that is still integrated within the immersive game setting.

The game is thus structured in a way that combines traditional, linear storytelling elements with fully immersive moments which offer the opportunity for exploration and decision making, even if ultimately the game experience is designed to adhere to the play's original structure and reach its pre-determined conclusion, which adheres to the broader educational intentions of our game and an ultimate desire to bring the student audience back to Shakespeare and his original text.

Figure 3: *Examples of frames from cut scenes showing the four different visual approaches*

3. MULTIMODAL APPROACHES TO MEDIATION

In adopting the above outlined approach to storytelling, our project demonstrates how multimodal approaches to technology can facilitate cultural transformation in terms of Shakespeare adaptation, and in turn offers reflections on how these findings might be expanded to inform the development of VR experiences within the education and cultural sectors more broadly. The diverse forms of mediation adopted in our adaptation process—gamification, animation, motion comics, and immersive VR - can be seen to facilitate heightened user engagement with both the game experience itself, and with the themes, characters and narratives at the heart of the original text.

Each of these elements in turn were specifically chosen to serve our approach to narrative storytelling at different points in our adaptation process, and their intersections act to create an innovative experience that presents a work of classic literature in a way that appeals to 21st century digital natives. For example, the riddle with which Pericles is presented at the court of Antioch in Act 1 was deemed well-suited to fully immersive, interactive, gamified VR due to its inherent problem solving, decision making and sense of tension and uncertainty. On the other hand, the complex and emotionally charged narrative sequence relating to the eventual reunion of Pericles with his wife and daughter at the end of the play is told through a cut scene. This decision was made on the advice of the Shakespeare scholars in particular, who identified this is a key moment in the play that was invested with thematic and emotional meaning that it was feared might be overlooked or trivialised if the episode was reimagined as a game.

Together, these forms work together to unpack the complex connections that exist between creative production and cultural transposition and re-contextualisation of existing stories as a result of hybridisation.

4. INCLUSION AND AUTHENTICITY

Our overall approach to adaptation has been designed to enable deeper engagement with, and a clearer understanding of classic literature, on the part of the students who are the target audience of our VR experience. This design has been informed by both research drawn from the field of animation studies and creative production, and also engagement with scholars working on Shakespeare performance and education.

Scholarly research into ideas of authenticity has also underpinned our approach to narrative and visual development, with "authenticity" requiring interrogation both in terms of authenticity to the historic and cultural environments which are reflected visually in our adaptation, and to the Shakespearean text itself, a work of fiction which has been variously described as "folkloric" [4] and "bizarre" [5]. By placing users within a virtual environment in which they can encounter and interact with aspects of the Shakespearean narrative on their own terms, we are instilling

them with a sense of agency and power to shape both their own learning experiences and their engagement with the historic narrative.

Whilst VR is still far from widespread in the classroom, Shakespeare studies as a field has been quick to embrace the potential that emerging technologies offer for both performance and education [6]. Multiple existing projects leverage the power of the medium to create both "theatre making" and "drama making" game experiences and amplify the "active learning" approach that has long been identified as beneficial for teaching works of Shakespeare to children and young people by emphasising the interpretive utility of space, embodiment, and movement in the study of his works [7][8]. Rather than leveraging solely upon the potential that VR holds to replicate the theatrical experience and the process of staging a play, however, our multimodal approach supports an experience which deeply immerses students in the original narrative and allows them to physically embody a Shakespearean character. Nevertheless, the experience also maintains a sense of detachment and distance that enables players to view the experience as one in which they are engaging with a constructed work of fiction and one which can be further engaged with through a return to the original play and its text. One example of this is our decision to maintain the character of the medieval poet John Gower, who features in the original play as narrator, appearing outside of time and space as a "teller of the tale". Gower's opening lines of narration – "To sing a song as old was sung" – establishes clearly that what is being presented is indeed a fictitious piece of folklore not an experience attempting to imitate real life. This is particularly important when considering that *Pericles* includes controversial themes that are arguably best avoided within a fully immersive environment such as incest, prostitution, sudden death, attempted kidnap, and murder.

5. CONCLUSION

In introducing *Pericles VR* as a case study, we have provided an insight into the transformative potential that technology offers for re-interrogating classic texts and how they might be taught in the literature classroom. In particular, we have stressed how taking a multimodal approach to adaptation, drawing upon a range of forms of mediation including immersive VR, gamification, animation, and motion comics, both suits the narrative demands of the original play and facilitates heightened user engagement with both our VR experience and the themes, plot, and characters of the play itself.

Throughout the development of the project, close collaboration between artists, animators, technical developers, researchers, and Shakespeare scholars has underpinned narrative and visual development at every stage, with this dialogue contributing to our approach towards balancing authenticity to the text and an adherence to its original narrative structure with the creation of an exciting, entertaining and unexpected VR experience.

It is hoped that our practice-led research approach and adaptation strategy will thus be of interest not only by educators working to create engaging experiences for use in the classroom or lecture hall, but also by those working to engage diverse audiences with history, literature and world cultures across the broader cultural sector.

6. ACKNOWLEDGMENTS

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Antike ohne Barrieren: Das Projekt „All-Inclusive“ des Museums für Abgüsse Klassischer Bildwerke München

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KURZDARSTELLUNG: Das Museum für Abgüsse Klassischer Bildwerke München vereint innovative analoge mit digitalen Methoden, um ein inklusives Besuchserlebnis zu schaffen. Unterstützt durch das Programm „kultur.digital.vermittlung“ des Bayerischen Staatsministeriums für Wissenschaft und Kunst bietet das Museum mit seinen taktilen Modellen, Braillebeschriftungen, digitalen Touchpoints, DGS-Videos, Texten in leicht verständlicher Sprache und interaktiven Touren multisensorische Zugänge. Der barrierefrei überarbeitete Internetauftritt des Museums hebt die Bedeutung des digitalen Zugangs hervor, während im Museum selbst ein Leitsystem bei der Orientierung hilft. Mit speziellen Angeboten für Personen mit unterschiedlichen Einschränkungen und Bedürfnissen sowie einer umfangreichen Online-Sammlung bietet das Museum bereichernde und inklusive Erlebnisse, sowohl analog als auch virtuell.

1. EINFÜHRUNG

Die Vision eines inklusiven Museums, das sowohl analoge als auch digitale Kanäle für barrierefreie Zugänge nutzt, stand im Museum für Abgüsse Klassischer Bildwerke München zwei Jahre lang im Fokus der Museumsarbeit. Unterstützt wurde das ambitionierte Projekt von 2021 bis 2023 durch das Bayerische Staatsministerium für Wissenschaft und Kunst im Rahmen der Förderlinie „kultur.digital.vermittlung“ [1, 2]. Dieses Programm hat es sich zur Aufgabe gemacht, staatliche Kulturinstitutionen bei der Entwicklung digital-analoger Strategien zu unterstützen. Das Museum für Abgüsse, hat in Partnerschaft mit dem Museumspädagogischen Zentrum das Projekt „All-Inclusive“ initiiert und so die Chance ergriffen, innovative und partizipative Formen der barrierefreien Vermittlung zu entwickeln, damit Menschen mit Beeinträchtigungen selbstbestimmt und kreativ am kulturellen Erbe teilhaben können. Neben praktischen Maßnahmen im Museum wurden auch die digitalen Angebote auf Barrierefreiheit umgerüstet und neu konzipiert.

In dieser dynamischen Umgebung verfolgt das Museum einen integrativen Ansatz, um die physische und die digitale Welt zu verschmelzen und ein umfassendes Besuchserlebnis zu gewährleisten. Taktile Modelle, Braillebeschriftungen und Vermittlungspersonal werden physisch im Museum eingesetzt, während digitale Touchpoints und adaptive multimediale Touren den Museumsbesuch bereichern. Die Stärke dieser kombinierten Herangehensweise zeigt sich in der praktischen Umsetzung: Eine blinde Person kann beispielsweise eine Statue über ein tastbares Modell physisch erforschen und sich gleichzeitig über das eigene Smartphone detaillierte Hintergrundinformationen in Audioform vorlesen lassen. Bei einem gemeinsamen Familienbesuch kann ein Kind mittels QR-Code ein Hörspiel abrufen und so mehr über ein Exponat erfahren, während die Großeltern ergänzende historische Informationen auf ihrem Tablet lesen. Das bedeutet, dass Besucher*innen, unabhängig von ihren individuellen Bedürfnissen und Fähigkeiten, die Möglichkeit haben, Ausstellungsstücke auf vielfältige Weise zu erleben. Dieser Ansatz erlaubt es, dass unterschiedliche Zielgruppen – sei es aufgrund von Alter, Beeinträchtigung oder Vorwissen – gemeinsam dasselbe Kunstwerk erleben und dabei auf die für sie geeigneten Zugangsmöglichkeiten zurückgreifen können. Das Museum wird so zu einem Ort der Inklusion, an dem analoge und digitale Erfahrungen nahtlos ineinander übergehen und das kulturelle Erbe für alle gleichermaßen zugänglich ist.

2. DIE BEDEUTUNG DES DIGITALEN ZUGANGS

Viele Besucher*innen entdecken das Museum zunächst online, bevor sie es physisch besuchen. Vor diesem Hintergrund wurde der Internetauftritt des Museums umfassend überarbeitet, wobei wir einen besonderen Fokus auf Barrierefreiheit gelegt haben. Hierbei standen nicht nur eine intuitive Navigation und eine klare Benutzeroberfläche im Vordergrund, sondern wir haben zudem darauf geachtet, dass alle relevanten Informationen in verständlicher und einfacher Form zugänglich sind. Zusätzliche Ressourcen, wie Informationen zum barrierearmen Zugang und den Anreisemöglichkeiten sowie Details zu barrierearmen Einrichtungen, wurden ergänzt. All diese Maßnahmen dienen dazu, möglichst vielen Personen ein selbstbestimmtes Museumserlebnis zu ermöglichen. Die Präsenz des Museums auf Plattformen wie „Kultur barrierefrei München“ und die Auszeichnung mit dem Signet „Bayern barrierefrei“ sind weitere Belege für das Bestreben des Museums, Kultur für ein breites Publikum erlebbar zu machen.

