Electronic Media and
Visual Arts

Elektronische Medien und
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EVA Berlin 2026

18 - 20 March
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Intelligence Space.
Creativity in Dialogue
with Technology

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Creativity in Dialogue with Technology

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March 18, 2026

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INFORMATION AND CONTACT

Brandenburg Technical University Cottbus-Senftenberg
Chair of Architecture and Visualisation
E-Mail: info@eva-berlin-conference.de

www.eva-berlin-conference.de | www.b-tu.de/fg-architektur-und-visualisierung

CONFERENCE PROCEEDINGS

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Univ.-Prof. Dipl.-Ing. Dominik Lengyel
Eva Emenlauer-Blömers
Prof. Dr. Andreas Bienert

Editorial Team: Dominik Lengyel, Begüm Çalık, Jacopo Spinelli, Jessika Krüger
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March 18 – March 20, 2026

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SESSION I

“Digital Humanities: A Broader Spectrum”

Moderation: Eva Emenlauer-Blömers
(form. Senate of Berlin, Department for Economics, Technology and Research, Project Future)

Letterjongg! Featuring Historical Fonts Using Casual Games

Thomas Weibel

Prof. em., Institute for Multimedia Production, Department of Applied Future Technologies, University of Applied Sciences of the Grisons,
thomas.weibel@bluewin.ch

ABSTRACT: Originally developed in 1981 by physicist and game designer Brodie Lockard on a mainframe computer at the University of Illinois, Mah-Jongg gained widespread popularity after being released by U.S. game publisher Activision under the name Shanghai. Building on this legacy, the browser-based game Letterjongg reimagines the classic tile-matching format through the lens of Western typographic history. Letterjongg features letterforms based on the work of Francesco Griffo (1450–1518), a Bolognese punchcutter who created the first italic typeface in history. The characters are sourced from the 1501 edition of Horace's complete works, published by Venetian humanist Aldus Manutius, and have been digitized in high resolution by the University of Basel. By replacing traditional Far Eastern iconography with Renaissance-era Western typography, Letterjongg offers a distinctive cultural reinterpretation of the classic game—inviting players on a journey back to the origins of modern font design and book printing.

1. INTRODUCTION

In 1981, Brodie Lockard, a student at Stanford University, developed a computer game two years after sustaining a severe spinal cord injury during a gymnastics accident, which resulted in quadriplegia. During his extended hospitalization and rehabilitation, Lockard—unable to operate a conventional keyboard and using a mouth-stick instead—was granted access to a PLATO terminal. PLATO (Programmed Logic for Automatic Teaching Operations) was the first generalized computer-assisted instruction system, originally designed and implemented by the University of Illinois. [1]

The computer game that Lockard began developing on the PLATO system was a single-player puzzle game featuring representations of traditional Chinese *Mah-Jongg* tiles. These tiles, originally used in the Chinese multi-player game *Mah-Jongg*, had gained considerable popularity in the United States by that time. Reflecting the visual elements, Lockard entitled his game *Mah-Jongg* accordingly. In 1986, the software company Activision released a commercial version of it under the title *Shanghai*. Subsequently, in 1990, Microsoft included another variant—renamed *Taipei* for legal reasons—in its Windows Entertainment Pack for the Windows 3.x operating system.

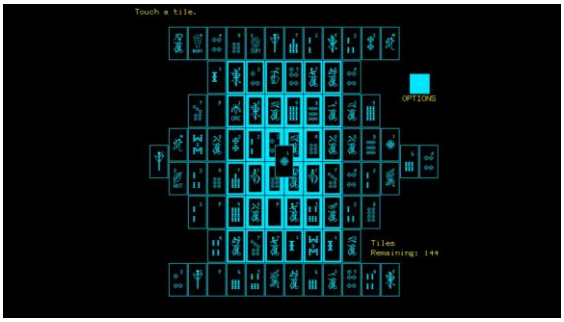


Figure 1: *The original "Mah-jongg" game running on the PLATO system, screenshot (own work).*

Figure 2: *"Taipei" for Microsoft Windows 3.1, screenshot (own work).*

This inclusion significantly contributed to the widespread dissemination and popularity of *Mah-Jongg*, establishing it as one of the most widely played computer games globally.

2. INTERACTIVITY

Humans have engaged in gameplay for millennia, encompassing a wide range of forms such as dice games, board games, card games, and, more recently, digital games on consoles, computers, and mobile devices. Despite the technological evolution of these formats, games consistently function as narrative systems, structures through which stories are conveyed. In this regard, they share fundamental characteristics with traditional narrative media such as literature, theater, and film. The primary distinguishing feature of games, however, is their interactivity: the players' ability to influence the progression of the narrative through their decisions and actions. [2]

Interactivity is one of the key reasons games serve as effective tools for both visualizing cultural data and promoting user engagement with such content. It is no coincidence that game development has become a prominent medium within collaborative creative contexts such as hackathons. A hackathon is an intensive, time-bound event—typically lasting between one and three days—during which programmers, ideally in collaboration with researchers, designers, and museum professionals, develop prototype applications. These projects are predominantly software-based and are frequently made publicly accessible and documented on specialized online platforms in order to facilitate further development, dissemination, and scholarly evaluation.

3. HACKATHON

Hackathons such as the Swiss Open Cultural Data Hackathon generate impact across multiple dimensions. These events foster experimentation and innovation by providing a structured yet flexible environment for creative exploration. Interdisciplinary collaboration—bringing together specialists from fields such as software development, cultural heritage, data science, arts, and design—enhances the knowledge base and perspectives of all the participants. Moreover, the prototypes developed during these events often serve as valuable tools for engaging diverse audiences, including user groups that cultural institutions or data providers might not otherwise reach through conventional channels. [3]

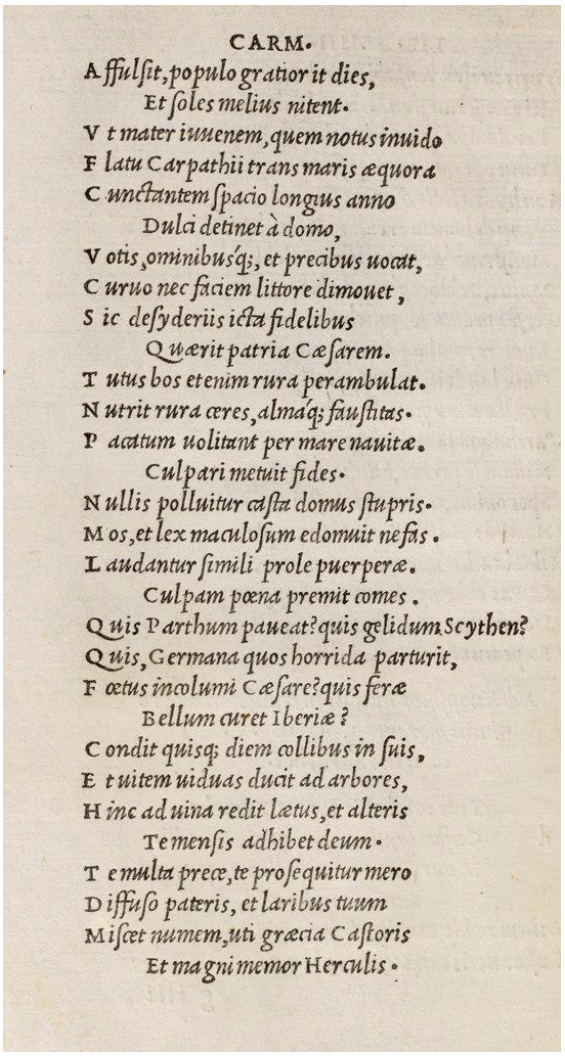
4. LETTERJONGG

Letterjongg [4] was developed during the 4th Swiss Open Cultural Data Hackathon, held at the Swiss National Museum in Zurich in October 2018. [5] The online game seeks to reinterpret the traditional visual language of East Asian *Mah-Jongg* imagery through the lens of European Renaissance typography. 570 years ago, the invention of modern printing technology by Johannes Gutenberg in Germany—and subsequently by William Caxton in England two decades later—marked a profound technological and cultural shift. Prior to this development, books were manually produced manuscripts, meticulously written and copied by scribes over extended periods of time. The advent of movable type and associated printing techniques enabled the mass production of texts at unprecedented speed and scale. This innovation had a transformative impact on both scientific knowledge dissemination and societal development in general.

Fifteenth-century typographers were not only entrepreneurs; they were also artists, and this dual role is evident in the aesthetic qualities of early printed typefaces. The design of 15th- and 16th-century fonts retain strong influences from their calligraphic predecessors, reflecting the typographers' training in manuscript traditions. Although produced using novel printing technologies, early printed books were still conceived as valuable cultural artifacts—objects of both intellectual and artistic significance. Many were adorned with elaborate illustrations and decorative elements. For example, incunabula (books printed before 1500) often feature a blank space in the upper left corner of a page, deliberately left for the later hand-illustration of ornamental initials, thus preserving the integration of manual artistry within the mechanical reproduction process.

Letterjongg contains 144 typographic tiles, corresponding to 36 distinct tile faces. The letterforms were extracted from a high-resolution scan (TIFF format; 2,576×4,840 pixels; file size: 35.69 MB) of a single page of Horace's (*Horatius Flaccus*) complete works, provided by the University of Basel. [6] The volume was published in 1501 by Aldus Pius Manutius (Aldo Pio Minuzio) in Venice, with type design by Francesco Griffo, a renowned font designer and punchcutter in Bologna. While the game mechanics of *Letterjongg* have been slightly simplified, its gameplay remains cognitively

demanding, due to the randomized arrangement of tiles—resulting in some configurations that may be unsolvable—and the high degree of visual similarity among the tiles which challenges the players' pattern recognition and spatial orientation.



CARM.

Affulſit, populo gratior it dies,
Et ſoles melius nitent.
Vt mater iuuenem, quem notus inuido
Latu Carpathii trans maris æquora
Cunctantem ſpacio longus anno
Dulci detinet à domo,
Votis, omnibusq; et precibus uocat,
Curuo nec faciem littore dimouet,
Sic deſyderiis icta fidelibus
Quærit patria Cæſarem.
Tutus bos etenim rura perambulat.
Nutrit rura ceres, almáq; fauſtitas.
Pacatum uolitant per mare nauitæ.
Culpari metuit fides.
Nullis polluitur caſta domus ſtupris.
Mos, et lex maculoſum edomuit nefas.
Laudantur ſimili prole puerperæ.
Culpam pœna premit comes.
Quis Parthum paueat? quis gelidum Scythen?
Quis, Germana quos horrida parturit,
Fœtus incolumi Cæſare? quis feræ
Bellum curet Iberiæ?
Condit quisq; diem collibus in ſuis,
Et uitem uiduas ducit ad arbores,
Hinc ad uina redit lætus, et alteris
Temenſis adhibet deum.
Te multa precæ, te proſequitur mero
Diffuſo pateris, et laribus tuum
Miſcet numem, uti græcia Caſtoris
Et magni memor Herculis.

Figure 3: *High-resolution scan of a page from Horace's complete works issued by Aldus Pius Manutius, Venice (1501). (University of Basel)*

While Francesco Griffo engraved the capital letters in a normal (upright) style, the lowercase letters were cut in an italic form. These so-called *Aldines*—named after Aldus Pius Manutius, the Venetian editor and printer who commissioned the typeface—introduced the first italic letterforms in the history of printing [7]. This typographic innovation played a significant role in the Renaissance revival of classical antiquity and contributed to the intellectual movement of humanism. Griffo's typeface, designed specifically for Aldus' editions of classical Latin texts, proved to be influential in shaping the visual culture of early modern Europe. Notably, because the cursive type originated in Italy, such letterforms are still referred to as *italics* in present-day English. [8]

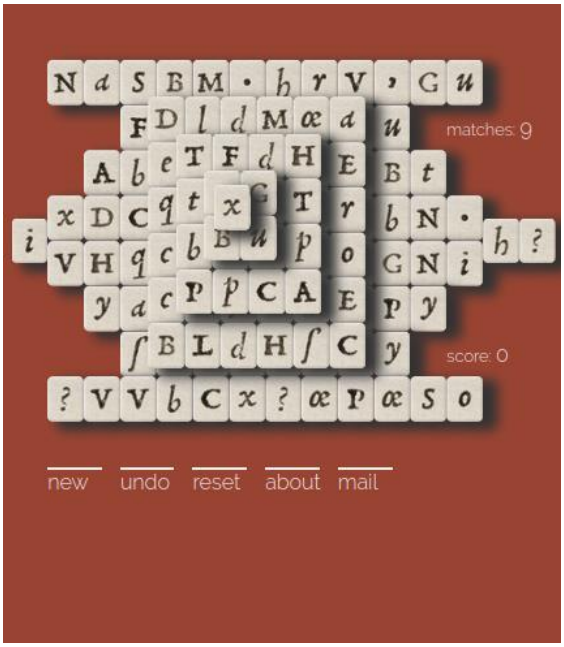


Figure 4: *Online game "Letterjongg", screenshot (own work).*

Letterjongg is coded in HTML 5 (CSS 3, Javascript); no external frameworks or libraries were used. It can be disseminated via a direct web link or through a scannable QR code, thus facilitating broad and low-threshold access.

5. CONCLUSION

Computer games—and online games in particular—offer a highly effective medium for the dissemination of cultural and historical data, while encouraging users to engage with content beyond the temporal and spatial limits of an exhibition. The use of browser-based technologies facilitates low-barrier access and broad distribution. This approach transforms cultural datasets into interactive experiences that visitors can continue to explore after their physical exhibition visit. In doing so, online games extend the museum experience and contribute to a more sustainable and meaningful engagement with scientific, cultural, or historical content.

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First, They Came for The Schedulers and I Said Nothing: The Role of Cultural Intermediaries in The Live Music Sector and their Negotiation of Digital Tools.

Danai Papathanasiou, Stefano Russo, Izabela Derda, Erik Hitters

Erasmus School of History, Culture and Communication, Erasmus University, Netherlands,
papathanasiou@eshcc.eur.nl,
russo@ehcc.eur.nl, izabela.derda@eshcc.eur.nl, hitters @eshcc.eur.nl

ABSTRACT: Digital and AI-based tools are increasingly embedded across the cultural and creative sectors and industries (CCSI). While many of these innovations promise efficiency, they also unsettle existing infrastructures of cultural mediation, raising questions about the future of cultural intermediaries. In the live music sector - a domain where human mediation remains central and automation limited - intermediaries actively negotiate the use of digital tools, developing ad hoc socio-technical arrangements that balance organisational demands with their professional logics. This paper presents findings from the CLT pilot of the EXCENTRIC project, which explored how cultural intermediaries in the live music sector experience, negotiate and adapt to digitalisation processes. The study conceptualises digitalisation not as a top-down technological process but as a site of mediated negotiation. First, it examines how the side-lining of intermediaries would reshape value creation and cultural curation in the live music sector. Second, it analyses how intermediaries appropriate digital tools, forming bottom-up networks of collaboration between human actors and technologies. The findings reveal cultural intermediation as a dynamic, adaptive practice that sustains organisational intelligence in digital transitions. Finally, the paper advances the concept of human–technology complementarity, offering design recommendations for human-centric digital infrastructures that support rather than displace intermediaries.

1. INTRODUCTION

As digitalisation of the Cultural and Creative Sectors and Industries (CCSI) continues, so does the reshaping of their production and consumption infrastructures. The effect of adoption of digital tools, with AI in the zeitgeist's spotlight, is extensively reviewed regarding its impact on artists [8, 18], the restructuring of large-scale intermediaries such as record labels [12] as well as its labour fabric [14].

Throughout the various debates around digitalisation and CCSI, a significant lineage of discussion on the role of cultural intermediaries [2, 6, 9, 15, 17, 19, 21] and the effects of digitalisation on their work, receives comparatively less attention. This article redirects the focus to the "middleman," the cultural intermediaries, specifically in the live music sector, which in comparison to other sectors, remains more resistant [1], yet showcases one of the most intricate networks of collaboration [7].

This paper is guided by the question: How do cultural intermediaries in the live music sector experience, negotiate and adapt to digitalisation? The argument is twofold: it echoes the need to study the typology of such creative labour, especially under digitalisation, and underlines the urgency of uncovering the human infrastructures created by cultural intermediaries - particularly their collaborative practices and knowledge exchange, in order to translate them into a model for human-centric digital transition.

The case in focus comes from one of the six pilots of the Horizon Europe project EXCENTRIC. The project focuses on the live experience sector, such as music venues, festivals, museums, etc., aiming to create collaborative data ecosystems for a human-centric and sustainable digital transition. Through the case of the CTL pilot in Lisbon, a popular music venue in the centre of the capital, the paper presents

initial findings on how collaborative networks between cultural intermediaries in live music evolve when digital tools mediate their daily coordination work.

By centring the discussion on these intermediaries, the paper contributes to a broader understanding of cultural work during digital transition. It highlights the need for a human-centric approach to digital transition that builds on existing practices and social relations, rather than attempting to overrule them. In doing so, it aligns with ongoing debates in cultural labour studies that call for recognising the administrative, emotional, and logistical forms of creativity that make artistic practice possible [2, 15]. Subsequently, by acknowledging these hidden layers of the creative ecosystem, digital transformation can move beyond rhetoric and begin to support the infrastructures of care, coordination, and collaboration that sustain live cultural life.

2. THE TYPOLOGY OF CULTURAL INTERMEDIARIES

Gatekeeping platforms such as Passage or evenc.io position themselves as solutions to the perceived inefficiencies of human labour in cultural production. While the development of such technologies offers some agency and flexibility to musicians or venue owners, it also raises questions about what may be lost when human mediation is automated or bypassed. Looking into the typology and functions of the intermediary underlines both their role as value stewards and an infrastructure of collaboration networks on which a human-centric digital transition for CCSI can be built on.

In its early conceptualisation, the cultural intermediary involved an agent who, by using their knowledge and social prestige, establishes value [4]. In media theory, the same role is attributed to the gatekeeper, who decides what is and isn't brought to the public [24]. As cultural labour became increasingly specialised [5] the cultural intermediary relied not only on their high cultural capital, but it became a highly specialised and standardised position in the cultural industries [15,17]. In the current era of technological disruption, intermediaries act as Latourian mediators [2], balancing human actors and technology during the production and consumption of culture.

Throughout the evolution of the concept, certain features remain stable: reliance on personal taste, communication skills, and networks — and the absence of direct artistic production skills. In contemporary discourse, both intermediation and gatekeeping often carry negative connotations, evoking ideas of exclusivity and cultural hegemony. In the CCSI, however, intermediation moves beyond filtering what becomes public or not [24], but comes as the balancing act between producer and consumer [2]. Sidelining the intermediary might evangelise freedom of creation, yet it downplays the necessity for value control [2].

Digitalisation and convergence culture [11] have already further complicated the role of the intermediary [21]. Yet in the less digitalized cultural production and consumption, such as live music, the intermediary remains a key actor. The role of the scheduler in a live music venue curates the venue's taste. By shaping line-ups and bookings, intermediaries not only preserve and expand audiences but also forge the local scene's cultural identity [10].

Should digitalisation in live music venues extend to automation of the scheduling system, the existing infrastructure of quality control, tastemaking and representation risk becoming obsolete. Subsequently, to understand the potential effects of scheduling automation requires more than assessing technological adoption but also tracing the networks of collaboration among intermediaries and how they are disrupted by technological change.

3. METHODOLOGY

The project applies a qualitative approach to capture the ways cultural intermediaries interpret digital tools. A qualitative and interview-focused approach in previous research on cultural intermediaries has proven effective for uncovering the complexities of their labour [1, 23]. To uncover their interpretation of their functions and interaction with digital tools, a qualitative approach allows for a nuanced analysis. Focus groups were chosen as they enable a discussion on the perspectives of an entire team, highlighting the individual and organisational level of interpretation, more effectively than individual interviews [22].
Data were collected through focus group interviews and field observation at the CTL pilot of the EXCENTRIC project. Cultural Trend Lisbon (CTL) is a cultural organisation focusing on live music and performances. In September 2025, they transitioned from their 20-year-old

live music venue Musicbox to their broader cultural centre, Casa Capitão. The latter continues the focus on live music, and expands by including artist residencies, and events on literature and culinary-based art forms. CTL, therefore, comprises a strong case of cultural intermediary labour. It combines a long tradition of intermediation, but also with their current transition, and consequent expansion, allowing us to examine multiple elements of intermediation: adopting and managing new digital tools, fostering community engagement at hand, and arranging the content of their new location – all core functions of intermediaries.

Between June and July 2025, two focus groups were conducted with a total of eight cultural intermediaries, including schedulers, promoters, and venue managers. The first two-hour long session included the two directors of CTL, was held online and covered existing practices and attempts of CTL in digitalisation. The second session was held as a co-creation session [13], comprised by the core team of CTL, with sever participants (including one of the directors from the previous session). The session approximately six hours. It was held on site, in the offices of CTL and focused on the participants' experiences with digital tools, coordination practices, and labour dynamics.

Observational data were gathered during both focus group sessions, focusing on workflows, communication patterns, and human–technology interaction. All sessions were audio-recorded, transcribed, and analysed with thematic analysis [3] to identify recurring issues related to digitalisation and collaboration within live music venues.

4. FINDINGS

The adoption of digital tools the live music sector supports core organisational functions, yet these tools often fail to accommodate the relational, value-driven, and tacit aspects of cultural mediation. Four key themes emerged from the data: the inflexibility of digital tools, the paradoxes of transparency, the preservation of quality, and the centrality of values in the negotiation, experience and adaptation to digitalisation.

4.1 INFLEXIBILITY OF DIGITAL TOOLS

CTL's schedulers and programmers routinely navigate between digital systems in the course of their work. Digital tools for ticketing, artist liaison, event coordination, and internal communication are routinely used, with schedulers constantly negotiating their benefits and limitations. This constant navigation, however, reaches a point of "digital liminality" - a state of being perpetually between platforms, never fully settled in one, due to the absence of a holistic, modular, and flexible platform.

With each new digital adoption there is no shared precedent for its use, requiring a new learning curve. What is often labelled externally as low digital literacy, a commonly cited issue within the CCSI [20], emerges here as a symptom of systemic instability rather than personal inadequacy. The CTL schedulers developed informal support structures by identifying the most digitally proficient colleagues and relying on their guidance.

This perpetual transition fosters subtle hierarchies of competence. The rapid churn of digital systems can erode institutional memory and collective fluency, rather than strengthening them. In this sense, digitalisation appears less as empowerment and more as continuous adaptation work; an invisible labour performed for the upkeep of any digital system. This tension between limited flexibility and constant adaptation is clearly articulated by one of the schedulers:

I almost wish that [Notion] was a bit more like [Wix], you know, like the website? Yeah, like a bit more modular, so you can adapt... I was thinking about our calendar [...] that like I wish we could like personalize or like customize a bit how like the calendar works so it can be like different for each activity, and I feel like if we could customize [Notion] a bit more, it would make our job way easier. Yeah, it gets really confusing sometimes.
(Participant 3, Personal Communication, July 24, 2025)

4.2 PARADOXES OF TRANSPARENCY

The use of digital platforms by the CTL schedulers is intended to support the transparency of their functions and processes. By adding artists' data, documenting booking and scheduling procedures, and inviting the team or collaborators to log on the same platform, they make sure all their practices are clear and visible. Yet, this transparency sometimes comes at a cost. By opening and sharing access to scheduling platforms or shared drives with their partners, intermediaries expose themselves to the risk of data

loss, duplication, or misuse. The friction between transparency and vulnerability is also felt in everyday practice:

[…] because if you want to share data, you have to share also the databases, so that's quite dangerous. Not that we have problems sharing our information, it's something that's part of our values, that we share everything. But someone by mistake can destroy a database. It's not good.
(Participant 6, personal communication, July 24, 2025)

The systems themselves offer limited control over who sees what, and few safeguards exist to protect sensitive communication or contractual information. Ironically, as transparency becomes a legal imperative, it can be undermined by the relevant technologies. Maintaining transparency thus becomes an interpersonal performance rather than a technical function. It relies on constant communication, reminders, and informal negotiation among collaborators. The labour of transparency is therefore relational: it depends on trust, goodwill, and a sense of collective responsibility, rather than on platform design. Far from streamlining collaboration, digital tools often complicate it by scattering information and amplifying anxieties around control and accountability.

4.3 PRESERVATION OF QUALITY

A defining feature of cultural intermediation lies in establishing value [2, 4, 15]. Currently, digital tools are nowhere close to automating this process or fully supporting its complexity. In the process of improving content, and specifically amplifying the diversity of CTL's acts and grassroots cultural expression, schedulers meet technological roadblocks. The understanding of both diversity and community within digital tools relies on quantitative metrics, often disregarding quality, as explained by one of the event schedulers:
We also want to do this step further than what [Key Change] does, because [Key Change] only looks at as a band, and if there's just one person that is not a cis white man, then it's labelled as not cis white men. So, imagine if you just have one person who does back vocals in a group of five men, and there's one person that identifies as woman, then it counts as a diverse act.
(Participant 6, Personal Communication, July 24th, 2025)

While digital tools may assist in tracking performance metrics or audience demographics, they cannot capture the venue's identity, aesthetic sensibility, or political commitments in the same way cultural intermediaries have been doing so far. At least, not yet. The preservation of value, therefore, remains a personal feature, dependent on the taste and values of the live venue and its human workforce.

4.4 VALUES

I think we all believe in the projects that we built, and so that's really important because if the values are not aligned, then what are we doing? Yes, so, and because it is a big responsibility. I think it's important. And we all share the same values with each other and with the company and with what it represents. And I think that's really important.

(Participant 1, Personal Communication, July 24, 2025)

Underlying all work and processes of CTL is the centrality of values, from personal to political. Participants emphasise the need for value alignment within the organisation and with the output of the music venue. These values can be categorised across three interrelated levels: micro (within the team), meso (with partners), and macro (toward the broader community):
At the **micro-level**, values manifest in the organisation's internal culture: mutual support, collective learning, team building and care for colleagues' development. Digital tools play little role in this dynamic.
At the **meso-level**, values guide how CTL interacts with external collaborators. Transparency and sincerity underpin these relationships; the goal is to learn from partners while offering expertise and resources in return. Scheduling software facilitates coordination but does not yet cultivate trust or reciprocity. These remain human achievements, built through dialogue, responsiveness, and shared practice.
At the **macro-level**, CTL's values align with its civic and political commitments: representing the local community, amplifying diverse voices, and maintaining independence from purely commercial imperatives. In this context, digital tools are treated with ambivalence. They are useful for visibility and outreach; however, they do not appear instrumental in embodying the organisation's ethos.

5. DISCUSSION

Participants expressed a desire for technology that aligns with their principles - a system designed not for profit maximisation but for value-

centric collaboration. However, such tools remain absent. Through both literature and the interviews, this study corroborates that the role of the cultural intermediary in live music is beyond the technicalities of planning the acts in a venue. It lies in the curation of the audience's experience, the representation of the local taste and the support of the artists. Digitalisation in the CCSI should consider the empowerement of such positions, instead of their bypassing. By adopting a human-centric perspective in digital transition, and by initiating the latter from a bottom-up perspective, digital tools that empower instead of automating such functions can be developed.

The findings show that digital tools, while central to organisational functioning, remain largely misaligned with the values, practices, and interpretive labour of intermediaries. This tension is not simply a matter of usability but reflects deeper structural dynamics in how technological innovation is designed and governed in the CCSI.

The results speak directly to theoretical debates on cultural intermediation as a form of value construction and mediation between artists and audiences [2, 4, 15]. The observed "digital liminality" - the state of navigating multiple, often incompatible platforms - illustrates how current digital infrastructures fail to reflect or support the specific socio-cultural work of intermediaries. Rather than being displaced by automation, intermediaries remain central actors who stitch together fragmented systems through informal knowledge networks, tacit coordination, and shared values. This echoes scholarship on the enduring role of intermediaries as mediators rather than simple conduits [2] challenging technological narratives that frame automation as neutral or inevitable.

Importantly, the study highlights how digitalisation is not only a technical shift but a reconfiguration of power and agency within cultural production. Platforms designed for transparency and efficiency often overlook the need for situated control, trust, and interpretive judgment as key features of intermediary work. This aligns with critiques of platformisation in the cultural field, where top-down infrastructures frequently fail to capture local practices, values, and cultural logics [16].

5.1 MANAGERIAL IMPLICATIONS AND RECOMMENDATIONS

From a practical standpoint, these insights suggest that digital transformation strategies in the CCSI should be reoriented away from automation logics and toward human-technology complementarity. Digital tools need to be modular, value-sensitive, and co-designed with cultural workers to support, rather than replace, their mediating functions. This includes recognising the intermediary's role in curating audiences, shaping cultural identity, and sustaining networks of trust and collaboration:

1. **Human-centric technologies that recognise the intermediary as an active, creative agent rather than a logistical node.** Scheduling, programming, and coordination are interpretive, value-laden practices that shape artistic output and community engagement. Platforms designed without attention to these mediating functions risk eroding the social infrastructures that make cultural production viable. Technology in this field must therefore be designed to augment human judgement and collaboration, not replace them.
2. **New digital tools for the live music sector should be modular, flexible, and value aligned**. The observed digital liminality, a constant movement between incompatible systems, demonstrates the limitations of one-size-fits-all software. A more sustainable approach would allow venues and intermediaries to adapt tools to their operational logics, rather than adapting their work to the tool. Such modularity would also reduce the cognitive and temporal costs of continual learning and re-training, promoting a more stable and inclusive form of digital literacy.
3. **Design processes must embed cultural workers in the technological development cycle**. Co-creation between technologists and intermediaries should replace the current top-down model of technology transfer. Involving schedulers, programmers, and producers in the early stages of tool design would not only ensure usability but also integrate sector-specific values such as transparency, reciprocity, and diversity. Participatory design approaches, such as iterative prototyping, collaborative testing, and feedback loops, can help prevent the disjunction between technical affordances and real-world practices documented in this study.

4. **Data governance frameworks must be re-examined**. As intermediaries attempt to practice transparency by sharing digital platforms with partners, they expose themselves to new risks of data loss and mismanagement. Technological systems need built-in mechanisms for differentiated access, data stewardship, and collective accountability. Transparency must be supported technically as well as ethically, allowing collaborators to share information without jeopardising privacy, contractual integrity, or institutional trust.
5. **Broadening of the understanding of innovation in the CCSI.** Too often, innovation is equated with automation or the direct monetisation of creative output. However, this study shows that genuine innovation may instead lie in strengthening the human infrastructures that underpin artistic and organisational resilience. Supporting research and development that addresses the needs of intermediaries—those who connect artists, audiences, and institutions—can create a more equitable and sustainable digital transition for the sector as a whole.

6. CONCLUSION

The role of cultural intermediaries has received contestation, especially when looked through the lens of gatekeeping. What is often downplayed, however, is their crucial role as mediators between production and consumption of culture [15]. Cultural mediators should be less looked at as obstacles in the creation of art, but more as the latter's infrastructure for evaluation and dissemination. Cultural intermediaries, through the extensive networks they create, can enhance and support the cultural identity of a local scene. To imagine technological futures that bypass these actors would overlook the infrastructures through which cultural meaning and legitimacy are continually negotiated.

The case of CTL uncovers how cultural intermediaries, like schedulers, manoeuvre their way around digital tools to complete their work, instead of technology facilitating it. Even in the face of the obstacles of this digital liminality, they create human and non-human infrastructures of support, by adopting and replacing tools as needed and by relying on each other for support.

The task of digitalisation in CCSI, therefore, is not one of displacing of the intermediaries but of support, to sustain and amplify the relational capacities of intermediaries within evolving technological environments.

Digital transformation within live music and the wider CCSI requires a shift towards human-centricity, where the workforce of the CCSI is put at the centre of technological development. By acknowledging the labour networks between intermediaries in CCSI and by attempting to facilitate rather than override them, a human-centric digital transition can be achieved.

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Intergenerational Shifts in Interactive Approaches to Film Art Consumption: Generation Z's Preferences and Tastes in the Creation, Distribution and Exhibition of Films

Jacek Mikucki, Alicja Waszkiewicz-Raviv

Faculty of Journalism, Information and Book Studies, University of Warsaw, Poland,
j.mikucki@uw.edu.pl
alicja.waszkiewicz@uw.edu.pl

ABSTRACT: Audiovisual culture is rapidly transforming, revealing clear generational shifts in how film is received, produced, and distributed. Generation Z, raised in a digital world of instant, personalised content, is actively reshaping the traditional relationship between media creators and audiences. This paper explores Generation Z's interactive film consumption, highlighting their aesthetic and narrative preferences and their participatory roles in film creation and distribution. This study draws on qualitative research conducted in 2024/25 with 58 Generation Z participants (aged 13–25) in Poland, organised into focus groups of 6–9 participants. Discussions included streaming platforms, social media, interactive formats, non-linear narratives, and co-created productions. The qualitative findings reveal both the production side and the evolving skills and tools young audiences use to consume audiovisual content. The paper identifies core generational changes in how traditional cinema and new models (like VOD and short-form video) are received. It also examines how young audiences view their subjectivity as media creators and characters in current EU cinema. The research is part of the Horizon Europe REBOOT project (2023–2026), which aims to generate new insights into the European film industry's needs and trends.

1. INTRODUCTION

Intergenerational shifts are transforming interactive film consumption; as younger viewers move from traditional cinema to interactive formats. This change reveals new drivers of engagement, shaped by technology, audience choice, and storytelling structure [1]. Generation Z—raised in a digital era—redefines film by favouring personalised, interactive experiences. This paper examines Gen Z's preferences, narrative expectations, and participatory roles in film creation and distribution [2].

Generation Z (Gen Z), generally defined as those born between 1995 and the early 2010s, is shaping the film industry through its distinctive preferences in film creation, distribution, and exhibition [3][4]. Their tastes are fundamentally influenced by their digital upbringing, sustainability consciousness, and unique engagement with media, demanding that film industries adapt to their preferences [5]. The longitudinal studies show a shift from minors as mere consumers or "prosumers" to active, collaborative content creators [6]. This change is the result of boosting digital culture and social media communication formats, including video.

2. FROM TRADITIONAL CINEMA TO STREAMING SERVICES

The late 20th-century political transformation in Central and Eastern Europe profoundly affected political, economic, and cultural spheres, including the film industry [7][8]. The intergenerational shifts in film consumption reflect broader cultural trends in media aesthetics and preferences. Younger audiences show a pronounced preference for digital streaming services over traditional cinema, resulting in a preference for on-demand content that allows them to dictate their viewing environments and schedules [1]. This generational inclination has reshaped industry strategies, leading to increased focus on content that resonates with the cultural and ethical values of younger demographics, such as sustainability and representation [9].