3. DER PHYSISCHE ZUGANG ZUM MUSEUM

Barrierefreiheit geht über architektonische Maßnahmen hinaus. Während Rampen, Aufzüge und behindertengerechte Toiletten essenziell sind, um physische Hindernisse zu überwinden, gibt es zahlreiche weitere Aspekte, die ein Museum berücksichtigen sollte, um als inklusiv zu gelten. Im Museum selbst wurde ein Leitsystem etabliert, um den Besucher*innen die Navigation in unserem historischen Gebäude zu vereinfachen. Die denkmalgeschützten Bauwerke aus den 1930er Jahren stellen aufgrund ihrer charakteristischen Architektur besondere Anforderungen an die Orientierung. Das neu eingeführte Leitsystem erleichtert nicht nur den Weg durch das Museum, sondern hebt auch wichtige Einrichtungen wie Toiletten und Schließfächer hervor und bietet Wegweiser für einen vollständigen Rundgang durch unsere Sammlung. Für Besucher*innen stehen zudem gemütliche Sitzmöglichkeiten zum Verweilen und Entspannen zur Verfügung. Hier kann man weiteres Informationsmaterial zum Museum und den Objekten konsultieren, wie Flyer, aber auch Audiokarten und Braillehefte.

4. VERMITTLUNGSANGEBOTE FÜR UNTERSCHIEDLICHE ZIELGRUPPEN

Zusätzlich zum generellen Leitsystem haben wir für die inklusive Vermittlung ein besonderes Signet kreiert (Abb. 1). Dieses stellt sowohl in analogen als auch in digitalen Medien ein gleichbleibendes Erkennungsmerkmal dar. Das aus fünf farbigen Kreisen bestehende Signet kennzeichnet für die Besucher*innen die Verfügbarkeit spezieller, zielgruppenspezifischer Angebote. Je nach Angebot werden unterschiedliche Kreise des Signets einzeln hervorgehoben oder aber mit QR-Codes zum jeweiligen Medium angereichert. Die Symbole sind im Museum an bestimmten Orten und Objekten sichtbar. Bei der Ausgestaltung der Stationen und Angebote wurde besonderer Wert auf die Entwicklung von speziellen Beiträgen für gehörlose, blinde und sehbeeinträchtigte Personen sowie für solche mit kognitiven Einschränkungen gelegt.

Abb. 1: *Das „ALL IN“-Signet dient als gleichbleibendes Erkennungsmerkmal, um den Besucher*innen die zielgruppenspezifischen Angebote zu signalisieren.*

Die Annahme, dass schriftbasierte Informationen als alleiniges Informationsmittel für gehörlose Personen ausreichen, ist ein Trugschluss. Insbesondere für diejenigen, die von Geburt an oder seit ihrer frühen Kindheit gehörlos sind, haben maßgeschneiderte Angebote eine essentielle Bedeutung. Der Grund hierfür liegt vor allem in den grammatikalischen und strukturellen Unterschieden zwischen der Deutschen Gebärdensprache (DGS) und der deutschen Laut- und Schriftsprache. Gehörlose Kinder lernen die deutsche Schriftsprache häufig als erste Fremdsprache [3]. Entsprechend sind Videos in DGS, also ihrer Muttersprache, oder zumindest Texte in leicht verständlicher Sprache notwendig.

Aus diesem Grund hat das Museum Videos in DGS erstellen lassen, die einen Überblick über das Museum und dessen wichtigste Stücke bieten (Abb. 2). Ein grünes Symbol mit gebärdenden Händen kennzeichnet diese besonderen Angebote. Die Videos erläutern nicht nur Ausstellungsstücke, sondern auch relevante Orte und archäologische Fachbegriffe. Sie sind sowohl für private Endgeräte als auch an festen Medienstationen im Museum verfügbar.

Abb. 2: *Martina Odorfer (Museum Signers) erläutert in DGS den Begriff „Troja" und seine Bedeutung. Das Video ist in Verbindung mit der Erklärung zur Laokoon-Gruppe zu sehen.*

Abb. 3: *Der Comic „Lisa und Linus" in DGS gibt eine Einführung in die Gipsabgüsse der griechischen und römischen Antike.*

Für jüngere und junggebliebene Besucher*innen wurde der Comic „Lisa und Linus und das Geheimnis der Gipsfiguren" in DGS übersetzt, der einen unterhaltsamen Zugang zur Welt der Gipsabgüsse antiker Kulturen ermöglicht (Abb. 3). Das Videoformat behält die ursprünglichen Textpassagen in den Sprechblasen bei und ergänzt sie durch Videos mit einer DGS-Darstellerin, wodurch es sich ideal für inklusive Gruppen eignet, da das gemeinsame Erlebnis beim Anschauen gefördert wird, und außerdem das Verständnis der Schriftsprache geübt wird. Zusätzlich helfen zwei Erklärvideos, schwierige oder unübliche Gebärden zu verstehen, und vermitteln Hintergrundinformationen zu Objekten, die Teil des Comics sind.

Um blinden und sehbeeinträchtigten Gästen – sowie allen anderen Besucher*innen – ein haptisches Verständnis der Kunstwerke zu ermöglichen, sind in diversen Ausstellungsräumen Reproduktionen der Exponate installiert (Abb. 4). Diese taktile Herangehensweise intensiviert das Kunstverständnis auf haptischer Ebene. An diesen Stationen ist ein hellblauer Kreis mit einer geöffneten Hand als Tastsymbol zu finden. Das Symbol ist mit erhabenen, also tastbaren Umrisslinien und mit deutlichen Farbkontrasten zum Sockel gestaltet. Für alle signalisiert dies die explizite Erlaubnis, das jeweilige Objekt anzufassen. Diese haptischen Modelle, oft in Form von verkleinerten 3D-Ausdrucken oder Gips-Abformungen, sind zur Berührung freigegeben. Auf dem Sockel (Abb. 5) steht zudem der Name des Kunstwerks in Braille- und Pyramidenschrift, ergänzt durch einen QR-Code, über den sich weiterführende digitale Informationen aufrufen lassen. Der korrespondierende Originalabguss befindet sich in unmittelbarer Nähe, was für sehende Besucher*innen einen direkten Vergleich zwischen dem Tastobjekt und dem Original ermöglicht. Zusätzlich stehen Audiospuren und Broschüren in Brailleschrift zur Verfügung, um das Besuchserlebnis zu vertiefen. Die Audiospuren können über die eigenen mobilen Endgeräte, über eigens entwickelte feste Audioklappen und über handliche Audiokarten abgerufen werden.

In Ergänzung zu den vorherigen Maßnahmen wurden an verschiedenen Stellen im Museum einfach und verständlich formulierte Texte bereitgestellt, um auch Personen mit kognitiven Einschränkungen den Zugang zu erleichtern. Diese Texte erläutern nicht nur ausgewählte Ausstellungsstücke, sondern bieten auch Informationen zu verschiedenen Themen – etwa zur Technik des Abgießens. Diese Inhalte sind online über die Webseite und direkt vor Ort über QR-Codes abrufbar. Für einen analogen Zugang haben wir zudem Flyer in verschiedenen Sprachniveaus entwickelt, um auf diese Weise die Abteilungen des Museums für alle gut verständlich vorzustellen.

Abb. 4: *Der Abguss des sog. „Diskobol des Myron“ mit zugehöriger Taststation in unmittelbarer Nähe für ein interaktives Besuchserlebnis.*

Abb. 5: *Detailansicht der Taststation: Sie beinhaltet ein haptisches Miniaturmodell, eine Beschriftung in Braille- und Pyramidenschrift sowie einen QR-Code für zusätzliche digitale Informationen.*

An dieser Stelle sei nochmals betont, dass Inklusion weit mehr als nur den Blick auf besondere Bedürfnisse umfasst [4]. Ein inklusives Museum nimmt die gesamte Bandbreite unterschiedlicher Herangehensweisen und Erfahrungen in den Blick und schafft entsprechende Angebote und Zugangsmöglichkeiten. So können ältere Menschen beispielsweise an altersbedingten Seh- oder Hörverlusten leiden, während Menschen mit unterschiedlichem Bildungshintergrund differierende Kenntnisstände haben. Das Museum sollte gleichermaßen für die Expertin und den Laien ansprechend sein. Auch Angebote, die sich speziell an Kinder und Familien richten und dabei kinderfreundlich und interaktiv sind, sollten nicht fehlen. Inklusion bedeutet, für alle Besucher*innen – unabhängig von Alter, Fähigkeiten oder Hintergründen – Barrierefreiheit und Engagement zu ermöglichen. Unsere Angebote sind daher für spezifische Zielgruppen konzipiert, sollen aber allen Besucher*innen ein individuelles, interaktives und partizipatives Museumserlebnis eröffnen.

5. DIE BEDEUTUNG DER ONLINE-SAMMLUNG ALS ZENTRALES WERKZEUG

Basierend auf dem Konzept der Inklusion und auf der Zielsetzung, ein vielfältiges Publikum anzusprechen, haben wir nicht nur die physischen Angebote im Museum erweitert und verbessert. Ein zentrales Element dieses Ansatzes ist unsere Online-Sammlung. Sie bietet zusätzlich zur traditionellen, analogen Museumserfahrung eine ideale digitale Ergänzung. In dieser Sammlung sind alle relevanten Medien und Daten hinterlegt, die den Besucher*innen entweder durch das Scannen von QR-Codes an den Ausstellungsstücken oder über unsere Medienstationen zur Verfügung stehen.