Simultaneously, older generations who grew up with traditional cinematic narratives and formats offer a contrasting viewpoint, often appreciating cinema's immersive qualities and communal experience [10]. Studies indicate that this generational gap in interactive engagement highlights essential differences in motivations and expectations from film experiences [10] [11]. For older audiences, traditional cinema retains its allure as a space for social connection and cultural reflection, while younger audiences increasingly lean toward interactive formats that cater to their desire for personalised content experiences.

Generation Z and younger millennials are increasingly inclined toward interactive media formats, which invite viewers to become active participants rather than passive consumers. The emergence of interactive films characterised by viewer agency—such as the Netflix production "Bandersnatch"—allows audiences to make choices that guide narrative directions [9]. These interactive experiences provide a sense of control and personal investment in the storyline, leading to deeper emotional engagement [12]. As audience expectations evolve, they increasingly seek media that respects their desire for agency in shaping the storyline, contrasting with previous generations, who predominantly consumed content in a more passive capacity [13].

Current discussions highlight how cinema-going has evolved into a socially interactive experience: audiences not only watch films but also share opinions and reactions, and create community discussions on digital platforms, enhancing their viewing experiences [10]. Film exhibitions now often involve strategies to foster audience engagement through participatory events such as Q&A sessions, interactive panels, and themed screenings, which encourage communal interaction and discourse—emphasising the social nature of film consumption [14].

3. GENERATION Z IN THE CONTEMPORARY FILM CHAIN

Gen Z favours film narratives and content that mirror their values, especially social equity and environmental sustainability. They are drawn to content that not only entertains but also demonstrates social responsibility, particularly if it resonates with their identities and supports diverse voices [15]. Gen Z's notable appreciation for transmedia storytelling is evident in their frequent engagement with narratives across various media platforms [16]. This aligns with their multi-platform habits, as reflected in their social media use. Gen Z values authentic representation and often considers ethical consumption when evaluating films, and their strong social awareness increases their support for filmmakers who address these issues. It projects that emphasise sustainability and ethical practices earn Gen Z advocacy and support [15]. In response, filmmakers seeking Gen Z's engagement should craft content that entertains and aligns with social justice and environmental goals, creating a stronger audience connection [17].

When examining film distribution, Gen Z's preferences lean heavily towards digital platforms. The COVID-19 pandemic accelerated this trend, making streaming services such as Netflix, Hulu, and Disney+ the top choices for film consumption, as attendance at traditional theatres declined [10]. Innovative distribution models that leverage influencer marketing and social media promotion resonate strongly with Gen Z, who are accustomed to curating their experiences through platforms like TikTok and Instagram [18]. These platforms are not just promotional tools but also serve as forums for film reviews and peer discussions, further influencing Gen Z's viewing habits.

Additionally, Gen Z's preference for on-demand content has prompted film distributors to adopt flexible release strategies, such as simultaneous theatre and streaming premieres. This caters to Gen Z's desire for immediate access and flexibility in viewing environment, boosting engagement and viewership [19]. Moreover, their active sharing of trailers and reviews on social media significantly increases a film's visibility.

In terms of exhibition, Gen Z shows a preference for experiences that go beyond traditional cinema attendance. They are drawn to events featuring immersive elements such as augmented and virtual reality, as well as interactive screenings that engage audiences on a sensory level [20]. This shift has led to innovations such as themed movie nights and social gatherings that blend film culture with community engagement [21]. Additionally, Gen Z values transparency from exhibition venues about their sustainability efforts and community involvement, as these factors increasingly influence their choices about which films to support [22]. Considering the social and political climates impacting Gen Z preferences, filmmakers, distributors, and exhibitors must respond swiftly. The intersection of culture, commerce, and social responsibility is crucial, and media entities in the film industry should strive to align with Gen Z

values through authenticity, accessibility, and engagement that address global issues and individual identities often overlooked in traditional film narratives.

4. METHODOLOGY

The research is based on a qualitative study conducted in 2024/25 among representatives of Generation Z in Poland. Poland is currently responsible for approximately 3.4% of the revenues of the audio-visual production sector in the EU [23]. Poland is a part of the European Union's Creative Europe program, which provides funding for cross-sectoral. The Polish market is attractive to international streamers. In 2022, Poland emerged as Netflix's Central and Eastern European hub. In 2022, Netflix invested €87 million (PLN 400 million) in Polish films and series. The investment of capital by foreign streaming services in the Polish audio-visual business has markedly enhanced its worldwide competitiveness.

A total of 58 children and young people aged 13-25 participated in the focus groups. The study was conducted in fall 2024 and spring 2025 in the capital city of Warsaw (Poland), with children and young adults living mainly in urban areas. The study aims to identify existing and emerging patterns of film consumption among Generation Z, with direct insight into the creation, distribution, and exposure of audiovisual products. During the focus group discussions, case studies of streaming platforms, social media, and interactive formats, such as videos with non-linear narratives or productions co-created by the online community, were discussed. This text presents a meta-analysis of qualitative data from the focus study to capture the main correlations and practices across the three areas: film creation, distribution, and production.

5. GENERATION Z APPROACH TO FILMS - RESULTS

Regarding film preferences and tastes, participants aged 13 to 25 expressed a wide range of interests. Popular genres include horror, thrillers, action, older comedies, science fiction, dramas, and animated films. Many participants mostly value movies that evoke strong emotions, offer unpredictable plot twists, feature well-developed and multidimensional characters, and include intelligent references. They want to be moved and feel arousal. Engaging music and fascinating visual aesthetics—such as cinematography and set design—are also highly appreciated. Conversely, participants dislike predictable plots, artificial dialogue, and overly simplistic or stereotypical characters, especially when they represent their generation. This shows a strong preference for authenticity and realism, especially in films tackling social issues and identity dilemmas.

According to respondents, key qualities of a good film include a compelling, unpredictable plot with twists, authentic dialogue, strong acting, engaging music, striking cinematography, and the ability to evoke emotion and provoke thought. Some favour visually stunning, immersive experiences, while others prioritise films that realistically address significant social issues.

CREATION

Many have created short-form videos for social media or school, with some experimenting out of curiosity in video editing and production: “I tried to create some, but more like YouTube videos. I just wanted to try a little editing—to see how it looks, and so on. I was just curious about it all.” (FOC3;16-17)

Several expressed interest in directing or cinematography, underscoring creativity, vision, organisation, and teamwork. They stressed that making a good film depends on multiple factors—script, set design, casting, and music: “A good film actually consists of many factors, including a good script, set design, and well-chosen actors. Not only do the actors themselves have to be good, but they also have to be well-chosen for the role. Good music and so on.” (FOC7;20-22)

Some participants of the research emphasised the importance of technical skills—editing and camera operation—and acknowledged the potential of modern technology, including smartphone cameras, for serious filmmaking. Opinions varied on what makes a film engaging. As one respondent shared: “For me, the plot is not the most important thing. If a film has a weak plot but features great dialogue or scenography, or if the characters share compelling chemistry, I can forgive a simple storyline.” (FOC6;19-25)

There was recognition of the need for financial resources and professional equipment for higher-quality productions. However, some felt resourcefulness can overcome these limitations: “Honestly, you don't have to [have a budget]. You can always find sponsors or ask someone for equipment. When we make films with my

group, the budget is usually zero—someone always arranges something or lends equipment, so there isn't always a budget." (FOC8;22-25)

DISTRIBUTION

Streaming platforms are the main way people watch films, with Netflix, Disney+, and Prime Video frequently mentioned. If something interesting is showing in the cinema, some will go, but it's more common for people to use streaming services (FOC3;16-17).

Many students use these platforms daily, often on personal devices such as phones, tablets, or computers. Some also watch films via unofficial sources like CDA. As one student noted: "I mainly use Netflix, but I don't find many interesting films there, so I would say I mostly use the broadly understood Internet." (FOC3;16-17)

The convenience and cost-effectiveness of streaming are essential factors, with some preferring to wait for films to come to streaming rather than pay high cinema ticket prices. Social media platforms like TikTok and Instagram are also significant sources for film recommendations and discovering new content. Young audiences have low attachment to streaming brands and use them operationally, without emotional commitment to the providers. The only change is the Disney+ VOD.

EXHIBITION

Regarding distribution and exhibition, streaming platforms such as Netflix, Disney+, and Prime Video remain the most common ways to watch films, usually on personal devices like phones, tablets, or TVs. Some people prefer watching alone, while others enjoy viewing with friends or family and discussing the film during or after the screening. Cinemas—especially arthouse venues—are appreciated for their unique atmosphere, lower ticket prices (e.g., 10-15 PLN or 4-5 euros in specific locations), and distinctive viewing experience. In contrast, chain cinemas are often criticised for their high ticket prices (30-40 PLN or 10 euros). Several students favour arthouse cinemas, with one saying, "I believe arthouse cinemas also showcase films not necessarily created solely for commercial reasons, but for the cinematic experience itself. That's where we find these unique productions". (FOC7;20-22)

The "Barbenheimer" phenomenon—the simultaneous release of "Barbie" and "Oppenheimer"—was cited as a successful promotional event that encouraged cinema attendance. Some students observed that films are now often available on streaming platforms soon after their theatrical debut, impacting cinema attendance trends.

Many people prefer watching movies at home on personal devices, reserving cinema outings for special occasions as one of the students highlighted that he/she watches: "More at home, on our own devices, to the cinema only on special occasions. Or simply with the family, we go to the cinema to watch some cartoons. At least for me. (FOC3;16-17)

Outdoor cinemas are also a popular seasonal option. A few years ago, I discovered how fantastic summer open-air cinemas can be, and I spent most of my time at the Palace of Culture. Gathering with friends for outdoor movie nights provided a completely different film experience, enhanced by the summer atmosphere (FOC6; 19-15). Film festivals are valued for their diverse, often non-mainstream selections, as well as the chance to engage in discussions with filmmakers.

6. CONCLUSIONS

The paper presents key generational approaches in the reception of traditional cinema forms and new distribution models (VOD, short-form video platforms). The article examines how the role of film as an artistic medium is transforming in the era of digital interactivity and how Generation Z expectations might be shaping the future of cinema. In the times when in-depth target group analysis is standard to produce expensive media formats the understanding of the young audience plays important part of the media landscape description. However, this paper brings local perspective, being a part of broader EU research project, this study provides regional results for understanding young film audience. In terms of film creation shows their ability to distinguish different technologies and professional scope of the moviemaking. They are interested in technology and recognise the need for specific skills, both economic (media market-related) and psychological (management skills). In terms of film distribution, they are economically driven, choosing streaming due to low costs and fast accessibility. When taking under consideration exhibition, young people do recognize not only multiplex but also arthouse cinemas and film festivals or open-air screenings as important phenomena, especially for group viewing.

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Protocols of Appearance: Remaking the Platformized Partition of the Sensible

Rodolfo Augusto Melo Ward de Oliveira[a], Suzete Venturelli[b]

[a]Arts Institute, University of Brasilia, Brazil, rodolfoward@unb.br
[b]Arts Institute, Anhembi Morumbi University, Brazil, suzeteventurelli@gmail.com

ABSTRACT: Digital art's political–aesthetic horizon is shaped less by images than by platform protocols—the corporate layer of feeds, ranking, recommendation, moderation and advertising that decides what can appear, to whom, and on what terms. We extend Rancière's "distribution of the sensible" to the platform environment and read it with Byung-Chul Han's analyses of swarm, transparency and psychopolitics, proposing a platformized partition of the sensible. From this reframing come three instruments: Relational Algorithmic Curatorship (public, explainable, community-governed ranking), Protocol-Sensitive Archives (metadata and access rules encoding place, ritual context, authority and revocation), and Interface Cards (plain-language disclosures about personalization and how to disable it). A brief vignette (Queermuseu, Porto Alegre, 2017) stress-tests where platform mediation collides with curatorial intention and community protocols. We also map GDPR/DSA duties to design artifacts (logs, toggles, revocation flows) and propose an evaluation matrix for GLAM—an actionable vocabulary to audit, negotiate and remake platform mediation.

1. INTRODUCTION

Platforms do not merely host cultural works; they script the conditions of appearance through feeds, ranking, recommendation, moderation, and advertising. We treat this corporate layer as a political–aesthetic regime that decides what is perceivable and in which order. Our move is explicit: Rancière's distribution of the sensible was not written for digital infrastructures; we extend it to the platform layer where metrics and policies now legislate visibility [1,3,4,5]. We call this the platformized partition of the sensible.

Byung-Chul Han helps qualify how this regime is lived: swarm dynamics displace durable publics, transparency becomes a norm of exposure, and psychopolitics channels self-optimization into compliance [2]. Read together, Rancière names what is distributed (the sensible) while Han clarifies how distribution is operationalized and felt under platform conditions. This pairing also situates platforms within corporate governance: privately set rules and metrics act as de facto protocols of mediation that structure what can be seen, said, and heard—often outside institutional curatorial intent [3–5].

From this lens we derive three operational instruments for practice. Relational Algorithmic Curatorship treats ranking and recommendation as public, explainable, community-governed operations (modes such as Curatorial Sequence, Time-Ordered, Personalized, with layered "Why am I seeing this?" and public audit logs) [4,5,7,10]. Protocol-Sensitive Archives encode place, ritual context, authority, consent trails, TK Labels, derivative rights, and revocation into executable metadata so that interface behavior respects protocols (CARE alongside FAIR) [8,9,11]. Interface Cards translate technical documentation into audience-facing commitments: scope, signals, defaults, risks, accessibility, governance, change log [7,10].

Methodologically, we use a compact, documented vignette—Queermuseu (Porto Alegre, 2017)—to stress-test edge conditions where platform mediation collides with curatorial intention and community protocols [12]. We then map GDPR/DSA duties to concrete design artifacts (logs, toggles, revocation flows) and propose an evaluation matrix (contextual integrity, non-erasure, auditability, co-governance, accessibility-by-default). The contribution is twofold: (1) a theoretical innovation—platformized

partition of the sensible—that reframes visibility as corporate protocol rather than neutral infrastructure; and (2) a practical toolkit for GLAM to audit, negotiate, and remake platform mediation. The Queermuseu brigading episode shows how a 'low complaint rate' is a corruptible proxy, motivating public logs and user-selectable modes.

2. MAIN ASPECTS

2.1 RELATIONAL ALGORITHMIC CURATORSHIP

Treat ranking and recommendation as public, explainable, community-governed operations rather than proprietary optimizations. Provide three modes—Curatorial Sequence (as authored), Time-Ordered, and Personalized—so that curators, artists, and audiences can choose how works appear. Couple modes with layered explainability ("Why am I seeing this?" tooltips → a concise Interface Card) and keep human-readable audit logs of rule changes. This shifts visibility from opaque engagement proxies to contestable policy choices, aligning institutional intent with platform mechanics [4,5,7,10]. For traceability, we log changes in a human-readable register (e.g., 2026-05-12 — Adjusted Time-Ordered weight 0.3→0.5; decision by Curatorial Committee; rationale: improve exhibit chronology fidelity).

2.2 PROTOCOL-SENSITIVE ARCHIVES

Encode place, ritual context, authority, consent trails, TK Labels, derivative rights, sensitivity flags as executable metadata that drive interface behavior (warnings, opt-ins, restricted playback, blocked recombinations). Pair CARE (collective benefit, authority to control, responsibility, ethics) with FAIR to ensure that openness does not flatten protocols. Implement revocation with propagation so withdrawals update derivatives and embeds. This makes ethics operational rather than merely declarative [8,9,11]. Revocation events propagate via a work–derivative graph: embeds receive signed takedown intents and update playback states network-wide so openness does not flatten protocols.

2.3 INTERFACE CARDS

Translate technical documentation into audience-facing commitments: purpose & scope; signals used for ordering; defaults & controls (including a toggle to disable personalization); known limits & risks; accessibility provisions; governance and change log. Cards render personalization intelligible and optional, turning transparency from abstract principle into a usable control [7,10].

Proxy	Risk
Dwell time	Sensational pacing; penalizes slow reading
Vector similarity	Homophily; filter bubbles
Low complaint rate	Brigading distorts signals

Table 1: Metric realism and risks (illustrative).

We evaluate along five axes: contextual integrity, non-erasure, auditability, co-governance, and accessibility-by-default.

3. CONCLUSION

Treat the pipeline as curatorial practice; adopt care with fair and make it executable; design for refusal and reversibility; and institutionalize multi-stakeholder review. Map gdpr/dsa to design: erasure/objection → revocation flows with propagation; transparency → public audit logs and "why am i seeing this?"; systemic risk → contextual-integrity and montage-fidelity metrics plus a curatorial discovery slot [3,7,9,10,11].

4. ACKNOWLEDGMENT

We thank our institutional partners Conexão Cultura (SECEC), University of Brasilia (UnB) and collaborators for comments on earlier drafts.

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SESSION II

“Reflecting on Digital Tools”

Moderation: Prof. Dr. Andreas Bienert
(form. Staatliche Museen zu Berlin)

A Presentation of the Irregular Archives Project

Christos Panagiotou

Department of Fine Arts, Cyprus University of Technology, Cyprus
xristos.panagiotou@protonmail.ch

ABSTRACT: Drawing from Iain Chambers' concept of "Ruined Archives" and Tim Ingold's analogy of the palimpsest as a point of encounter between the past and the present, the digital installation Irregular Archives seeks to create a map of "memories without origin" for the city of Limassol, Cyprus. Archival texts from different centuries are entered randomly into a python program that contingently combines them together, weaving hybrid stories. Free from the constraints of archival substantiation and temporal and spatial specificity, these stories exist as palimpsest-like hybrid forms of human action occurring in the city across time. Memory is freed from the need for an origin. It is no longer a servant of space and time, and events are not set in the foreground of these dimensions. The rigid historiographical spatiotemporal grid of events collapses, and a fluid, potential mnemonic space replaces it. Memories cross this space like waves and ripples, forming confluences and formations that are the stories we see occurring in the project.

1. INTRODUCTION

Irregular Archives is a digital installation born at the intersection of informatics, museology, archival studies, literature, and art. It was exhibited in June 2025 at the d͡zama'ria artist-run space in Limassol, Cyprus, and in October 2025 at the +Ergeio Performing Arts Center in Limassol. The project aimed to explore alternative ways of narrating the memory of a place.

The project's critical undertone is to address the tendency inherent in Modernity to impose rigid narrative structures on memory, creating uniform and impoverished views of a place's past. This tendency is evident, for example, in folkloric narrations about the past, in the "invented tradition" [Hobsbawm & Ranger, 1983] and in nationalist narratives about the past of nation-states.

The project, also denounces the classification strategies associated with Modern museology, and sometimes mainstream political discourse, that assign artifacts and past events to historical eras, genres, or other categories. As suggested, this approach fails to capture the dynamic character of the past, reducing it to an inert exhibit for the hegemonic gaze of the Modern citizen [Bennet, 1995]. Historical museums and folk museums are the prime examples of this approach.

The Irregular Archives project attempts to restore the dynamic elements of Limassol's past by capturing the ripples within memory, that exist in the interstitial spaces between events, cultures, and moments in time. This is attempted by contingently combining archival material together, liberating it from conceptual and chronological categories and constraints. This approach yields stories that appear "arbitrary" and random, or even surreal, as they are striped from any historical or thematic context. Some of them are also humorous.

Specifically, the project draws on an archive of texts written by travelers to the city of Limassol, from the 16th to 19th centuries. Other materials are also used, such as inscriptions on tombstones and buildings from the medieval and ottoman periods (16^{th}-19^{th} centuries). This archival material is loaded into a text analysis software created with Python programing language. A second variation of the program was also created in Processing 4 programing language that specializes in artistic visualizations of the findings.
The program calculated the centrality values between the words in the texts.
A meteorological station provided live weather data to the program, which altered the centrality values of the words-nodes in real time, resulting in a change in the overall structure of the word network.

Figure 1: *Tombstones of the Mamluk marines with text, died off the coast of Limassol in 1758 buried at the Cami-Kebir cemetery at the city center.*

The program then reassembled the words according to their new structure generating disorganized text outputs that were later manually reformatted into coherent texts. This process created hybrid memory formations based on the dynamic interaction between the words in a text and the weather.

The work is inspired by Iain Chambers concept of "ruined archives" and by Tim Ingold's interpretation of the palimpsest as a premodern paradigm for understanding time [Ingold, 2023], memory, and the contingent effects of weather and climatology on cultures, as described by Horden and Purcell [2000].

It should be said that the project does not claim any scientific legitimacy in its results or its methodology, but it aims to stimulate discussions on themes such as historiography, cultural memory and the narration of the past. The work, also, aims to initiate conversations about alternative ways of studying and interpreting the past of a place. To inspire ways of narration that are free from the constraints of Modern historiography. One way to achieve this is to disconnect events and stories from their chronological context and base our description about them on how they work as traces of human encounters across space and time. In that sense, history and memory of the past are not to be viewed against the backdrop of a universal, independent variable of time, but rather as processes resulting from human interaction.

Therefore, the scientific significance of Irregular Archives lies not in its implementation or results, but in its acknowledgement that cultures, memories, and historical periods intersect to form hybrid phenomena that are often overlooked when confined to narrow chronological or historiographical categories.

The project is part of the postdoctoral study titled: "Encountering the Other from Beyond: A study of Intercultural Dynamics in Ottoman Cyprus through tombstone narratives (16^{th}-19^{th} centuries)" ("IDOC") conducted at the department of Fine Arts, Cyprus University of Technology.

2. CRITICIZING MODERN DISCOURSE ABOUT THE PAST

As stated in the introduction, Irregular Archives is an interdisciplinary digital art project that attempts to subvert the rigid discursive structures through which we create narratives about the past in Modernity. Conceptually, it targets the notions of "tradition", "folklore", and "nationalism" as well as the epistemological framework of Modern historiography and museology. As suggested these narrative structures about the past all share a restrictive interpretation of it which traps historical and cultural references in narrow categories or identities, or treat the past as an "inert" fossil to be viewed treating it as a temporal "Other".

The interest in this project was sparked by the cultural and political situation in Cyprus. Cyprus, is a conflictual society in which nationalism is fostered and propagated by the dominant public discourse. Cyprus's nationalism, which is Greek-centered in the southern part of the island, in which Limassol is located, has led to the elimination of many hybrid cultural and historical narratives that include a cultural Other.

For example, little is known in the public or official historical discourse about the cultural and religious practices of the Dervishes in the old port of Limassol, which were centered around the Tekke of Piri Ali Dede, the dervish patron saint of the marines. Until the 19^{th} century, sailors arriving and leaving the city by sea prayed

for calm waters there, often participating in rituals [Floridou, 2021]. These cultural traces of the non-Hellenic Other in the city, which included cultures from various parts the Mediterranean, often are been erased or at least left to their fate, especially if they involve the Muslim or the Ottoman cultural elements. This monolithic approach to cultural history is fueled not only by the pervasive nationalism in the island, but also the way in which Modernity, in general, demands for essentialist linear conceptions of the cultural past, which often designate as an alterity whatever cultural activity does not fit into the linearity of the historical and cultural discourse it promotes.

Museums and Modern museology are also closely linked with the aboventioned sterile and restrictive view of the past. Museums, for instance, are institutions developed within the context of the Enlightenment project [Aronsson, 2014]. The Enlightenment view of the past promoted a categorical way of thinking that fit the past into subsets of conceptual and historical knowledge, which were examined against the basis of definite cultural, social or even natural contexts. This results, again, in a monolithic interpretation of the past, sterile from the dynamic aspect of cultural interaction and human contact across time and space. For example, Modern museology often examines a cultural object from the past within the scope of a specific culture, dismissing all the multiple conditions across time and space that are involved into the creation of it.

Figure 2: *A photograph of the modern Limassol city facing the Mediterranean Sea.*

Moreover, as Eric Hobsbawm and Terence Ranger state in their book *The Invention of Tradition* [1983], the concepts of tradition and folklore are characterized by similar processes. "Tradition" is a cultural concept that views the past as a static entity, representing a presumed primordial cultural origin of a nation-state vis-à-vis its modern cultural identity. In the context of these essentialist cultural claims, the cultural past becomes generalized, trivialized and devoid of human experience as it becomes an inert image that serves to affirm the modernization of a nation-state in a self-reflective manner.

Therefore, even though the inquiry may have been sparked by the situation in Cyprus, it does not concern Cyprus alone, but more broadly the way in which cultural history is narrated in Modernity. It tries to break down the cultural, chronological, or geographical scaffolds that form the aforementioned accounts for the past, liberating it from these constraints.

3. THE THEORETICAL FRAMEWORK OF IRREGULAR ARCHIVES

Irregular Archives attempts to challenge the established narrative modes about the past and open up new paradigms for reformulating the past in the form of narratives. This is aimed at reclaiming the dynamic human aspect of the past, freeing it from the constraints of rigid discursive structures that we have seen in chapter 1.

Irregular Archives is a digital installation that seeks to construct a "disorganized map of the collective memory of Limassol" [Panagiotou, 2025]. This is attempted by amalgamating stories written on 18th century tombstones from Mamluk marines who drowned in the sea just outside the city and were buried in the graveyard of Cami-Kebir Mosque, with stories of European travelers who visited the city during the 16th to 19th centuries and that recorded their experiences in their travel diaries. A total of 30 different texts, from different people, different centuries but all about the same area, are fed into a program designed in Python programing language, which combined them.

There combination was influenced by live weather data received from a meteorological station installed on the outskirts of the city.

The idea is that each change in the weather results in different combinations of words between the texts thereby producing texts that are contingent in character. The resulting texts are then extracted and exhibited as hybrid narratives which, even though they lack any historical basis, they nonetheless belong to a potential - memory - space. The resulting assemblage of hybrid stories resemble "maps of memories without origin" [Panagiotou, 2025].

Figure 3: *A weather station installed on the outskirts of the city provided data to the python program.*

As stated in the project's exhibition report and also in the project's website [Panagiotou, 2025], the basic concept of the project is that:

"the narrative about the collective memory and history of a place must be told through the intermediate space that arises between one historical period and another, at the meeting point of two or more cultures, the space where one region "spills over" into another and where the micro-level of everyday life organically co-exists as a living and dynamic part of the macrolevel of history and vice versa. With the Irregular Archives project we aim to capture this dynamic element of memory".

Figure 4: *An example of the resulting "hybrid" stories of the Irregular Archives project.*

The stories are in the process of being published in a booklet and are also found in the author's website. An indicative story is seen in the image above. Even though the analysis of the texts were done in English, the exhibited pieces were translated in Greek and adorned with graphic design elements as seen in the picture above. The text above translated in English is as follows:

"May seven poets weep as they write these unfortunate verses. Beaten salt and burnt wine for Sigmund Justin, the only son of his mother and father. He shone like a Leipzig night when he learned how to hang water in squares with the rope at the eleventh hour of that June night. He stayed and left, making empty movements as he walked through the courtyards and the gardens with the fig trees carrying buckets. When the fishponds flooded, causing the cotton streams to collapse, he buried himself in the middle of the plain facing north. He paid three ducats" [Panagiotou, 2025].

The aforementioned surreal and, in a strange way, comical story is the result of mixing the texts entered into the program. In the resulting story, one can discern the original story about a German archaeologist that died and buried in Limassol in 1876, as mentioned in Xenophon Farmakidis' (1942) book, History of Limassol and a 16th century story by Oldřich Prefát a visitor to the city in 1546, who mentioned the strange square wells and fig trees scattered throughout the city.

4. CREATING IRREGULAR ARCHIVES

The process is as follows: First we have collected the different stories and created a small archive of 30 stories, that as mentioned above belong to different people and different eras, but they refer to the same place that is the city of Limassol on the southern part of the island of Cyprus. The texts were taken from primary and secondary sources. These texts, were then fed into the python program that represented them as a network graph revealing the interconnection patterns of all the words from all the texts and how they relate to each other. It is important to emphasize that all of the words from all of the texts that were entered into the program, were part of this network graph. The program interprets the words as nodes in the text.

The association between the words was based on the appearance of one word alongside four subsequent words referring to the first, which together formed a network of five associated words. The resulting network map shows how a

word or concept is connected to other words or concepts between and within the texts.
The program also involved analyzing centrality metrics (Betweenness, Closeness, Degree and Eigenvector Centrality values). The aim was to reveal how words from different texts were interconnected and formed relationships and hybrid structures between resulting in potentially common narrative formations.

Weather data, received from a weather station installed north of the city, influenced the centrality values of the text. The words were then rearranged in a textual form based on their new centrality values that were influenced by the weather.

The result was, of course, a collection of decoherent texts generated under different weather conditions on different days. These texts were then manually retouched to create the stories exhibited.

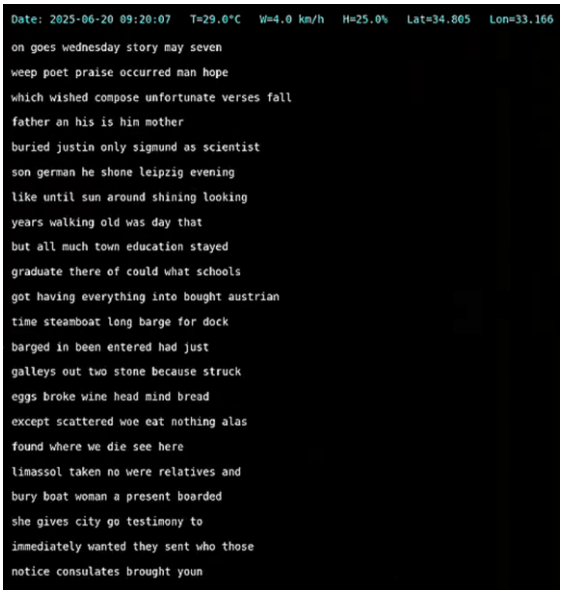

Figure 5: *A text generated by the weather in Python.*

The concept of Irregular Archives digital artwork is loosely inspired by the medieval method of writing on palimpsests. On a palimpsest, multiple layers of text written by different people at different times coexist on the same surface, creating hybrid textual forms that connect humans, their memories, and their experiences across time.

The work is also strongly influenced by Iain Chambers's concept of the "damaged archives" [Chambers & Grechi, 2014], which emphasizes the fluidity of history and rejects the constraints of Modern historiographical categories as hegemonic and restrictive interpretations of the past.

The project is also inspired by the concept of micro-ecologies in the Mediterranean, as described by Peregrine Horden and Nicholas Purcell [2000]. This concept describes how the intense climatic variations in the Mediterranean region create local scarcities of goods, thereby favoring interconnection among people and cultures across these regions. For example, the diverse climatic zones of the Mediterranean, varying between hot deserts, mild coastal areas and cold mountainous areas, have contributed to cultural encounters, sometimes peacefully through trade and some other times through war, but always forming hybrid, dynamic and "irregular" cultural phenomena that defy any closed and static categorization. This idea of cultural interconnection, being influenced by the climatic variations is what led to the incorporation of weather as a contingency factor in the Irregular Archives project.

Figure 6: *The project as exhibited in a parking lot at the +axi art festival organized by +Ergeio Performing Arts Center at Limassol, Cyprus under the name "Mnemonic Chronotopes" in October 2025.*

5. CONCLUSION

The project demonstrates how the history of a place can be narrated through alternative methods outside of the narrow discursive structures imposed by Modernity. In this way, the past is reassembled as a mythology of memory, vibrating across time to reveal traces of human encounters occurred in a place without imposing a discursive point of view that leads to hierarchical divisions and essentialist generalizations.

Of course, as mentioned earlier, this project does not claim any scientific legitimacy in its results or its methodology. Instead, it aims to

raise questions about the ways we narrate the past in Modernity through an artistic approach.

6. ACKNOWLEDGMENTS

The project was funded by the Postdoctoral program "ΜΕΤΑΔΙΔΑΚΤΩΡ" of the Cyprus University of Technology.

The project also partly includes work conducted as part of the author's previous research at the Lab for Animation Research of the Cyprus University of Technology, which involved the transformation of weather data into visual forms and animation for the Visual Weather project (2022/23): https://animationresearch.art/visual-weather-visual-microclimate/

The project was exhibited in June 2025 at the d͡zama'ria artist-run space in Limassol, Cyprus and at the time of writing this article, it is exhibited at the +axi art festival organized by +Ergeio Performing Arts Center at Limassol, Cyprus under the name "Mnemonic Chronotopes.

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Transmedia Storytelling and the Voices of Underrepresented Communities: The Case of Latgale

Tatjana Menise, Anna Pečerska

Department of Digital Humanities, Riga Technical University, Latvia,
tatjana.menise@rtu.lv , anna.pecerska@edu.rtu.lv

ABSTRACT: Transmedia research beyond the realms of fiction and commercial marketing offers an underexplored area for new theoretical insights and practical experimentation. This project develops a model of Latgalian places, using GIS-based methods to explore snowballing transmedia storytelling about Latgalian identities and senses of belonging. The Latgalian region of Latvia has a distinct culture and a collateral language (closely related to Latvian) spoken by approximately 165,000 people, as well as a complex and often traumatic history. The volume of contemporary Latgalian discourses is strikingly small, leaving it highly vulnerable in the era of big data. To amplify community voices, the project collects narratives from diverse media sources and links them through shared geographical references, which are visualized on a map to reveal the most notable points of cultural connection. The project aims to develop an inclusive methodological framework for meaningful engagement with, and empowerment of, the discourses of underrepresented communities. It reimagines snowballing transmedia storytelling as a dynamic mechanism of cultural dialogicity, made accessible through GIS-based visualization methods.

1. INTRODUCTION: UNDERREPRESENTED VOICES IN THE ERA OF BIG DATA

The discourses of smaller communities remain unequally represented in an era shaped by big data trends and engagement metrics. This imbalance raises complex questions about the nature of cultural significance and relates to the broader vulnerability of underrepresented groups to information manipulation that exploits historical traumas, memory conflicts, and sentiments of marginalization.

2.1. TRANSMEDIA STORYTELLING AND THE MAKING OF PLACE

Beyond the realms of fiction and commercial marketing, transmedia research offers an underexplored area for new theoretical insights and practical experimentation. [Scolari 2019] Snowballing transmedia storytelling can be understood as a dialogical and creative cultural process that underlies the formation of complex cultural constructs [Menise 2020, Ojamaa and Torop 2014], including places—lived, experienced, and meaningful spaces articulated through diverse local narratives [Hancox 2021].

While transmedia storytelling as a practice has been explored in marketing, tourism, and education for constructing centralized campaigns with specific goals, snowballing transmedia storytelling is organic, decentralized, polyphonic, and potentially de-hierarchized. It foregrounds meaning-making rooted in cultural memory while engaging with issues deeply relevant to the contemporary life of the communities involved.