Die Online-Sammlung stellt den zentralen Conten-Hub (Abb. 6) dar und bietet sowohl intern wie auch extern für Forschung, Bildung und den allgemeinen Museumsbesuch, ob vor Ort oder von zu Hause aus, einen barrierefreien Zugang zu den Inhalten des Museums. Unter einer webbasierten Oberfläche sind alle relevanten Inhalte zu den jeweiligen Stücken gebündelt und werden bedarfs- bzw. zielgruppengerecht ausgespielt. Darunter befinden sich neben Fachinformationen auch Inhalte für Kinder, Texte in einfach verständlicher Sprache oder Videos mit Gebärdenübersetzung. Für die Besucher*innen ist somit ein einheitliches und barrierearmes Portal nutzbar.

Abb. 6: *Vermittlungsangebote für alle, illustriert am Beispiel des sog. „Diskobol des Myron“. Die zentrale Online-Sammlung bündelt alle digitalen Angebote und stellt sie bei Bedarf bereit.*

Das digitale Angebot ist für Personengruppen mit unterschiedlichen Bedürfnissen geeignet, da ein einheitlicher Zugang besteht und zwischen den aufbereiteten Inhalten simultan umgeschaltet werden kann. Dies erlaubt beispielsweise Familien oder Gruppen mit Inklusionsbedarf ein gemeinsames, barrierefreies Erlebnis vor Ort im Museum. Die Oberfläche des Portals passt sich zudem automatisch an die persönlichen Bedienungshilfen des Endgeräts an oder lässt sich nach Bedarf einstellen.

6. FAZIT

Das Museum für Abgüsse Klassischer Bildwerke möchte mit diesem Projekt eine Brücke zwischen Tradition und Moderne schlagen. Durch die Kombination von analoger und digitaler Vermittlung entsteht eine inklusive Kulturerfahrung, die allen Besucher*innen, unabhängig von ihrer Herkunft, ihrem Wissen oder ihren Fähigkeiten, zugänglich ist. Digitale Vermittlungsangebote erweitern nicht nur den Zugang zu den Kunstwerken, sondern fördern auch den Dialog und den Austausch der Besucher*innen untereinander. Das inklusive Angebot ist ein dynamischer Prozess, der in Zukunft durch weitere Ideen bereichert werden soll. Wir laden alle Besucher*innen ein, aktiv daran teilzunehmen, sei es durch Feedback oder persönliche Erfahrungen.

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Three-Dimensional Modeling of Two-Dimensional Objects in Coin Datasets and an Innovative Pipeline for the Extraction of Distorted Details

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ABSTRACT: In the area of conserving cultural heritage and enhancing its accessibility for individuals with disabilities, we introduce a methodology designed to extract intricate details from portrayed coins and to produce three-dimensional (3D) representations of the artifacts depicted on them. Our approach consists of three distinct phases, each executed asynchronously and offline. The initial phase is dedicated to the mitigation of image noise in the coin's visual representation, stemming from various factors such as suboptimal photography techniques or imperfections during the manufacturing process. The subsequent phase involves the derivation of segmentation masks and an evaluation of the attained level of detail pertinent to the specific issue at hand. The concluding phase utilizes the extracted objects to formulate 3D models. Throughout these stages, we employ cutting-edge deep learning models that have undergone meticulous fine-tuning.

1. INTRODUCTION

In today's world, the prevalence of visual impairments poses a significant challenge to approximately 1.3 billion individuals worldwide, underscoring the imperative for digital content accessibility. Within the United States alone, a staggering 25.5 million people grapple with vision loss, further accentuating the urgency of addressing this issue on a national scale.

Digital content accessibility signifies a pivotal paradigm shift towards inclusivity, advocating for the creation of digital materials that cater to the diverse needs and abilities of all citizens, irrespective of their physical capabilities. It encompasses the implementation of strategies and technologies that ensure digital content's usability and comprehension, transcending barriers posed by disabilities.

To tackle the multifaceted dimensions of this challenge, we have introduced an innovative pipeline designed to harness the potential of technology in enhancing the accessibility of visual content. This pipeline specifically targets 2D-optical representations of coins that are often found within museum collections, with a focus on rectifying distortions that may have accrued over time, as well as the creation of 3D models. These models could lead to 3D print models or other tactile tools and provide an effective way for visually impaired people to perceive the visual information at a similar rate to those that have normal vision. This pioneering approach comprises a sequence of three deep learning models, each tailored to address distinct facets of the accessibility conundrum. Initially, we deploy a supervised deep learning super-resolution architecture, adept at significantly improving image resolution and restoring altered details. Subsequently, a segmentation model comes into play, adapting to the unique requirements of each input, thereby enabling the detection of even smaller objects and details. Finally, we employ a view-conditioned 2D diffusion model, facilitating the generation of multiple images, each from different vantage points, so that we can generate the 3D structure, thus creating a more complete understanding of the object of interest.

2. RELATED WORKS

In the domain of cultural heritage, recent advancements in artificial intelligence (AI) have centered on the utilization of machine learning and deep learning methodologies to facilitate the preservation and safeguarding of cultural artifacts [1]. Notably, the application of deep neural networks has been employed in the context of an ancient text restoration model, which effectively reconstructs missing characters from a damaged textual input [2]. Additionally, the domain of semantic segmentation has been extensively explored, predominantly employing 3D point clouds [3,4], with the development of the DGCNN (Dynamic Graph Convolutional Neural Network) model. Furthermore, extensions of this model, such as DGCNNMod+3Dfeat, have exhibited promising outcomes in 3D cultural semantic segmentation within point clouds [5]. AI techniques have also been employed for the analysis of rock art, whereby various 2D and 3D automatic segmentation algorithms have been proposed and tested on a relatively limited set of rock art images [6,7,8].

Drawing inspiration from these notable endeavors, our primary aim in this study is to apply similar methodologies for the purpose of conducting semantic segmentation on the Coin Dataset currently at our disposal.

3. COIN DATASET

The subject of investigation in this study revolves around a selection of 31 coins procured from the Semmelweis Orvostörténeti Múzeum (SOM). These artifacts are documented in .TIF format, with each exhibiting distinct resolutions, e.g. 838x848, 2560x1920 pixels, and conforming to a 3-channel structure, specifically the RGB format. Among these 31 coins, certain instances demand meticulous attention to detail, while others possess readily discernible features even without undergoing additional processing. This inherent variability in the intricacy of the data under examination provides us with a valuable opportunity to assess the capabilities of our proposed methodologies in handling diverse complexities.

Figure 1: *Left Coin: Clear Details / Right Coin: Subtle Details*

4. METHODOLOGY

As previously noted, due to the limited dataset at our disposal, our methodologies rely on pre-trained models and their subsequent fine-tuning.

4.1 PREPROCESSING

This stage involves the utilization of a Super Resolution algorithm, specifically ESRGAN (Enhanced Super-Resolution Generative Adversarial Network) [9]. ESRGAN is a deep learning model engineered for high-resolution image analysis, focusing on the enhancement of low-resolution images to produce sharper, clearer, and more intricate renditions. By employing this model, we observe a substantial enhancement in the quality of low-resolution images, which proves particularly beneficial for our research endeavor aimed at detecting minute details.

Figure 2: *Original Coin Image*

Figure 3: *ESRGAN output*

We observe that the Super Resolution algorithm has the capability to improve points with large gradients, rendering object differentiation more pronounced. For each image we carefully choose the degree of denoising we will apply ensuring that the fundamental features remain unaltered.

4.2 SEGMENTATION MODEL

One recent advancement in fundamental segmentation models involves Meta's release of the Segment Anything Model (SAM) [10] and the Segment Anything 1-Billion mask dataset (SA-1B), which are now accessible to the research community. SAM serves as a foundational vision model for image segmentation and zero-shot learning. This model is engineered to enable the segmentation of any object from an image using specific prompts. Upon receiving a prompt, SAM provides a segmentation mask, which can be in the form of a set of points, bounding boxes, or text. Our objective is to leverage SAM for cultural heritage data, particularly for the coin dataset. Therefore, we have initiated a retraining session to fine-tune our model.

For training the Segment Anything Model, a collection of images and a specific prompt, like a bounding box, points, or text, is required. We opt to generate masks, specifically points, from 300 images sourced from the World Coins Dataset [11], utilizing Roboflow to produce the segmentation masks. For the training process, we select the Dice Loss (=1−Dice(A, B)) as the metric, where:

$$\mathbf{Dice(A,B)} = \mathbf{2} * \frac{|\mathbf{A} \cap \mathbf{B}|}{|\mathbf{A}| + |\mathbf{B}|}$$

Dice loss is particularly effective in addressing class imbalance in the data, which is a common issue in segmentation tasks where the background class often dominates the number of pixels compared to the foreground class. Also is relatively robust to noise and small local variations in the segmentation masks. This robustness makes it a suitable choice for handling noisy or low-resolution images.

For result evaluation, we will employ two distinct pre-trained models. The first model, PSPNet [12], integrates a pyramid pooling module to capture comprehensive global context information, thereby enhancing pixel-wise segmentation accuracy. The second model, Yolov8 [13], is recognized as state-of-the-art for detection purposes, and this will be its designated application in our assessment.

4.2 3D MODELING

After confirming the high quality of the segmentation masks, we expand our methodology by incorporating the One-2-3-45 [14] architecture to capture 3D perspectives. Specifically, this model represents an integrated process for reconstructing 3D multi-view meshes. It employs the 2D Zero123 [15] view-based diffusion model and a neural surface reconstruction module, namely SparseNeuS [16], which relies on a cost volume approach.

Firstly, the authors introduce the original Zero123, a technique enabling image synthesis under transformed camera views achieved through meticulous adjustments on a 3D dataset. Subsequently, they propose a novel neural surface reconstruction module based on volume cost, which efficiently generates a 3D mesh in a single feed-forward pass. This module is further enhanced to accommodate 360° mesh reconstruction, achieved through strategic training techniques employing a hybrid truth-prediction-based training strategy.

These proposed methodologies exhibit substantial advancements in managing

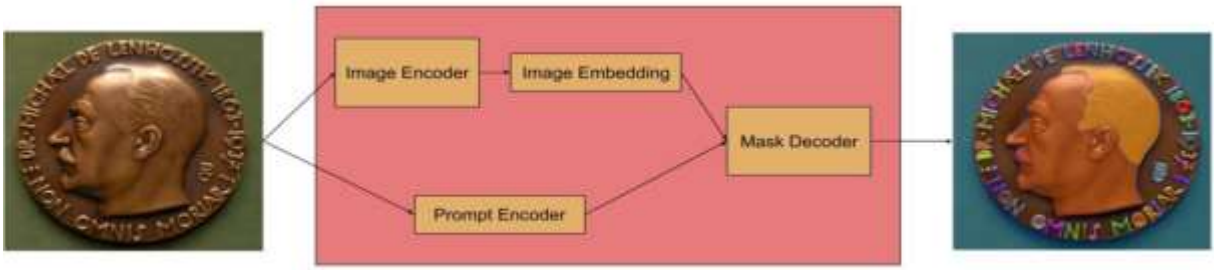

Figure 4: *Overview of the Segment Anything Model architecture*

inconsistent multi-view predictions and attaining superior quality 3D mesh reconstructions originating from Zero123 outputs.

5. RESULTS

Regarding the segmentation task, we will utilize two separate pre-trained models for result assessment. the first model, PSPNet, which is considered a state-of-the-art deep learning model for semantic image segmentation. The second model, Yolov8, is acknowledged as the cutting-edge solution for detection, and we will apply it accordingly in our evaluation. The subsequent images depict a sequence of outputs. The initial image, positioned on the left, represents the original input. Adjacent to it on the right, we observe the output derived from Yolov8. This is succeeded by the output of PSPNet, and finally, two variations of the Segment Anything Model. Notably, Yolov8 frequently encounters challenges in detecting any object.

Regarding the 3D modeling findings, our model is predominantly applied to sizable objects such as heads, with various views of the output presented.

6. CONCLUSION

The implications of this novel pipeline are far-reaching and particularly profound for individuals with visual impairments. Notable applications include the capacity to remove or diminish background details, affording users the autonomy to prioritize and emphasize essential elements within the visual content. Additionally, the pipeline enables the resizing of objects, elements, and text, encompassing functionalities such as magnification, font customization, alteration of contrast between foreground and background text colors, and adjustment of brightness levels. Moreover, it paves the way for 3D printing of objects, providing a tactile and immersive experience that further enriches the understanding and appreciation of cultural heritage assets. These innovative strides in accessibility technology hold the promise of transforming the way individuals with visual impairments engage with and experience digital content, thus fostering a more inclusive and equitable digital landscape.

7. ACKNOWLEDGMENT

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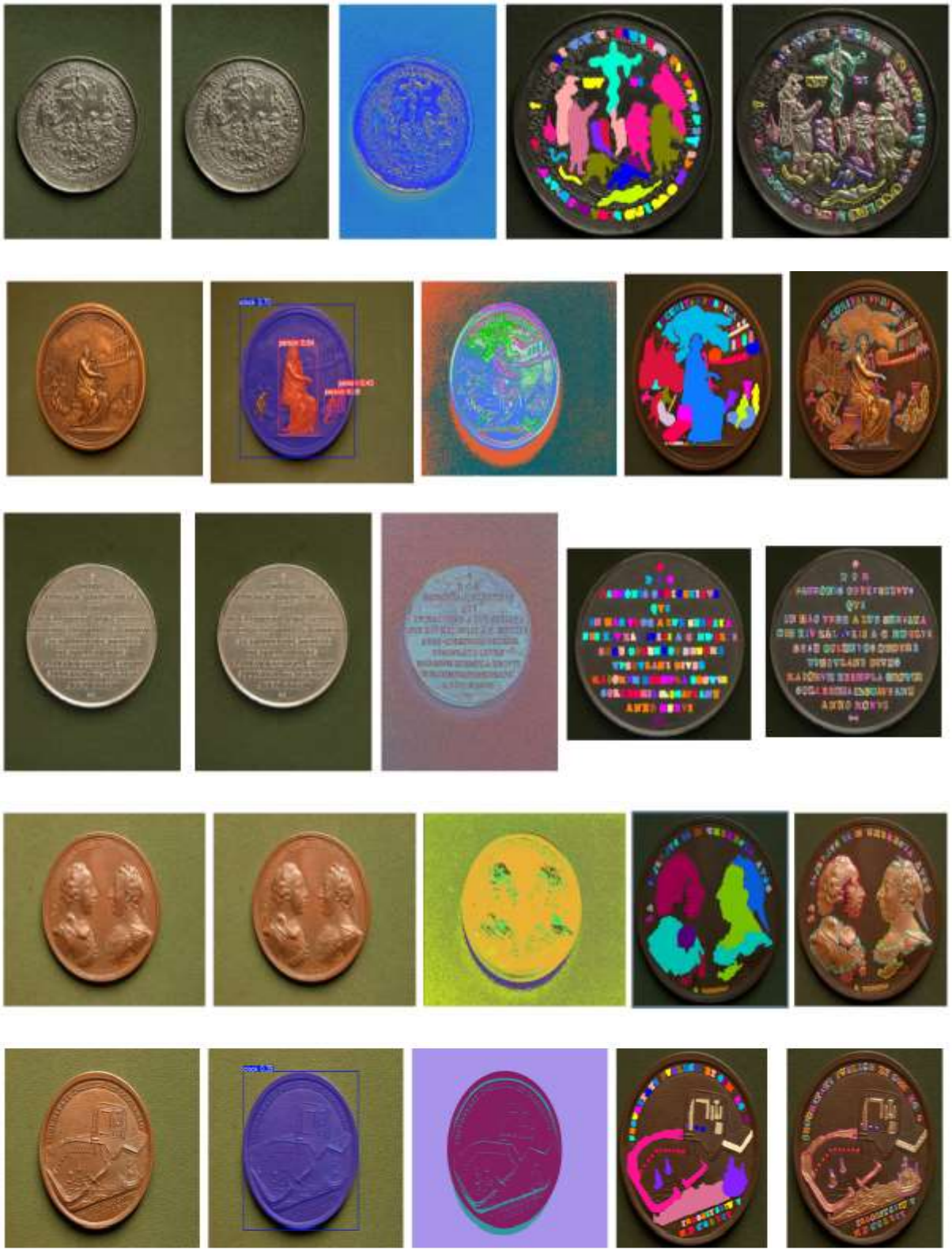

Figure 5: *Output of the different segmentation models: (a)Original, (b) Yolov8, (c) PSPNet, (d) SAM view option 1, (e) SAM view option 2*

Figure 6: *3D Modeling of a head*

Figure 7: *3D Modeling of a top part of the body*

Figure 8: *3D Modeling of a full body*

Figure 9: *3D Modeling of a top half body with hat*

Figure 10: *3D Modeling of a complex top half body*

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Heuristics for guided online tours to digital exhibitions – Some pieces of advice from the research literature

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ABSTRACT: During the Covid-19 pandemic museums found their exhibition halls suddenly empty as physical visits were impossible due to museum closures. Virtually overnight, online exhibitions and corresponding guided online tours became the only ways to stay in touch with the audiences using traditional service provisions in a new environment. Museums answered to this situation by creating 360° representations of physical exhibitions in the digital realm, the software to clone exhibitions from high-resolution images and further information was already at hand. While some museums relied on self-guided exploration on the side of the virtual visitors, others invested in guided online tours. In the beginning, these tours were experimental, but soon evaluations were undertaken, studies conducted and published in a timely manner to support these new undertakings.

This paper takes a closer look at the research literature to identify useful pieces of advice for guided online tours to digital exhibitions which are transformed into heuristics serving as rules-of-thumb that can be used to improve the visitor experiences of guided online tours until better substantiated knowledge is available.

1. INTRODUCTION

During the Covid-19 pandemic museums found their exhibition halls suddenly empty. While physical visits were impossible due to museum closures, the demand for online access grew rapidly. Virtually over night, online exhibitions and corresponding guided online tours became the only way to stay in touch with the audiences using traditional service provisions in a new environment (El-Said & Aziz 2022: 529). Museums answered to this situation by creating 360° representations of physical exhibitions in the digital realm. According to the NEMO 2021 survey, 29% of museums have introduced virtual museum tours, with 18% expanding this service to an even greater extent (Komarac & Ozretić Došen 2021: 3679). These digital exhibitions are experienced via the World Wide Web – usually as 360° views – using a computer, through which a visitor can see and interact with a simulated environment using a monitor and a mouse, respectively, as El-Said & Aziz (2022: 529) indicate. Other advanced technologies such as virtual reality (VR) are not in the scope of this paper as they require specific tools such as VR headsets and powerful computers and fast internet access to process the content without delay and stuttering, tools that are most likely not yet available to the majority of the potential museum audiences. These technologies have to become more accessible to people (El-Said & Aziz 2022: 544). In addition, there is a lack of public experience in interacting with a VR environments, especially for elderly or novice users as Kabassi et al. (2019: 1) suggest.

While some museums relied on self-guided exploration on the side of the virtual visitors, others invested in guided virtual tours in order to offer aesthetic and educational experiences in combination. As El-Said & Aziz (2022: 529) point out, the term virtual tours (VTs) has several interpretations and thus lacks a generally accepted definition. In this paper, the terms guided online tours and guided virtual tours are used synonymously. The terms refer to internet-based guided tours conducted by

museum guides as an equivalent to the established format of traditional guided tours (Best 2012: 35; Specht & Loreit 2021: 97, 99). According to Specht & Loreit (2021: 99), a guided tour is a structured or semi-structured activity with an educational intent during which a guide leads a group through an exhibition.