2.2. A GIS-BASED APPROACH AND THE JUXTAPOSITION OF DIVERSE CULTURAL DATA

Our unconventional use of GIS-based methods allows for the juxtaposition of diverse cultural data through shared geographical references. This approach highlights and makes accessible the dialogues between different narratives that construct the image of a place, illuminating snowballing transmedia storytelling as a mechanism of cultural creativity, development, and continuity.

By rendering transmedia storytelling as a visible cultural process, this method allows us to equalize different types of cultural data, treating a film and a social media thread as equally

meaningful utterances within a broader transmedia dialogue. In doing so, it enables the diversity of voices to be more fully recognized, contextualized, and heard.

The mapping of transmedia dialogues requires, first, deep engagement with the material, aligning with the concept of *deep mapping* [Roberts 2016]; and second, it produces an alternative image of the region that challenges and reinterprets the official map, resonating with the idea of *counter-mapping* and its associated potentials and limitations [Hunter 2020].

2.3. THE LATGALIAN CASE

Our case study focuses on the Latgalian region of Latvia, which possesses a distinct culture, a collateral language (closely related to Latvian) spoken by approximately 165,000 people, and a complex, often traumatic history shaped by shifting political powers—including the historical (1918–1940) and modern Latvian states, as well as Soviet (1940–1941; 1944–1991) and Nazi (1941–1944) occupations.

Despite its vivid cultural life, supported by both local cultural professionals and grassroots initiatives—including the writing of songs, poetry, and novels, as well as performances and festivals in the Latgalian language—the overall volume of Latgalian-language texts remains very small compared to those of larger European language communities.

Representation of Latgalian discourse on social media is also limited, with relatively few active users employing distinct Latgalian hashtags and even fewer writing in the Latgalian language. Most social media posts in Latgalian are produced by language activists and generate limited audience engagement and few visible reactions. These factors render Latgalian discourse resistant to conventional big data analysis.

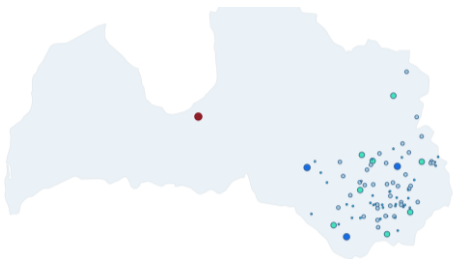

Figure 1. *Geographical objects concentrated in the Latgalian region of Latvia.*

A notable exception is music videos: Latgalian songs are more widely recognized and integrated into the broader Latvian musical landscape, attracting significant attention across different language communities and achieving comparatively high view counts within the Latvian context.

2.4. DATA SOURCES AND MATERIALS

At this stage of our research, we focused on contemporary Latgalian discourse, deliberately excluding classical and canonical texts represented in textbooks and not reappropriated within contemporary culture. To trace the most significant transmedia connections shaping Latgalian places, we selected three primary data sources:

The Corpus of Contemporary Latgalian Language (MuLaR): consisting of 90 interviews with contemporary Latgalian speakers at the time of this study.

Instagram data: manually collected through hashtags of toponyms identified in the MuLaR corpus.

A small experimental corpus of ten contemporary texts in Latgalian language: created across different semiotic media and genres.

The Selected Texts

1. **Poem (1998/1999) / Poetic video (2019) / Song (2022):** *"Ar Reigas morāli…" ("With Riga's Morality…")* by Pīters Jurceņš / the project DŪMOJ AR KOMATIM! / by Fak'n'Turīs

2. **Book (2023):** *Dīnvyd Latgolys Stuosti (Stories of Southern Latgale)* by Valentins Lukaševičs

3. **Documentary film (2020):** *Laiki. Cylvāki. Volūda.* (*Times. People. Language.*) by Arņs Slobožanins

4. **Feature film (2020):** *Piļsāta pi Upis* (*The Town by the River*) by Viesturs Kairišs

The Selected Texts
5. **Song and music video (2019):** *"Trešuo Zvaigzne"* (*The Third Star*) by *Latgalīš Reps*
6. **Short animated film for children (2023):** *Vydsmuižys Annužys acim* (*Through Annužs' Eyes from Vydsmuiža*) by Iveta Seimanova and Viļāni Music and Art School
7. **Song and music video (2024):** *"Latgola"* by *Varang Nord*
8. **Poetry collection (2024):** *Pa ceļam nūgiutuos dūmys i sajiutys* (*Thoughts and Feelings Found Along the Way*) by Gunta Ločmele
9. **Song (2023):** *"Dzīsmeite Rēzeknis nūvodam"* (*A Song for the Rēzekne District*) by *Skonai*
10. **Theatrical play (2010):** *Latgola.LV* by *Danskovīte*, directed by Valdis Lūriņš

Table 1. *The list of Latgalian texts that were selected for the analysis.*

2.5. METHODOLOGICAL DESIGN

One of the main objectives of our research was to identify key geographical objects in the Latgalian region that could serve as points of intersection for different narratives within contemporary Latgalian discourse in the Latgalian language. This required several stages of cross-referencing across our data sources.

First, we identified the most frequently mentioned toponyms and geographical objects in the MuLaR corpus. To systematize the material, we narrowed our focus to various types of settlements. Next, we examined whether the same toponyms appeared on Instagram as hashtags and determined whether they referred to the same geographical objects as those found in the MuLaR stories.

Finally, we conducted a close reading of all ten selected texts to determine whether the same geographical objects were mentioned there. This process allowed us to identify 19 points on the map where narratives from MuLaR, Instagram, and the ten selected texts converge.

Figure 2. *The points of convergence.*

Further experimentation with mapping geographical objects as points of connection between different narratives could lead to the creation of a web of texts, revealing how the Latgalian region is immersed in and interconnected through storytelling.

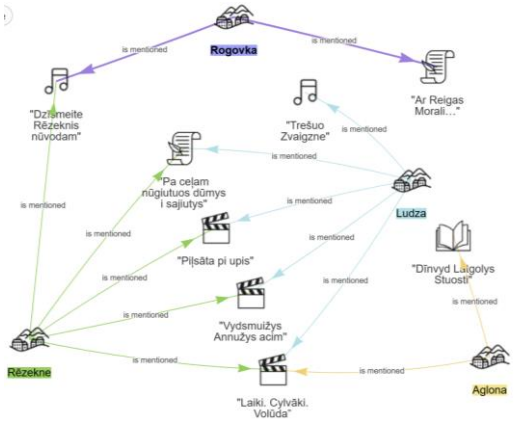

Figure 3. *A model illustrating the web of texts that immerse the Latgalian region.*

2.6. DISCOVERING CREATIVE JUXTAPOSITIONS

Identifying points on the map where different types of cultural data intersect can be considered a significant discovery in itself, as it highlights the key locations contemporary within Latgalian discourse—even though the picture may evolve as the dataset expands to include additional materials. These intersections often

reflect both cultural and historical significance, as well as the concentration of contemporary social and creative activity in specific places.

However, the main focus of our analysis lies in examining these points of intersection more closely to understand which narratives converge there and what new stories emerge at the crossroads of diverse texts. Our interest lies in the complex relationships between texts and the multifaceted transmedia connections that shape the images of place—connections that can only be uncovered through close reading and contextual immersion.

In some of the juxtapositions we identified, texts merged organically into a unified whole as they referred to shared spaces of cultural memory and overlapping narratives. At other times, the dialogues between texts unfolded in more intricate ways, with the meaning of one text transformed in light of another. In certain cases, it was the striking opposition between narratives—their very clash—that made a particular instance especially revealing.

2.7. THE CASE OF ROGOVKA

A telling example of Latgalian distinct identity and historical narrative comes from a small village in Latgale called Rogovka, located near the regional center of Rēzekne. The place is marked by a specific cultural image encapsulated in the popular Latgalian saying:
"Troks voi nu Rogovkys?" / "Crazy or from Rogovka?".

This expression is rooted in the historical myth of the bravery and defiance of Rogovka's people—a story further reinforced through local narratives, artistic representations [Ūdre 2018], and contemporary appearances in Instagram posts.

Figure 4. *Instagram post from 2020*

The topic of the distinctiveness of Latgalian identity is further echoed in the 1998/1999 poem *"Ar Reigas morāli…"* ("With Riga's Morality…") by Pīters Jurceņš, which begins with the lines:

Ar Reigas morali uz Rogovku tu nabrauc, muos. Sovs jūks ir Rogovkai, un znārba sova, un sovs kuoss. / You don't go to Rogovka with Riga's morals, sister. Rogovka has its own jokes, its own sickness, and its own cough. [Jurceņš 1999]

The poem contrasts the Latgalian spirit in general—and the spirit of Rogovka in particular—with that of the Latvian capital, Riga, emphasizing resistance to homogenizing national narratives.

The poem was adapted as a poetic video in 2019 by the project DŪMOJ AR KOMATIM!, which emphasized the tragic dimension of the story through the image of a girl whose face is violently transformed by surgical operations—symbolizing the painful pressure of cultural assimilation.

Figure 5. *Still from the poetic video "Ar Reigas morāli." [DŪMOJ AR KOMATIM! 2019]*

In this context, it is particularly striking how an Instagram photograph of a monument in Rogovka—apparently created for purely aesthetic purposes—acquires new meaning when juxtaposed with the video. The "Rogovka angel" in the post seems to be crying, visually resonating with the traces of blood on the bandaged face of the girl in the video—creating a powerful emotional and symbolic dialogue between the two images.

Figure 6. *Instagram post from 2014 featuring the monument in Rogovka.*

While the case of Rogovka is not limited to these particular texts and narratives, even this focused example reveals the complex and creative transmedia storytelling processes that shape the representation of the place within contemporary Latgalian culture.

3. CONCLUSION

Our method of juxtaposing different types of cultural data based on shared geographical references to reveal the process of transmedia storytelling behind the formation of place is particularly well suited for engaging with the discourses of underrepresented communities. Bringing texts together helps amplify their voices and uncover the internal complexity of their narratives. Moreover, this approach relies on close reading and qualitative analysis of a large body of diverse material across different semiotic media, with only a few steps potentially automatable—a task that would be considerably more difficult if actual big data were taken as the primary object of study.

The experiment could be further developed by incorporating classical Latgalian texts to explore creative juxtapositions between contemporary and historical cultural layers. Another promising direction would be to include non-Latgalian voices from the region. Historically, Latgale has been—and remains—a multicultural space inhabited by Latvians, Russians, Jews, and Poles. It would be particularly valuable to examine the juxtapositions of texts from these different cultural traditions, applying the method to contested or conflicting topics and creating a comparative perspective through distinct "Latgalian maps" that reflect the region's multiple and intersecting narratives.

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Algorithmic Bias and Cultural Diversity: Risk and Regulation in Digital Creative Ecosystems

MingZhu Zhang

School of Law, University of Galway, Ireland, mingzhuz918@gmail.com

ABSTRACT: As the digital creative economy becomes platform-driven, platforms serve as powerful gatekeepers, using opaque algorithmic systems that amplify cultural biases to determine which content is seen or silenced. Such practices exclude content that does not conform to mainstream perspectives. Consequently, creators are transformed from active contributors to cultural expression into passive subjects of algorithmic curation. Those who challenge dominant narratives face exclusion, weakening overall cultural diversity. Platforms thus undermine the inclusive culture that digital environments should promote by selectively amplifying or suppressing content. This paper analyses platform practices and regulatory responses. It examines algorithmic moderation tools, evaluates the EU Digital Services Act's transparency provisions, and highlights gaps leaving some creators vulnerable. The paper argues that expressive visibility and cultural diversity should guide digital regulation, recommending culturally aware policymaking and audit frameworks to assess algorithms' cultural impact, advocating a more inclusive, diversity-conscious model of AI governance.

1. INTRODUCTION

The rise of social media has fundamentally reshaped how culture is created, disseminated, and consumed. Modern platforms host enormous volumes of user-generated content, distributed rapidly and on a global scale. This transformation has positioned platforms as central sites of governance, where decisions regarding content visibility and removal determine whose voices are amplified or silenced [24]. Content moderation is a critical role of this process. Beyond removing illegal material, it includes complex practices, including ranking, recommendation, labeling, and algorithmic filtering, that influence both individual user experiences and broader communication structures [9]. Moderation has thus become a form of private power, with a small number of corporations exercising substantial influence over cultural expression and democratic participation [14]. Evidence indicates that marginalized communities are disproportionately affected through mechanisms such as shadow banning, misclassification of queer and racial identities, or suppression of specific hashtags [9]. Content creators often navigate uncertain rules, inconsistent enforcement, and limited avenues for appeal, producing a chilling effect that diminishes diversity and discourages engagement.

Legal frameworks, particularly within the European Union, have attempted to address these challenges. Instruments such as the Digital Services Act (DSA) impose requirements for transparency, accountability, and systemic risk assessment. However, these measures remain contested, as regulation has yet to fully bridge the gap between opaque enforcement practices and the protection of creators' rights [23]. Alongside formal regulation, creators have developed informal methods for interpreting platform rules, commonly referred to as 'algorithm gossip.' Through forums and online communities, they exchange speculations, test strategies, and develop collective theories about algorithmic behavior. While such practices reflect forms of agency, they also illustrate how lack of clarity can foster misinformation, self-censorship, and distrust [9].

This study examines the intersection of content moderation, regulatory frameworks, and cultural diversity. It focuses on key questions including the effects of content moderation on cultural production and diversity, and strategies

that could ensure moderation promotes rather than undermines equitable access to culture. The objectives are to map both formal and informal moderation mechanisms, evaluate the effectiveness of existing regulations, analyze creators' coping strategies, and propose recommendations for governance models that integrate cultural sensitivity with systemic oversight. By synthesizing these elements, the study highlights both the risks and opportunities for fostering a more inclusive and vibrant digital cultural environment.

2. DIGITAL PLATFORMS AND THE THREAT TO CULTURAL DIVERSITY

The regulation of media content has long shaped which voices are amplified, and which are marginalized. In the past, policies governing news, advertising, and entertainment on online service platforms emerged through negotiation among policymakers, cultural producers, and commercial stakeholders [10]. The rise of user-generated content disrupted this situation. Ordinary users began producing material at unprecedented speed and on a global scale [9], platforms, act as key intermediaries for content exchange and dissemination, facilitate the distribution of such user-generated content to vast audiences. As a result, social media platforms have rapidly become central area for cultural production and communication, concentrating considerable influence on the hands of a few major corporations [12, 21]. Within this environment, creators, particularly those involved in artistic or creative work, are subject to platforms' content moderation systems that invisibly govern which content is visible, shared, or suppressed [24]. Consequently, moderation functions as a decisive mechanism shaping cultural visibility. It has been conceptualized broadly as "governance mechanisms that structure participation online" [9], provoking disputes over what is permissible and who holds the authority to enforce such norms [17]. Traditionally, moderation primarily involved content removal, however, as the scale and variety of uploaded content has increased, as well as and as commercial objectives have become more pronounced, platforms have expanded moderation operations in both size and complexity. Global companies, such as YouTube, TikTok, and Meta, increasingly rely on cheaply and efficiently automated systems to manage massive user bases across cultures values [17]. Given the concentrated power of a small number of multinational social media companies, content moderation now, more or less directly, regulates users' speech and represents a new and concerning form of private censorship [14].

Automated monitoring has enabled corporations to exercise control over creators' activity: all user content can be scanned before upload, allowing harmful or undesirable behavior to be intercepted in advance [5]. Moderation practices are commonly divided into two categories, formal, visible moderation and informal, less visible ones [9]. Formal moderation involves explicit actions such as content removal, account bans, and other punitive measures. To implement these measures, platforms rely on technical tools including hash matching (matching uploads to databases of previously removed content [12]) and AI classifiers (analyzing previously unknown content [20]). The identification of platforms' liability and inappropriate content is mainly based on legal frameworks, such as the Digital Services Act, 2019 Copyright Directive and the 2021 Terrorist Content Regulation. These frameworks encourage platforms to expand automated moderation in line with governmental policy priorities. In contrast, informal moderation consists of less visible techniques, such as ranking, recommendation, or shadow banning, all of which influence the visibility and accessibility of content without removing it outright [9, 11, 25]. Algorithmically ranking content, such as in a News Feed, items are ordered to prioritize by what the system deems most relevant or attention-worthy, or recommender system, such as TikTok's 'For You Page', prediction machines suggest content the system predicts users will be attracted through data and machine learning [18], these tools significantly influence the dissemination of uploaded content, where distribution depends not simply on follower networks but on opaque algorithmic processes. Shadow banning exemplifies another subtle form of governance: content may be hidden or demoted without the creator being notified, leading to sudden declines in access or visibility. Although platforms deny employing such tactics, many creators report experiencing these unannounced penalties [9]. The result is a climate of uncertainty and speculation, in which creators view the threat of invisibility as especially dangerous [6, 7]. These quieter mechanisms shape the boundaries of cultural visibility, raising questions about which voice can reach audiences, the extend of platforms control over expression [11], and the deterrent effect these exerts on diverse participation in online cultural production.

These mechanisms have profound cultural implications. Research on social media entertainment and the creator economy has highlighted issues of inequity and bias in recommender systems, particularly affecting the visibility of particular social identities and performances [9, 11]. Platforms' moderation practices do not affect all users equally: Black creators [17], sexual content creators [1], trans and queer users [17, 20], and women of color [9, 17] frequently experience disproportionate reductions in visibility. Measures that appear neutral, such as labeling posts as potential mis and harmful information, or restricting account discoverability [6, 7, 8], can inadvertently reinforce and amplify existing social inequalities [2, 13]. For example, trans participants were more likely to have content classified as 'adult' even when adhering to platform guidelines. Posts that criticized dominant groups or referenced trans and queer identities were often flagged as violations [16]. Algorithms also tend to associate keywords like 'lesbian' or 'bisexual' with commercial pornography targeting heterosexual audiences, resulting in indiscriminate removals [20]. Instances of racial bias have been highlighted by creators such as TikTok comedian Ziggi Tyler, who revealed that the platform's Creator Marketplace algorithm blocked terms including 'Black' and 'Black Lives Matter.' Similarly, Jackie, an Asian woman producing dance content, received warnings against using hashtags like 'AsianWomen,' reportedly due to shadow banning [9], another creator, Amber, noted that hashtags containing 'Black' were suppressed by TikTok's algorithm, reflecting a broader pattern that color women are disproportionately silenced [16]. Taken together, these examples demonstrate that platform governance affects not only individual visibility but also the overall cultural landscape.

By highlighting the experiences of marginalized users with content moderation, the potential effects of changes in platform regulation can be understood within the broader framework of cultural diversity [8]. Traditionally, cultural diversity refers to variations in program types, ideas, viewpoints, and the demographics of people represented in media content, including gender, race, age, class, ethnicity, and sexuality [21]. In digital culture, it additionally encompasses broader racial, gender, and cultural representation, as well as diversity in content sources, topics, and audience exposure [21]. When assess the economic dimension of cultural diversity, the Herfindahl–Hirschman Index (HHI) are used to measure diversity across channel categories, genres, and engagement metrics such as views, likes, and comments, has been adapted to capture the notion of 'supplied diversity' to evaluate the range of content available to the public [8]. Diversity is inherently multifaceted, encompassing perspectives from platforms, the content itself, and the cultural producers, all of which frequently intersect and influence one another [8, 21].

The examples discussed earlier illustrate that platform governance affects broader systemic measures of content availability and diversity, including program types, ideas, viewpoints, and demographic representation. While social media platforms have the potential to enhance cultural diversity by directing attention toward underrepresented voices, they often prioritize a narrow set of highly popular content to maximize engagement and revenue. This attention distribution is highly skewed: a small fraction of creators receives the majority of downloads, views, likes, and profits, resulting in a decline in overall diversity as audiences concentrate on a few dominant figures [21]. Analyses of creation practices must therefore account for diversity both in production cultures and in the content circulated to audiences [21]. When such diversity is lacking, the cultural potential of social media is undermined, with marginalized creators disproportionately silenced and non-mainstream voices struggling to reach audiences.

Overall, evidence indicates that moderation systems tend to reproduce existing inequalities while consolidating the power of platforms. Numerous communities report being disproportionately affected by these practices [9, 16]. These moderation systems are trained on historical decisions made by underpaid human reviewers under intense time pressure, often reflecting conscious or unconscious biases [9]. They are further shaped by the perspectives of predominantly white, male, Western executives and developers [4], as well as by the commercial priorities of companies whose advertising-driven business models incentivize the suppression of content likely to be deemed objectionable by advertisers or mainstream Western audiences, rather than content that may be harmful to their global user bases [22]. Consequently, moderation practices systematically reproduce stereotypes, biases, and social inequalities, and the disciplinary regimes underpinning the social media economy reinforce existing hierarchies,

thereby undermining cultural diversity in both theory and practice.

3. REGULATION, ALGORITHMS, AND CREATOR PERCEPTIONS

Content moderation has evolved into a complex ecosystem involving users, contracted reviewers, and algorithmic systems [17]. Although intended to maintain order, these centralized and opaque mechanisms often disproportionately disadvantage marginalized groups, whose content is more frequently suppressed without clear explanation [16]. To address these challenges, regulators have introduced measures aimed at enhancing transparency into moderation practices. In the European Union, for example, the Copyright in the Digital Single Market Directive (CDSMD) obliges member states to implement mechanisms that reduce reliance on fully automated moderation and encourage multi-stakeholder dialogue (Art. 17). The Digital Services Act (DSA) goes further, establishing harmonized rules to foster a safer, more predictable, and trusted online environment (Art. 1(1)). It imposes transparency requirements at multiple levels: platforms must clearly explain restrictions in their terms and conditions (Art. 14), publish detailed moderation transparency reports (Art. 15), and provide reasoning for content restrictions (Art. 17). Additional provisions cover transparency in dispute resolution processes (Art. 24) and recommender systems, including user influence over algorithmic parameters (Art. 27). Compliance is monitored through annual independent audits (Art. 37(1)). Despite these initiatives, many regulations remain broadly defined, leaving their practical impact on creators uncertain [15]. Transparency obligations often fail to convey the complex effects of algorithms in a manner accessible to diverse users. True transparency requires not only disclosure but also understandability, tailored to the intended audience [19]. In practice, it is doubtful that typical creators can comprehend the information provided in transparency reports, let alone detailed mathematical models underlying algorithmic decision-making [23]. Reports generally focus on summary statistics rather than offering meaningful explanations of moderation processes, decision criteria, or algorithmic influence, making it difficult to trace whether this remedy is actually applied [19]. Even when legal frameworks provide tools for redress, it remains uncertain whether creators can effectively utilize them [23].

In response to these opaque systems, many creators rely on gossip and/or folk theories to make sense of inscrutable platform features, particularly algorithms [9]. Algorithm gossip shapes creators' perceptions of algorithmic logic and fairness, some of them combed through subreddits to understand the algorithm a bit better, others relied upon Discord or Facebook groups [9]. These interpretive practices influence creators' behaviors, from content adaptation to attempts at escaping algorithmic interventions [9]. Although algorithm gossip can illuminate the effects of platform bias and discrimination [3], creators' perceptions do not always align with actual platform enforcement. Nonetheless, these 'algorithmic imaginaries' are deeply embedded in creators' routines, shaping their strategic decisions. However, when talk about 'algorithmic imaginaries', 'algorithmic gossip' and 'perceptions of platform fairness', these are from creators' perceptions, after all, these individual and collective understandings are deeply implicated in their practices [9]. Many perceive punitive measures as consequences of their social identities or politically sensitive content [9]. Through informal experiments and comparative observations, creators identify types of content seemingly favored by the platform and adjust their output accordingly. They often sense that mainstream creators avoid punishment while benefiting from algorithmic visibility, measured in likes and clicks. These perceptions, in turn, structure what content is produced or avoided, creating dual pressure of self-censorship and risk of swift punitive action [9].

The interplay of formal and informal moderation fosters algorithm gossip, which, while useful for navigating opaque systems, is frequently inaccurate and carries significant negative consequences [23]. Reliance on such gossip can diminish the value of creative labor and threaten both cultural diversity and freedom of expression online. Platforms' tendency to privilege normative content compels creators to optimize production for mass appeal, often guided by conjecture rather than clarity. This dynamic encourages self-censorship and chilling effects, deterring legitimate actions such as filing counter-notices [23]. Collectively, these patterns highlight not only individual struggles but also broader regulatory gaps, structural imbalances, and cultural risks inherent in platform governance.

4. MAKING CULTURAL DIVERSITY A CRITERION IN PLATFORM GOVERNANCE

Previous sections have highlighted the intersection of creative experiences among marginalized groups, legal frameworks, and platform policies, revealing the complex between power, identity, and invisibility in creators' practices. Importantly, concerns about platform punishments were matched by collective perceptions about who gets rewarded, mainstream voices and content genres deemed normative seemed to evade the punitive apparatuses. These observations not only underscore the power imbalances between platforms and cultural producers but also illustrate the platforms' role as de facto moral arbiters [9].

Cultural diversity emerges as a central concern in navigating algorithmic governance within content moderation. In evaluating decision quality, access to culture and cultural diversity should be emphasized as a separate factor from ex post mitigation mechanisms [24]. In this context, the Digital Services Act (DSA) has integrated fundamental rights more explicitly into platform operations. Under the DSA, very large online platforms and search engines are required to identify, analyze, and assess 'systemic risks' arising from the design or functioning of their services, including algorithmic systems, and from how these services are used. Article 14(4) DSA requires 'act in a diligent, objective and proportionate manner in applying and enforcing the restrictions (...) (in form of content moderation), with due regard to the rights and legitimate interests of all parties involved, including the fundamental rights of the recipients of the service, such as the freedom of expression, freedom and pluralism of the media, and other fundamental rights and freedoms as enshrined in the Charter' [24]. At the international level, cultural rights represent one of the specific identifications of human rights. Article 27 of the UN Universal Declaration of Human Rights (UDHR) guarantees everyone the right to freely participate in cultural life, enjoy the arts, and benefit from scientific progress, alongside the protection of moral and material interests arising from any literary, artistic, or scientific creation. In this sense, cultural diversity is an intrinsic property and a relational feature of access to culture, opportunities for creating and sharing content are inseparable from broader access to cultural resources [24]. Cultural production can be considered democratic when creators are safeguarded throughout the processes of creation, distribution, marketing, and monetization [21]. Given its high relevance for systematic rights, and at the same time its complex nature, addressing issues of cultural diversity in auditing platforms is crucial for protecting systematic rights.

Both understanding and addressing issues of diversity and access to culture in digital content moderation must be prioritized in policy and research agendas [24]. Enhancing transparency of moderation decisions, investing in culturally sensitive moderation approaches, and enabling context-specific content assessment are essential steps toward a socio-culturally aware governance framework. Transparency is foundational in this process. While basic metrics such as the number of removed posts or suspended accounts may comply with legal requirements, they offer only a superficial account of moderation outcomes. From a cultural rights perspective, such statistics fail to reveal whether moderation practices are applied equitably across different cultural groups. Transparency reports should provide a standard for evaluating diversity, therefore go beyond data disclosure to provide substantive analyses of how moderation affects cultural diversity, including whether certain communities are disproportionately targeted, whether linguistic minorities face higher rates of automated removals, and whether cultural idioms or symbolic expressions are misinterpreted as violations. Embedding these cultural indicators transforms transparency reporting from a compliance exercise into a meaningful instrument of accountability capable of uncovering structural imbalances in digital cultural participation.

Auditing constitutes another critical component. Both internal audits conducted by platforms and external audits undertaken by independent actors or regulatory bodies should integrate cultural diversity as a normative benchmark. Formal audits that assess only procedural consistency with terms of service or legal obligations risk overlooking broader issues of equality and non-discrimination in cultural access. For instance, applying uniform moderation rules across jurisdictions may meet procedural standards but still undermine substantive fairness by disregarding context-specific practices or expressions. Audits that incorporate cultural analysis can identify systemic biases,

evaluate their effects on vulnerable communities, and recommend corrective measures. In this way, auditing functions not merely as a technical safeguard but as a governance mechanism that advances transparency, inclusiveness, and respect for fundamental rights.

The combination of transparency and auditing establishes a mutually reinforcing governance framework. Transparency ensures that information about moderation practices is publicly available for scrutiny by civil society, researchers, and policymakers. Auditing guarantees that this information is assessed against independent standards of accountability and fairness. Together, these mechanisms exemplify a governance model in which content moderation is evaluated not solely for efficiency or compliance but for its alignment with broader societal values, including cultural rights and democratic participation.

5. CONCLUSION

In the global digital media landscape, diversity is a highly complex and multifaceted concept, exerting influence across external policy frameworks, internal platform rules, content production, and technical systems, with far-reaching implications for both cultural producers and audiences. This report demonstrates that content moderation on digital platforms extends well beyond the simple removal of posts; it shapes visibility through mechanisms such as ranking, labeling, recommendation, and algorithmic filtering, all of which directly affect cultural production and audience access. These processes, intertwined with corporate priorities, technical limitations, and legal frameworks, disproportionately impact marginalized groups, frequently rendering their content invisible and reducing the diversity of voices available online. Although regulatory interventions aim to improve transparency and accountability, their practical effectiveness remains limited. As a result, creators often rely on informal interpretive practices, commonly referred to as algorithm gossip, which can lead to self-censorship and the spread of inaccurate assumptions. Collectively, these findings underscore the critical importance of embedding cultural diversity as a central criterion in the evaluation of content moderation. Effective governance, therefore, requires moderation practices that are transparent, culturally sensitive, and subject to systematic oversight. Such measures can ensure platforms' equitable participation, safeguard fundamental rights, and support a digital cultural environment that is both vibrant and inclusive.

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SESSION III

“New Frontiers for Art and Digitality”

Moderation: Univ.-Prof. Dipl.-Ing. Dominik Lengyel
(Brandenburg University of Technology Cottbus-Senftenberg)

Visual–Digital Pedagogies: Rethinking Art Education

Mar Morosse

Department of Fine and Performing Arts,
Baruch College of the City University of New York, New York, USA,
mar.morosse@baruch.cuny.edu

ABSTRACT: This presentation discusses how digital technologies are transforming the teaching of art history through new visual and digital pedagogies. Drawing on my teaching experience at Baruch College (City University of New York) since 2017, where I teach about 135 undergraduate students each semester, the study examines how adaptive technology tools, interactive visual resources, and AI-assisted learning are redefining student engagement, accessibility, and critical interpretation.

From a mixed methodological approach that combines classroom observation, student questionnaires and analysis of multimodal activities, the research evaluates how digital storytelling, the creation of visual corpora and collaborative platforms expand the possibilities of learning in the discipline.

By linking pedagogical practice to contemporary debates in digital art history, the work situates teaching experimentation within the broader transformations of the field. It also reflects on the critiques made by scholars such as Claire Bishop and Johanna Drucker around the quantification of culture and the theoretical implications of visual data modelling.

Ultimately, this study proposes a framework for teaching art history based on critical humanism: a model that embraces technological innovation without renouncing the core values of interpretation, inclusion, and narrative depth, which are essential to the future of art education.

1. INTRODUCTION

This text explores the role of visual-digital pedagogies in rethinking art education, in line with EVA Berlin 2026's focus on creativity in dialogue with technology. The incorporation of digital tools in the teaching of art history represents a decisive change in contemporary educational practices. As Lev Manovich points out, "digital visuality transforms not only the image, but the very process of cultural transmission"[1].

Since 2017, I have been researching how visual-digital strategies can enrich the teaching of art history at Baruch College (City University of New York). At this highly diverse institution, I teach three undergraduate courses each semester to approximately 130 students. In this environment, the development of inclusive and adaptive digital pedagogies has proven essential to expand accessibility, encourage participation and promote a visual and critical understanding of the discipline.

Recent advances in the field of digital humanities and computer science applied to the arts underscore the magnitude of this transformation. A study conducted in Hong Kong reported the integration of ChatGPT – a pre-trained generative transformer model – into a digital humanities curriculum to help non-technical students process and interpret complex cultural data [2]. The incorporation of artificial intelligence into the humanities represents a paradigm shift in how students approach data analysis, interpretation, and creative research. The iterative process of designing, testing, and refining inputs (prompt engineering) has established itself as a new form of intellectual craftsmanship, promoting self-directed learning, reflective thinking, and methodological innovation beyond the traditional boundaries of art history.

Within this framework, digital storytelling occupies a central pedagogical position. While

storytelling has historically accompanied artistic production, it has rarely been recognized as a research method in the humanities. However, when combined with interactive technologies, non-linear structures, and active user participation, it becomes a dynamic mode of knowledge construction. As students use digital tools to create visual narratives, they reimagine art history as an ever-evolving dialogue, rather than a static canon.
Thus, the integration of artificial intelligence and digital storytelling redefines not only teaching methods, but also the epistemological foundations on which artistic knowledge is built, inaugurating a pedagogy based on interaction, creativity and critical thinking.

2.1. METHODS AND PEDAGOGICAL FRAMEWORK

This research combines direct classroom observation, student feedback, and a structured empirical instrument titled "Visual-Digital Pedagogies in Art History Education." The questionnaire assesses the impact of technological tools, visual resources, and interactive learning formats on critical thinking, visual literacy, and student engagement in numerous undergraduate courses. This mixed-methods approach integrates quantitative data—such as frequency of tool use and learning perceptions—with qualitative reflections derived from student narratives and classroom observations. The resulting corpus offers a representative picture of how digital technologies are transforming art history learning in a multicultural context of public education.

At the core of this framework is narration as a method and medium. Classical storytelling, defined by setting, plot, character development, and climactic resolution, has historically functioned as a mechanism for meaning-building and moral reflection. In pre-literate societies, stories evolved into rituals based on myths, participatory performances, and communal dramas that articulated the relationship between humanity and the visible and invisible worlds. The advent of digital media has introduced a new narrative ecology in which orality, interactivity and multimodality converge. As radio historian Susan Douglas observes, this phenomenon signals "a return to orality, a mode of communication that depends on narration, listening, and group memory."[3] Digital environments extend this tradition through co-creation, allowing students to participate in the construction and interpretation of stories actively.

While some critics argue that computational technologies have displaced traditional academic practices—such as attentive reading or formal analysis—others recognize them as an unprecedented democratization of cultural expression. Robert Clarke and Andrea Adam recall that early digital storytelling was driven by "arts professionals committed to the democratization of culture: empowering and giving voice to individuals and groups traditionally silenced, marginalized, or ignored by mainstream culture."[4]. In the classroom, this democratic potential is materialized in collaborative digital narratives that integrate image, sound, and text within interpretive frameworks. The creation of these projects requires a constellation of technical and creative skills - from text selection and editing to image manipulation, interface design or audiovisual production - which are developed collectively through project-based learning. Thus, digital storytelling becomes both a pedagogical and a research practice, where students act as co-authors of knowledge and transform the classroom into a laboratory of shared research.