To make it clear from the start, it is considered to be a misconception that virtual tours are competitors or substitutes for actual site visits and tours; research indicates that this is simply not the case (cf. El-Said & Aziz 2022: 542; Lafontaine & Sawchuk 2022: 390). However, it is admitted that at the current state of the art, a pure virtual replica of an exhibitions might have a lesser quality of experience compared to a visit in a real exhibition, especially when originality and authenticity matter (cf. Wolf, Reinhardt & Funk 2018: 81). But digital exhibitions have the advantage that "space, time, location, and money are no barriers of museum visits" (Wolf, Reinhardt & Funk 2018: 85). In addition, online guided tours can deepen and broaden the relationship and connection to a museum which might lead to the desire to visit in person (Lafontaine & Sawchuk 2022: 399f, El-Said & Aziz 2022: 542). Many museums have developed their digital communities on social media during the COVID-19 pandemic; now, they could take advantage of their links to the communities to increase the interest in a physical museum visit (Komarac & Ozretić Došen 2021: 3689).

2. HEURISTICS FOR GUIDED ONLINE TOURS TO DIGITAL EXHIBITIONS

2.1 HEURISTICS AND THEIR DEDUCTION AND APPLICATION

Heuristics are strategies based on previous experiences, rules-of-thumb or educated guesses to achieve a practical solution where optimal solutions are impractical or impossible. They are widely used in heuristic evaluation of internet usability and communication (cf. van der Geest & Spyridakis 2000). Such heuristics can also be used to improve visitor experience of guided online tours until better substantiated knowledge is available – as this is still an under-researched field of study (cf. Dybsand 2022: 2; El-Said & Aziz 2022: 529; Li, Nie & Ye 2022: 3; Wolf, Reinhardt & Funk 2018: 79).

2.2 THE HEURISTICS OUTLINED

Each of the following heuristics is based on experience and/or findings from recent studies. A statement of hypothesis outlines the problem in question followed by supporting results from the research literature. Then the problem is discussed and a potential solution is presented. In this way, a checklist for the evaluation of guided virtual tours is developed. This checklist, still short and provisional, can be extended, adjusted or corrected as soon as further research is available. Therefore, these heuristics seem to be a feasible and practice-oriented tool to quickly improve virtual tours.

An outline of the heuristics:

1. Virtual tours should be easy to find for potential audiences.
2. Virtual tours should be easy to access on an informational level.
3. Virtual tours should be easy to access on a technical level.
4. Virtual tours should be easy to access on an intellectual level.
5. Programmes of physical and digital visits should be "interwoven".
6. Take into account the visitors' behaviours and motivations.
7. Provide interacitve elements during the virtual tour.
8. Do not only provide interactivity but social interactions and shared experiences.
9. Offer something extra in the digital.
10. Space and size are difficult to convey in the virtual tour.
11. Provide as sense of "closeness" to the exhibits by showing and explaining details.
12. Don't worry about the aura of the objects.

The following paragraphs present the individual heuristics.

2.3 HEURISTIC 1: VIRTUAL TOURS SHOULD BE EASY TO FIND FOR POTENTIAL AUDIENCES.

Hoffmann (2020: 211) claims that "virtual museum tours are frustratingly hard to find from a museum's own website, even when you are searching for them. Using a universal search engine is your best bet." This claim is supported by El-Said & Aziz (2022: 542) who state, that virtual tours "should be displayed on official websites and major communication channels and be easy to find". The problem is actually twofold: finding a virtual tour in general and finding it on the museum website. A potential solution to the general problem is to make both

the digital exhibition and the virtual tour more visible by promoting them more prominently. Such promotional tools for more general visibility can be online platforms such as *Calaios - Plattform für Live-Online-Veranstaltungen zu Kunst, Kultur, Natur und Wissenschaft* where virtual tours can be announced by museums and booked by virtual visitors. The visibility related to the museum's existing audiences can be increased by a prominent display on the museum's website, in newsletters and social media.

2.4 HEURISTIC 2: VIRTUAL TOURS SHOULD BE EASY TO ACCESS AT AN INFORMATIONAL LEVEL.

As Dybsand (2022: 9) emphasises, virtual visitors need correct information about how to join the tour, both on how to use the virtual platform and on the time zone of the tour. In addition, they need information on how to use high-quality visual or auditory aids in order to create an atmosphere that is as authentic as possible. This may sound like a platitude but is essential for a successful participation on the side of the visitors.

2.5 HEURISTIC 3: VIRTUAL TOURS SHOULD BE EASY TO ACCESS AT A TECHNICAL LEVEL.

The digital audiences have a quite heterogeneous computer literacy and therefore need a high level of accessibility, as El-Said & Aziz (2022: 541) found: "VTs should be accessible. This means that people from different backgrounds and from different devices should be able to use it." First of all, it is important to keep the technical aspects of access as simple as possible – focusing on the abilities of "computer-users or non-users, children, elderly people or disabled people" (Kabassi et al. 2019: 1f). In addition, technical accessibility can be supported by aids such as Frequently Asked Questions (FAQs) or technical glossaries for users with diverse skills and by personal assistance for coping with technical problems during guided virtual tours.

2.6 HEURISTIC 4: VIRTUAL TOURS SHOULD BE EASY TO ACCESS AT AN INTELLECTUAL LEVEL.

In their study, Lafontaine & Sawchuk (2022: 393) found that also in the digital realm, "there is a risk of further entrenching the museum's traditional image as elitist institutions". This claim is supported by the findings of Li, Nie & Ye (2022: 13): "Some interviewees also pointed out that the exhibit descriptions were too academic, which affected the learning effect." Instead of using highly specialised academic language, museums should avoid specialist terminology where ever possible. Where this is not feasible, they should provide conceptual accessibility, e.g., definitions of specialist terms, so that also nonspecialists can benefit from the content (Clerkin & Taylor 2021: 167).

2.7 HEURISTIC 5: PROGRAMMES OF PHYSICAL AND DIGITAL VISITS SHOULD BE "INTERWOVEN".

Lafontaine & Sawchuk (2022: 390) found that many participants of their study preferred hybrid program deliveries "that would allow them to alternate between virtual visits and on-site tours so they could benefit from the distinct advantages of each format." Therefore the opportunities for physical and digital visits should be intertwined to motivate each other. However, that virtual tours should simulate physical visits is debated controversially (cf. Clerkin & Taylor 2021: 166).

2.8 HEURISTIC 6: TAKE INTO ACCOUNT THE VISITORS' BEHAVIOURS AND MOTIVATIONS.

Ciaccheri (2020: WWW) postulates to take visitors' behaviours and motivations into account, as they are key factors for any effective experience. At the same time, it is important to realise that the attention of the virtual visitors decreases over time: for this reason, the visit should implement different interaction strategies to avoid tiredness and fatigue (Ciaccheri 2020: WWW). In this way, the motivation (cf. Schweibenz 2013: 46f) to continue the virtual visit could be kept up.

2.9 HEURISTIC 7: PROVIDE INTERACTIVE ELEMENTS DURING THE VIRTUAL TOUR.

Motivation and attention can be kept up by interactive elements such as quizzes, polls, Q&A sessions, asking for interpretation of quotes, or group decisions where the online guide would go next, all these possibilities for participants to interact with the guide and each other were highly appreciated, whereas participants were displeased without such acitivities, as Dybsand (2022: 9) found. This is no surprise as also in traditional tours activities are included which allow their audiences to feel engaged (Best 2012: 48).

2.10 HEURISTIC 8: DO NOT ONLY PROVIDE INTERACTIVITY ONLY BUT SOCIAL INTERACTIONS AND SHARED EXPERIENCES.

For virtual tours, social interaction is the key issue (Jokanović 2020: 52), which is why Ciaccheri (2020: WWW) asks "how to solicit social interactions between visitors, themselves or their families". This issue is highly relevant as findings show that participants used virtual guided tours not only for entertainment but also as a way of socializing during the pandemic by participating in virtual guided tours together in order to connect with old friends, family, coworkers they could not physically meet during the lockdowns (Dybsand 2022: 9f). However, as the results of Lafontaine & Sawchuk (2022: 391f) indicate, the virtual format posed challenges to socializing within the online group. Essentially, "the online museum tours did not cultivate social engagement in the same way that the on-site activities did" (Lafontaine & Sawchuk 2022: 393), although it is often claimed that virtual tours allow for shared experiences and support collaborations (Johnson, Díaz & Pickering 2012: 106). In all likelyhood, it seems to be the responsibility of the online tour guide to encourage social interactions that may lead to shared experiences. High-quality guiding can turn virtual tours into positive experiences (Dybsand 2022: 9).

2.11 HEURISTIC 9: OFFER SOMETHING EXTRA IN THE DIGITAL.

One of the participants of El-Said & Aziz's (2022: 542) study stated: "a virtual tour needs to do something extra in the digital. The VT can never replace the physical, but it can add something and create other kinds of experiences." The idea behind this statement can be interpreted twofold: Firstly, the digital visit could include content that is not available on-site or objects and places that are not accessible in the traditional exhibition, a feature highly appreciated in virtual tours as the findings of Dybsand (2022: 8) show. Secondly, it holds true that in the digital realm, information can be easily linked, and again something that sounds like a platitude. However, reviews of virtual tours showed that most of them did not provide additional information related to the exhibits such as annotations or supplementary content (Kabassi et al. 2019: 9). Best practice exemples for layering information are provided by the Getty Online Scholarly Catalogue Initiative (2017).