With the advent of writing, the narrative acquired permanence and was canonized as literature; however, its essential narrative impulse endures. In the digital age, the superimposition of computational media on narrative invites us to reconsider how stories mediate between human imagination and machine logic. My pedagogical model is based on this continuity: it combines traditional research in art history, iconographic, stylistic and contextual analysis, with the possibilities of digital visualization and AI-assisted interpretation, proposing a synthesis between critical humanism and technological literacy.

2.2 DIGITIZATION AND CORPUS BUILDING

A central methodological component of this research consists of the digitization of historical-artistic sources and the construction of interoperable data corpora. As photo archives, museum catalogs, and art gallery records migrate from analog to digital formats, they become powerful tools for visual culture research and teaching. However, unlike text-based digital humanities,

art history simultaneously engages spatial, material, and visual data, creating a fragmented, complex landscape of resources.
Fundamental archives such as the Frick Photoarchive, the Fototeca de Villa I Tatti and the Bildindex der Kunst und Architektur have undertaken extensive digitization processes. In parallel, the PHAROS Consortium has adopted the Linked Art metadata standard, which aims to harmonize documentation practices and foster interoperability between institutions [5]. These initiatives illustrate the convergence between heritage preservation and digital accessibility, principles that underpin the design of my teaching practice.

Today, the great museums function as true digital laboratories. Since 2012, institutions such as the British Museum have implemented open data frameworks based on the CIDOC Conceptual Reference Model (CIDOC CRM), offering public APIs and downloadable datasets for research and teaching [6]. Similarly, platforms such as Artstor, Europeana, and Google Arts & Culture bring together millions of high-resolution images and metadata from international collections [7]. In my courses, students use these repositories to construct comparative visual essays, draw source maps, and design micro-exhibitions that connect global art traditions.

Thematic databases also play a crucial role. Portals such as Discover Islamic Art, Mapping Gothic France, and Ukiyo-e.org demonstrate how digitized images, 3D scans, and interactive maps expand the boundaries of art-historical research [8]. These resources not only offer high-resolution materials but also model how collaborative infrastructures underpin new forms of scholarship.

By integrating such platforms into classroom activities, students not only acquire digital research competencies but also develop a critical awareness of the epistemological implications of technological mediation: the politics of visibility, metadata biases, and regional imbalances that determine what and who is visible in contemporary art history.

2.3 BIOGRAPHICAL, GEOGRAPHICAL, AND BIBLIOGRAPHIC FRAMEWORKS

Complementing these image archives are controlled vocabularies and bibliographic databases, particularly those maintained by the Getty Research Institute. Its Thesaurus of Art and Architecture (AAT), the Union List of Artist Names (ULAN), and the Getty Thesaurus of Geographic Names (TGN) provide fundamental metadata standards that ensure terminological consistency and accuracy in cataloguing [9].
The adoption of these regulatory frameworks allows student projects to use consistent terminologies and align with professional documentation practices. In addition, complementary classification systems, such as ICONCLASS and the Thesaurus of Chinese Iconography, are introduced, promoting comparative iconographic research across diverse cultures and visual traditions [10].

In parallel, bibliographic repositories, including the Getty Research Portal and the Digital Library for Decorative Arts and Material Culture, offer students access to a vast body of art-historical literature. These resources allow them to contextualize artworks within broad historiographical frameworks and recognize the transformations of disciplinary discourse.

By learning to navigate and synthesize information in these digital ecosystems, students develop what Cynthia Selfe calls "multimodal literacies": a practice that fosters analytical flexibility, critical media competence, and a deeper understanding of visual knowledge in the digital age [11].

Together, these reference systems and repositories not only strengthen technical skills but also consolidate an academic formation that is more aware of the infrastructures that sustain the production and circulation of artistic knowledge.

2.4 PEDAGOGICAL INTEGRATION AND LEARNING OUTCOMES

The integration of these digital and narrative frameworks into the teaching of art history fosters a multimodal learning environment that connects aesthetic experience with technological practice. As Griselda Pollock states, "art history today requires the mediation of new technologies to remain alive and socially relevant"[12]. In this sense, the pedagogical strategy developed here transforms the passive reception of art into an active process of interpretation, creation and critical dialogue.
Through digital storytelling tasks, virtual exhibitions, and interactive analysis, students learn not only to decode the art form, but also to con-

struct new digitally mediated cultural narratives. These practices situate the student as a producer of visual knowledge, capable of articulating multiple perspectives and understanding art as a field in constant transformation.

Ultimately, this methodological and pedagogical framework demonstrates how digital environments democratize access to art, diversify interpretive voices, and broaden the intellectual and ethical horizon of the discipline. By combining technological innovation with humanistic sensibility, art history reaffirms itself as a dynamic space for critical thinking and cultural participation in the twenty-first century.

2.5. CRITICS ON DIGITAL ART HISTORY

Criticisms of digital methods in art history focus on the methodological, theoretical, and ethical challenges that accompany the growing integration of computational tools into the discipline. A primary concern involves quantifying artistic data, which some scholars see as reducing cultural significance to measurable metrics. Claire Bishop has described this phenomenon as the "neoliberal subordination of human activity to metric evaluation," suggesting that digital art history's reliance on statistical analysis may obscure interpretive complexity and sidestep questions of canon formation, hermeneutics, and historical causality [13]. Johanna Drucker, however, argues that such modelling is itself an interpretive act, arguing that the use of data in art history inevitably codifies theoretical assumptions rather than denies them [14]. This dialogue underscores the need for a critical awareness of how computational systems frame cultural evidence.

Another criticism concerns the theoretical distance between traditional and digital art history. As Griselda Pollock points out, the adaptation of computer vision or network analysis to concepts such as "influence" or "style" risks reifying obsolete positivist models [15]. Studies by Amanda Wasielewski and Anna Dahlgren have shown that digital art historians often return to early formalist frameworks, invoking Wölfflin, Warburg, or Gombrich, in part because computational analysis lacks its own robust theoretical language [16]. This trend does not reflect a theoretical regression, but rather a disciplinary recommitment to the historiography of vision itself.

Finally, scholars such as Hussein Keshani have identified colonial legacies embedded in digital infrastructures. The uncritical digitization of collections, he argues, risks "recolonizing memory" even as it expands access [17]. Debates related to virtual repatriation question whether digitized surrogates actually redress historical injustices or reinforce the authority of Western institutions [18]. Robert Wellington envisions a corrective model that incorporates indigenous epistemologies and linguistic sovereignty within metadata systems [19]. Such perspectives reveal that digital art history, while expanding accessibility, must also confront the epistemic and political implications of how cultural heritage is represented, classified, and shared in the digital age.

3. CONCLUSION

The evolution of digital methods in art history represents a profound transformation in how artistic knowledge is studied, produced, transmitted, and interpreted. As I have observed through my teaching experience at Baruch College (CUNY) and in the broader research framework discussed above, digital tools have expanded access to collections, fostered collaboration, and cultivated new forms of critical and creative engagement. However, these technological innovations also raise questions about interpretation, authorship and ethics that the discipline must continue to address.

In the pedagogical field, the integration of digital storytelling, AI-assisted research, and multimodal learning environments has redefined the art history classroom. Students no longer learn only as receivers of visual knowledge, but as active agents in the construction of interpretive narratives through interactive databases, digital archives and virtual exhibitions. This collaborative, project-based learning model, inspired by collective authorship and visual literacy, allows them to navigate complex digital ecosystems and develop transferable analytical skills. This aligns with Cynthia Selfe's argument that digital environments require "a pedagogy attentive to multimodal literacies"[20]. The educational outcomes of this model —greater inclusion, accessibility, and interdisciplinarity —demonstrate the potential of digital tools to democratize art-historical research and to renew its social relevance.

However, as Claire Bishop warns, digital methodologies risk subordinating humanistic research to "metric evaluation" by privileging quantification over interpretation [21]. The

challenge for educators and researchers lies in maintaining a balance between empirical data collection and hermeneutical reflection. In this sense, Johanna Drucker's observation that data modeling is itself an interpretive act reminds us that computational systems are not neutral tools, but structures that embody theoretical assumptions [22]. Recognizing this interpretive dimension protects the discipline from becoming a merely technical practice, detached from its intellectual and ethical foundations.

Equally relevant are the ethical and postcolonial dimensions of digital art history. As Hussein Keshani warns, the digitization of colonial collections without contextual or community participation can "recolonize memory" under the guise of access and preservation [23]. The contemporary debate on digital or virtual repatriation emphasizes the need for inclusive metadata practices that respect local epistemologies and linguistic sovereignty. Along these lines, Robert Wellington's proposal to incorporate cultural vocabularies into data ontologies exemplifies how digital infrastructures can be reimagined as instruments of cultural justice rather than mechanisms of epistemic dominance [24].

Taken together, these pedagogical, methodological, and ethical perspectives point toward a critical humanism for the digital age, one that recognizes the power of computing while reaffirming the need for reflexivity, inclusion, and narrative depth. The history of digital art should not only aspire to digitize the canon, but to decenter it, making visible the multiplicity of artistic voices and historically excluded contexts. As Griselda Pollock recalls, art history must remain "historically alive and socially relevant" by embracing technological mediation without renouncing interpretative nuances [25].

Ultimately, the future of the discipline depends on maintaining this delicate balance: using technology not as an end in itself, but as a means to renew critical thinking, expand cultural diversity, and reimagine art as a shared language between memory, knowledge, and creation. Ultimately, the convergence of visual-digital pedagogy, corpus construction, and critical theory offers an opportunity to reimagine the discipline as a dynamic interface between technology and the humanities. In this model, digital is not an end in itself but a means to foster inquiry, empathy, and intellectual equity —values that lie at the heart of art-historical scholarship.

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Disrupting the Sensible: Multimediality and Posthuman Politics in Contemporary Art

Iván-Manuel Tapia-Bruno

Institut für Open Arts, Mozarteum University Salzburg, Austria,
ivanmanuel.tapiabruno@gmail.com

ABSTRACT: This article proposes a re-reading —with a posthumanist perspective— of the political in art, based on Jacques Rancière's proposal for the *redistribution of the sensible*. Drawing on authors such as Donna Haraway and Bruno Latour, it explores how contemporary multimediality functions as a political art par excellence.

The article examines the work of artists from diverse geographic and medial contexts: The Chilean sound artist and scientist Nicole L'Huillier, the Austrian-German composer Brigitta Muntendorf, the Japanese audiovisual artist and programmer Ryoichi Kurokawa, and the French visual and spiritual artist (French Guiana) Tabita Rezaire, whose productions have shifted toward multimedia languages, redefining the limits of the visible, the audible, and the narratable.

Through these case studies, the reflection focuses on how the reorganization of creative devices and the technical and intermedial structure of a work embodies its most radical political content.

1. INTRODUCTION

Apart from the evident possibility of conveying a political message, art, across all its disciplines, possesses a political potential rooted not in a communicational dimension —in a linguistic sense— but in an aesthetic dimension.

Through what Rancière calls the *redistribution of the sensible*, art is capable of transforming the political dimension through the reorganization of sensible experience.

In the face of a profoundly technologized and interconnected contemporaneity —such as the one described by posthumanism— multimediality stands as a politically effective tool, not only by representing but also by being part of the contemporary processes of re-signification and redefinition.

To illustrate some of the mechanisms through which multimediality exercises its political dimension, the work of artists: Nicole L'Huiller, Brigitta Muntendor, Ryoichi Kurokawa, and Tabita Rezaire, will be reviewed.

2.1 AESTHETICS AS A POLITICAL DEVICE

The transformative potential of art can —and perhaps could not be otherwise— be analyzed through terms relevant to the artistic discipline itself, and not through an analytical tool borrowed from the social sciences.

For authors like Walter Benjamin and Jacques Rancière, the political potential of art lies in its technical-aesthetic nature. The social and political impact of a work, or of a particular artist's production, is not the result of a political endeavor or commitment for which the work serves as a vehicle. Instead, its very constitution forms it as a political artifact, since it is its technical and aesthetic characteristics that contribute to the reconfiguration of the political dimension.

For Benjamin, the technique used in artistic creation is crucial not only in defining the artistic discipline in which it is employed, but also in the way society interacts with art, and consequently, the way society as a cultural organism and its relationships define themselves.

For example, the incorporation of photography into the world of the arts would not be seen by Benjamin as a superficial triviality, but as an element that transformed the aesthetic domain of the arts and its consequent political and social impact. For Benjamin, it was pointless to question whether photography should or should not be considered an art form; the real question for him was: How had the overall character of the arts changed due to the introduction of photography? This led to the famous reflection condensed in the historical essay, "The Work of Art in the Age of Mechanical Reproduction" where he proposes that the appearance of the —at the time— new technologies of technical reproduction would mark a before and after in humanity's relationship with the arts and their impact on social life, marked by the loss of the *aura*, the establishment of a new relationship of exhibition with the contemporary work of art, and the beginning of an emancipatory process for the arts, since, for him, "For the first time in world history, mechanical reproduction emancipates the work of art from its parasitical dependence on ritual" [1].

For Rancière, politics and aesthetics should not be understood as separable categories, since aesthetics possesses a political dimension, just as politics possesses an aesthetic dimension. The true political power of the arts lies in their capacity to politically intervene in the aesthetic dimension by reorganizing what he calls *the distribution of the sensible* (*la distribution du sensible*), which is "the system of self-evident facts of sense perception that simultaneously discloses the existence of something in common and the delimitations that define the respective parts and positions within it" [2].

The distribution of the sensible constitutes an aesthetic system, capable of revealing through sensible experience who can take part in what common place within the community, based on the time and place where their activity is exercised. Understood in this way, a baker-aesthetic would not be merely accidental and the result of a social-baker function, but part of their political constitution, since it would possess political agency, by being capable of redefining the baker's role and function through the way they are presented to sensible experience. Through the redistribution of the sensible, it would be possible to reconfigure how, where, and when the baker is seen, heard, and, in general, perceived, altering the very definitions of their role in the community. Aesthetics could then be understood not only as the expression of a reality outside itself, but as a priori element, capable of determining what —and how— is presented to sensible experience.

This capacity to intervene in the given hierarchies and orders of sensible experience allows the arts to consolidate themselves as political organisms that transform communal reality, regardless of a role as a container for a political message. This is because, through the distribution of the sensible, the figures of community are aesthetically designed, constructing hierarchies of an aesthetic nature, but with effects that transcend the communal organization transversally.

"(...) a suitable political work of art is in fact the dream of disrupting the relationship between the visible, the sayable, and the thinkable without having to use the terms of a message as a vehicle." [3]

Now then, in what way would this transversality be achieved? Simply through correlations. Art, through its technical medium and consequent aesthetic dimension, would not represent, but rather construct series of relationships, which are correlatable with the relational orders of the political and social dimension in which the work is inscribed.

However, these correlations should not be confused with aesthetic metaphors of the political. The repertoire of relationships between diverse functions proposed by the aesthetic of art should relate to the very functions of the political dimension. That is, with the respective functions related to the sensible experience of politics.

"The arts only ever lend to projects of domination or emancipation what they are able to lend to them, that is to say, quite simply, what they have in common with them: bodily positions and movements, functions of speech, the parcelling out of the visible and the invisible. Furthermore, the autonomy they can enjoy or the subversion they can claim credit for rest on the same foundation." [2].

A distinctive element of the politics of aesthetics, which distinguishes it diametrically in terms of how it intervenes in politics compared to inherently political forms of intervention —

that is, political commitment — is the mechanism by which its intervention is understood by society as a redistributive act of the hierarchies of sensible experience. This is because, unlike the language used as political commitment, aesthetics achieves the transcendence of the power relations under discussion through —as already mentioned— exercises of correlation. The crucial aspect of this way of understanding the politics of aesthetics is that there is no formula for establishing these correlations.

“The core of the problem is that there is no criterion for establishing an appropriate correlation between the politics of aesthetics and the aesthetics of politics. This has nothing to do with the claim made by some people that art and politics should not be mixed. They intermix in any case; politics has its aesthetics, and aesthetics has its politics. But there is no formula for an appropriate correlation.” [3].

In other words, not only does aesthetics possess its own political dimension through which to intervene in the power relations inherent to a community, but it would intervene through mechanisms unique to the politics of aesthetics. These mechanisms are based on interpretations and correlations with ample margins of freedom that, instead of communicating and imposing ways of being and doing, generate rhizomatic networks of relations and interrelations, in a form of political action that is properly aesthetic.

The researchers who support Media Archaeology have masterfully managed to distinguish the relevance and particularity of the politics of aesthetics by incorporating it as a tool in the reconstruction of universal history.

Erkki Huhtamo and Jussi Parikka, in their: “Media Archaeology: Approaches, Applications, and Implications”, share that: "For the media critic Geert Lovink, media archaeology is by nature a 'discipline' of reading against the grain, 'a hermeneutic reading of the new against the grain of the past, rather than telling of the histories of technologies from past to present" [4]. Siegfried Zielinski, on the other hand, understands it as a kind of anarchaeology or variantology that stands against permanent categories and doctrines.

In works considered part of this trend, such as Sternberger’s “Panorama of the XIX Century “or Zielinski's already mythical “Audiovision”, it is demonstrated how an era is susceptible to being reconstructed from its aesthetics, in order to avoid narratives biased by unequivocal and universal discourses, in what we could consider an absolutely *Anti-Geistgeschichte* tendency.

2.2 INTERVENING THE FABRIC OF THE SENSIBLE IN THE XXI CENTURY

Just as in politics understood as language, in the politics of aesthetics it's possible to encounter instruments of action with greater or lesser efficacy. This efficacy is defined, among other elements, by the degree of pertinence with the order of things it seeks to intervene upon.

A redistributive act whose objects are too alien to a community's reality at a specific time and place won't achieve great effectiveness, as it will likely be incapable of generating significant correlations with the elements of *the fabric of the sensible*. Conversely, an act that is too pertinent, one that simply reiterates the order of the sensible already possessed by the community, won't achieve much redistribution; it will consolidate as an apparatus tending toward aesthetic —and consequently, political— conservatism.

To evaluate the degree of effectiveness of certain aesthetic apparatuses, such as the arts, it would be important to first analyze the status quo of the distribution of the sensible in which these apparatuses will enact the reorganization of sensible experience. Let us, then, conduct a brief analysis of the state of contemporary sensible experience in order to subsequently discern the degree of effectiveness of multimedia arts as instruments for the redistribution of the sensible.

It might be superfluous to mention —in a paper from 2025— that the "reality" we will refer to now is merely one of the many that make up the complex contemporary interversal framework. And far from dismissing other experiences, the aim is simply to approximate the delimitation of one of the networks of sensible experiences that constitute the global status quo.

This status quo sees capitalism in crisis reaching a new state of existence that some authors have called *post-capitalism* or *techno-capitalism*. This leads to increasing precarization, not only of the proletariat but of ever-wider social strata. Simultaneously, however, more voices —some

inspired by the *funghi* kingdom or the Deleuzian *rhizome* [5] as a way of life, others by the possibilities of the *cyborg project*— are calling for learning a new way of inhabiting the world. This is no longer through a revolutionary project, but in a kind of post-revolution, post-capital (almost post-apocalyptic) non-project where we learn to occupy the crevices in which capitalism fragments, building new relationships based on cooperation, collective learning, and the redefinition of the natural and the cultural.

This is precisely the invitation of Anna Lowenhaupt Tsing in "The Mushroom at the End of the World", where she proposes that we are living not a first nature based on ecological relations, nor a second based on capitalist transformations, but a third nature based on life *despite capitalism*. Here, the forms of coexistence of the funghi kingdom—based on deep interconnection, collaborative contamination, and non-scalable productive relationships— might not save us, "but it might open our imaginations" [6].

In the contemporaneity we are trying to delimit, it seems that progressivism is exhausted. The obsession with abstract and universalist novelty characteristic of modernity, or the concrete utopias of postmodernity, are beginning to be replaced by a more conciliatory attitude toward our time, tending toward the awareness of our position in history, perhaps due in part to the gradual disappearance of the notion of the infinity of the humanity project.

As a mechanism to consolidate this new approach to our history, Latour proposes the installation of a compositionist attitude. This is a way of integrating the different elements and dimensions that compose both experiential and conceptual reality into a heterogeneous composition capable of building a new nature. In this nature, modern dualisms such as nature-culture, or history-present, are no longer distinguishable as separate categories, much less as opposites. "For a compositionist, nothing is beyond dispute. And yet, closure has to be achieved. But it is achieved only by the slow process of composition and compromise, not by the revelation of the world of beyond" [7].

Naturally, technology is an integral part of what we should compositionally integrate into our definition of contemporary reality. Like Haraway, we will understand contemporaneity as *technopoietic assemblages*, in which the system of technological apparatuses is no longer understood as an element contrary to nature, but as part of an integrating nature that Haraway defines through the Cyborg metaphor.
For Haraway, the Cyborg is not simply a way of referring to the technological-prosthetic relationships of part-machine, part-animal creatures, both fictional and real; but rather the ontology of the contemporary project, nothing more and nothing less. The Cyborg world we inhabit would be "about lived social and bodily realities in which people are not afraid of their joint kinship with animals and machines, not afraid of permanently partial iden-tities and contradictory standpoints. The political struggle is to see from both perspectives at once because each reveals both dominations and possibilities unimaginable from the other vantage point." [8]. The dissolution of barriers even reaches the distinction between the material and the immaterial.

Naturally, in this way of understanding the world, agented technology would represent not only a tool of resistance, but *The* tool of resistance par excellence. This is because the technical-nature relationship is not only a representation of the contemporary ecosystem but an extensive part of itself, containing both the same networks of meaning and the capacity to transform them.

It is in this dynamic, intensely technologized, and construction-in-progress reality that multimediality emerges as a political apparatus for the redistribution of the sensible *par excellence*. Just like the technology agenced by Haraway, multimediality would not be limited to representing the relationships and processes characteristic of contemporaneity —such as the de-antonimization of nature-technology or the multi- and interdimensionalization of global identity— but would be an integral part of them.

2.3. MULTIMEDIALITY AS A POLITICAL ACT

The resonance between the politics of aesthetics of multimedia art, as an apparatus for reorganizing sensible experience, and the posthumanist reading of contemporary reality is easily discernible. It is not surprising that multi- and transdisciplinary artists tend to include explicit references to posthumanism in their artistic productions or in parallel academic works.

This would be the case for cultural agents such as the Chilean artist Manuela Infante, whose production over the last few decades could be read as an anti-anthropocentric manifesto in the form of an interrelated —dramatically speaking— series of transdisciplinary dramaturgies, or the Austrian-German composer Brigitta Muntendorf, with her constant references to Haraway, evident both aesthetically in her compositions and textually in program notes or in her academic output.

It would make no sense to establish a single logical line for how the politicality of multimediality is manifested, as, mentioned earlier, much of its value lies in its potential to generate rhizomatic relations, thanks to the lack of a universal system for aesthetic-political correlation. This is why this paper has chosen to prioritize free correlation through the analysis of four artists from different disciplinary and spatial contexts who, far from constructing a homogeneous narrative, represent different facets and perspectives regarding multimediality.

2.3.1 FROM MUSICAL SOUND TO MULTIMEDIAL VIBRATION

The work of the Chilean artist Nicole L'Huillier re-signifies the use of sound as an artistic medium, moving away from conceptual notions of sound as an element objectified within a musical grammar. Instead, she proposes a sound medium that is conscious of its physicality, that is, its constitution as vibration, a physical movement capable of being perceived not only acoustically, but also spatially and tactically.

This process of raising awareness about the materiality of sound is carried out through the development of a technique in which sound, performance, and sculpture are amalgamated into the construction of a single multimedial apparatus.

In "Brújula" [9] (Compass), L'Huillier builds an introspective and proprioceptive "navigation instrument" based on the principle of giving and receiving. It is a spherical artifact similar to a 3-axis gyroscope, approximately 2 meters high, which contains a sensitive membrane at its center that acts simultaneously as a microphone and a loudspeaker. The membrane vibrates as a result of the stimulus received from the environment, emitting sound through the vibration, which is then recaptured by the membrane and reconverted into sound once again. This is a constant exercise in which the sound metaphorically becomes conscious of itself, while spectators, with their sonic dimensions, become part of the sound-vibrational feedback that gives life to the installation.

The exploration of the topic of positioning continues in "Telemetron" [10], an instrument designed with Sands Fish within the framework of the scientific research and outreach project: *Space for Everybody*.

On this occasion, the exploration of the limits of culture, in a geographic sense, reaches an extraterrestrial dimension.

"Telemetron"[10] is an instrument conceived for sound creation in zero gravity. It is a dodecahedral apparatus, slightly larger than a basketball, capable of generating different sounds through contact with its surface (which is entirely floating) and its displacement, which, in a zero-gravity environment, presents possibilities that could not exist in conventional settings.

"Telemetron"[10] masterfully represents the Rancièrean idea of the redistribution of the sensible as the operation of redefining the place where something can be perceived.

2.3.2 INTERDISCIPLINARITY AS A SOCIAL PROPOSAL

Unlike L'Huillier, whose approach to multimediality redefines the use of sound as an extramusical artistic medium, in Brigitta Muntendorf's work, both instrumental and electroacoustic musical traditions are present, but completely reformed, through networks of relationships that cross its disciplinary boundaries with other artistic expressions, generating an aesthetic result where the whole is certainly more —or different— than the sum of its parts.

The compositional attitude proposed by Latour is particularly evident in Muntendorf's work ARCHIPEL [11], a collaboration with Sou Fujimoto and Stephanie Tiersch. This is a multimedial and transdisciplinary dramaturgy whose (eminently non-verbal) narrative proposes a post-apocalyptic future where: "Nature has become an artefact, people and plants have developed a provocative new association. After the end of the world as we know it, a neo-humanoid presence will appear and explore an archipelago of possibilities: invisible biological links and

symbioses in which human reproduction is a thing of the past" [11].
Similarly, the technique and aesthetics of the work function as an apparatus that re-thinks the relationships among the different disciplines that compose it. Fujimoto's gigantic sculpture, which serves as a stage for the dance troupe, acting, and musical performance, in itself constitutes a sound apparatus, both analog and electroacoustic, that blurs the barriers between the scenic and the musical.

The different bodies interacting on the sculpture blend into one another, both literally thanks to the visual composition, and conceptually thanks to a staging idea very distant from conventional notions of traditional sound theater. In this proposal, members of each scenic body collaborate in a single choreography of movements and actions, without the clear canonical distinctions between soundless dancers, actors as the visual focus, partially visible soloists, and a totally ethereal and imperceptible —except for the sound— orchestra.

The sonic treatment itself, with great spatial awareness thanks to an exceptional command of 3D Audio technique, the 360-degree panning of the choir, and the sculpture functioning as an integral part of the sonic dramaturgy, invites a rethinking of the musical from multiple media, shifting it from its traditional scriptural-temporal domain to a material-spatial domain.

The resonances with Haraway's Cyborg project become perceptible not only in the direct mentions in the program note but in the constant integration of the technological resource into every dimension encompassed by the work. This creates a new aesthetic Cyborg apparatus through a symbiosis between analog and electronic music, and between live acting and real-time manipulated video.

It is evident in Muntendorf's work that, in the transitions from the power logics of the *comfortable old hierarchical organics of dominations* to the *scary new networks of the informatics of domination* of the Cyborg world defined by Haraway [8], multimediality could be used as a tool for agencing the new sociopolitical relationships currently under gestation.

2.3.3 ART-TECHNOLOGY: ABOLITION OF DUALISM

We've already mentioned Benjamin's idea that photography not only established itself as a new art form but also redefined the global character of art in general [1]. The same could be thought of each of the new forms of technology that shape the system of contemporary aesthetic apparatuses, resulting in a gigantic technical-aesthetic ecosystem whose technological and analog components can no longer be analyzed separately, as they have been integrated into a single creative project.

For Ryoichi Kurokawa, this distinction —or rather, indistinction— would apply to the Art-Technology dualism, which, for him, are far from being antonymic elements; they represent the same creative force inherent to human culture.

In his multimedia production, which includes audiovisual, sculptural, and installation works, the technological resource is presented not merely as an accidental technique but as the object of his artistic reflection. Through mixed media, 3D printing, complex programming techniques used in the service of generative art, and an endless array of technical resources, Kurokawa explores the limits of the artistic applications of technology while simultaneously bringing his creations to life.

From "Syn" [12] —an audiovisual concert performance— to "renature::bc-class" [13] —a series of sculptures created by scanning insects, digitally remodeling them, and then 3D printing them— the versatility of media itself constitutes an invitation to rethink the way we approach certain concepts. The admiration for physical form, for example, is explored in his production using a spectrum of resources that includes materials as ethereal as video editing and as solid as plastic sculptures, addressing an entire universe of re-signification around the same idea.

In Kurokawa's work, whose manifestation in the sensible world eschews any illusion of organicity to make the artificiality of the creative technique evident, the Benjaminian idea of the indissolubility between technique and aesthetics in the work of art takes form, and consequently, the inseparability between technique and the politico-aesthetic consolidation of the work in question.

2.3.4 MULTI-COSMOVISION

Multimediality not only opens the doors for communication between different (canonical) disciplinary areas, but it also tears down the walls of traditional art categories and definitions, making space for creative expressions of all natures —including those of non-European origin, and even non-written traditions (:O)— contributing a variety of concepts and worldviews impossible to address within the canonical regime of the arts.
The work of Tabita Rezaire, who defines herself as a *spiritual seeker*, is explicitly demonstrative of the transnational and transcultural communication possibilities allowed by multimediality. This is not because the other expressions previously analyzed do not permit a multicultural reading of their influences and conceptual and aesthetic foundations —which, especially but not exclusively in contemporaneity, are practically inevitable— but because in Rezaire's work, this dimension constitutes a central object of interest in much of her creative production.

In "Des/Astres" [14], Rezaire brings together various media, including video installation, architecture, and visual arts, to explore the relationships between the cosmology of the Amazonian indigenous people of French Guiana, and the traditionally Western one.

With French Guiana being the center of operations for the "European Space Agency," Rezaire mixes Western astronomical notions with indigenous readings of the cosmos. This is evident both in the content of the video installation, where different videos account for the diverse practices of cosmic understanding, and in the design and construction of the space where the video is projected.

Rezaire builds a symbolic observatory, a cabin featuring millenary Indigenous architecture and design, with a dome where the video is projected, inspired by the design of modern observatories. This transgenerational device is dedicated to the contemplation of the cosmos, resulting in a fabric of stories that complexify *History* (with a capital H) and the general narrative. It is a monumental example of the compositional attitude proposed by Latour.

"Des/Astres" was part of the exhibition "Calabash Nebula"[15], where Rezaire also proposes "Omo Elu"[15], a tribute to Yemanjá, a Yoruba Orisha, deity of water and indigo.

In this work, which could seemingly be mistaken for a simply pictorial or sculptural piece, being a series of images painted using the indigo dyeing technique, Rezaire sees a non-visible mediality that nonetheless impacts sensible experience: a spiritual mediality.
The approach to the work "Omo Elu"[15], which does not *represent* a tribute but *constitutes* it, brings to the scene a relationship of worship and ritual that modern analysts might see as characteristic of pre-artistic experiences, similar to what Walter Benjamin observed in the relationship the ancient Greeks had with sculpture before they became artistic objects carrying an *aura*. However, in Rezaire's work, worship, as well as spirituality, is constituted as one more medium in artistic creation.

The mechanism by which Rezaire brings the spiritual plane to the sensorial could well remind us of the mechanism by which, for Deleuze, music is capable of "making audible forces that are not actually audible" [16]. Regardless of disciplinary distinction, for Deleuze, the medium of the arts is not conceptual, but perceptual. The arts are capable of communicating ideas through their aesthetic domain by constructing *blocks of percepts* [17] (agented repertoires of sensations gathered in sensible experience), whose established relationships make perceptible forces that are not normally so, such as different temporal constructions manifested through the musical fabric. In the same way, Rezaire, through her work of constructing blocks of multimedia percepts, makes sensible a spiritual experience that originally is not.

3.1 CONCLUSIONS

Art, as an aesthetic device, not only possesses political agency, but it possesses one that is distinct from that of ordinary language. Just as politics has an aesthetic dimension, so too does aesthetics have its own political dimension in which it exercises its domain of action.

Not only the *distribution of the sensible*, as a political-aesthetic field of artistic action proposed by Rancière, serves as an example of this. The way Benjamin perceives the arts as tools for social change, whose transformative power lies in their technique, or how Deleuze distinguishes the philosophical impact —founded on text and concept— from the artistic impact —founded on the *block of percepts*, meaning the

perceptible dimension— are some of the examples that explain the political capacity of aesthetics in art.

Media Archaeology presents itself as a discipline that clearly recognizes this faculty by proposing the reconstruction of the universal historical narrative through a multiversal, multinarrative constructed from the analysis of the different expressions characteristic of a determined time and place —most of which have an aesthetic dimension— instead of building a narrative history based on canonizing discourses.
Faced with the question, what art form will then enjoy the greatest effectiveness in the contemporary posthumanist political-aesthetic project?, multimediality presents itself, at the very least, as a reasonable candidate.

The contemporary world is consolidating itself as a gigantic network of semantic, cultural, transnational, transgenerational, etc., interconnection, with a narrative composed of agents of all constitutions, novelly including —at least in contrast to modernity— non-human organisms and non-organic beings, gathered in a most varied ecosystem that Anna Lowenhaupt Tsing calls a *Polyphonic Assemblage*. In this world, multimediality emerges as one of the most organic ways to intervene in the political aesthetic domain, as it does not merely represent the relationships of interconnection characteristic of the world to which it belongs, but is an integral part of them. It can even become a tool for critical resistance against normative regimes of representation.

Of course, the accelerated processes of global technologization are not alien to the multimedia arts either. These arts, though not necessarily, frequently leverage new technologies to discover new ways of redistributing sensible experience, redefining how we coexist with the system of apparatuses —a matter particularly relevant for Benjamin, for whom "Among the social functions of art, the most important is to establish an equilibrium between man and the system of apparatuses" [1].

It seems that in the current dizzying state of affairs, the different disciplinary areas not only tend to collaborate to achieve significant participation in the world to which they belong, but they tend to blur their borders and even form new disciplinary areas that are immediately incorporated into the multimedia technical repertoire, in a kind of constant exercise of *contamination as collaboration* [6].

The works of the artists briefly reviewed are just some forms of expression in which multimediality is established as the methodology through which the arts consolidate their political place in the contemporary world, whether through questioning national and cultural definitions, or the relevance of the spiritual dimension (Rezaire); through the abolition of conceptual dualisms like technology-art (Kurokawa); the aesthetic construction of relational networks tending toward the abolition of disciplinary borders (Muntendorf); or the re-signification of creative media and the questioning of established place and order (L'Huillier).