2.12 HEURISTIC 10: SPACE AND SIZE ARE DIFFICULT TO CONVEY IN THE VIRTUAL TOUR.

In virtual tours, the sensation of space can get lost (Wolf, Reinhardt & Funk 2018: 85). The same holds true for the size of objects, which may stimulate reactions among the visitors and induce feelings such as feeling overwhelmed, and their physical arrangements (Kaplan 2021: 537). Moreover, there is "a marked lack of 'sensory' or 'emotional' triggers when viewing a work through a Zoom screen" (Lafontaine & Sawchuk 2022: 389). These are effects that have to be taken into account when planning virtual tours. While it seems difficult to provide a sense of space in guided online tours, experienced online guides point out the actual size of objects by providing their measurements (Kaplan 2021: 537).

2.13 HEURISTIC 11: PROVIDE A SENSE OF "CLOSENESS" TO THE EXHIBITS BY SHOWING AND EXPLAINING DETAILS.

One of the advantages of virtual tours is that is "possible to get a much closer look at the sights, […], for example, 'you could zoom in and focus on particular elements of the work, which made it really visually satisfying.'" (Dybsand 2022: 8), while in the traditional exhibition viewers might miss significant details (Kaplan 2021: 540) that difficult or impossible to see due to the required distance and the exhibition settings. Here, the digital offers an advantage: Zooming in and focussing on details are easy and appreciated by virtual viewers. This can provide a feeling of "closeness" to the exhibit, especially if there are explanations why these details were chosen and what makes them special. This can create a sense of exclusiveness on the side of the virtual visitors and give them the feeling to have a special experience online.

2.14 HEURISTIC 12: DON'T WORRY ABOUT THE AURA OF THE OBJECTS.

As soon as digital reproduction comes into play, the aura of the object takes a prominent place in the discussion about the relationship between originals and digital reproductions. According to Stopka (2022: 33), aura is not embedded in the object but an experience on the side of the viewer which is triggered by the object. This experience is a dynamic phenomenon between

the subject and the object, a kind of contemplative amalgamation process that conveys the impression of being part of something unique. If this holds true, the trigger does not have to be a physical object. If we consider fandom of immaterial culture such as movies or music, it seems obvious that triggers can be immaterial. Therefore, some researchers rightfully ponder about "the possibility of a virtual aura that allows enchantment in a technological world of mediated rather than first hand experiences" (Schweibenz 2013: 41).

3. CONCLUSION

Although the future role of virtual tours in general seems to be still undecided, it is clear that the "[i]nnovations made out of pandemic necessity will remain critical for museums even after this health crisis has passed" (Clerkin & Taylor 2021: 174). Studies offer quite different perspectives of participants: On the one hand, some participants indicated that they viewed virtual tours as temporary substitutes (Dybsand 2022: 10). On the other hand, their comments indicate that there might be a (smaller) market for virtual tours after the pandemic (Dybsand 2022: 10). Considering the demographic factors in Europe, the audience for virtual tours might be growing as findings suggest that virtual guided tours were especially important to participants who were disabled or elderly (Dybsand 2022: 12). In contrast, the crucial question is how virtual tours correspond with the transmedia perception of a younger, digital-born audience (Jokanović 2020: 48). Nevertheless, this suggests a growing need to evaluate and improve the quality of guided virtual tours. The checklist presented in this paper can be a first step to develop a set of heuristics for this purpose. However, further research in museological and technical aspects of guided online tours is necessary. It is important not to rely on technical solutions alone as technology is only a means to an end. To call for the creation of "non-human guides that have a similar level of sensitivity to the audience built in" (Best 2012: 49) will not offer feasible solutions as long as we do not have to a better understanding of how guided online tours work well for different audiences. High-quality guiding is an essential feature in turning guided virtual tours into positive visitor experiences. (Dybsand 2022: 9). The elements of such high-quality online guiding have to be identified by future research.

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29. November – 01. Dezember 2023

PROGRAMM | PROGRAMME

Programm

MTTWOCH | WEDNESDAY, 29. November 2023

WORKSHOP I Tactile Museum Project: Using 3D Printed Tactile Artifacts for Creating Inclusive Experiences in Museums.

10:00 – 12:30 **Moderation: Vicente Gascó Gómez | Atlantic University**

Museums are valuable institutions where culture, history, and education converge. However, quite often such experiences rely heavily on visual elements, inadvertently excluding individuals with functional diversity such as visual impairments. This workshop aims to provide a comprehensive guide for those seeking to make culture, history, and art more sensory-inclusive with 3D printed tactile artifacts. Through a series of projects and case studies done with museums in Puerto Rico, the workshop discusses design principles, 2D-to-3D workflows, project considerations, and 3d printing processes and materials relevant for creating tactile objects.

WORKSHOP II Algorithmen zur Erstellung und Bewertung visueller Bildersortierungen

14:00 – 16:00 **Moderation: Prof. Dr. Kai Uwe Barthel | Nico Hezel | Konstantin Schall HTW Berlin**

Da die Menge visueller Daten ständig wächst, wird die Organisation von Bildern wichtiger. Menschen können komplexe Einzelbilder leicht verstehen, aber sie haben Schwierigkeiten, große unsortierte Bildsammlungen zu durchsuchen. Dieses Problem tritt z.B. in Archivrecherchen oder bei Mediensuchen auf. In diesem Workshop werden grundlegende Prinzipien der visuellen Bildsortierung vermittelt. Nutzertests zeigen, wie sortierte Bilder die Suche und Übersicht über große Bildmengen erleichtern. Eine neue Metrik ermöglicht die Vorhersage der Benutzerwahrnehmung bei sortierten Bildmengen. Außerdem wird ein extrem schneller Algorithmus für hochwertige visuelle Sortierung vorgestellt. Nach dem Workshop können Teilnehmer Bildsortierungen selbst durchführen. Schließlich wird gezeigt, wie die Kombination von Bildsortiertechniken mit Bildgraphen die explorative visuelle Erkundung extrem großer dynamischer Bildbestände ermöglicht.

FREITAG | FRIDAY, 01. Dezember 2023

WORKSHOP III Initiativen, Verbundprojekte und Kooperationen für die Kultur

12:00 – 13:30 **Mit Beiträgen von | With Contributions by:**

Dr. Sabine de Günther | Giacomo Nanni | Ilias Kyriazis | Prof. Dr. Marian Dörk | Dr. Linda Freyberg
(UCLAB, Fachhochschule Potsdam | Leibniz-Institut für Bildungsforschung und Bildungsinformation | „Tracing and Telling: Exploring collection holdings through graph-based narratives“)

Dr. Martin Breuer | Alan Riedel
(Deutsche Digitale Bibliothek |
“Come one, come all(?)” Engaging Users of the German Digital Library)

Dr. Thomas Hörnschemeyer | Rebecca Krämer
(Museum Wiesbaden | Hessisches Landesmuseum für Kunst und Natur |
„Ein gemeinsamer Datenraum für das historische Erbe Hessens“)

Dr. Karsten Dahmen | Dr. Jürgen Freundel
(Das Münzkabinett der Staatlichen Museen zu Berlin |
“Normdatenportal und IKMK.net”)

KONFERENZ I CONFERENCE I

TRANSFORM I

MITTWOCH | WEDNESDAY, 29. November 2023

09:15 – 18:00

09:15 **Eröffnung** **Dr. Sibylle Hoiman**
(Direktorin des Kunstgewerbemuseums der Staatlichen Museen zu Berlin)

Session I **Inklusion und Partizipation | Inclusion and Participation**
Moderation: **Eva Emenlauer-Blömers**
(ehem. Berliner Senatsverwaltung für Wirtschaft, Technologie und Forschung, Projekt Zukunft)
vertreten durch:. Univ.-Prof. Dipl.-Ing. Dominik Lengyel (B-TU Cottbus-Senftenberg)

09:30 **Open Cultural Heritage Projects for Social and Educational Inclusion**
Athina Chroni
(Archaeologist-Art Historian N.K.U.A.-MSc UNI.PI.-PhD N.T.U.A.- Post-doctorate N.T.U.A. Hellenic Ministry of Education, Religious Affairs and Sports Athen Griechenland)

09:50 **Social Flow - Social Connectedness and Flow Through Participatory Art Zeitgeist**
Dr. Oliver Gingrich | Dr. Shama Rahman | Dr. Daniel Hignell-Tully
(University of Greenwich, NeuroCreate, University of Greenwich)

10:10 **Between the Absence of the Object and Presence for Everyone –**
On the Virtual Experience of Art and its Mediation
Theresa Stärk M.A. (Institut für Kunstgeschichte, Heinrich-Heine-Universität Düsseldorf)

10:30 **"Concrete Sculptures" in Hong Kong – Explorations in Expanded Photography**
Dr. Elke E. Reinhuber (SCM School of Creative Media, City University of Hong Kong)

11:00 – 11:30 **Kaffeepause | Coffee Break | Networking | Postersession**

Session II **Erweiterte Umgebung | Extended Environments**
Moderation: **Eva Emenlauer-Blömers**
(ehem. Berliner Senatsverwaltung für Wirtschaft, Technologie und Forschung, Projekt Zukunft)
vertreten durch:. Univ.-Prof. Dipl.-Ing. Dominik Lengyel (B-TU Cottbus-Senftenberg)

11:30 **Digital Exhibitions vs Real Exhibitions or Curator vs AI Driven Curator**
Alessandro Colombo (Architekt)

11:50 **Comparing the Experience of Art Appreciation in a Gallery and a Shop Context Using VR**
Itay Goetz (Department of General Psychology and Methodology, University of Bamberg Research Group EPÆG Bamberg Graduate School of Affective and Cognitive Sciences)

12:10 **The Prompt Wrangler: AI Text-to-Image Generation as Curatorial Practice**
Mitch Goodwin (University of Melbourne)

12:30 **Open Justice Transformations Impacting Extended Reality (XR) Environments**
Prof. Adnan Hadziselimovic (University of Malta)