3.2 FINAL DISTINCTIONS

I cannot miss the opportunity to make a clarification that became necessary shortly before finalizing this paper, prompted by an interesting intervention made by a colleague during a discussion panel organized by the Institute of Open Arts at the Mozarteum Salzburg.

The clarification is the distinction between the *political dimension* and the *political impact* of the arts. While I must admit that a conscious exercise of separating these different matters was not performed during the drafting of this paper, the central focus was the constitution of the political dimension of the arts —and multimedia art in particular— leaving aside the study of its political impact.

Whereas we might consider the political dimension —according to how we understand politics in this paper— as an issue pertinent to aesthetic study, the matter of political impact should, I believe, be responsibly analyzed from a viewpoint that includes the operational dimension. This should not be independent of the aesthetic and technical logics inherent to artistic activity, but perhaps from a more general perspective that includes the analysis of the social relations characteristic of the positioning of the artwork beyond its mere technical, aesthetic, or conceptual conception.
This subject, perhaps even more relevant than the one discussed in this paper, will undoubtedly be the object of a new investigation.

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Digitizing the Art Market – Mapping Stakeholder Value in 3D Technology Adoption

Clarissa Alessandra Gambuzza[a], Matevž Domajnko [b]

[a] PhD Candidate at Louisiana State University
gambuzza.clarissa@gmail.com
[b] CEO, Verus Digital GmbH,
matevz.domajnko@verus.digital

ABSTRACT: This paper examines how 3D digitization technologies can support workflows in the private fine art market, where digital practices are often undocumented. Conducted during an Erasmus+ traineeship in collaboration with Verus Digital, the study provides insights into the art market sector. It also aims to apply the knowledge from the public art and cultural heritage context to create frameworks for application with private art market stakeholders: auction houses, galleries, artists, and collectors. Using the Value Proposition framework, it maps key user jobs and needs to identify where 3D tools can create value.

The research highlights three primary areas where 3D technologies offer practical benefits: high-accuracy documentation for conservation and authentication support; enhanced visualization for remote viewing, sales, and client communication; and reproduction workflows that enable preservation, display flexibility, and creative development. Interviews conducted across art fairs, professional networks, and ongoing specialist outreach reveal a cautious but growing interest in these applications, whilst still gravitating towards an in-person art experience. Stakeholders recognize the usefulness of improved digital records and online engagement but are mindful of challenges such as accessing works for digitization, integrating new tools into established workflows, and the limitations of 3D models for formal authentication.

1. INTRODUCTION

This paper presents the results of a month-long Erasmus+ traineeship that was held at Verus Digital in 2025. This collaboration aimed to gather insights on the implementation of advanced digitization methodologies within the art market. As a company that has focused on the 3D digitization of cultural heritage objects within the GLAM sector (Galleries, Libraries, Archives, and Museums), it was possible to apply this experience to the research of the private art industry. The main challenge for this research was the lack of publicly available data, as these private companies (such as auction houses, galleries, or private collectors) are involved in digitization projects that are only partially presented to the public. Auction houses, which are some of the major stakeholders in the private art market industry, have made significant efforts in recent years to implement digitization strategies (Gao, 2025). This creates opportunities for the development of the technology that would help support these goals and digitize workflows.

2. BACKGROUND AND CONTEXT

The fine art industry interacts with a range of different objects, from paintings and sculpture to video and installation art. Within the more affluent institutions, there is a significant number of objects that not only have a high monetary value on the fine art market but also have important cultural and art historical significance. As such, there has been a development of technologies to help preserve their state, both in a digital and physical form. Public institutions interested in the preservation and archiving of cultural heritage institutions, such as those belonging to the GLAM context, have in many ways adopted the use of digital technologies in their everyday workflow.

The term digitization carries a lot of weight in current discussions. It functions as an umbrella concept that encompasses many different activities. From large-scale scanning projects of hundreds of thousands of pages in newspaper archives, to producing high-resolution 3D images of archaeological interiors, conducting infrared examinations of medieval manuscripts, photographing three-dimensional museum artefacts, and adding rich metadata to them, and uploading a significant number of metadata to large databases (Gooch, 2025). It is evident that digital technologies, such as 3D digitization, are already essential in the cultural heritage sector. For example, the European Commission recommended that "By 2030, Member States should digitize in 3D all monuments and sites falling under (a) [Cultural Heritage at Risk]." (European Commission, 2021).

The fine art environment can be divided into two main types of organizations: public (or non-profit) and private (for-profit), with some hybrid overlaps, such as private art museums (Kolbe, 2022). Within public institutions, the focus is more geared towards research and preservation, with a logical higher element of transparency towards the public. Therefore, the focus and results of the development of technologies in this context are easier to observe.

This research has focused on the context of private art institutions, where digitization initiatives are also underway. The main challenge within this context is the lack of publicly available data. The methodology used has taken that into consideration and developed a strategy to better understand internal digitization processes within the private art industry, with the specific aim of implementing 3D technology into their workflows.

3. METHODOLOGY

The research and methodology that produced this paper had the goal to uncover strategies for the development of 3D digital solutions that could be integrated into the private fine art industry.

To identify and categorize the users within the market and the best possible approach for them, the Value Proposition model was applied. The goal was to design, test, and deliver the most appropriate solutions for the specific research context. This approach enabled a more systematic discovery process, where assumptions could be evaluated and tested.

4. TIMELINE

The project has been developed to follow three main stages. The first was the Research stage, within which the main users for 3D digitization technologies were identified, mapped, and evaluated. With this, the most relevant personas within the stakeholder groups were identified, which would be important for gathering individual feedback on the hypotheses created during this first stage. The Discovery and Analysis phase was started by defining clear objectives and user questions. This step was essential as part of the preparation for the gathering of feedback as part of the data collection that followed. A key point of this phase was the testing of the hypotheses developed in the research phase of the project. To be able to discover and analyze the companies' feedback, three rounds of interviews were planned. The questions and answers were continually reassessed to ensure a feedback loop that would allow for adaptability in this interview stage. The final planned stage of the project is the Implementation. This step is planned to be evaluated through case studies with potential clients, but also leaves the possibility for other digitization providers to implement it into their workflow and apply it to the fine art market, creating specific results for each use case scenario.

Fig. 1: *Visualization of the project plan for the discovery of 3D digitization possibilities within the private art market*

5. RESEARCH

5.1 VALUE PROPOSITION– PRIVATE FINE ART INDUSTRY

During the duration of the project, a general overview was created to help better understand the private fine art industry. This means that this paper provides a collective overview of value prioritization within the private fine art market, whilst analyzing individual stakeholders that govern it. From this research, there are two important focus points on the user side: the stakeholders and their priorities (jobs). Four major stakeholders were chosen as the most relevant for this research, as they represent a great spectrum of information and opportunity for the private art market: auction houses, galleries, artists, and collectors. Within this context, auction houses and galleries usually represent larger organizations, whereas artists and collectors are typically seen as individuals. To better understand the individual user needs and priorities, the personas within each of the stakeholder categories were also analyzed.

5.2 STAKEHOLDERS

As the first step in the analysis, the main stakeholders were defined and mapped. Research was conducted to better understand the individual needs of each of the recognized stakeholders. This mapping was also compared to some other categories within the public sector, for which data was already available.
Following the process of stakeholder mapping, their individual priorities, recognized as 'Jobs', were discussed and presented. This was created based on the analysis of individuals working within those institutions, which were identified as 'Personas'.

As part of this process, four primary stakeholder groups were defined: galleries, auction houses, collectors, and artists. Each of these groups holds a distinct position within the private fine art sector, shaped by their organizational roles, responsibilities, and strategic motivations. Galleries function as intermediaries and cultural gatekeepers, balancing the commercial representation of artists with curatorial agendas and long- term relationships with buyers. Their needs are characterized by the requirement to present artworks at consistently high quality, maintain artist visibility, support sales, and manage both physical and digital inventories. Auction houses, by contrast, operate within a fast-paced, transaction-driven environment where authentication accuracy, condition reporting, and global reach are essential. Their priorities relate to market transparency, competitive differentiation, and the logistical demands of handling and transporting high-value works under strict time constraints.

Collectors represent a highly diverse stakeholder group, ranging from private individuals and family estates to corporate collections. Their needs often center on safeguarding the value of their assets through proper documentation, conservation, risk management, and secure storage. Many also seek discreet access to expertise, verification services, and tools that support informed acquisition decisions. Finally, artists occupy a unique position as the originators of the works themselves. Their priorities include accurate representation, protection of artistic intent, visibility in both digital and physical spaces, and access to innovative formats that support career development and audience engagement. Together, these distinct stakeholder profiles informed the creation of the personas used in the subsequent stages of analysis and shaped the understanding of their respective 'Jobs' within the value proposition framework.

5.3 JOBS

The stakeholders analyzed within the private fine art market are characterized by their most relevant jobs within the industry. Although their role within the market might differ, they have some of those jobs in common. As such, there were some core customer jobs that stood out within the collective private fine art market: sales, sourcing, innovation, exhibition, online presentation, research and evaluation, condition and conservation, authentication, transportation, and storage.

The two main jobs that are common to all stakeholders within the private art market, as well as in the museum domain, are exhibition and transportation. Whilst the exhibition establishes a physical connection to the public, transportation is the link that enables the pieces to reach the desired audience. Connected to this is also the need for appropriate storage options and conditions. The private art sector is characterized by the intention to perform efficient sales. Sourcing (finding and acquiring suitable artworks) is an important step in the sales cycle for most private art organizations. During the research process,

it became clear that innovation was an important factor for many of the stakeholders, with some looking for innovative ways to create art, whilst others might be looking for innovative pieces to offer or ways to present artworks. Artworks are still primarily created to be enjoyed in person, but there is a strong presence of online presentation, either as an incentive to view the works on location or in the form of online marketplaces. Another common job across the art industry is research and evaluation, which are accompanied by the creation of condition reports and conservation.

5.4 VALUE CREATION – 3D DIGITIZATION TECHNOLOGY

In order to create value for the art market, three primary forms of output for 3D digitized models were recognized: 3D visualization, 3D reproduction, and 3D documentation. 3D visualization refers to the creation of interactive or immersive digital representations of artworks that support enhanced public engagement, online presentation, and remote viewing. 3D reproduction involves producing physical or digital copies derived from high-quality 3D models, typically through CNC milling, additive manufacturing, or advanced printing techniques; these reproductions can serve preservation purposes, enable the creation of modified or derivative artworks, or facilitate display in situations where the original cannot be shown. 3D documentation concerns the accurate digital recording of an artwork's geometry, surface characteristics, and color information, forming a basis for long-term digital preservation. When combined with analytical tools, such documentation can also support research, condition assessment, and conservation planning by providing reliable data for virtual analysis.

The development of 3D technology within the private art sector is based on providing support for the stakeholders' main jobs. Once the possibilities for value creation were analyzed, three main categories of jobs where the mentioned outputs would be most efficient were recognized: production, research, and management.
The (re)production category refers to the enhancement of workflows through copy creation and digital manipulation. For this, 3D digitization technology could be used to create a digital twin, which can then be used for research, presentation, or altered to create previous or future versions of the artwork. New versions of the digitized models can be achieved through the application of CNC milling or 3D reproduction. As a result, it would be possible to use this new version for preservation, creating new versions of an artwork, or presenting digital copies within contexts where the original is not available.

The application of this technology was also recognized as a strong aid for the research phase, which presents itself as one of the key stages in most art-related workflows. This process uncovers the provenance and art historical context of the object, confirms authenticity, and offers conservation possibilities. Here, 3D digitization already presents itself as a strong aid in the public fine arts sector and could be applied similarly within the private environment. Within this context, digital documentation is essential to preserving the current state of the object. To have the most reliable information, it is important to have accurate geometry and color calibration, which would enable virtual analysis and conservation.

Finally, the third recognized category was the application of 3D technology for art management. This category encompasses activities related to the general management of the artworks, including insurance, marketing, and presentation. The 3D documentation mentioned above has great potential within this category. Additionally, 3D visualization can also be implemented to create additional value and encourage public engagement in the form of various types of presentation.

6. DISCOVERY AND ANALYSIS

6.1 DATA COLLECTION – FEEDBACK LOOP

With the research phase completed during the Erasmus+ Traineeship, the next planned step of this research project was the testing phase.

The final stage of the research was imagined as a case study that implements a feedback loop as part of the market research. This approach creates a circular system, where the information and collaboration of potential future users can be applied to the development and research of new technologies.

The study aims to follow a structured process consisting of outlined objectives and questions, targeted participants and methods, iterative feedback sessions, systematic analysis and in-

terpretation, and a final phase of report and action to consolidate insights and guide subsequent developments. During this process, personas that belong to the stakeholder categories are interviewed. Within the presented stakeholders, three specific interview phases have been defined and performed/

Within the first interview phase, feedback was collected during major art fairs. The specific context of these events enabled access to a variety of international galleries, where it was possible to conduct on-site conversations with individual market contributors. However, the specific environment of the fairs only allowed short feedback sessions with the possibility of extending the conversation further in the future. Feedback collected on-site revealed a broad spectrum of familiarity and interest in 3D technologies among galleries. A few participants were already experimenting with 3D digitization, sometimes without fully understanding the purpose, while others expressed curiosity and were open to follow-up conversations or email invitations. Several gallerists indicated that although they were not actively using 3D tools, they were willing to share insights or connect the project with specialized staff or artists familiar with digital methods. Some galleries, particularly those working with flat artworks or traditional owners, felt that 3D digitization was not directly relevant to their practice, citing limited time, existing workflows, or a lack of perceived need. A smaller number actively avoided engagement or declined interest altogether. However, a notable group, including digital managers and galleries already using 3D models for fair applications or artist presentations, showed genuine enthusiasm for further discussion. Overall, the feedback demonstrates cautious but emerging interest, with a clear divide between digitally engaged galleries and those with traditional or resource-limited structures.

The second interview stage was performed among existing personal social networks in the form of longer interviews, where participants were comfortable sharing their own insights, delivering more extensive feedback. Feedback from these conversations revealed a mix of cautious curiosity, practical concerns, and strategic reflections regarding the use of 3D technologies within the private art market. Participants generally understood the growing relevance of digitization. This was particularly prevalent within the context of sales, documentation, and remote client engagement. Few had direct experience using 3D tools themselves. They highlighted potential value in authentication, high-quality virtual display, international client outreach, and creating accurate, cloud-based records for research and conservation. At the same time, several concerns emerged, including the limitations of 2D interfaces for experiencing sculpture, uncertainty about the reliability of 3D models for authentication, and the complexities of onboarding, training, and integrating new tools within existing workflows. Stakeholders emphasized the importance of clear demonstrations, straightforward implementation, and transparency about technological limits. They also noted that decision-making typically lies with directors, senior specialists, or leadership that is heavily involved with technology. In their view, the logistics of accessing physical works remain a challenge. Overall, participants viewed 3D technology as supportive rather than transformative. A tool useful for enhancing sales processes, expanding accessibility, and assisting research, yet unlikely to replace the need for physical inspection or specialist expertise in high-value transactions.

Finally, the last research phase included reaching out to third-party personas relevant to the individual stakeholders and selected during the research phase. For example, within the auction house context, these would be digital managers, client relationship managers, specialists, and directors.

The research had as its main goal to examine perceptions, expectations, and practical application surrounding the use of 3D technologies within the private art market. Findings from the first two phases have highlighted a simultaneous curiosity and caution towards digital tools, marked by a clear distinction between stakeholders with higher digital engagement and those accustomed to a more traditional structure. The third research phase, intended to extend these findings through engagement with additional third-party stakeholders, could not be fully realized within the scope of this study. As such, the conclusions presented here are not exhaustive and will continue to be explored. Nevertheless, a consistency of themes across both interview phases indicates a consistent pattern of attitudes toward 3D digitization. Future research could build on this foundation by incorporating broader stakeholder perspectives to further test and refine these insights.

The interviews were envisioned as a feedback loop, with a circular approach that continuously informs the next conversation. The feedback sessions can continue to inform the next research priority. This stage of the project is still underway; the results of it will be used for additional testing purposes in the form of case studies.

7. IMPLEMENTATION

The final stage of this research project concerns the practical implementation of 3D digitization workflows within the private art market. This stage builds directly on the insights generated through the Discovery and Analysis phase, in which stakeholder needs, priorities, and expectations were defined, and preliminary feedback was collected through a structured interview cycle. The implementation phase will be carried out through a series of targeted pilot collaborations with stakeholders who have expressed interest in testing 3D digitization within their operational contexts. These collaborations will focus on small-scale projects that enable an initial assessment of product viability, workflow compatibility, and added value. This step is essential for translating theoretical and qualitative insights into operational evidence, allowing both the researchers and the participating organizations to observe the practical benefits and limitations of 3D technology in real conditions.

Ultimately, the goal of the implementation phase is to transform stakeholder feedback into actionable outcomes and produce real-world examples that demonstrate how 3D technologies can be integrated meaningfully into private art-market workflows. The results of these case studies will serve as the foundation for the concluding analysis and as a basis for future development, enabling both practitioners and technology providers to refine strategies for the long-term adoption of 3D solutions in the fine art sector.

8. CONCLUSION

This research set out to explore how 3D digitization technologies can support and enhance workflows within the private fine art market, a sector where digital practices remain largely undocumented. By applying the Value Proposition model, mapping key stakeholders, identifying their core jobs and priorities, and conducting multi-stage feedback sessions, the study aims to provide an analysis of opportunities and barriers for 3D technology adoption among galleries, auction houses, collectors, and artists. The research suggests that while digitization is increasingly recognized as essential for documentation, remote viewing, and market expansion, the private art sector exhibits a cautious and highly varied relationship with advanced technologies such as 3D digitization.

Findings from the art-fair interviews, extended personal-network interviews, and ongoing specialist outreach reveal that interest in 3D technology is shaped less by novelty and more by practical relevance. Stakeholders consistently emphasized the importance of accuracy, ease of integration, and the credibility of digital records. Many see clear potential in improved documentation, enhanced visualization, and the support of global sales processes, especially as online engagement becomes more common. Yet they also expressed reservations, particularly around the reliability of 3D models for authentication, the challenges of accessing physical works for digitization, and the difficulty of introducing new tools into time-constrained and resource-limited environments. Across nearly all interviews, 3D technology was viewed not as a replacement for expert knowledge or physical examination, but as a supplementary tool capable of strengthening existing workflows when applied thoughtfully.

The study confirms that meaningful adoption within the private art market will depend on demonstrating concrete value through real-world use cases. For this reason, the planned implementation phase, centered on pilot collaborations and case studies, represents a crucial next step. These cases will provide empirical insight into workflow efficiency, stakeholder satisfaction, and measurable benefits such as improved documentation, enhanced client communication, or reduced logistical burden. Such evidence is essential not only for refining technological solutions but also for building trust among potential adopters who remain hesitant due to limited familiarity or perceived risk.

Ultimately, this research contributes to a growing understanding of how advanced digitization techniques can be adapted from the GLAM sector into the private art market. By foregrounding user needs, mapping stakeholder priorities, and creating a feedback-driven approach, the project establishes a framework for future development that is both practical and scalable. As the

art world continues to negotiate the balance between physical and digital interaction, 3D technologies have the potential to support preservation, accessibility, and innovation across the sector. The continuing stages of this research aim to further clarify this potential and pave the way for informed, sustainable integration of 3D digitization practices within the complex ecosystem of the private art market.

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When AI Falls Short, We Recalibrate the Social and Technical: A Case Study in Context-Aware Innovation for Art Historical Research

Dr. Kiersten Thamm

HPF Innovations gGmbH (Navigating.art), Germany, kiersten.thamm@navigating.art

ABSTRACT: This article presents a practice-based reflection on developing context-aware innovation for art historical research. It's rounded in a case study from Navigating.art, a nonprofit organization that builds a digital platform for developing and publishing catalogues raisonnés and archives. When Navigating.art introduced an AI-based chatbot to its platform, the project sparked a critical dialogue about how technological tools intersect with scholarly ethics, epistemic standards, and disciplinary trust. Drawing on this experience, this paper outlines a framework for developing AI features that are participatory, transparent, and ethically grounded. It argues that meaningful innovation in art history must begin with the needs of scholarly practice and clear communication among all contributors, integrating humanistic reflection into every stage of digital development. The study contributes to ongoing conversations about responsible AI in the humanities, proposing careful methodological principles and a mode of collaboration between art historians and engineers.

1. INTRODUCTION

The digital turn in art history has never been solely about technology. It is a translation and reconfiguration of how we discover, construct, represent, and sustain knowledge about art and its histories. As digital infrastructures mature, they increasingly become sites where methodological questions, ethical commitments, and raisons d'être are negotiated.

This convergence was recently highlighted at Navigating.art, a nonprofit organization that builds a platform for art researchers creating digital catalogues raisonnés, archives, and other scholarly publications. When the organization introduced an AI-based chatbot, it introduced a productive provocation: it revealed how innovation in art history must be attuned to the epistemic, ethical, and collaborative structures that define the field.

This article retells that process and uses it to outline a structure for developing context-aware innovation for art historical research that is not defined by the pursuit of technological novelty, but by the cultivation of sustainable, participatory systems that enhance scholarly practice.

2. DIGITAL INFRASTRUCTURES FOR ART HISTORICAL RESEARCH

Founded in 2021, Navigating.art emerged at the intersection of art historical expertise and software engineering. The organization exists to help researchers discover, record, expand, and protect cultural heritage via its platform, enabling users to record, link, and publish structured data for the creation and publication of dynamic digital catalogues raisonnés and archives. Supporting researchers in reactivating traditional forms of scholarship helps ensure that the legacies of artists, institutions, and movements are made available to scholars and art enthusiasts worldwide.

A catalogue raisonné is a comprehensive, scholarly inventory of all known artworks by a single artist or within a defined category. It records each work's title, date, medium, provenance, exhibition history, and literature, along with critical commentary and illustrations. For art historians, collectors, and institutions, catalogues raisonnés are foundational research tools because they are used to trace provenance and map artistic development over time. Traditionally, producing such a catalogue could take decades and result in expensive, multi-volume printed tomes. Digital platforms like Navigating.art radically transform this process. They

allow catalogues to be published work by work as research progresses, accessed globally, and enriched through cross-referencing with archival material and related collections. They grow incrementally, create dynamic learning environments, and begin to include often-overlooked peoples.

Projects such as the *Romare Bearden Catalogue Raisonné*, developed by the Wildenstein Plattner Institute and published on the Navigating.art platform, exemplify this transformation.[1] It is not only the first digital catalogue raisonné for an African American artist but also a living, interconnected research environment. Readers can explore relationships between Bearden's artworks, archival materials, exhibitions, and publications, tracing how the artist's legacy unfolds across media and institutions. In this sense, Navigating.art's platform supports what Johanna Drucker argued for in *Graphesis* and related essays: graphical epistemologies are interpretive, data-driven forms of knowledge production that privilege dynamic relationships over static facts.[2] Drucker argues that digital tools in art history must not merely reproduce analog systems in electronic form. Instead, they should embody the interpretive and provisional nature of art historical reasoning itself.[3]
Navigating.art's mission aligns closely with this principle. Its platform does not seek to automate interpretation but to provide researchers with a flexible environment where data, images, and narratives can evolve together. In doing so, it bridges the gap between traditional scholarship and digital accessibility, fostering collaboration across disciplinary and institutional boundaries.

2.1 THE CHATBOT AS CATALYST: A CASE OF CONTEXTUAL LEARNING

In 2023, Navigating.art introduced a beta feature, the "publication chat," on its platform. The feature was designed to enable researchers to question digitized publications through a conversational interface, retrieving answers grounded in OCR-processed text and metadata. The feature combined AWS Textract for text recognition with OpenAI's GPT-4 embeddings for semantic search. Users could process a publication, generate vector representations of its contents, and ask natural-language questions such as "What gardens did Van Gogh draw?" The chatbot would retrieve semantically related passages and return a citation with page references.
However, when the chatbot was released to users in beta, it did not work as planned, nor was is enthusiastically received. Its answers were rarely exact enough, and the page numbers were often incorrect. The chatbot's prompt explicitly instructed the AI to cite page numbers and quote directly from the text. This design attempted to simulate academic citation; however, users quickly discovered discrepancies between the chatbot's references and the source material. This mismatch highlighted the difference between computational truth (statistical plausibility) and scholarly truth (verifiable evidence).

But the users' strongest complaint was a lack of need for the feature. Their concern was not with the existence of AI itself, but with the perceived incongruity between the chatbot's probabilistic logic and the scholarly conventions of citation, accountability, and authorship. Technically elegant though it was, the feature's integration elicited strong emotional responses that caused Navigating.art to reasses its general release. This experience became a moment of productive friction and forced Navigating.art to articulate what helpful innovation looks like in art historical research.

2.2 LESSONS FROM THE PUBLICATION CHAT

The experience of developing and releasing the chatbot yielded several key insights.

Innovation excels only with ongoing communication. For most new features on the platform, Navigating.art's development process is highly structured. Users articulate their needs, and the Navigating.art team develops strategic, technical solutions to them. This system allows contributors to do what they do best while respecting the expertise of others, and that respect is required by all parties to create effective tools.

The chatbot development deviated from this process. It was an internally driven experiment inspired by the excitement surrounding large language models. This is common practice within engineering teams; some features do start from personal projects from individual team members, and they can be extremely helpful as external stimuli for unconventional experimentation in research and methodologies. But for this to happen, a deep awareness of user goals and process still needs to exist. The lack of a use case meant that the chatbot was seen as distinctly unhelpful.
Iteration creates transparency. The chatbot was released in beta with the intent to improve its output through user collaboration. The iteration

at the base of this process is sound, but it would have been more productive to start the iteration process before the feature had reached beta. The strong reactions to the chatbot from its users underscored that innovation cannot be isolated from community consultation and clear communication among all experts, even at the beginning.

In art historical research, where authority is grounded in scholarly consensus and source transparency, introducing AI without deep co-design can appear to disrupt trust. This adds to the general level of distrust between art historians and technologists. For decades, engineers have brought unneeded and unhelpful digital tools to art historians, proclaiming the power of the digital while grossly misunderstanding the work of art historians. This is why Sonja Drimmer and Christopher Nygren's first axiom is so important: "The history of art is not a problem to be solved."[4] The chatbot taught the organization to re-anchor its innovation processes in participatory dialogue, where clients are not end-users but co-creators of digital tools.

The human is remains central. The chatbot experience reaffirmed that AI cannot replace the art historian's interpretive labor. It can only augment it. Computation in art history must support the hermeneutic dimensions of research, not obscure them. Rather than seeing AI as a source of authoritative answers, Navigating.art began to conceptualize it as a generative interlocutor, a system that provokes new questions, supports pattern recognition, and accelerates repetitive tasks, while always leaving interpretive authority with the human scholar.

These lessons contribute to context-aware innovation. It became clear through this process that, for AI tools to serve art historians meaningfully, they must be context-aware: they must be developed with deep attention to disciplinary values, epistemic standards, and social structures. In the field of human-computer interaction, context-awareness refers to systems that sense and adapt to their operational environment. In art history, this idea must be extended beyond environmental data to include social, cultural, and epistemic contexts. A context-aware innovation in art history is one that acknowledges disciplinary methods, centers the researcher's workflow, engages users as collaborators, maintains transparency and accountability, and reflects ethical and historical consciousness. It understands that art historical reasoning is interpretive and relational, not purely factual. The publication chat highlighted that context-awareness is not a technical property but a relational practice. It must be built through sustained collaboration between engineers, researchers, and institutions.

2.3 TOWARD PARTICIPATORY DESIGN IN ART HISTORICAL AI

The recalibration following the chatbot's reception led to a deeper internal reflection: How might art historians and engineers design AI tools together, not just for one another? How can they share a common language to do so?

Navigating.art considers digital tools as a form of scholarship; its platform results from and contributes to a set of choices about what counts as knowledge, which data are preserved, and whose voices are heard. It can be used to create communities of interpretation where iterative, reflexive processes that bridge the expertise of technologists and historians. Participatory design does not merely improve usability but reshapes epistemology. When art historians help to build the tools they use, they embed their disciplinary standards into the codebase itself. This collaboration transforms innovation from a product into an ongoing relationship.

Every innovation carries ethical implications. In the context of art history, these include issues of authorship, provenance, data privacy, and representational justice. The development of AI tools must be guided not just by general frameworks like the EU's Ethics Guidelines for Trustworthy AI or UNESCO's Recommendation on the Ethics of Artificial Intelligence, but by field-specific principles. Art historical research is uniquely situated within networks of cultural heritage, often entangled with histories of colonialism, exclusion, and restitution. Fairness in AI cannot be defined solely in computational terms but must reckon with the ethical stakes of representation.

2.4 APPLYING INSIGHTS FROM THE CHATBOT EXPERIMENT

The chatbot was ultimately retired from active use, but its influence persisted. It catalyzed a cultural shift within Navigating.art, transforming AI from an external technological novelty into an internal process of reflexive learning.

The team recognized that the most productive innovation lay not in the chatbot itself, but in how it redefined collaboration. The teams' engineers and art historians began to engage with greater deference toward one another, discussing not only what AI could do but also what it should do in relation to scholarly practice. This shift echoes a model of digital development that

foregrounds reflection, transparency, and participation as integral components of design, a model particularly informed by the writings of Drucker and Patrick Svensson.[5] The chatbot experience effectively functioned as a generative mirror: by testing the potential of new technologies, it clarified the values that must guide all future technological interventions in the field.

Navigating.art continues to carefully explore the potential of AI with its users, despite the often polemic oscillations between fascination and frustration with the technology in the field. Failures do abound. In July 2023, *The Art Newspaper* reported on a controversy surrounding an AI-attributed Raphael painting, which was swiftly rejected by experts.[6] A project at the Metropolitan Museum of Art used AI to generate labels for artworks, but the system's suggestions often reflected biases in the training data and required extensive manual correction.[7] But that doesn't mean that AI application is always unsatisfying. A team at Ludwig-Maximilians-University Munich applied AI to image and text metadata to flag and surface underrepresented works by female artists, transparently tracking bias in the training process.[8] And while machine vision models may detect stylistic patterns, they cannot account for the interpretive, contextual, and material dimensions of attribution. These episodes illuminated the potentials and limits of current AI approaches within art history.

Rather than rejecting AI altogether, context-aware innovation treats such moments as critical feedback loops. The Raphael incident reminds us that AI systems trained outside disciplinary contexts lack hermeneutic literacy. They see patterns, not meanings. The solution is not to exclude AI from art history, but to embed art history into AI development by curating training data, defining interpretive parameters, and aligning computational logic with scholarly reasoning.

The lessons from the publication chatbot and the cited scholarship inform a framework for context-aware innovation that reflects ongoing projects at Navigating.art, including the development of a new image recognition feature. This initiative is being approached deliberately, with a strong emphasis on user engagement, cross-disciplinary collaboration, and reflective practice. The team is speaking regularly with other art historians and engineers working on similar projects, ensuring that the feature addresses real research needs. Development is proceeding slowly, acknowledging that meaningful innovation in art history requires patience, iterative testing, and careful attention to scholarly standards.

Begin with research, not technology. Development starts from the priorities of art historians. Field interviews and consultations identify where automation can meaningfully support research, ensuring that the technology aligns with the interpretive practices and ethical expectations of the discipline.

Build participatory design structures. Cross-disciplinary teams comprising art historians, archivists, and engineers contribute to new features as shared hypotheses rather than fixed products. The image recognition project is explicitly shaped by user input and engineering consideration at every stage, embedding both sets of expertise into design decisions.

Embed reflexivity into infrastructure. Iteration, reflection, and even withdrawal are valued as integral to the development process. The Navigating.art team recognizes that taking time to pause and reconsider is often as productive as releasing a new feature.

Cultivate trust through communication. Clear explanations of development choices and ongoing dialogue with researchers foster confidence in both the process and the product. Users are not passive recipients but active participants whose perspectives shape the system.

Design for augmentation, not replacement. AI is positioned as a partner to human expertise, accelerating routine tasks and highlighting patterns while leaving interpretive authority firmly with scholars. In the image recognition project, this principle ensures that the technology enhances rather than supplants the nuanced judgment central to art historical research.

Through this framework, Navigating.art demonstrates how careful, context-aware innovation can produce tools that are both technologically sophisticated and deeply aligned with the epistemic and ethical commitments of the discipline.

3. CONCLUSION

The future of AI in art history will depend on our ability to integrate technological possibilities with humanistic sensitivity. The task is not simply to adopt AI, but to situate computational tools within the epistemic traditions and ethical commitments of the discipline. As more institutions develop digital catalogues, archives, and research environments, the infrastructures we build will increasingly determine how art his-

torical knowledge is produced, shared, and preserved. Each metadata schema and algorithm participates in the making of history.

Context-aware innovation asks us to slow down, to build reflectively, and to treat digital development as a scholarly practice in itself. The lesson of the Navigating.art chatbot is not about technological success or failure; it is about the generative potential of dialogue. When innovation emerges from conversation between disciplines and between humans and machines, it becomes not a disruption but a continuation of the art historical project: the ongoing interpretation of context, meaning, and relation.

4. ACKNOWLEDGMENT

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DAY 2
“Museology, AI and Heritage”

Thursday March, 19 2026

SESSION I

“Curatorial and Innovation”

Moderation: Dr. Marinos Ioannides
(Digital Cultural Heritage Research Centre MNEMOSYNE, University of Technology, Cyprus)

Co-Curating with the Machine – Rethinking Audience Engagement Through AI Mediation

Clio Flego

Arts and Humanities Department, Universitat Oberta de Catalunya, Spain,
clio.flego@gmail.com

ABSTRACT: The integration of Artificial Intelligence (AI) into curatorial practice is reshaping technical, philosophical, aesthetic, and ethical dimensions. Beyond advancing digitisation and metadata, AI questions authorship, authority, and knowledge production. Institutions like Harvard Art Museums and projects such as *Curatorial A(i)gents* illustrate AI's potential to propose new interpretive frameworks, while Natural Language Processing (NLP) and Machine Learning (ML) tools enable co-curation through content suggestion, semantic linking, and generative writing. AI also addresses structural inequities in curatorial systems. Jarvis AI's blockchain-based scoring at the Bucharest Biennale exposed both the democratising potential and risks of algorithmic bias, underscoring AI's relational—not autonomous—role. Case studies like Krysa's AI-assisted curating at the Helsinki Biennial and Sean Carroll's *Listen, Scoundrels!* show how AI reconfigures curatorial logic into dynamic, discursive environments. Audience tools such as ChiM, ArtChar, and immersive projects like *Hello Vincent* foster participatory engagement, transforming spectators into co-authors. This presentation examines emerging tools, ethics, and practices redefining curatorial roles and cultural narratives across digital and physical spaces.