13:00 – 14:00 **Mittagspause | Lunch | Poster Session**

Session III **Generative Erzählungen | Generative Storytelling**
Moderation: **Prof. Dr. Dorothee Haffner (HTW Berlin)**

14:00 **Data Spaces // Data Worlds: Perspektivwechsel mit künstlerischer Unterstützung**
Monika Reich M.A. | Brian Eschrich | Dr. Robert Fischer | Maria Matthes
(Interactive Science Lab, Center for Interdisciplinary Digital Sciences, TU Dresden)

14:20 **A symbolic homecoming. 3D Digital imaging of Greek vases from the MHNC-UP**
Vera Moitinho de Almeida | Rui Morais (Universidade do Porto)

14:40 **Reviving the Past: Visualising Cultural Heritage in Dynamic User Interfaces**
Elena Karittevli | Neofytos Kokkinos | Marinos Ioannides | Kyriakos Efstathiou
(UNESCO Chair on Digital Cultural Heritage)

15:00 **Visualising Drawings: from Archives to QGIS. A methodological overview**
Chiara Vitaloni (University of Palermo)

15:30 – 16:00 **Kaffeepause | Coffee Break | Networking | Postersession**

Session IV **Standards und Formate | Standards and Formats**
Moderation: **Frank v. Hagel**
(Wissenschaftliche Museumsdokumentation, digitales Sammlungsmanagement|
Institut für Museumsforschung |Stiftung Preußischer Kulturbesitz)

16:00 **Berlin's Digital Cultural Heritage. A Quantitative Glance at Metadata Quality**
Alexander Winkler
(Forschungs- und Kompetenzzentrum Digitalisierung Berlin digiS, Zuse-Institut Berlin)

16:20 **Authority Files for Search and Filter Options in the German Digital Library**
Dr. Domenic Städtler
(Institut für Museumsforschung Staatliche Museen zu Berlin - Preußischer Kulturbesitz)

16:40 **Von der digitalen Sammlung zur „Sammlung als Daten".**
Wie effizientes Qualitätsmanagement diesen Wandel unterstützen kann
Dr. Celia Krause
(Deutsches Dokumentationszentrum für Kunstgeschichte - Bildarchiv Foto Marburg)

KONFERENZ II CONFERENCE II

TRANSFORM II DONNERSTAG | THURSDAY, 30. November 2023

09:00 – 19:00

09:00 **Begrüßung** **Keynote Speach: Prof. Dr. Sebastian Sierra Barra**
„Digital aufgelöste Demokratie:
Von der Unabhängigkeitserklärung des Cyberspace zur neuen Unmündigkeit.“

Session I **Digitale Reproduktion | Digital Reproduction**
Moderation: **Prof. Dr. Andreas Bienert (EVA-Berlin Vorsitz | ehem. SMB)**

09:30 **Interactive Volumetric Video in VR Experiences—Technology, Design & Evaluation**
Prof. Dr. Anja Ballis[a] | Oliver Schreer[b]
(Ludwig-Maximilians-Universität München, Germany [a] | Fraunhofer Heinrich-Hertz-Institut [b])

09:50 **Digital Reinassance. A Platform for the Interactive Dissemination of the Monumental Heritage of the Calabrian Coast Depicted in the Codice Romano Carratelli (XVI century)**
Prof. Francesca Fatta | Marinella Arena | Daniele Colistra | Domenico Mediati | Paola Raffa
(Università degli Studi Mediterranea di Reggio Calabria)

10:10 **Digitization of Object Rich Natural History Collections with DORA – a Multi-Organizational Approach to Success**
Dr. Nora Lentge-Maaß
(Department of Collection Future, Leibniz Institute for Evolution and Biodiversity Science)

10:30 **Integriertes modulares Stacking-System Deimos**
Dr. Frederik Berger | Bernhard Schurian (Museum für Naturkunde Berlin)

11:00 – 12:00 **Kaffeepause | Coffee Break | Networking | Postersession**

Session II **3D-Modelle und Repliken | 3D Models and Replicas**
Moderation: **Prof. Dr. Andreas Bienert (EVA-Berlin Vorsitz | ehem. SMB)**

12:00 **New Scale Model of the City of Pergamon**
Univ.-Prof. Dipl.-Ing. Dominik Lengyel | Jacopo Spinelli M. Sc. | Lyubov Dimova M. Sc.
(Brandenburgische Technische Universität Cottbus-Senftenberg)

12:20 **Let´s Play´s from Buildings, Exhibitions and Museum Pieces**
Birgit Tsuchiya | Bernhard Strackenbrock (Illustrated architecture)

12:40 **The Representation of Pastoral Stone Architecture: Towards a Graphic Reconstruction**
Lorella Pizzonia (PhD S. Università degli Studi Mediterranea di Reggio Calabria, Italy)

13:00 **From Physical to Virtual, from Virtual to Physical, and Back to Virtual again. Representations of an Underground Church in the Field of Xreality**
Arch. Francesco Stilo (PhD Università degli Studi Mediterranea di Reggio Calabria, Italy)

13:30 – 15:00 **Mittagspause | Lunch | Ausstellung**

Session III **Multimodale Erfahrungen | Multimodal Experiences**
Moderation: **Sandro Schwarz (Referent für IT Strategie | Stiftung Preußischer Kulturbesitz) vertreten durch Katja Sternitzke (Staatsbibliothek zu Berlin)**

15:00 **Multimodal Science Communication In An Interactive Exhibition**
Dr. Annett Schulze | Prof. Dr. Michael Beuthner | Andreas Will
(Bundesinstitut für Risikobewertung (BfR), Deutschland | SRH Berlin University of Applied Sciences, Deutschland | Garamantis GmbH, Deutschland)

15:20 **The Transfomer Tower**
Jorge Cruz Pinto (School of Architecture, Universidade de Lisboa)

15:40 **Digital Shift of Knjaževac Museum towards Accessible Collections**
Milena Milošević Micić (Museum advisor art historian, The Homeland Museum of Knjaževac (Zavičajni muzej Knjaževac) & Balkan Museum Network)

16:00 **Performatics, Creativity, Conceptual Art and YouTube Tuts**
Prof. Dr. Daniel Buzzo (CODE University of Applied Sciences Berlin, Germany)

16:30 – 17:30 **Kaffeepause | Coffee Break | Networking | Postersession**

Session IV **Multisensorische Transformation | Multisensory Transformation**
Moderation: **Univ.-Prof. Dipl.-Ing. Dominik Lengyel (B-TU Cottbus-Senftenberg)**

17:30 **Avatars of Digital Stories. From Classic to Enriched Audio-Video Constructs**
Ioana Cornelia Cristina Crihană
(The National Association of Public Librarians and Libraries in Romania, University Politehnica of Bucharest, Romania)

17:50 **Von Bronze zu Bits: Die Erforschung und innovative Vermittlung von Pompejis Lichtkunst im Rahmen der Ausstellung „Neues Licht aus Pompeji“**
Manuel Hunziker M.Sc. M.A.
(Institut für Klassische Archäologie, Ludwig-Maximilians-Universität München, Deutschland)

18:10 **“Cultural Heritage is our Passion”**
Andrea de Polo Saibanti | Christian Hohendorf (Zeutschel GmbH, Germany)

18:30 **Künstliche Intelligenz in Museen – Erschließung von Sammlungsbeständen mithilfe von KI**
Sonja Potter[a] | Frank Dührkohp[a] | Lars Mischak[b] | Sebastian Klarmann[c]
(Verbundzentrale des GBV (VZG) [a] | Dataport AöR[b] | Programmfabrik [c])

ABENDVERANSTALTUNG | EVENING EVENT

19:00 Führung durch die Ausstellung „Großes Kino – Filmplakate aller Zeiten”

Guided tour of the exhibition “The big screen – Film Posters of All Time”

KONFERENZ III CONFERENCE III

TRANSFORM III

FREITAG | FRIDAY, 01. Dezember 2023

09:30 – 16:30

Session I **Transformationen | Transformations**
Moderation: **Univ.-Prof. Dipl.-Ing. Dominik Lengyel (B-TU Cottbus-Senftenberg)**

09:30 **Can the metaverse save the planet?**
Terry Trickett (Architect, London)

09:50 **The Agency of Image in an Age of Urban Re-Imagination**
Alex Yuen (Harvard University Graduate School of Design)

10:10 **From a Museum of Things to Narratives of People**
Dr. Thomas Tunsch (Staatliche Museen zu Berlin)

10:30 **VI-Train**
Pedro Vaz | Bárbara Vaz (Presidencia da Republica Portuguesa)

11:00 – 12:00 **Kaffeepause | Coffee Break | Networking | Postersession**

Session II **Digitale Gemeinschaft | Digital Community**
Moderation: **Dr. Thomas Tunsch (Kustos | Museum für Islamische Kunst | SMB)**

12:00 **Computer 3D Models in Visual Arts Education - Some Experiences from Croatia**
Ass. Prof. Dunja Pivac | Vana Mardešić | Bojan Vondra
(Arts Academy, University of Split, Croatia | Independent Researcher | Split, Croatia | Senior Software Engineer | Emovis Croatia, Split, Croatia)

12:20 **New Technologies, New Narratives, New Experiences. Stories between Exhibiting and AI**
Dr. Pamela Bianchi (École Nationale Supérieure d'Architecture de Paris-Belleville (ENSAPB) École d'Art et Design de Toulon (ESAD))

12:40 **Articulating Peripheral Space: New Perspectives in Digital Heritage**
Simon Withers | Steve Kennedy (Captivate London)

13:00 **Where Past and Future meet: Artificial Intelligence and the Art Museum**
Dr. Astrid Fendt (Abteilungsleitung Archäologie, Landesmuseum Württemberg, Stuttgart)

Workshop **Initiativen, Verbundprojekte und Kooperationen für die Kultur**

12:00 – 13:30 **Mit Beiträgen von | With Contributions by:**

Dr. Sabine de Günther | Giacomo Nanni | Ilias Kyriazis | Prof. Dr. Marian Dörk | Dr. Linda Freyberg
(UCLAB, Fachhochschule Potsdam, Deutschland |
Leibniz-Institut für Bildungsforschung und Bildungsinformation |
„Tracing and Telling: Exploring collection holdings through graph-based narratives“)

Dr. Martin Breuer | Alan Riedel (Deutsche Digitale Bibliothek |
„Ein Portal für alle(s)? Digitale Kulturvermittlung der Deutschen Digitalen Bibliothek“)

Dr. Thomas Hörnschemeyer | Rebecca Krämer
(Museum Wiesbaden | Hessisches Landesmuseum für Kunst und Natur |
„Ein gemeinsamer Datenraum für das historische Erbe Hessens“)

Dr. Karsten Dahmen | Dr. Jürgen Freundel
(Das Münzkabinett der Staatlichen Museen zu Berlin |
“Normdatenportal und IKMK.net”)

13:30 – 15:00 **Mittagspause | Lunch**

Session III **Intelligente Partnerschaft | Smart Partnership**
Moderation: **Freya Schlingmann (Referatsleitung Digitale Museumsdienste | SMB)**

15:00 **Deciphering the Engraved Crosses in the Chapel of St. Helena**
Moshe Caine | Amit Re’em | Doron Altaratz
(Israel Antiquity Authority and Hadassah Academic College)

15:20 **Reinterpreting artists’ self-portraits through AI derivative creations**
Ass. Prof. Helena Barranha (Instituto Superior Técnico, Universidade de Lisboa and
Institute of Art History, NOVA FCSH / IN2PAST, Portugal)

15:40 **“Promised too much? AI in use in the Image Archive of the ETH Library”**
Nicole Graf (ETH-Bibliothek / ETH Zürich)

16:00 **May (A)I help you? – AI-based Dialogues in the Museum**
Anke Neumeister | Michael Schiffmann
(Deutsches Meeresmuseum Stralsund | Cologne Cobots Lab der Technischen Hochschule Köln)

16:30 **Verabschiedung | Fare-well**

17:00 **Konferenzdinner | Conference dinner (Selbstzahler | self-pay)**

POSTERSESSION [Mittwoch bis Freitag | Wednesday to Friday]

AUSSTELLUNG | EXHIBITION [nur am Donnerstag | Thursday only 09:00 -19:00]

- **Der responsive Waldmistkäfer**
  werk5 GmbH
  Eva Waldherr | Tina Schneider

- **Kulturgut erhalten und digital verfügbar machen**
  Zeutschel GmbH
  Christian Hohendorf | Markus Wagner

- **SOCIAL FLOW: Social connectedness and flow in participatory art**
  School of Design, University of Greenwich, UK[a] | NeuroCreate, UK[b]
  Dr. Oliver Mag Gingrich[a] | Dr. Shama Rahman[b] | Dr. Daniel Hignell-Tully[a]

- **Virtuelle Touren und Ausstellungen im robotron*Daphne Multimedia-Guide**
  Robotron Datenbank-Software GmbH
  Ulrich Servos

- **Genetic Sandbox. Ein interaktives Ausstellungsobjekt zur Künstlichen Intelligenz**
  Interactive Science Lab, Center for Interdisciplinary Digital Sciences, TU Dresden
  Brian Eschrich | Dr. Robert Fischer | Maria Matthes | Monika Reich

- **Algorithmen zur Erstellung und Bewertung visueller Bildersortierungen**
  Visual Computing Gruppe, HTW Berlin
  Kai Barthel | Nico Hezel | Konstantin Schall

- Bauhaus-Universität Weimar
  Jens Weber

- Programmfabrik GmbH
  Sebastian Klarmann | Jens Kloppmann

- Mirai Media Lab GmbH
  Sven Bauer

PROGRAMM ORGANISATION | PROGRAMME ORGANISATION

Vorsitz | Chairs

Univ.-Prof. Dipl.-Ing. Dominik Lengyel (Brandenburgische Technische Universität Cottbus-Senftenberg, Lehrstuhl Architektur und Visualisierung)

Prof. Dr. Andreas Bienert (ehem. Staatliche Museen zu Berlin – Preußischer Kulturbesitz)

Eva Emenlauer-Blömers (ehem. Berliner Senatsverwaltung für Wirtschaft, Technologie und Forschung, Projekt Zukunft)

in Zusammenarbeit mit | in collaboration with

Dr. Anko Börner (Deutsches Zentrum für Luft- und Raumfahrt e.V. - Optical Sensor Systems)

Dr. Christian Bracht (Deutsches Zentrum für kunsthistorische Dokumentation - Bildarchiv Foto Marburg)

Prof. Dr. Matthias Bruhn (Hochschule für Gestaltung Karlsruhe)

Prof. Dr. Dorothee Haffner (Hochschule für Technik und Wirtschaft Berlin)

Dr. Harald Krämer (Hong Kong University Museum and Art Gallery)

Prof. Dr. Robert Sablatnig (Technische Universität Wien)

Pedro Santos (Fraunhofer-Institut für Graphische Datenverarbeitung IGD, Darmstadt)

Prof. Gereon Sievernich (ehem. Hauptstadtkulturfonds Berlin)

Dr.-Ing. Ralf Schäfer (Fraunhofer Heinrich-Hertz-Institut, Berlin)

beratend | advisory

Prof. Vito Cappellini (emer. University of Florence)

Dr. James R. Hemsley (EVA Conferences International, UK)

TEILNEHMERPROFIL | WHO SHOULD ATTEND

- Museen, Bibliotheken, Archive und Einrichtungen der performativen Künste
- Kultur- und Bildungsministerien, Museums- und Denkmalämter, Kulturverbände und kulturell orientierte Institutionen
- Forschung in der Bildverarbeitung, Computergraphik, Informations- und Medienwissenschaft
- Anbieter von Multimedia- und Bildverarbeitungssystemen, Hard- und Software, Online-Informationsdiensten, Datenbanken
- Museums, libraries, archives and performing arts institutions
- Ministries of culture, museum and heritage organizations, other cultural associations
- Research institutions for image processing, computer graphics, information and media sciences
- Suppliers of multimedia and image processing systems, hardware and software, online information services, databases

ZIELE | OBJECTIVES

Die Berliner EVA Konferenz ist das jährliche Forum für elektronische Dokumentations- und Visualisierungstechniken im Kulturbereich. Erfolgreiche Digitalisierungsprojekte mit Bezug zum kulturellen Erbe, netzbasierte Forschungs- und Vermittlungskooperationen sowie innovative informationstechnische Serviceangebote für Museen, Bibliotheken, Archive und Einrichtungen der performativen Kunst werden praxisnah, anwendungsorientiert und in fachübergreifenden Zusammenhängen vorgestellt. Gedächtnisinstitutionen, Technologieentwickler, Informationswissenschaftler und öffentliche Verwaltungen treten in einen Diskurs über aktuelle Tendenzen und innovative Techniken in der digitalen Transformation. Konferenz, Workshops und begleitende Ausstellungen bieten Gelegenheit zum Erfahrungsaustausch, zum Kennenlernen neuer Verfahren und Produkte sowie zur Vorbereitung kooperativer Zusammenarbeit.
Als Teil des Netzwerks EVA International mit seinen Standorten in London, Florenz und Paris ist die 27. Veranstaltung in Berlin auch eine Plattform internationaler Orientierung und europäischer Kooperation.

The EVA Berlin conference is an annual discussion forum for electronic documentation and visualization technologies in the field of cultural heritage applications. Ambitious digitization projects with regard to cultural context, network-based research and new technical opportunities for museums, libraries, archives and the performative arts are presented with a strong reference to their usage. It encourages the exchange between heritage institutions and technology providers, information professionals and the public administration on current issues and innovative technologies of the digital society. Conference, workshops and exhibition offer a valuable opportunity to gain insight into new products and services and to establish partnerships.
As part of the international network of EVA conferences in London, Florence and Paris, the 27th EVA event in Berlin is a platform for transnational exchange and European co-operation.

VERANSTALTUNGSORT | VENUE

Staatliche Museen zu Berlin
Kulturforum, Vortragssaal des Kunstgewerbemuseums
Matthäikirchplatz 8
10785 Berlin

http://www.smb.museum/museen-und-einrichtungen/kunstgewerbemuseum/home.html

Ansprechpartner | Contact

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Organisationsteam | Organisation Committee

Jacopo Spinelli M.Sc.
Jessika Krüger
Lyubov Dimova M.Sc.
Jonas Görke M.Sc.
Ignacio Daniel Garrido Balut B.A.
Linda Kolodziej B.A.

(Brandenburgische Technische Universität Cottbus-Senftenberg)

info@eva-berlin-conference.de

Verkehrsverbindungen | Transport

U-Bahn U2 (Potsdamer Platz)
S-Bahn S1, S2, S25 (Potsdamer Platz)
Bus M29 (Potsdamer Brücke), M41 (Potsdamer Platz, Bhf Voßstraße),
M48, M85 (Kulturforum) oder 200 (Philharmonie) |

Metro U2 (Potsdamer Platz)
S-Bahn transit S1, S2, S25 (Potsdamer Platz)
Bus M29 (Potsdamer Brücke), M41 (Potsdamer Platz Bhf / Voßstraße),
M48, M85 (Kulturforum) or 200 (Philharmonie)

Die 27. Konferenz EVA Berlin 2023 ist Teil des internationalen EVA Netzwerks

EVA Conferences International 2023 http://www.eva-london.org/eva-conferences-international

EVA Florenz	**05. – 06. Juni**
EVA London	**10. – 14. Juli**
EVA Paris	**20. November**
EVA Berlin	**29. November – 01. Dezember**

www.eva-berlin-conference.de