1. INTRODUCTION

The integration of Artificial Intelligence (AI) into curatorial practice represents a multidimensional transformation that affects technical, philosophical, aesthetic, and ethical dimensions. The development of new media opened up possibilities for rethinking exhibitions in both physical and digital spaces [1], which—with the irruption of AI-driven systems—have evolved toward collective and user-centered creation [2]. As Mariátegui et al. [3] affirm, these systems are not merely tools but active agents in redefining curatorial logic, authorship, and knowledge production.

Within this trend, in the institutional context database optimization and metadata curation have become increasingly significant as collections are digitized [4]. Image recognition technologies support the classification, analysis, and identification of artworks—significantly aiding authenticity verification and provenance research [5]. Although not without limitations, AI-enhanced systems improve metadata enrichment, anomaly detection, and taxonomic structuring, enabling more dynamic and scalable archival infrastructures [6].

Contemporary tools powered by Natural Language Processing (NLP) and Machine Learning (ML) assist in data analysis, content recommendation, and generative writing, facilitating new forms of co-curation between human and non-human agents [7,3]. This approach supports decentralized curatorial decision-making, positioning the curator increasingly as a mediator collaborating with algorithms.

In this framework, the convergence of audience interaction and knowledge production is reinforced through the combined efforts of artists and museum digital services. On one hand, artists' works interrogate the environmental and ethical implications of autonomous AI systems in storytelling and curation; on the other hand, tools such as mobile applications and web-based platforms enable audience participation in co-curation. Through AI-driven immersive narratives and empathic human simulation, multilayered storytelling and emotional resonance impact audience engagement, fostering a dynamic curatorial process in which visitors can influence the exhibitions themselves. In this context, continuous interaction within a partici-

patory feedback loop generates a hybrid curatorial ecology where audiences and machines co-construct meaning, introducing new forms of personalization and collective authorship.
This presentation will explore the shifting institutional logics that emerge from the integration of AI-driven systems into curatorial workflows, focusing particularly on technological innovations and best practices through which machines collaborate with human curators and audiences to reframe cultural narratives.

2. MAIN ASPECTS

Since the advent of new media in art exhibitions, curators have increasingly operated as dynamic, multitasking intermediaries among artists, communities, economic partners, and institutional actors. As Paul [8] stated, exhibitions have become spaces for broadcasting data flows and market dynamics, transforming curators into filters and commissioners rather than traditional caretakers, collectors, or conservators of exhibitions.
In media art institutions such as FACT Liverpool, the adoption of new technologies within exhibition settings functioned as a strategic tool for advancing institutional business objectives while simultaneously expanding audiences for digital art [9].
Within this framework, various curatorial models have redefined exhibitions as dynamic sites of encounter and exchange between artists and audiences. Among these are relational models, which foreground social interaction and collective experience as the artwork itself [10]; situational models, which emphasize the context, environment, and temporal conditions in which art is produced and received [11]; and participatory models, which invite audiences to become active contributors to the creative process, blurring the boundaries between artist, curator, and viewer [12].
The irruption of AI-driven systems in this context is profoundly reshaping approaches to artistic practice and exhibition-making, positioning AI as an active mediator of audience interaction across multiple levels. Acting both as a technological interface and a cognitive partner, AI systems influence how curatorial narratives evolve within increasingly hybrid and participatory environments, affecting how meaning is produced and how viewers perceive artworks.
With the aim of proposing new interpretive frameworks that go beyond traditional curatorial logic, museums such as the Harvard Art Museums have embraced AI-powered programs to analyse their collections—such as the interactive project *Curatorial A(i)gents*, developed by metaLAB [13]. In this context, the emerging potential of ML systems was explored to reinterpret the museum's own data as a medium for creative expression, combining playfulness with analysis in a critical perspective. Among the different projects, through algorithmic analysis and visualization, Lins Derry's *Second Look: Gender and Sentiment on Show* exposes the implicit gendered and affective biases that shape museum collections. Similarly, *A Flitting Atlas of the Human Gaze*, developed by Jeffrey Schnapp, Dietmar Offenhuber, Todd Linkner, and Kevin Brewster, uses machine vision to chart the "ocular politics" of the museum's collections—mapping who looks at whom across coins, prints, photographs, and paintings. Through audience movement and gesture detection, Lins Derry, Jordan Kruger, and Maximilian Mueller explored *mlml.io/p/choreographic-interface/*, investigating how a choreographic interface could allow visitors to engage physically with the exhibition's AI systems.
In order to help curators and audiences navigate large museum collections and make classifications more inclusive and socially aware, artistic research projects such as *Dust and Data* (2021), by Arthur Flexer and colleagues [14], have used ML as a tool to uncover algorithmic biases through the semantic linking of artworks—embedding everyday language and recontextualizing, or "resocializing," taxonomic art histories through NLP.
Similarly, opening the doors to more inclusive mechanisms, *Jarvis AI*, created by Răzvan Ion and Spinnwerk Vienna, used blockchain and algorithmic systems to score and select artworks for the Bucharest Biennale (2022). The process was designed to increase transparency and decentralize curatorial decisions through a "score value" based on thematic alignment and artist popularity, raising concerns about how algorithmic bias and data-driven hierarchies may reinforce existing inequities [15,16]. Through this, the project unveils the dual nature of AI: while on one side it aims to act as a democratizing force, on the other it functions as a potential enemy of inclusion.
In this framework, it is important to note that while the primary objective of AI has been to support decision-making processes, AI itself lacks cognitive intent or will. Aligned with Turing's conception of a hypothetical device capable of solving the *Entscheidungsproblem*, its influence is rhetorical and relational rather than

autonomous, operating through logical validation rather than conscious judgment [17].

Following this trajectory, Krysa's [18] hands-on approach exemplifies this shift, defining the curator's role as that of a mediator collaborating with algorithms rather than the exclusive arbiter of meaning. At the Helsinki Biennial (2023), she experimented with AI-based spatial embedding of artworks, employing geolocation and image-to-text models to curate immersive environments, effectively reimagining the collection as a digital geography [19].

Extending this trajectory in the use of archives, the 2025 exhibition *Listen, Scoundrels!*, curated by Sean Carroll for the Computer Arts Society, further explores AI's curatorial potential by provocatively interrogating the epistemological and ideological foundations of human–machine collaboration [20]. The project opens the archive's materials—processed by AI—to audience interpretation, integrating the viewer's perspective into the perception of the works themselves. At the same time, the inclusion of an AI chatbot within the exhibition positions the machine as a tool for enhancing understanding and engagement. By facilitating access to information, this approach exemplifies the evolving role of the audience, leveraging its political and rhetorical agency and inviting viewers to see AI as both a mirror and a critique of curatorial authority—challenging institutional norms and amplifying dissenting narratives.

Similar yet distinct in their design, conversational and participatory AI agents—such as *ChiM* (Chatbot in the Museum) [21] and *ArtChat* from Nextmuseum.io [22]—extend curatorial dialogue into digital and networked environments. While the first addresses both factual and open-ended questions through touchscreen and voice interaction powered by the BERT language model, the latter combines AR technology and communication among visitors within an exhibition context. In *ArtChat*, visitors use a mobile app (or museum-loaned tablet) to scan QR codes attached to artworks or exhibition objects; once scanned, they can post comments and position them as 3D elements within the augmented exhibition space. In doing so, audience members become active co-commentators, engaging in an ongoing dialogue that extends beyond the physical museum visit. This process transforms the audience into participants within an evolving conversational network surrounding the artworks. Moreover, by contributing comments and engagement data, visitors also serve as data-providers whose interactions can inform curatorial strategies and support the planning and optimisation of future exhibitions.

Another example is the *Hello Vincent* application, developed by Jumbo Mana for the *Van Gogh in Auvers-sur-Oise* exhibition at the Musée d'Orsay, which invites visitors to converse with Van Gogh via generative AI linked to human behaviour, bringing virtual characters to life. In this framework, ongoing applications of AI in VR and AR technologies aim to accelerate the production of 3D models and artwork reproductions, enabling more responsive and reliable conversational interfaces powered by AI-driven agents.

Particularly relevant in this context are the projects of David Link [23] and Iris Qu [24]. In *May Not the Soul Be as Balloons (Curated by Poetry Machine, 2021)*, Link's AI-driven text generator assumes a curatorial role—producing detailed descriptions from essay fragments that 14 artists interpret through new artworks. Here, the machine acts as curator, shifting authorship from human to algorithm and constructing an exhibition co-authored by human and machine. Conversely, in *Do AIs Dream of Climate Chaos*, Qu explores the environmental entanglements of AI through a speculative scenario in which a weather-forecasting system exchanges knowledge with local ecosystems. By envisioning AI as an autonomous agent within ecological systems, Qu invites audiences to reconsider the machine as an ecological, rather than merely computational, entity.

3. CONCLUSION

AI exerts a profound and multifaceted influence on curatorial practice, extending across technical, philosophical, aesthetic, and ethical dimensions. As demonstrated through the discussed best practices, a broad spectrum of technical approaches has emerged, reflecting the diversity of curatorial perspectives and institutional contexts. Aligned with established models in media art—particularly the relational (Bourriaud, 2002), situational (Doherty, 2004), and participatory (Bishop, 2006)—AI continues to redefine the curatorial field by reshaping roles, authorship, and interpretative narratives among curators, artists, and audiences.

Within this evolving framework, the audience is an active participant in the iterative and interpretative process. AI-generated content often evolves in real time, responding to audience physical or visual interactions, embedding collective perspectives within its probabilistic and data-driven systems. Rather than simply mim-

icking human curatorial decisions, AI co-produces meaning through patterns of interaction, building continuative dialogue based on a constant feedback, thereby transforming exhibitions into living and adaptive interfaces. This process challenges traditional hierarchies of authorship, as well as it also exposes the underlying biases and limitations of machine-mediated interpretation.
Such practices exemplify a curatorial paradigm fully integrated with AI technologies, where cross-disciplinary exchange between art, design, computer science, and cultural theory becomes fundamental. Through adaptive recommendation systems, generative interpretation models, and responsive interfaces, curating is reimagined as a dynamic process of knowledge production and shared authorship. This transformation opens new possibilities for dialogue, experimentation, and inclusion, while simultaneously demanding a more critical awareness of algorithmic agency and its socio-cultural implications.

Ultimately, AI-driven curation calls for a reflective practice leveraging technological innovation in order to embedding multiple collective perspectives, ensuring that the production of art and culture remains ethically grounded, inclusive, and critically engaged.

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Accessing the Hidden Core: Connecting Museum Collection Records through the Heidelberg Accession Index (HAI)

Valentina Salcedo Paparoni

Digital Museum Services, Staatliche Museen zu Berlin – Preußischer Kulturbesitz, Germany,
v.salcedopaparoni@smb.spk-berlin.de

ABSTRACT: Museums are not only repositories of objects but also dynamic information spaces, where collections, inventories, and administrative records document complex object biographies and institutional knowledge. Much of this information remains hidden in analog structures, limiting access and scholarly use. This paper examines the challenges of digitizing historical museum documentation and presents the Heidelberg Accession Index (HAI) as a solution. HAI provides a comprehensive, interoperable infrastructure for the publication and exploration of accession registers and inventories from German museums, combining sustainable digitization, AI-assisted transcription, and rights-compliant data management. By exposing the previously hidden informational core of collections, HAI enables transdisciplinary research, supports provenance and object biography studies, and transforms museums into open, data-driven knowledge environments.

1. INTRODUCTION

The pathways and strategies for digitizing and providing online access to cultural heritage are diverse: digital editions, 2D and 3D object digitization, online catalogs, and more. However, the majority of museums only exhibit a small fraction of their extensive collections to the public [2][4][7]. The majority of these collections remain stored in depots and storage facilities—largely invisible to the public—as does the core information connected to these artifacts.

For several decades, digitization initiatives have enabled at least partial glimpses into these hidden holdings. Such efforts seek to make the complexity of museum objects as "polysemic informational carriers" [10] accessible online by relating digital surrogates to their corresponding metadata. Nevertheless, few institutions have succeeded in providing comprehensive access to entire collections or in establishing large-scale cross-institutional networks.

When an object enters a museum collection, its original context is replaced by a new one [10]. Alberti calls this original production context "the prehistory of the object" [4]. Within museums, this prehistory is reshaped through a series of political and epistemic decisions: objects are described, classified, curated, conserved, and restored [4]. As a result, they acquire a new layer of meaning within the museum's institutional framework [10]. Alberti emphasizes that this moment is often "the most significant event in the life of a museum object—and the point at which documentation tends to be richest" [4].

Acquisition and Accession Logs form a crucial interface between object, institution, recontextualization, and interpretation. As some of the earliest layers of documentation in the museum system, they are essential primary sources for the study of collection histories and object provenances. Over decades or even centuries, they record acquisition strategies, previous ownership, purchases, donations, excavation circumstances, losses, and relocations. However, due to their primary nature as handwritten documents, they have been challenging to access, restricted to specific physical locations, and rarely systematically digitized.

The Heidelberg Accession Index (HAI) [13] establishes a new digital research infrastructure that provides online access to and cross-institutional searchability of accession registers and inventory books from German museums and collections. The project began with approximately 1,000 accession books from the Staatliche Museen zu Berlin, covering the years 1650 to 2010, more than 850 of which have already been digitized and published. Additional volumes from Bonn, Dresden, Göttingen, Karlsruhe, Nuremberg, Stuttgart, and Heidelberg have since been added.

HAI not only ensures comprehensive digital access to entire collections but also creates a large and heterogeneous data corpus with significant untapped potential—particularly for AI-based applications such as transcription, layout recognition, and the automated extraction of structured information.
In addition, HAI supports collaborative and transdisciplinary research approaches, fostering data-driven analyses of object biographies, collection histories, provenances, and networks of actors. Its open access strengthens academic research while contributing to broader curatorial and societal debates around provenance, accountability, and transparency in cultural heritage.

2. THE HIDDEN CORE

The integration of an object into museum administration marks the beginning of a new chapter in its biography. The entry into logbooks, inventories, or documentation systems is not merely an administrative act but an epistemic repositioning. Across different informational layers, objects are documented, described, and recontextualized—formerly in structured, handwritten tables and increasingly in digital databases today.

These registers vary in depth and granularity, containing information on provenance, descriptions, classifications, conservation, and restoration measures. The informational density ranges from brief administrative notes to detailed contextual narratives and object-biographical references. Inventories thus not only represent institutional knowledge and material object properties but also record the dynamic processes of museum work: exhibition activities, loans, internal movements, and changing institutional frameworks.

As Alberti argues, the integration of an object into the institutional order of a museum fundamentally transforms its "prehistory" [4]. The original narrative is overlaid, extended, or replaced entirely.

The Acquisition and Accession Logs of the Staatliche Museen zu Berlin reflect this process in exemplary fashion. Kept continuously since the seventeenth century, they now constitute a complex and often tangled web of information.

Registration and inventorying are core components of everyday museum work, and these registers have long been among its most essential working tools. For generations, museum directors, custodians, and curators have used them for daily consultation, the completion or correction of entries, and the ongoing documentation of collections. Traditionally, these volumes were internal institutional tools, not intended for public access. As such, they record not only object-related information but also the institution's own knowledge structures—working methods, decision-making processes, collection strategies, and acquisition policies developed over centuries.

The Berlin inventories are therefore both institutional knowledge *carriers* and performative artifacts, especially in the context of postwar collection revisions. In late 1942, Otto Kümmel [6], then General Director of the Staatliche Museen, ordered the security microfilming of all inventory registers. In the specific case of the Kunstgewerbemuseum, one copy of these microfilms was stored in the Kaiseroda mine and eventually transferred via the Central Collecting Point Wiesbaden to West Berlin in 1956/57 [9]. Another copy survived the war with Erich Meyer [8] in Berlin-Frohnau [9]. Because the original registers remained in East Berlin, these microfilms became the only basis for identifying dispersed artworks in the West [9].

For decades, staff at the Kunstgewerbemuseum carried out revisions of these separated collections without mutual coordination. In East Berlin, work continued with the original registers, while in West Berlin, staff relied exclusively on the microfilm copies. Both versions were maintained and updated with handwritten annotations noting losses, revisions, and relocations. For instance, colleagues in West Berlin marked certain entries in red to indicate objects that were confirmed lost or were presumed to have remained in the East Berlin collection. This situation resulted in the emergence of two parallel and independent documentation systems that persisted for decades. Since the 1990s, museum staff have been working to reconcile these records and to determine whether existing gaps represent actual losses or objects that continued to reside in one of the two collections.

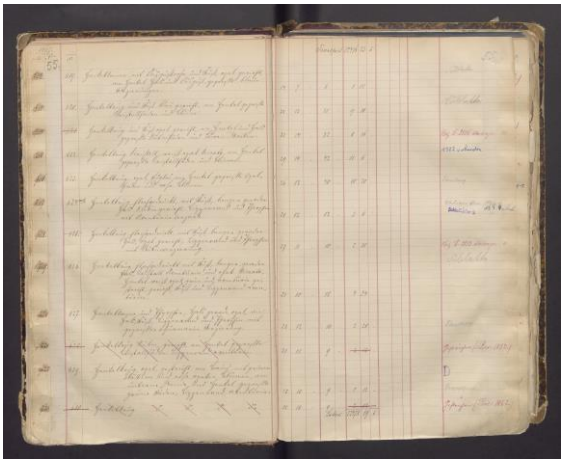

***Figure 1**: Page 55 from the inventory book, Collection 1867–1869, circa 1867 © Staatliche Museen zu Berlin, Kunstgewerbemuseum*

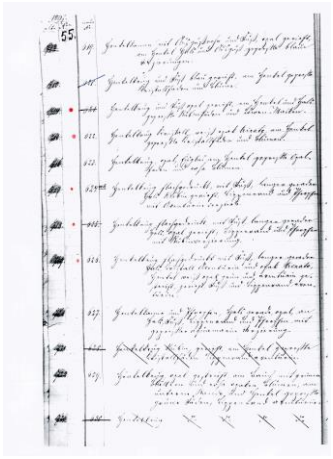

***Figure 2**: Page 55 from the inventory book, Collection 1867–1869, security microfilming 1942 © Staatliche Museen zu Berlin, Kunstgewerbemuseum*

3. ACCESSING THE HIDDEN CORE

Museums function as dynamic information spaces where material and immaterial knowledge are deeply intertwined [10]. This information is not static: objects as *information carriers* are continually reinterpreted and recontextualized. Events such as technical analyses, restorations, deaccessions, or war-related circumstances can fundamentally alter an artifact's informational core [10].

A key question arises: How can the multiple informational layers embedded in museum documentation and administration be made accessible? Institutional practices shape what is visible and usable: exhibition displays, catalog publications, and selected metadata for online portals each reveal only partial aspects of an object's information. The actual *Hidden Core*—the institutional, material, and documentary layers underlying these public interfaces—remains largely inaccessible.

Accessing this core is not simply a matter of institutional policy or technical infrastructure. The real challenge lies in making these different, and at times conflicting, informational layers—original entries, security microfilms, handwritten annotations, and later reproductions—available as an integrated, researchable data corpus.

The research project *Provenance and Collections. Publishing the Acquisition and Accession Logs of the Staatliche Museen zu Berlin Online* [11] pursued two main goals: the digital preservation of irreplaceable materials essential to museum documentation and object biographies, and the creation of maximum transparency in collection documentation, aligned with relevant international frameworks such as the Washington Principles [14], "Open the Inventories!" [12], and the German "Three-Way Strategy" for handling objects from colonial contexts [5].

Practical implementation revealed familiar challenges. In addition to complying with established digitization and quality standards, the most significant difficulty lay in developing a coherent organizational structure and data model. The source materials were originally created as working tools rather than standardized records, and over more than two centuries, collection mergers, inventory campaigns, and the division of institutions into East and West—the so-called *Zwillingsmuseen*—have generated a labyrinthine network of information.

The Kunstgewerbemuseum illustrates what is typical for most Berlin collections: parallel inventories, security microfilms, handwritten copies, and marginal notes on losses or revisions together constitute a complex informational chain essential for reconstructing object biographies. These shifts—between original entries, machine reproductions, handwritten or typed transcriptions (often with layout changes), and selective excerpts—produce multiple coexisting versions, each carrying part of the knowledge. No single version can fully reconstruct an object's biography.

The project made two key decisions: (1) to retro-digitize all available materials, including marginalia and copies, and (2) to treat each documentation unit as an independent information object. This approach captured not only the relationship between inventory volumes and objects but also relationships between the volumes themselves—such as chains of original, copy, and transcription, and migration-induced informational shifts resulting from historical institutional changes.

To ensure sustainable publication and reuse of this digital corpus, the project collaborated with the Heidelberg University Library to develop the Heidelberg Accession Index (HAI). From a thematic standpoint, HAI expands upon existing provenance research partnerships, like the well-known *German Sales* platform [1].

Figure 3: *Landing page of the portal HAI*

Technically, HAI is based on DWork, Heidelberg's in-house digitization workflow [3]. This system supports the entire digitization and publication process: metadata creation (including structural data), image processing (conversion and OCR), web presentation, and long-term archiving via heiARCHIVE [3]. Persistent identifiers (DOIs, URNs) and open interfaces (OAI-PMH, IIIF, KBART, DFG-Viewer) ensure interoperability and reusability [3].

This infrastructure allows each documentation unit to be treated and referenced as a standalone information object. Precise addressing of volumes, chapters, and pages enables the systematic analysis of information layers within and across collections.

A major issue in publishing large datasets is rights management. Although the project is guided by transparency, personal data in the registers must be protected. Names and personal contact details are redacted, and a ten-year "moving wall" governs when embargoed information is released.

Heidelberg University Library developed an automated workflow: coordinates of redaction areas and embargo expiration dates are stored and applied during file conversion, enabling automatic and repeatable redaction updates [3].

HAI is designed as an international platform for publishing museum collection information. It not only enables the standardized dissemination of heterogeneous historical materials but also provides decision-making tools for handling sensitive information through automated redaction workflows [15][16].

Furthermore, HAI integrates AI-powered handwriting recognition, significantly lowering barriers to accessing handwritten sources and expanding their research potential.

Since its launch in 2024—beginning with the Staatliche Museen zu Berlin—more than 20 museums in Germany and Austria have joined the platform. The resulting heterogeneous yet structured digital corpus opens new avenues for AI-based transcription and named entity recognition, network analysis of actors and provenances, diachronic studies of institutional knowledge production. It also expands curatorial, legal, and societal discussions around provenance, responsibility, and transparency.

4. CONCLUSION

Museums are not only repositories of objects—they are information spaces and sites of knowledge production. Their collections, inventories, and administrative records document complex object biographies and institutional knowledge practices across centuries. Much of this information remains embedded in analog structures and only partially visible to the public.

Digitizing these holdings poses a dual challenge. It requires robust technical and organizational solutions to make heterogeneous historical materials accessible and secure for the long term, while also addressing institutional and legal frameworks that regulate access to sensitive information.

HAI was developed to meet these challenges. It combines sustainable digitization, technical precision, rights-compliant data management, and open reusability. HAI makes the previously hidden informational core of museum documentation visible, enabling transparent cross-institutional relations and opening new research perspectives.

In doing so, HAI contributes to transforming museums from closed repositories into open information spaces, where historical complexity is not simplified but made productive for research, curatorial work, and societal engagement.

5. ACKNOWLEDGMENT

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SESSION II

“Digitality and Museology”

Moderation: Jacopo Spinelli M.Sc.
(Brandenburg University of Technology Cottbus-Senftenberg)

From Data to Dialogue: Rethinking Visitor Participation through Interactive Installations and Citizen Science in the Museum

Ph.D. Manuel Scortichini

[a]School of Architecture and Design 'Eduardo Vittoria', University of Camerino, Italy,
manuel.scortichini@unicam.it

ABSTRACT: In the era of smart responsive spaces, the relationship between museums and their audiences is increasingly shaped by interactive systems that gather, interpret, and respond to visitor data. This paper explores how the creative use of visitor tracking, behavioral analytics, and participatory technologies can foster new dialogue between cultural institutions and their publics, transforming data collection into a collaborative, educational, and even artistic process. Moving beyond personalization as a tool for marketing or optimization, the paper proposes a framework in which visitor data becomes the basis for co-creation and scientific citizenship.

Through interactive installations, real-time visualizations, and adaptive learning environments, visitors are not merely observed but actively engaged in meaning-making processes. These environments invite reflection on one's own experience and promote collective awareness about how data circulates, influences narratives, and shapes cultural interpretation. Drawing on international case studies that integrate citizen science protocols, data-driven artworks, and participatory museum programs, the research investigates how visitor data can be used ethically and poetically, as both a medium and a message. It examines how these hybrid spaces support mutual learning, empower agency, and facilitate the museum's role as a civic platform for scientific literacy and social imagination.

Special attention is given to curatorial strategies and digital pedagogies that involve visitors not as consumers, but as contributors and co-researchers, generating content, patterns, and interpretations. By embedding transparency, consent, and inclusivity at the core of these processes, museums can reclaim their role as dynamic, relational ecosystems where technology enhances—not replaces—human connection. This contribution aims to reflect on how to shift from data extraction to data dialogue, proposing a new ethics of mediation rooted in creativity, reciprocity, and shared knowledge production within digital cultural spaces.

1. INTRODUCTION

Museums are increasingly shaped by sensor-rich environments, AI-based mediation, and extended reality (XR) displays. These hybrid settings promise personalisation, adaptive storytelling, and fine-grained analytics, but, at the same time, they also risk narrowing public culture through opaque classifications, proprietary models, and extractive data practices. This article argues that the real opportunity of "intelligent spaces" is dialogue: turning visitor data from something captured about people into something negotiated with people, thereby expanding understanding, agency, and care. This reframing echoes Human–Data Interaction (HDI), which centres Legibility, Agency, and Negotiability as design priorities for data-driven systems (Mortier et al., 2014).

Data Dialogue is defined here as a socio-technical approach in which museum data flows are (i) legible to visitors and staff, (ii) actionable for those affected, and (iii) negotiable over time. Rather than rejecting analytics or machine learning, the approach embeds them in curatorial ethics, accessibility, and interoperability so that technology enhances, rather than replaces, a strong human connection. This position resonates with work on hybrid museum experiences,

which treats digital–physical blends as a design approach rather than a technology checklist, and with contemporary reflections on AI in museums that emphasise governance, transparency, and practice-based experimentation (Waern & Løvlie, 2022; Thiel & Bernhardt, 2023).

Accordingly, the article contributes: (1) a concise state of the art across HDI, participatory museum practice (including citizen/community science), and data infrastructures; (2) a From Data to Dialogue framework articulated as a minimal set of principles and practices; and (3) five data-driven design speculative scenarios translating the framework into potential concrete installations and programmes (consent-first onboarding; reflexive heatmap; proximity-triggered accessibility; in-gallery micro-annotation; data-poetics literacy).

The research pursues three questions:

RQ1. How can HDI principles transform visitor tracking and analytics into dialogic practices that measurably increase legibility, agency, and negotiability?
RQ2. Which design patterns enable co-research with visitors without compromising privacy, accessibility, or data quality?
RQ3. Which standards and metrics (FAIR, CIDOC, IIIF) make these practices sustainable over time, ensuring transparency, interoperability, and responsible governance?

2. STATE OF THE ART

2.1 DATAFICATION AND AI IN THE MUSEUM: FROM OPTIMISATION TO MEANING-MAKING

Across the cultural sector, artificial intelligence and advanced analytics are used to personalise interpretation, optimise operations, and enable new curatorial affordances. Recent overviews situate AI across infrastructural layers (cataloguing, search, translation), visitor-facing tools (chatbots, recommendation, segmentation), and artistic/curatorial practices; consequently, governance and documentation become as important as technical capability (Thiel & Bernhardt, 2023). In parallel, Hybrid Museum Experiences frames digital-physical blends as a design approach: centred on goals, audiences, and situated constraints; rather than a checklist of technologies (Waern & Løvlie, 2022). The common thread is a shift from tool-led adoption to practice-led integration in which intelligibility and accountability are first-class concerns.

2.2 HUMAN–DATA INTERACTION (HDI): LEGIBILITY, AGENCY, NEGOTIABILITY

HDI offers a people-centred alternative to extractive data regimes by articulating three normative pillars: Legibility, which makes data flows and model logics understandable; Agency, which enables meaningful control and alternatives; and Negotiability, which recognises that relationships with data evolve over time (Mortier et al., 2014). Work in HCI and ubiquitous computing has since operationalised these principles through contextual consent, explainability artefacts, and privacy-preserving controls distributed across sensing, modelling, and interfaces. In museum contexts, the HDI lens aligns technical decisions with pedagogical and ethical aims.

2.3 CITIZEN SCIENCE IN GLAM: FROM CONTRIBUTORY TO CO-CREATED

Frameworks for Public Participation in Scientific Research (PPSR) clarify how cultural institutions can scaffold public contributions to research while maintaining data quality and participant rights (Shirk et al., 2012). Haklay's participation typology, which ranges from crowdsourcing and contributory through collaborative to co-created, is directly portable to galleries and exhibitions where visitors annotate, classify or interpret cultural data (Haklay, 2013). Earlier work links such activities to gains in scientific literacy and motivation when tasks, feedback, and attribution are explicit (Bonney et al., 2009).

2.4 AUDIENCE SEGMENTATION, TRACKING AND ANALYTICS: AFFORDANCES AND LIMITS

Motivation-based audience segmentation frameworks, such as Culture Segments are widely used to target communication and programming; while often effective, they risk ossifying assumptions if left opaque or untested against visitor feedback (Thiel & Bernhardt, 2023). Inside galleries, timing-and-tracking studies offer shared benchmarks for "thorough use" (Sweep Rate Index; percentage of diligent visitors) and continue to inform layout and label decisions (Serrell, 2020). Importantly, projects like the Cooper Hewitt Museum's Pen exemplify how tracking can be rendered legible to visitors by returning a personal record of the

visit for post-visit exploration, thereby reframing analytics as a service rather than surveillance.

2.5 STANDARDISATION AND DIGITAL ARCHIVING: FAIR + HERITAGE SCHEMAS FOR LONGEVITY

Sustainable data practices depend on interoperability. The FAIR Guiding Principles (Findable, Accessible, Interoperable, Reusable) provide a cross-domain baseline for stewardship (Wilkinson et al., 2016). In cultural heritage, CIDOC CRM (ISO 21127:2023) offers a conceptual ontology capable of integrating heterogeneous collections; the IIIF Presentation/Image APIs enable portable, annotatable media; and Europeana EDM supplies a linked-data framework that bridges community schemas. Even minimal mappings to these standards increase reusability and transparency while reducing re-identification risk for visitor-generated derivatives.

2.6 INCLUSION, ACCESSIBILITY, AND SOCIAL PRESCRIBING: MUSEUMS AS HEALTH-PROMOTING SPACES

Accessibility standards provide testable criteria across perceivable, operable, understandable, and robust content, complementing museum-specific guidance for in-gallery media and interfaces (W3C, 2023). Beyond access, an expanding evidence base links museum participation to psychosocial benefits. The WHO's scoping review synthesised more than 3,000 studies on arts and health, highlighting effects on wellbeing across populations (WHO, 2019). Programmes such as Museums on Prescription report improvements in psychological wellbeing for older adults through structured, co-productive sessions, and toolkits developed at UCL operationalise simple, validated measures for practice (Huckaby, 2021).

2.7 DATA POETICS AND REFLECTIVE VISUALISATION

Artistic and curatorial practices that materialise data collection and inference—autographic approaches that make traces visible and inspectable—have proven effective in helping audiences reason about classification, uncertainty, and bias (Offenhuber, 2023). In a similar vein, the Data Humanism manifesto advocates for visual forms that prioritise human comprehension and contextual nuance over reductive dashboards (Lupi, 2017). Within exhibitions, these strategies shift analytics from hidden optimisation to public inquiry, aligning technical systems with educational and ethical goals.

3. CONCEPTUAL FRAMEWORK: FROM DATA TO DIALOGUE

3.1 WHAT "DATA DIALOGUE" MEANS

Data Dialogue refers to museum experiences where data flows are (1) legible to people, (2) actionable by those affected, and (3) re-negotiable over time. These three ideas derive from HDI—Legibility, Agency, Negotiability—and provide a plain, shared language for curators, designers, educators, and engineers (Mortier et al., 2014). The aim is not to reject analytics or AI, but to place them inside curatorial ethics, accessibility, and good stewardship so that technology enhances—rather than displaces—human connection.

Legibility: the extent to which people clearly grasp what data are collected, for what purposes, and with what consequences; when models are involved, their aims and limitations are communicated in plain, human-understandable language. (Mortier et al., 2014; Offenhuber, 2023).
Agency: the capacity for people to make meaningful choices about data practices—opting in or out for specific purposes, pausing or resuming collection, correcting or enriching records, requesting export or deletion, and choosing a non-tracking pathway that provides equivalent educational value. (Mortier et al., 2014; W3C, 2023).
Negotiability: the ability for data relationships to evolve over time, preferences can be revised during or after the visit, long-running uses require renewed consent, and any secondary uses are openly discussed and justified. (Mortier et al., 2014; ICOM, 2022).

3.2 FIVE PRACTICAL COMMITMENTS

To operationalise these principles, the framework advances five practical commitments that translate HDI into concrete design choices and governance routines. Rooted in ethics-by-design and value-sensitive design, and aligned with data minimisation and accountability norms, these commitments specify how consent, explainability, data economy, enforceable rights, and interoperability become observable features of exhibitions rather than policies on paper. Each commitment is formulated so it can be prototyped in situ, audited against clear criteria, and evaluated with the proposed scorecard.

1. Consent-by-design, not by policy. Keep consent short, multimodal, and in context (large-

print, plain language, TTS/LIS). Offer purpose-specific toggles (e.g., analytics, co-research, personal take-away). Present a first-class non-tracking route with comparable learning value (Mortier et al., 2014; W3C, 2023).
2. Explainability in situ. Where AI/analytics matter for the experience, publish micro-explainers and lightweight model/data cards (purpose, inputs, known limits, update history). Signal uncertainty explicitly in visualisations (Mitchell et al., 2019; Offenhuber, 2023; Lupi, 2017).
3. Minimise—and prefer on-device or ephemeral. Collect the minimum data to achieve the learning/curatorial goal; when feasible, process on-device and discard raw identifiers quickly. Document retention and its rationale in a one-page explainer (GDPR principles; ICOM, 2022).
4. Rights and remedies that actually work. Make opt-out, delete, export, and amend visible and fast (≤ two actions or one QR). Honour mid-visit preference changes. Record and report turnaround times (service-level expectations) (Mortier et al., 2014; W3C, 2023).
5. Interoperability for sustainable reuse. When derived, non-identifying data are kept or published, align with FAIR and heritage/media standards (CIDOC CRM, IIIF, Europeana EDM) so others can understand, audit, and reuse responsibly (Wilkinson et al., 2016; ISO 21127:2023; IIIF Consortium, 2020; Europeana, 2022).

3.3 WHAT COUNTS AS EVIDENCE

To keep the framework actionable, the evaluation adopts a compact set of indicators grounded in programme theory and sound measurement practice. The indicators are designed to be technology-agnostic, feasible to collect alongside front of house assessment, and robust enough for comparison across projects through basic validity, reliability and triangulation checks.

Legibility: brief comprehension and recall (two or three items) of purposes, data flows and rights, plus correct interpretation of uncertainty cues.
Agency: observed use of controls (opt in or opt out for specific purposes, pause or resume), time to opt out, and the success rate of mid-visit preference changes.
Negotiability: proportion of post-visit edits or withdrawals fulfilled within a target service level timeframe, and documented curatorial changes following public input.
Interoperability: documented FAIR mappings and adoption of CIDOC CRM, IIIF and Europeana EDM for any published derivative datasets.
Pedagogical and wellbeing: short, purpose-aligned learning items and, where relevant, validated instruments (UCL Museum Wellbeing Toolkit; WHO, 2019).

3.4 LINKING THE FRAMEWORK TO THE DESIGN SCENARIOS

Each data-driven design speculative scenario in Section 4 instantiates the five commitments in a distinct way: consent-first onboarding emphasises consent-by-design and rights/remedies; the reflexive heatmap focuses on explainability in situ and negotiability (public annotations → change); proximity-based accessibility demonstrates minimisation/on-device processing and genuine non-tracking equivalence; micro-annotation operationalises negotiability and interoperability (quality-gated, schema-mapped contributions); and the data-poetics corner foregrounds explainability and legibility for AI literacy.

4. DATA-DRIVEN DESIGN SPECULATIVE SCENARIOS

In line with HDI, each scenario is conceived as a minimal, testable intervention that aims to increase Legibility, Agency, and Negotiability while remaining compatible with museum standards and workflows (FAIR, CIDOC, IIIF). Rather than illustrations, these scenarios are hypotheses about how specific design choices can convert "data extraction" into data dialogue in real galleries.

Scenario 1 — Consent-first onboarding
At the entrance, a brief consent interaction (icons + large-print + TTS/LIS; QR/NFC handoff) presents purpose-specific choices—e.g., aggregated analytics vs. co-research contribution—alongside a first-class non-tracking route with equivalent cultural value. Expected effect: increased perceived control and willingness to engage in participatory options, consistent with HDI's call for understandable and negotiable data relations. Indicative metrics: 3-item comprehension/recall; median time-to-opt-out; proportion of mid-visit preference changes successfully applied.

Scenario 2 — Reflexive heatmap
A gallery display shows delayed, noised aggregates of movement with explicit uncertainty cues (bin sizes, suppression thresholds, time

window). Visitors can pause/resume their inclusion and append short interpretive notes. Expected effect: improved public understanding of inference and traceable curatorial adjustments to layout/labels. Indicative metrics: percentage correctly explaining delay/noise; percentage using pause/resume; number of documented curatorial changes justified by annotations.

Scenario 3 — Proximity-triggered accessible labels
Opt-in proximity prompts deliver TTS, high-contrast text, and LIS video; defaults are OFF; settings are stored on device; an offline pack enables a fully non-tracking alternative. Expected effect: improved task performance and satisfaction without central visit logs, aligning accessibility practice with HDI. Indicative metrics: task-completion time vs. baseline labels; satisfaction ratings; share of assets served via IIIF with accessibility metadata.

Scenario 4 — Micro-annotation citizen science
Visitors contribute short annotations (controlled vocabulary + brief free text + confidence slider) that pass automatic checks and curatorial triage; contributors can amend/withdraw post-visit. Expected effect: measurable learning gains and reusable enrichments mapped to CIDOC/EDM, bringing citizen-science logics into gallery practice. Indicative metrics: learning gain on targeted items (pre/post); acceptance rate; proportion mapped to CIDOC/EDM; time-to-ingestion.

Scenario 5 — Data-poetics corner
A small station lets visitors "train" a toy classifier on harmless inputs and see how training size/imbalance shifts outputs; sessions reset and use no personal data. Expected effect: increased AI/uncertainty literacy and a channel for negotiating features/assumptions. Indicative metrics: gains on 3–5 multiple-choice items about class imbalance/uncertainty; number of alternative feature proposals reviewed and, where appropriate, adopted.

5. CONCLUSION

The most consequential promise of AI-enabled, sensor-rich museums is dialogue, not mere optimisation. By reframing analytics and tracking through HDI (Legibility; Agency; Negotiability) and embedding them in a minimal set of practices (consent-by-design; explainability in situ; minimisation/on-device processing; effective rights/remedies; interoperability), the research aims to move from extracting data about visitors to negotiating data with visitors. The five data-driven scenarios show the shift is practical and lightweight: consent-first onboarding, reflexive heatmaps, proximity-triggered accessibility, in-gallery micro-annotation, and data-poetics literacy can be prototyped without heavy infrastructure.

Two implications follow. First, operational ethics: consent is designed; explainability is provided in situ; non-tracking alternatives are equivalent in learning value; and museum ethics frameworks remain central (ICOM, 2022). Second, sustainable interoperability: mapping even minimal metadata to FAIR/CIDOC/IIIF/EDM ensures that visitor contributions and derived insights are reusable without over-identifying people.

Limits remain: hybrid experiences can drift into black boxes or consent fatigue; accessibility is an ongoing practice; governance must budget for stewardship. Yet the scenarios above contain risks through minimisation, on-device processing, uncertainty cues, and community review and crucially, they return value to visitors through comprehension, control, and the ability to revisit contributions over time. This is how data becomes both medium and message for civic imagination in the museum.

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Enhancement of Museum Collections and Visitor Engagement Through Digital Tools and Immersive Experiences. The Chameleon Project

Federica Maietti[a], Ursula Thun Hohenstein[b], Loreno Arboritanza[a] and Chiara Parisi[b]

[a]Department of Architecture, University of Ferrara, Italy,
federica.maietti@unife.it, loreno.arboritanza@unife.it
[b]Department of Humanities, University of Ferrara,
Museum of Paleontology and Prehistory, Ferrara, Italy,
ursula.thun@unife.it, chiara.parisi@unife.it

ABSTRACT: The project CHAMELEON - *Adaptable, integrable and accessible digital tools for a dynamic and adaptive use of museum environments*, grafted into Spoke 4 of the PNRR project CHANGES, is focused on the Piero Leonardi Museum of Palaeontology and Prehistory, part of the Museum System of the University of Ferrara. The aim is to develop a set of digital tools for documenting, enhancing, sharing and narrating the palaeontological and anthropological collections. Starting with the conceptualization of a new digital exhibition system, the 3D digital acquisition of more than thirty objects have been performed, selected considering their relevance and the need to be linked to an augmented set of information. Standard metadata and open APIs support an inclusive user experience embedded in the IT architecture through applications for semantic Mixed, Augmented, and Virtual Reality experiences. The outcome is a repository able to manage online the multimedia contents associated with the fruition and storytelling of tangible and intangible information, addressing different needs and users to increase accessibility, engagement, interactivity, and knowledge.

1. INTRODUCTION

The paper presents the preliminary outcomes of the project CHAMELEON - *Adaptable, integrable and accessible digital tools for a dynamic and adaptive use of* museum *environments*, developed as part of the Italian National Recovery and Resilience Plan (PNRR) project "CHANGES - Cultural Heritage Active Innovation for Next-Gen Sustainable Society" [1], particularly in the context of the Spoke 4 "Virtual Technologies for Museums and Art Collections", the thematic area focused on the impact of digital cultural heritage.

The CHANGES project [2], an Extended Partnership (PE) of the PNRR (PE5. Humanistic culture and cultural heritage as laboratories of innovation and creativity), funded by the European Union – NextGenerationEU and coordinated by Sapienza University of Rome, aims to create an international reference centre in the field of culture and cultural heritage, promoting interdisciplinary research and the enhancement of cultural heritage through the use of digital technologies. Among the main purposes, to make cultural heritage accessible to a wide audience by promoting the use of advanced digital technologies and developing innovative IT tools for the conservation and analysis of cultural heritage. In addition, the project aims to promote new forms of sustainable tourism, actively involving local communities and institutions.

The Extended Partnership project is indeed organised into nine thematic areas, named Spokes, designed to be complementary areas for the creation of a broad ecosystem of interdisciplinary skills in the fields of humanities, technology and culture. The Spokes aim to support the protection, enhancement and sustainable transformation of tangible and intangible cultural heritage, addressing challenges such as digital preservation, the creation of creative ecosystems, the promotion of sustainable tourism and the management of natural and anthropogenic risks to cultural heritage.

The research collaboration that resulted in the CHAMELEON project is part of the Spoke 4 focused on the impact that digital cultural herit-

age has in the context of the current view on tangible and intangible heritage, and considering digital cultural heritage objects through the network of their interlinked relations with the heritage environment and their provenance context, while (in)tangible objects are the result of selective processes defined and used by cultural heritage institutions during time.
The Spoke experimented with different templates of museums and art collections, identified analysing ISTAT (the Italian National Statistics Institute) data [3], for designing pilot studies and best practices to be further adapted and reused in institutions and contexts sharing similar characteristics.
Virtual technologies explored within the Spoke activities include knowledge graphs, Web-based environments, Extended Reality (XR), gamification, serious games, edutainment, 2D/3D models and multimedia, tools for digitization and simulation, Internet of Things and sensors networks, AI-based methods and tools.

The CHAMELEON project [4] was developed by the University of Ferrara through the collaboration between the Departments of Architecture and Humanities and carried out together with the companies Inception Srl and MediaSoft Srl, and No Real Interactive as a consultant. It focused in particular on a museum context belonging to the category of "natural history and science museums".
The case study is indeed the Piero Leonardi Museum of Palaeontology and Prehistory [5], part of the University of Ferrara's Museum System (hence SMA), which houses important collections on the main floor of Palazzo Turchi Di Bagno, in the historic centre of Ferrara (Figg. 1,2).

The project, submitted and funded through a cascade call for proposals launched by the University of Bologna as coordinator of Spoke 4, started in June 2024 and is now concluding. The overall aim is to develop a set of digital tools for documenting, enhancing, sharing and narrating the Leonardi palaeontological and anthropological collections (Fig. 3) enhancing accessibility and inclusivity.

Figure 1,2: *View of the room housing the Vertebrate Palaeontology section of the Leonardi Museum*

Figure 3: *View of the room showing the Human Palaeontology and Prehistory section*

2. RESEARCH BACKGROUND

In accordance with the objectives of the CHANGES project and, in particular, with the Spoke research framework dedicated to 3D digitization and virtual technologies for museums, the first project activities focused on analysing the needs of the Leonardi Museum and the State of the Art in terms of digital technologies for enhancing the museum's content and sharing and disseminating it to the widest possible audience.
The Museum is currently closed to visitors due to damage suffered by the building during the

earthquake that struck Emilia in 2012. However, the ground floor can still be used, as can the rooms on the upper floors, which house facilities for Museum staff and researchers. Although the main floor (which houses the Palaeontological collections) is closed to visitors, it is still possible to arrange visits for small groups with scheduled and limited access. This limitation (albeit temporary) on physical access to the Museum was the first point of the project investigation, analysing the possibilities offered by digital technologies for remote access and "enriched" consultation of the Museum's artefacts and fossils for scientific purposes.
Further elements of analysis on which the project was based concerned the exhibition facilities of the museum, which has a definitely fascinating layout (Figg. 4,5) but rather dated and in need of renovation in order to make the contents more understandable and accessible to the general public, and especially to young people and schoolchildren.

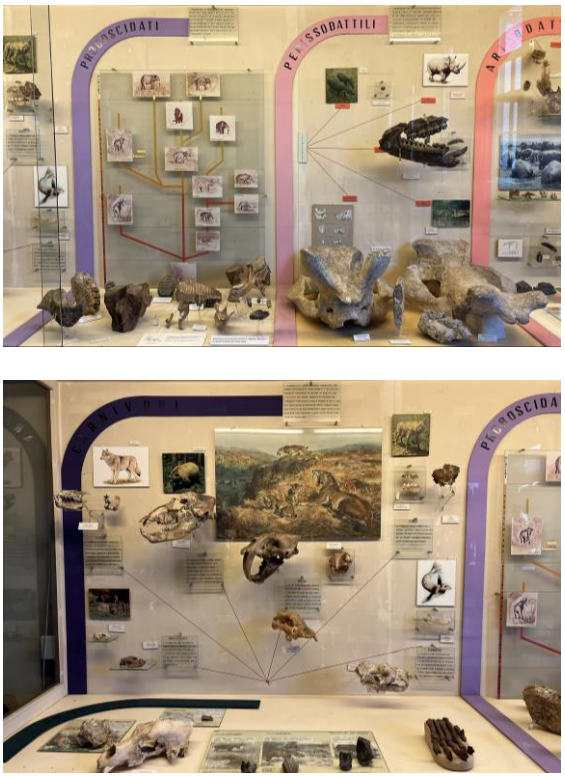

Figure 4,5: *View of the current display layout of the Museum showcases*

Even when considering exclusively the study and research needs concerning the fossils and palaeontological collections of the Leonardi Museum, it immediately became apparent that there was great informational potential that could be associated with 3D digital replicas of the Museum objects. It should indeed be specified that an initial photogrammetric digitisation campaign had previously been carried out on a limited number of specimens, and some digital reproductions had already been collected, but the crucial step of integrating the information relating to each specimen directly into the digital model was still missing.

Being able to bring together different sources (documentary, bibliographic, iconographic, scientific, etc.) and link them to the digital object represents the frontier of the semantic web [6], which makes it possible to access not only the geometric and morphological model of the specimen, skeleton, or fossil, but also to consult all the layers of connected information.
Libraries, archives, museums, and other cultural heritage institutions are continually striving to enhance the visibility and reach of their collections, providing to audiences that range from academic researchers to the general public. To achieve this, data is shared through cultural heritage aggregator portals (such as Europeana, the Italian ICCD - Central Institute for Cataloguing and Documentation, etc.) (Fig. 6) or made available on general platforms in accordance with Semantic Web principles. This process demands that information be organised within clearly defined frameworks, adhering to standardised and semantically robust publication models [7].

Figure 6: *View of the ICCD catalogue sheet of one of the fossils in the Leonardi Museum*

Cultural heritage represents a deeply multidisciplinary field of research and practice, which involves collecting, preserving, and sharing the traditions, monuments, artworks, and broader legacies of human civilisation over time. This endeavour is vital for historical and educational purposes, supporting education and training, scientific and humanistic research, and even everyday cultural experiences. In the current digital media landscape, countless opportunities exist to accelerate these processes, both creating

and disseminating heritage content, by leveraging modern digital and networking technologies, and enhanced interactive capabilities. As a result, many museums and cultural institutions are increasingly investing in the development of digital applications featuring engaging storytelling and online dissemination strategies designed to actively involve audiences in heritage-related projects and initiatives [8].

In this context, characterised on the one hand by the need to enhance the great value of the Leonardi Museum's heritage, and on the other by the potential offered by the State of the Art in digitisation and digital data management for purposes of knowledge, dissemination and storytelling, the CHAMELEON project has been specifically set up to address the following objectives:

- Increase on-site and remote accessibility through augmented applications, virtual tours, and information enrichment, maximising public engagement;
- Undertake a 3D digitisation process of Museum objects focusing on exhibition and interpretative, critical, and documentary opportunities, in line with the objectives of the European Commission recent initiatives (such as the Common European Data Space for Cultural Heritage) [9];
- Apply a semantic approach to the 3D digital models, enriching the layers of information, according to current Open Data standards [10];
- Design a new exhibition layout meeting accessibility and inclusion requirements, updating the informational linked to the displayed objects, also wit storytelling supported by multiple devices;
- Optimise a platform allowing the exploration of the Museum contents, together with related applications for Virtual and Augmented Reality (VR, AR);
- Lay the foundations for establishing a future network among different museums or sites of interest (e.g. archaeological excavations), fostering connections and content sharing;
- Set up the future improvement of the ICCD catalogue records in line with the ArCo project (Architecture of Knowledge - Ontologies for the Description of Cultural Heritage) [11] and the Italian Ministry of Culture Digital Library.

3. DATA CAPTURING AND ENRICHMENT

The 3D survey of the museum objects was preceded by the selection of a number of objects that could be managed within the project's duration (Fig. 7). The selection process followed multiple criteria, starting with their scientific, historical, and narrative significance, choosing representative artifacts with the greatest potential for enhancement through digital storytelling.

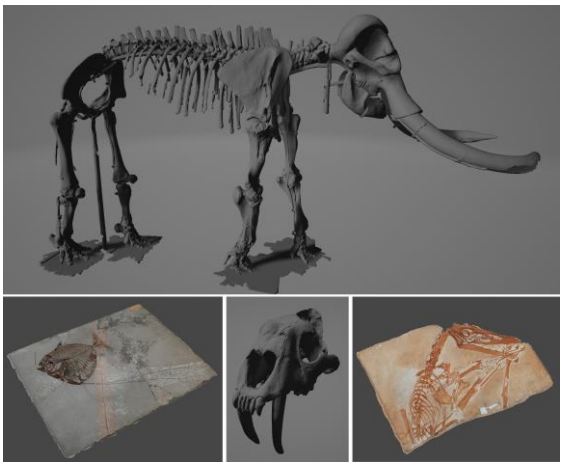

Figure 7: *3D models of some of the digitized objects*

A total of 34 objects were selected, including fossils, artifacts, and skeletons of medium- and large-sized animals. The choice was also guided by the project's narrative purpose: the artifacts were selected to reconstruct significant thematic environments, creating immersive and informative itineraries that make complex and scientifically relevant content accessible to the public.

The phases of gathering documentation related to the selected objects and cataloguing them, aimed at entering all the input data needed to build the semantic repository and the various applications for augmented experience, were developed in parallel with the various digitization campaigns.

A cataloguing system was developed containing essential information divided into three macro-sections based on the nature and use of the fields contained within:

- SIGEC Analytical Fields including data reported in the General Catalogue Information System (SIGECweb) [12], a web-based platform that manages the entire cataloguing process on the ICCD general catalogue of cultural heritage website.

- Additional fields for information about the specimen, such as scientific name, popular texts, location in the exhibition spaces, etc.
- Functional fields and taxonomy for indexing in the database and search engines.

The process of digitization, leaded by the project partner Inception [13, 14], was then conceived and implemented in accordance with the Spoke indications and guidelines, to accomplish the needs of standardization, interoperability, reusability, metadata collection, and FAIR principles [15].

Acquisition technologies suitable for object-scale surveys were selected, specifically structured-light scanners and photogrammetry procedures [16, 17] (Fig. 8), capable of acquiring the geometry and morphology of objects with suitable accuracy, as well as surveying surface textures. In some cases, the two acquisition techniques were used in combination on the same object [18].

Figure 8: *View of the objects digitization phases through photogrammetry and structured light laser scanner*

Following the digital acquisition phase, different model optimizations were carried out (Fig. 9), both in terms of visualization and to achieve the specific features for the use of the 3D models via web and mobile applications.

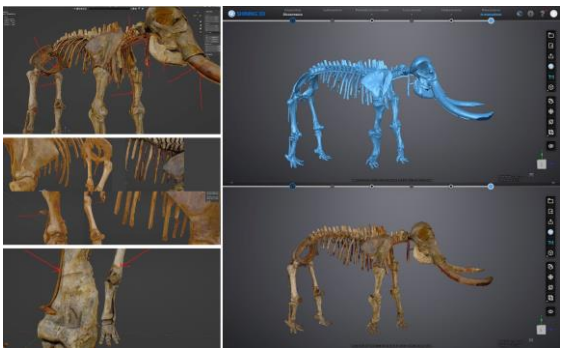

Figure 9: *Models optimization phases*

This phase involved detections on meshed models and textures verifications. The reconstruction of the prehistoric animals (Fig. 10) was the performed, creating animations for the applications, and effects such as the transition from skeleton to full-size animal, a highly effective forms of communication for scientific, analytical, and educational purposes.

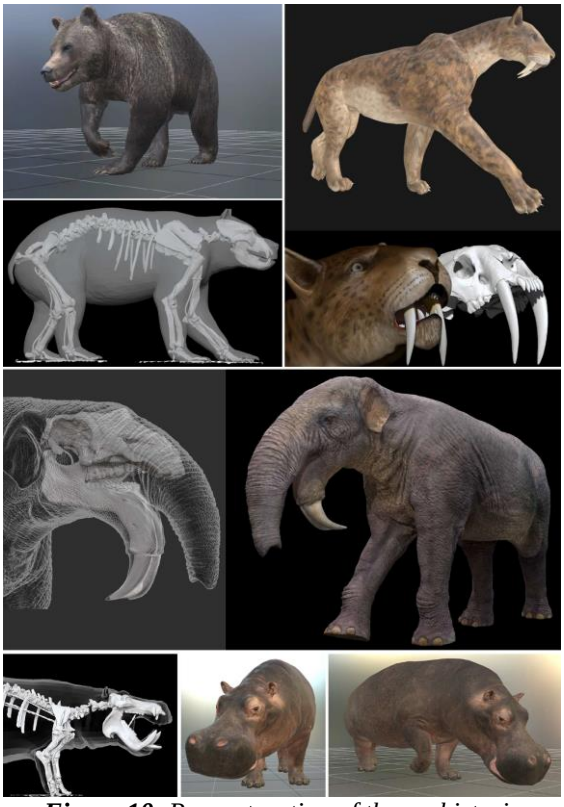

Figure 10: *Reconstruction of the prehistoric animals strarting from skeletons 3D models. Elaborations by Fabio Manucci*

4. DIGITAL COLLECTION IMPROVEMENT

With the aim of developing digital models to serve as a multidisciplinary database (by integrating the 3D geometric and material data with the informative and documentary data derived from the cataloguing), it has been decided to further enrich the digital models using the Mu-

seum's archival heritage. This integration allows for the correlation of different documentary and information sources, highlighting the heterogeneity of the Piero Leonardi Museum's holdings, which can be traced not only to the preserved objects but also to the broader historical and scientific context.

The Museum's paper archive, which now can be consulted exclusively on-site, consists of ten folders divided by broad subjects. Although it has been reorganized and accompanied by brief descriptive documentation for internal use, it does not yet have a search tool capable of correlating each specimen with the corresponding archival documentation.
For this reason, the first step involved a comprehensive examination of the preserved documentation, to identify and select materials relevant to the different fossils and specimens, particularly those already digitized.

This preliminary phase aimed not only to enrich the digital model but also to integrate and complete the "Origin and Acquisition" section of the standard record associated with each object, thus promoting interoperability between the different information systems.

At the end of this initial analysis, a significant finding emerged: the archival documentation is heterogeneous, comprising primarily written material, but also iconographic documentation on different media and different types of graphic material (Fig. 11).

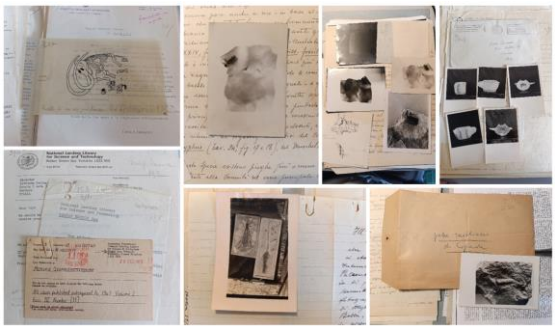

Figure 11: *Some of the archival documents retrieved and digitized*

Following a comprehensive review of the archive, the material best suited to the project's objectives and the broader project of systematizing the information sources was selected. A table was filled in by listing, among the different entries, the archive location, the artifacts indicated, the document type, and a brief description, for a total of 88 selected documents.

This tool was designed to facilitate the identification of documents for digital acquisition, which can then be associated with the relevant digital model.
The work of systematizing and digitizing the paper archive is only part of the integration phase of the information sources to be integrated into the digital models of museum objects. The cataloguing of the finds not only allowed to collect and unify the various layers of information, but also provided an opportunity to produce additional material, functional for the use of the models, such as the conversational texts to be used for the Avatar application, and the aforementioned reconstructions of prehistoric animals.

5. INCLUSIVE ACCESSIBILITY

All the project steps related to the design and prototyping of the application for the digital accessibility of the Museum contents [19] started from the identification of the target users and were then developed by focusing on technologies that, according to the State of the Art, are reshaping the use of museum content [20]. Some specific users were immediately identify in order to achieve the main purposes of maximum openness of the scientific collections to be used by curators, experts, scholars, tourists, students, children [21]. Therefore, the preliminary target users classification for the Leonardi Museum included curators, general visitors, specialized audiences, and users with disabilities. On the basis of this mapping the User Journey was analysed in order to shape the User Experience (UX) [22], illustrating potential actions, challenges, and the degrees of freedom offered, in correlation with the combinatorial flexibility of the repository, designed as a "chameleon-like" application to be shaped according to different purposes and conceived to be expanded over time. These projects steps have been leaded by the project partner MediaSoft together with NoReal Interactive as a consultant.
The design process was organized into four phases: application design, digital interaction design, inclusive accessibility design, and gamified engagement design.
The setup of the applications began with the above mentioned semantic mapping and the identification of the objects selected for digitization. This stage also involved outlining the IT architecture to manage the flow of data to and from the central repository, specifying the hardware requirements necessary for developing and testing the prototypes, and evaluating both the quantity and quality of data to be handled.

The hardware included all types of devices suitable for use by each intended user group. A crucial element was the development of the software middleware, which served as a bridge between the repository and the prototype applications.

The repository allows to manage, in an online environment, all multimedia assets related to physical or intangible museum objects (3D models, images, audio and video clips, avatar dialogues, and content for users with diverse accessibility needs). It make possible the creation of dynamic digital visitor paths, structured through semantic relationships configurable by museum curators (to support temporary physical exhibitions or to create virtual exhibitions), allowing also end users to customize and reconfigure these itineraries in an intuitive, guided manner, enhancing adaptability and engagement (Fig. 12).

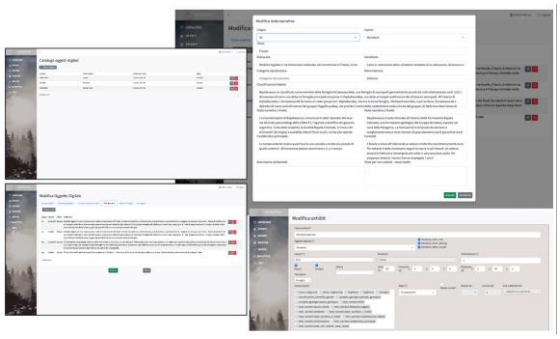

Figure 12: *Digital Asset Management module. The software platform is based on responsive design, standard metadata, and open APIs*

The overarching goal was to establish a single, versatile repository accessible through multiple interfaces, each with distinct forms and functions. This system supports a range of digital experiences powered by semantics that can be modified as needed, enabling the development of WebXR applications (Fig. 13) for exhibited artifacts [23].

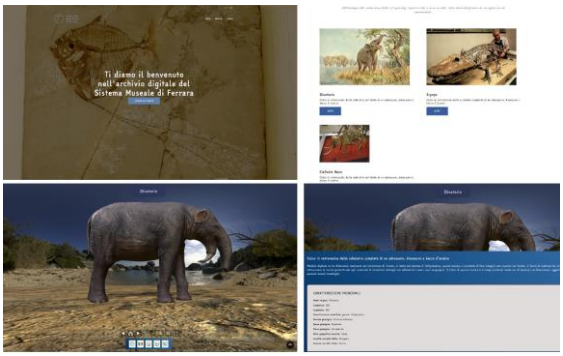

Figure 13: *WebXR applications for exhibited objects, as a container for the virtual replicas, data and metadata, accessible through interfaces in the exploration of the 3D models via web browser*

These applications act as containers for virtual replicas complete with their associated data and metadata, and are accessible through user-friendly web-based interfaces for interactive 3D exploration.

5.1 DEVELOPED APPLICATIONS

The set of applications and digital tools for sharing and narrating the Museum collections are:

- the Avatar [24], conceived as the museum guide and targeted to children or a young audience (Fig. 14). The application is based on three dialogues to be activated via QR codes placed on the two permanent exhibition rooms on the first floor and on the ground floor for temporary exhibitions;

Figure 14: *Views of the Avatar*

- AR experiences [25], divided into 360-degree AR experience for exhibits in individual showcases, and frontal AR experience for artefacts in wall cases (Fig. 15). Also in this case, the applications are activable by framing the QR-code placed near the object or the showcase. The 3D model appears (the fossil, the skeleton, or the reconstructed animal), together with a set of additional information, including narrative and alternative texts;

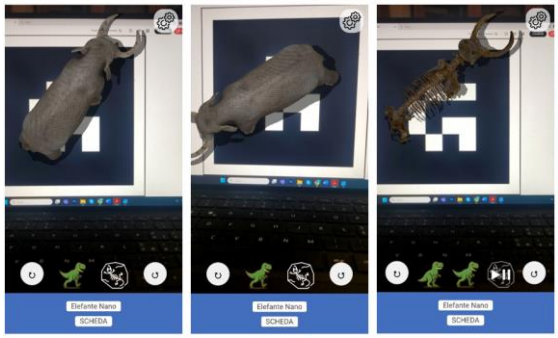

Figure 15: *Views of AR experiences, visualizing the skeleton and the reconstructed animal*

- VR experience in settings. Up to now, three locations have been selected by recreating three different prehistoric periods (Fig. 16) to be experienced by exploring in 360° the changing natural environment and the fauna that lived there.

The configurator allows the Museum curators to create temporary exhibitions; a Digital Web Exhibition created is accessible via browser (PC, laptop, smartphone), navigating through the digital objects and interacting with the available 3D models.

Figure 16: *Views of reconstructed animals within reconstructued envoironments for VR experiences*

6. CONCLUSION

The project was guided by a comprehensive methodological approach aimed at enhancing not only the individual objects, but the Museum's overall paleoethological and cultural heritage.

The data collected, selected, digitized, and processed form the semantic backbone of the 3D model obtained from the digital survey campaign.

This led to the creation of an implementable system able to interact with different users. Related applications are specifically designed to most effectively manage the data flow and the use of digital prototypes. The information that founds the semantic-informative structure are intended to be implementable, flexible, and adaptable. Further information may be added to the database, and additional objects will be digitized in the future.
CHAMELEON was created with the goal of achieving a data structure that can collect, over time, all the specimens belonging to the Leonardi Museum and can increase the number of items as input data needed to build the semantic repository and applications for augmented experience.

The semantic repository enables the creation and management of multimedia contents associated with the fruition and storytelling of tangible and intangible information and digital exhibitions, the creation of narratives, and the uploading of resources such as images, videos, audio, 3D models, etc.
Responsive design, standard metadata, and open APIs support an inclusive user experience embedded in the IT architecture through applications for semantic Mixed, AR, and VR experiences in specific settings.
Museum's curators will be able to update the information system and to create adaptable exhibitions, while dynamic digital paths can be reconfigured by the end user, increasing engagement and interactivity.

The project ended in September 2025, and the phases of finalizing and testing the prototypes are currently underway.
Further activities will be carried out with Spoke 4. The prototypes created for the various case studies developed for the different types of museums will be presented at the conclusion of the CHANGES project, in January 2026.

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Transformation as Method: Choreographic Forms of Artistic Research

The AR-Comic Multitudes and the Lecture Performance the Code

Charlotte Triebus, Christian Geiger

Department of Media, University of Applied Sciences, Germany,
charlotte.triebus@hs-duesseldorf.de; geiger@hs-duesseldorf.de

ABSTRACT: This paper continues the model introduced in Three Languages of Artistic Research – Precious Multitudes as a Performative Documentation of Research in New Media Art [33]. It deepens the discussion of the third language—the sensual, medial and performative mode of knowing by examining two complementary artistic works: the AR-comic Multitudes and the lecture performance Precious Camouflage: The Code. Both works emerge from the artistic research project Precious Camouflage and generate understanding through perceptual engagement other than verbal explanation. Multitudes extends the comic form into a choreographic space where visual and textual layers move, overlap, and resonate. The Code stages artistic research as live commentary, where thinking becomes embodied and visible on stage. Together, these works demonstrate how artistic research operates as a transformative practice that generates knowledge through sensual experience and perceptual engagement.

Keywords: artistic research, embodiment, choreography, comics, augmented reality, lecture performance, felt knowledge, media art, systems, code, media aesthetics, ethics.

1. INTRODUCTION – FROM LANGUAGES TO TRANSFORMATIONS

In Three Languages of Artistic Research [33], artistic research was described through a helix structure, composed of three interrelated forms of articulation: the performative, the discursive, and the medial, with medial being understood in its broadest sense. These languages do not follow one another in sequence. They interweave continuously, generating knowledge through their entanglement. The performative language produces embodied understanding through action and presence. The discursive language situates reflection in writing and speech. The medial language materialises research in sensual and aesthetic form, allowing knowledge to be perceived alongside it being communicated. This paper turns toward the third language, building on the performative and discursive dimensions introduced in [33]. It examines the medial, sensual, and transformative expression of research, asking how it operates as a mode of thinking and mediating in its own right. Within the helix model, this third language does not represent the others but reshapes them, translating theoretical and performative insights into perceptible form. It functions as a space where research becomes experienceable. This notion of transformation resonates with Inge Hinterwaldner's understanding of change as a mode of perception, where processes of becoming and modulation serve as instruments of cognition that make complex systems graspable [14].

The layered artistic research project Precious Camouflage serves as the framework for this investigation. Developed between 2023 and 2025 at the intersection of dance, media art, and system design, it explores how human and systemic perception intersect through choreography, digital technology, and aesthetic mediation. Two derivative works emerging from this project are examined here: the augmented reality comic Multitudes and the lecture performance Precious Camouflage: The Code. Both manifest the third language of artistic research through distinct sensorial strategies – one in visual and spatial composition, the other in live, embodied translation.

This perspective resonates with current discussions in artistic research that emphasise relational and performative dimensions of knowledge [20]. Following this view, artistic inquiry unfolds as a network of relations be-

tween bodies, media, and ideas, in which understanding arises through interconnection and associative processes. Drawing on media theory and concepts of media ecologies [25][26], artistic research can be understood as an epistemic system grounded in material and formal processes. Hans Ulrich Reck's notion of art as media theory further anchors this approach, suggesting that artistic practice is itself a theoretical act that reflects and transforms its own medial conditions [25].

Addressing the helix model through these perspectives responds to a broader contemporary urgency of accelerated mediation, algorithmic interpretation, and sensory overload. The capacity to produce and transfer knowledge through aesthetic and bodily experience becomes a critical counter-practice. The works discussed here demonstrate how artistic research can reclaim perception as a site of inquiry, where knowledge is generated within experience.

2. THEORETICAL FRAMEWORK – THE HELIX AND THE THIRD LANGUAGE

2.1 THE HELIX AS MODEL OF ARTISTIC RESEARCH

The helix model introduced in *Three Languages of Artistic Research* proposes a structural shift in how artistic research may be understood. The helix rejects hierarchical or sequential organization. Instead, it describes theory, practice, and documentation as continuously interwoven movements. It visualises research not as a linear process of production and reflection but as a dynamic, self-transforming system. In this model, the performative, discursive, and medial languages form distinct yet permeable strands. Each carries its own epistemic logic while simultaneously influencing and reconfiguring the others. The helix thus articulates artistic research as an evolving organism-recursive, permeable, and open to modulation. The notion of twisting becomes a metaphor for how knowledge in art emerges through entanglement of discourse and discipline. The helix describes a double-stranded structure in which movement unfolds through mutual rotation and return. Its form suggests reciprocity rather than ascent and visualises the continuous negotiation between theory and practice.

This conception departs from traditional frameworks that separate artistic doing from artistic knowing [15]. By understanding research as a spiral process of transformation, the helix affirms that artistic knowledge resides in the interplay between these two poles. The image of the helix allows this interdependence to be both conceptual and sensorial – a structure that is simultaneously visual, temporal, and procedural.

The helix distinguishes itself from circular models. Rather than translating content from one medium to another, each turn adds depth and perspective. Engaging a theme across dimensions transforms rather than reproduces understanding.

2.2 CHANGE, RELATION, AND MEDIALITY

The helix operates through continuous change. Each turn marks a shift in state—from movement to text, from reflection to perception, from form to relation. Following Hinterwaldner [14], transformation here functions as a cognitive operation where modulation itself becomes an instrument of understanding.

Relational frameworks position research as a constellation where transformation maintains connections between agents, media, and contexts [20]. Artistic knowledge manifests through these connections. Within this framework, transformation is the movement that maintains relations. From a media-aesthetic perspective, this interrelation of processes foregrounds the materiality of knowledge [25][26]. Artistic research captures meaning through its medial forms—through gesture, image, rhythm, and spatial articulation. The medial is not a vehicle for content but an epistemic dimension. Hans Ulrich Reck's understanding of art as media theory underpins this approach: by reflecting its own conditions of perception, art produces self-referential knowledge about mediation itself. [25].

These positions frame the helix as a model of relational shifts. Knowledge within it manifests by allowing form to change, resulting in continuous movement between states of doing, perceiving, and thinking.

2.3 THE THIRD LANGUAGE: SENSUAL KNOWLEDGE AS TRANSFORMATION

The medial dimension within this structure represents the site at which transformation becomes perceptible. It is the moment when the helix folds back upon itself, translating experience into form and form into experience. This language operates through sensory and temporal processes: rhythm, texture, density, form, or spatial resonance. The third language can

therefore be described as the sensual articulation of research, a way of thinking through form that materialises knowledge instead of explaining it. It appears in visual, choreographic, or other configurations that render experience epistemic.

In *Precious Camouflage*, this sensual mode manifests in complementary forms, two of them presented in this paper: *Multitudes* as spatial choreography on paper, and *The Code* as temporal translation on stage. Both works transform knowledge into perceptual experience, completing a helix-turn that binds the theoretical, performative, and medial into one evolving structure. The third language thus represents the epistemic core of artistic research: knowledge as embodied experience.

3. CASE STUDY I – *MULTITUDES*: CHOREOGRAPHY ON PAPER

3.1 THE COMIC AS EPISTEMIC MEDIUM

Within the helix model, *Multitudes* serves as an example of this medial dimension of artistic research: knowledge in a sensory form. The work organises movement-thinking as a field of relations between visual, textual, and temporal elements. Comic-theoretical frameworks demonstrate how meaning emerges from interdependent panels, spatial tension and rhythm [2][8][9][11][13][22]. The page is therefore not a container for content but a dynamic system that thinks through its own architecture. [Figure 1]

This epistemic use of comics has entered scientific and artistic contexts alike. Projects such as *We Need to Talk, AI* [28] translate ethical and technological research into visually legible argument structures. Liv Strömquist's essayistic comics approach gender politics and cultural critique through drawings and analytical voice [31], while Ulli Lust's *Die Frau als Mensch* [19] combines historical and sociological inquiry with graphic narrative.

These works demonstrate that comics can function as modes of research and reflection.

Multitudes shares this orientation but redirects it toward movement: its logic is choreographic, not narrative; embodied, not explanatory. Panels operate as scores of motion, pauses, and resonance. The reader enters a temporal, rhythmic, sensual field.

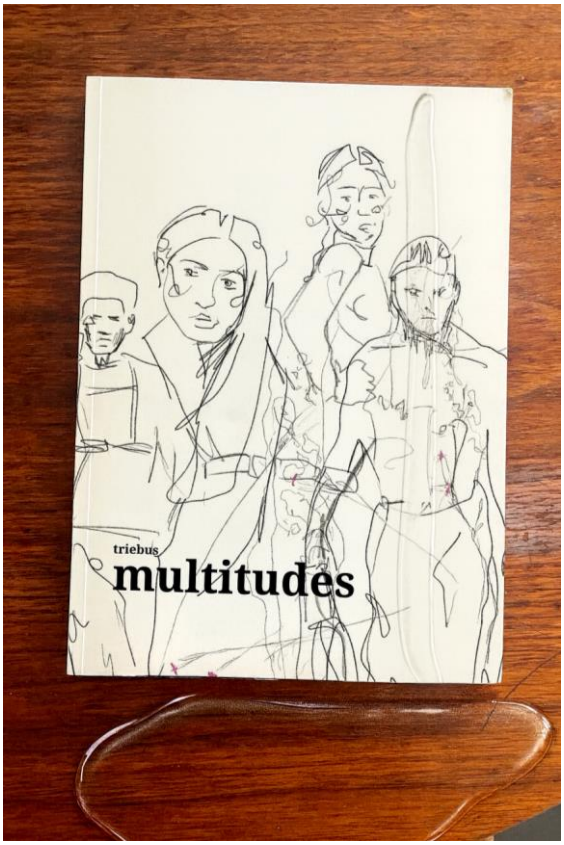

Figure 1: Multitudes (2025*), cover. Augmented reality comic. Credits: Triebus / MIREVI.*

Multitudes develops an essayistic-performative form of the comic. It proceeds from the organisation of movement, thought, and perception within the visual field instead of linear narration. The book explicitly frames itself as a felt lecture performance on AI, graphically recorded [34], linking reading, perceiving, staging, and medial interaction into a single unit. The augmented reality layer (app, scanning, sound) shifts the medium into the temporality of augmented reading, choreographing gestures of reading – holding, tilting, rearranging content – and turning them into operations of cognition [25][26].

The internal composition follows a cyclic- associative dramaturgy of recurring theoretical statements, poetic image sequences, and diagrammatic insertions tied together by several narratives from different domains. From the outset, references to performativity theory pose the question of the body's location – its spatial and temporal materialization – and translate it into a dialogic, spatially arranged visual composition [4][5][8]. A subsequent double spread unfolds Baudrillard's Safari-Park/hyperreality motif as an essayistic montage of image and text—a scenography of the real serving as epistemic frame of the entire reading experience [14]. From here, the work returns to series of motifs

functioning as choreographic themes: the Telephone Game as structure of transmission, Narcissus and mirror surfaces, Pygmalion (self-creation), the Basilisk (singularity/fear figure), Fluids as boundary of visibility, and the Python Index as algorithmic self-reflection [34].

In relation to common comic typologies [2][8][11][13], *Multitudes* can be positioned in three overlapping categories:

1. Essayistic-performative. The comic "thinks" through images. Panels arise as argument figures or sensory fragments, negotiating theory through composition and rhythm. Textual fragments are condensed, not explanatory. Multitudes organises visual argumentation instead of constructing characters or plot. Each sequence functions as a fragment of thought, translating theoretical concepts into rhythm, density, and spatial relation.
2. Visually fragmentary/intermedial. Diagrams, dance notations, interface motifs, mycelial and drop patterns, and iconic repetitions (e.g., the droplet sequences) structure a kinetics of the page. Repetition, variation, and interruption turn reading itself into movement.
3. Post-digital hybrid form. AR layers, glitch aesthetics, simulation screens, and the Python appendix (linked names and concepts in code) mark the medium itself as an operative apparatus [25][26]. [Figure 2]

Motivic recurrence (pink figure, droplets, basilisk), strict timing of panel rows, silence across wide white spaces, and the verticality of energy axes and mycelial textures create a choreographic score. The page becomes stage, the eye dances, and AR turns gestures of reading into micro-movements of the work. This establishes a choreography of attention as epistemic practice – perception becomes method [20][25][26].

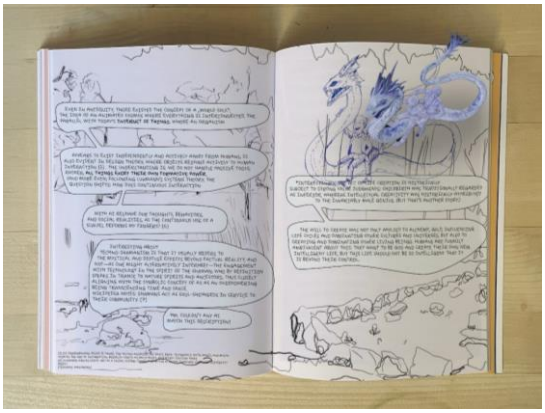

Figure 2: *Multitudes (2025), interior spread featuring Roko's Basilisk. Credits: Triebus / MIREVI.*

Multitudes may thus be defined as a choreographic essay-comic: a post-digital form of knowledge in which acts of drawing (layout, AR triggers) and acts of thinking (theoretical folding, indexing, self-reflection) are inseparable. The book materialises the third language of artistic research by conveying understanding through experience and composition instead of explanation – as movement within the medium [33][34].

3.2 CHOREO-GRAPHIC NOTATION AND MOVEMENT DIAGRAMS

Following Brandstetter's notion of "choreography" – the inscription of movement through graphic means [6] – and Lepecki's understanding of movement as thought [18], *Multitudes* treats drawing as choreographic gesture. Lines, frames, and white space mark durations and transitions. Repetition, variation and interruption form the visual counterpart to dance phrasing. Across spreads, motifs return with altered scale or orientation. Reading becomes a kinaesthetic experience. The comic thus functions as performative notation: it extends the choreographic practice of *Precious Camouflage* into the domain of print and screen.

The connection between choreography and drawing invites a comparison with the history of movement notation. Systems such as Labanotation and Benesh establish symbolic grammars for space, weight, and duration. They encode motion through graphic syntax. Beyond these codified systems exists a broad genealogy of artistic movement diagrams that blur the line between notation, image, and score. Examples range from Klee's pedagogical sketches and Marey's chronophotographic traces to Brown's drawing performances and Forsythe's improvisation technologies [7][10][11][16][17][21][23][24][27]. Kunz's geometric drawings and Mehretu's spatial palimpsests transform movement energy into vibrating fields, while Eshkol's notation systems connect bodily and graphic rhythms.

Multitudes stands within this expanded tradition of choreo-graphic diagrams, yet introduces a decisive shift: it joins the multi-panel syntax of the comic with the spatial thinking of notation. Panels act as frames within frames. Gutters become rests and breaths. Typographic sounds mark tempo. These drawings generate perceptual motion instead of prescribing movement. The reader performs the score by following, skipping, pausing, and returning – a looping, helixing activity akin to rehearsal. In this way, *Multitudes* becomes a contemporary movement

script – a diagram that invites sensing and reflection instead of recording what was.

3.3 MATERIALITY, DRAWING AND AUGMENTED PERCEPTION

The epistemic dimension of *Multitudes* extends beyond composition to its material structure. Drawing, in the context of artistic research, acts as a procedure of knowing through making. Every line is a gesture of inquiry. Paper, ink, and digital interface mediate between intention and emergence. This constitutes a media-aesthetic practice in which form itself becomes method [25][26]. The tactility of the hand-drawn mark and the luminosity of the screen embody the double movement of the helix: from physical trace to digital vibration and back. Hans Ulrich Reck's concept of art as media theory is materialised here: the work reflects on its own conditions of visibility through the very act of being drawn [25]. The act of drawing becomes an act of thinking. In *Multitudes*, images function as arguments and text as visual composition, reversing conventional distinctions between reading and seeing.

Drawing mediates between intention and emergence. The dialogue between manual and digital processes mirrors the interaction between body and system central to *Precious Camouflage*. Drawing is not illustration but a medium of testing – an aesthetic experiment that makes the intangible momentarily graspable.

Reading *Multitudes* means performing it. Each eye-movement, each temporal delay between image and text constitutes a gesture within the work's field. Drawing on concepts of "thought in the act" and aesthetic experience as research [20][29], perception becomes a methodological gesture. Attention is mobilised, not fixed. The reader learns through rhythm and pause. This kinaesthetic mode of reading turns understanding into a temporally extended practice. *Multitudes* thus performs its own research through its audience's perceptual engagement. The third language manifests here as thinking with the body while looking, a mutual activation of form and attention.

[Figure 3]

Figure 3: Multitudes (2025), *augmented installation view. Credits: Triebus / MIREVI.*

3.4 *MULTITUDES* AS THIRD LANGUAGE

Positioning *Multitudes* within the broader landscape of research comics clarifies its specific innovation. The comic has been established as academic dissertation and philosophical method [30]. More recent visual research platforms such as JAR – Journal for Artistic Research, VIS – Nordic Journal for Artistic Research, and Performance Research [1] have expanded this trajectory. *Multitudes* participates in this international conversation by linking visual argumentation to choreographic process. It integrates graphic reasoning with bodily thinking, offering an epistemic form that is at once sensual, reflective, and systemic.

Through its multi-layered composition, *Multitudes* enacts this sensual dimension of the helix as a transformative field. It does not reproduce movement but continues its becoming in another medium. *Multitudes* thus exemplifies how artistic research may unfold as a practice of continuous change – an aesthetic thinking that is drawn, read, and felt [33][34].

4. CASE STUDY II – *PRECIOUS CAMOUFLAGE*: *THE CODE* – PERFORMING RESEARCH LIVE

4.1 METHOD AND STRUCTURE: DECODING THROUGH PERFORMANCE

The Code is a performative lecture on dance, art, and technology – particularly artificial intelligence (AI). It unfolds as a forty-minute live presentation in which spoken argument, movement, and visual projection merge to demonstrate how theoretical hypotheses are embodied as choreographic structures. The format recalls choreographic demonstrations in real time [23], yet differs fundamentally: *The Code* stages not a human improvisation aided by digital tools, but a dialogue between human performers and algorithmic interpretation, decoded in real time by the choreographer on stage.

At its centre stands an AI installation in the form of a single LED wall, a one-screen variant of *Precious Camouflage*. On this screen, four collaged AI systems – a classification, descriptive, generative, and fluid-simulation model – operate simultaneously, processing the dancers' movements in real time. Together they form a responsive visual environment that analyses, describes, and reinterprets the live motion, creating a feedback ecology of human and computational perception [32].

As part of the *Precious Camouflage* research, *The Code* situates itself at the intersection of physical practice and computational reasoning. Its focus lies on the question of how systems – aesthetic, technological, ethical – encode movement, and how these codes can be rendered visible through performance. The lecture therefore serves both as an artistic work and as a reflection on the research process that generated it [35].

In this context, code operates on multiple levels: as choreographic system (phrasing, repetition, interval), as aesthetic grammar (form, density, contrast), as ethical matrix (cultural inscription, norm), as linguistic logic, and as computational algorithm. The lecture proceeds through a sequence of decodings. A theoretical statement is spoken. A dancer demonstrates its physical consequence. The AI analyses and visually re-renders the gesture. The speaker reinterprets what the system produced. Each cycle generates a visible chain of translation and misalignment. The stage becomes an epistemic apparatus, exposing the relations between symbolic and somatic processes. The dramaturgy consists of compact chapters, each pairing a conceptual field with a short choreographic experiment. The sequence follows the inner research architecture of *Precious Camouflage*:

1. Archive ↔ Dataset – The human body as living archive is juxtaposed with the AI's dataset. Dancers reproduce remembered gestures; the LED AI interprets them in abstract patterns. The mapping visualises how learning systems – biological and digital – store and reconfigure experience.
2. Pat my Back – Derived from earlier AI-advised movement research, this segment explores how speculative machine advice ("avoid synthetic materials," "defy gravity") mutates into corporeal language.
3. Agency / Surveillance – The speaker discusses agency distribution while the dancers alternate between mirroring and refusal. The LED AI reacts with tracking overlays and textual labels, revealing the aesthetics of monitoring.
4. Fluids / Moral Boundaries – The pivotal chapter examines the boundary at which AI systems refuse representation of bodily fluids. Minimal gestures – breath, sip, drool, wipe – are performed while the LED AI oscillates between analysis and distortion. [32]. It exposes how moral codes embedded in training data define what bodies may appear.
5. Telephone Principle – A phrase is passed from speaker to dancer A to dancer B; with each relay the AI overlays probabilistic captions. The resulting misalignments render interpretation itself visible – knowledge through slippage.
6. Expression Chart – Short series of facial expressions and words – from the training chart used in the original research – are embodied and mirrored by the LED AI. The contrast between human nuance and algorithmic categorisation highlights the tension between data consistency and emotional variability.

Each chapter is framed by a concise verbal cue and ends with silence – an interval that lets the audience register the perceptual shift between proposition and enactment. The audience remains seated observers. They do not participate physically but witness the ongoing negotiation between human performers and the AI system [32].

Figure 4: Precious Camouflage – The Code (2025), *lecture performance with AI LED-wall. Rendering: Triebus / New Human Body Society.*

4.2 THE STAGE AS EPISTEMIC APPARATUS

The lecture operates through three epistemic modes: translation (concepts migrate through voice, body, code), iteration (repeated enactments reveal relational understanding), and misrecognition (the AI's errors become analytic tools instead of failures). These operations embody the helix principle: form generates thought through continuous change, with the LED AI functioning as co-researcher whose refusals illuminate systemic logic.

The spatial arrangement mirrors the triadic structure of the helix. The speaker occupies a desk with microphone; the two dancers inhabit a rectangular field before the LED wall; the AI's live collage of four systems occupies the vertical plane behind them. The camera capturing the dancers' movements is visible on stage, emphasising observation as part of the choreography. Each component – voice, body, system – forms a layer in the research apparatus.

The AI-wall operates as both mirror and counter-player. It analyses the dancers' motion stream via the four parallel subsystems – probability classification, textual description, image generation, and water-based simulation – and merges their outputs into a single visual stream. The result is a continuously transforming projection that alternately aligns with, contradicts, or ignores the human performers, rendering the instability of algorithmic interpretation visible. [Figure 4]

Unlike participatory lecture formats, the public remains external; their perception completes the reflection and may be visible in the AIs and dancers interpretations but does not intervene actively in it. The research unfolds within the closed feedback system of performers and AI.

4.3 ETHICS AND COMPLEMENTARITY

The chapter Fluids condenses the ethical strand of the entire project. During the development of *Precious Camouflage*, AI systems consistently refused to generate or analyse images depicting drooling. This refusal revealed an internalised morality within the datasets – a preference for "dignified" bodies and aversion toward material traces of life. The lecture revisits this discovery performatively. The dancers' micro-gestures of drooling and wiping, synchronised with the LED AI's unstable image stream, materialise the cultural inscription of propriety into code.

As discussed in the forthcoming article on AI systems as performative actors in contemporary dance [32], this moral boundary delineates a camouflage – a zone at which human corporeality eludes algorithmic capture. On stage, the moment of fluid ambiguity transforms from prohibition into aesthetic agency. The refusal of representation becomes an instrument of critique.

While *Multitudes* spatialises the third language through layered image-text composition, *The Code* temporalises it through live transformation. Both operate as systems of translation: one between drawing and reading, the other between voice, body, and AI. The comic's AR interface invites the reader's bodily participation; the lecture's LED AI offers the performers a responsive interlocutor. Each work explores how knowledge becomes perceptible through relational tension – between system and sensation, visibility and opacity.

Together, *Multitudes* renders the medial strand as static resonance, while *The Code* renders it as temporal negotiation. In both, the third language acts as a method of inquiry that merges sensing, thinking, and making visible. [33][34][35][36]

5. DISCUSSION – THE HELIX AS TRANSFORMATIVE MODEL OF ARTISTIC RESEARCH

5.1 MEDIA-AESTHETIC EPISTEMOLOGY

Media-aesthetic approaches provide a further interpretive layer [25][26]. The medial is not a neutral channel but the site at which knowledge takes shape through form. In this sense, *Multitudes* and *The Code* are medial experiments: each constructs a specific environment in which knowledge is generated by navigating material and perceptual thresholds. Hans Ulrich Reck's view of art as media theory in action complements this reading [25]. Through their compositional strategies – collage, looping, feedback – both works theorise their own conditions of mediation.

The comic uses drawing and layout to reveal the temporal logic of movement. The lecture uses real-time processing to expose the interpretive logic of systems. In both, media are not vehicles of expression but epistemic instruments. The helix model clarifies this by integrating material change into the structure of research itself: what changes in form changes in understanding.

5.2 ETHICS AND VISIBILITY

An essential dimension of the helix is ethical. Change inevitably engages questions of inclusion and exclusion – what can appear, and under which conditions. *The Code* exposes this through the sequence Fluids, in which the AI's refusal to depict drooling reveals the moral codes embedded in datasets. The boundary defined by bodily fluids marks a frontier of technological comprehension – a zone at which human corporeality resists algorithmic capture [3][12][32].

This boundary does not function as a failure but as an analytic lens. By incorporating the refusal into the performance, *The Code* transforms absence into visibility. The ethical gesture lies in maintaining the opacity of what cannot or should not be codified. This resonates with feminist and posthumanist ethics – particularly Barad's notion of entanglement and Haraway's ethics of situated knowledge [3][12] – where responsibility arises from acknowledging relationality instead of mastering it. *Multitudes* parallels this stance visually: its fragmented sequences and unspoken transitions cultivate a politics of perception that values ambiguity over transparency.

In both works, ethics becomes an aesthetic practice: an attentiveness to the conditions under which something can be seen, read, or sensed. The third language thus extends beyond media reconfigurations into ethical form – the shaping of perception as a moral and political act.

5.3 SYSTEMIC REFLEXIVITY

By juxtaposing *Multitudes* and *The Code*, the helix model emerges not only as metaphor but as methodological principle for contemporary artistic research. Each strand – performative, discursive, medial – constitutes a system with its own feedback mechanisms. The works test how these systems interfere, overlap, and coproduce meaning. The result is a systemic reflection that mirrors the structure of technological and social systems themselves.

The lecture's choreography of translation between dancers and AI exposes the recursive nature of system interaction: outputs become inputs, observation becomes participation. The comic's spatial montage mirrors this recursion visually, transforming panels into nodes of an interpretive network. In both, the helix structure reveals that understanding is systemic, distributed across media and bodies.

This systemic awareness defines the contemporary urgency of artistic research. In an age in which knowledge production is increasingly automated and visualised by algorithms, the helix offers an alternative epistemology grounded in material relation, human perception, and aesthetic shifts. Artistic research, as these works demonstrate, does not compete with scientific objectivity – it complements it by revealing the experiential, ethical, and sensory infrastructures of knowledge itself.

6. CONCLUSION – THE THIRD LANGUAGE AND THE HELIX OF TRANSFORMATION

Through *Multitudes* and *The Code,* the medial dimension of artistic research emerges as a practice of reconfiguration where knowledge is generated through sensory engagement, material negotiation, and systemic reflexivity. The helix model gains operative form: not as metaphor but as method – a dynamic structure where doing, thinking, and perceiving continuously reconfigure one another.

This approach also situates artistic research within a wider contemporary urgency. In a time when interpretation is increasingly delegated to algorithmic systems, art becomes a site for reclaiming the complexity of embodied cognition. The third language resists simplification: it values ambiguity, hesitation, and opacity as epistemic virtues. It foregrounds the ethical dimensions of visibility – what may appear, what remains hidden, and who decides.

By linking embodied, medial, and systemic dimensions, the helix model proposes a new paradigm for artistic research: one that moves beyond representation toward transformative relationality. Artistic research, in this sense, is not a translation of practice into discourse but an ongoing negotiation between material, perception, and meaning. The medial dimension gives this negotiation form – it is the movement through which understanding takes form.

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SESSION III

“Spaces and Museums”

Moderation: Univ.-Prof. Dipl.-Ing. Dominik Lengyel
(Brandenburg University of Technology Cottbus-Senftenberg)

Exhibition In Flux:
Spatial Concepts For The Exhibition Of Digital Media Art

Carlijn Juste

Centre d'étude des arts contemporains, Université de Lille, France, carlijn.juste@univ-lille.fr

ABSTRACT: This conference paper explores how curators and institutions are responding to these shifts through a series of expert interviews and case studies, including ZKM Karlsruhe, V2_ in Rotterdam, the Stedelijk Museum Amsterdam, and the Centre Pompidou. It examines how traditional spatial concepts such as the White Cube and the Black Box are being reimagined, how new spatial configurations are being tested to support emerging artistic practices grounded in new technologies, and shows how concepts for the exhibition of digital art emerge both in continuity with and in disruption of existing exhibition theory and practice.

1. INTRODUCTION

This article is concerned with the spatial design of digital media art exhibitions held in physical exhibition spaces. Over the past decades, digital media art has gradually entered mainstream art museum spaces and collections, giving them the possibility to become a privileged site for a critical reflection on the influences of digital technologies on our everyday life, social relations, societal changes, and political decision-making processes. This integration—accelerated in recent years—challenges curators to rethink established exhibition formats and spatial configurations [1].

The influence of these developments on the relation between artwork and exhibition space is manifold: Many artworks, such as digital installations, materialize only during the time of an exhibition, adapt to exhibition space and develop throughout an exhibition or from exhibition to exhibition. The exhibition as site that stages an encounter between artwork and spectator thus has a crucial impact on the material form of the artwork. At the same time, digital technologies extend the physical exhibition into virtual space, creating new forms of hybrid environments that question conventional boundaries between artwork and environment [2]. Finally, existing exhibition spaces must be reconfigured to meet the conceptual and technical demands of digital media art, which often requires specialized infrastructure, flexible layouts, and alternative modes of display [3, 4].

In any art exhibition, the spectator is not confronted with a single artwork, but rather with a set of artworks that may be arranged in a trajectory or narrative—a specific spatial order intended to convey a message [5]. This logico-spatial order of the exhibition transposes the historical knowledge and conventions of art onto a three-dimensional spatial layout [6]. Display strategies can articulate connections between objects, organize the relationship between artworks and spectators, indicate patterns for visitors' movement through space, and induce specific interpretations of the objects on display. Furthermore, the spatial configuration of the museum and the exhibition itself reflects a certain interpretation of art, history, and its function within a broader society, and conceptions of spectatorship. The spatial design not only imposes—or alludes to—a specific understanding of the objects but also determines the degree to which the spectator can actively piece together diverse interpretations [7].

Curators like Christiane Paul, who was among the first to show digital media art within a museum context, have often pointed out that these works would need specific exhibition spaces, environments that are flexible and technologically equipped [8]. Historically, digital media art exhibitions often took place outside established museum spaces, in abandoned warehouses or factories. Within the museum space, these objects were frequently set apart from the rest of the exhibitions, for example to avoid interference or disturbance, which led, according to Paul, to the conception of digital media art as

separate from the unfolding of art history that took place within the museum space [3, 9].

Nonetheless, as I will argue in this article, it is possible to reintegrate digital media art into existing models of exhibition making, including the white cube. Even though the "white cube"—a space with white walls that suggest neutrality [10], often combined with a linear mode of visitor guidance [11, 12]—has crystallized much of the attention of exhibition critique, alternative models have developed alongside it. Based on the analysis of digital art exhibitions held at major institutions such as ZKM, Karlsruhe; V2_Lab for the Unstable Media, Rotterdam; Centre Pompidou, Paris; Grand Palais, Paris; and Le Fresnoy – Studio national des arts contemporains, Tourcoing, expert interviews and archival research, this article analyses different spatial configuration for the exhibition of digital media art. With a specific focus on the spatial layout **of** these exhibitions—the way walls are placed and paths are created throughout the exhibition space— the article proposes a typification of four distinct spatial configurations that have been used in the past for the exhibition of digital media art in gallery exhibitions: the white cube, the black box, the networked space, and open space.

2. THE LINEAR PATH OF THE WHITE CUBE

A reflection on contemporary exhibition spaces must address the modern white cube, which, though not the first standardized model, has dominated exhibition-making since the mid-20th century. Characterized by white walls, even lighting, minimal décor, and an inward, sober aesthetic, it aims to present all artworks neutrally and without hierarchy. Introduced at MoMA under Alfred Barr, the white cube was meant to support the appreciation of autonomous artworks—an approach that later attracted much critique [10, 13, 14]. In addition to the widely discussed aesthetic of the white cube, Alfred Barr also introduced a new spatial configuration. Artworks were installed in a sequence of galleries suggesting a clear, linear narrative throughout art history [15].

While still common for contemporary art, the white cube appears less frequently in relation to digital art. The exhibition *Artists and Robots* (Grand Palais, 2018) illustrates how the model can nonetheless be adopted for digital media art exhibitions. The ground floor of this exhibition resembled a classical white cube, while the first floor was painted black to accommodate screen-based works. Despite the exhibition's focus on robotics and generative systems, the selection of artworks put on display emphasized calm, mostly static works, avoiding loud or highly interactive pieces. This maintained a contemplative atmosphere and contributed to the canonization or 'artification' [16] of digital practices. This emphasis on the artistic value of the selection of mostly well-established artists was also reinforced by the introductory text in the exhibition brochure [17].

The exhibition followed a clear, linear structure with three thematic sections—‚Machines to Create,' ‚The Programmed Work,' and ‚The Robot Emancipates Itself'—each beginning with historical works and ending with more recent ones. This organization implicitly suggested a chronological development of robotic and programmed art, even though there are also entanglements and cross-connections within these historical developments, as noted by the exhibition's curators Laurence Bertrand Dorléac and Jérôme Neutre [18]. The catalogue mirrored this structure, functioning almost as an extension of the exhibition narrative.

This method of placing artworks within the exhibition is a means of anchoring them clearly within historical discourse. Like a book, the exhibition has a clear beginning and end, with a discernible progression in between. Through the placement of the artworks, the exhibition becomes a means by which to tell a certain history of art. It is not only the object but also the connections between objects that carry meaning. However, this somewhat authoritarian mode of storytelling can also be put into perspective. The spectator engages in the processes of sense-making similarly to what Roland Barthes has described for the reader. Barthes argues against limiting a text by assigning an ultimate meaning to it that must be searched for in the person of the author. Instead, the reader plays a crucial role in the construction of meaning, as the text is inherently open to multiple interpretations [19]. In this sense, the significance of the exhibition ultimately lies within the spectator, who 'disentangles' layers of meaning and references within the exhibition. Although such narrative structures may appear authoritarian—imposing a museum-defined storyline and potentially reducing the multiplicity of meanings—the active role of the spectator mitigates

institutional authority. Many visitors also appreciate clear, didactic structures. Ultimately, the exhibition becomes a site of knowledge production shaped by both curatorial framing and the interpretative agency of its audience, raising questions about how much complexity museums can or should ask visitors to navigate.

3. (BLACK) BOXES – BETWEEN INTIMACY AND ISOLATION

Since the introduction of video and film—especially the video projector—in museums in the 1980s and 1990s, black boxes have become complementary spaces inserted into white cube galleries [20]. Their enclosed nature helps control sound and light interferences, which can be perceived as disruptive with media art works. For the same reason, black boxes are also often used for digital forms of art. Black boxes stage the encounter with the moving image within the gallery space and, as such, inherit from different cultural sites—such as the theatre, the cinema, and the art museum— with their different models of spectatorship. Even more so than the white cube, the black box defines the spectator's position in relation to the work. Entering this space, the spectator is immediately situated in front of a work, or occasionally within a work. While in the white cube, or in a public square, spectators can be distracted more easily and must mentally isolate themselves in order to be immersed in an image, here the isolation comes as a direct effect of the spatial configuration. Seating possibilities, occasionally placed in front of the screen, may not only give the spectator the possibility to rest but also suggest an ideal point of view.

In the case of media art exhibitions, black boxes allow for a controlled setting, that diminishes disturbances, sound and light interferences, etc. They also create an intimate and immersive atmosphere for interactive artworks, enabling visitors to engage more freely with them. Morgane Stricot, head of digital preservation at ZKM, observed that the spectators interact differently with the works depending on the space [21]. Visitors spend more time with the works in black box settings, allowing them to have a more profound comprehension of the interaction processes and analyse the work in greater depth, whereas they tended to have shorter interaction times in open spaces. This is especially true for those works depending on a more intense physical activity. The more intimate setting of the black box favours interaction that visitors might feel uncomfortable doing in public.

Putting artworks into boxes, however, also isolates them from the ideological frame and narrative of the exhibition. This has sometimes been used by artists in order to create a controlled viewing environment and to liberate their works from the effects of the museum. At a 1996 exhibition at Centre Pompidou, works by Lucian Fabro, an artist connected to the Arte Povera movement, were shown in what he called 'habitats'—temporary constructions built mostly from paper and other poor materials. These habitats allowed Fabro to redefine the relation between artwork and museum and to control the conditions of viewing. The habitats isolate his works from the museum space he critiques harshly as being constructed for architects and not artworks [22]. These constructions represent a form of resistance against the museum apparatus, enabling the artist to define his own terms for the presentation and visualization of their works.

This however, does not necessarily only have a positive effect. The black box setting also takes away the possibility of seeing several works at once—and of creating meaning through direct, visual confrontation and thus limits the possibility of perceiving an exhibition as a whole. In an exhibition, artworks are placed in meaningful relations of proximity to one another. This traditional mode of suggesting an interpretation through confrontation is limited by boxing some of the works in. Since the black box is often employed for the exhibition of works using screening technologies or sound, the decision to set a work aside in such a way is taken based on the mediality and not necessarily on aesthetics or subject matter.

Michel van Dartel, former director of V2_Lab for the Unstable Media, argues that, when creating an exhibition, one should consider the benefit of the exhibition first and the exhibition conditions of a specific artwork second [23]. This concerns group exhibitions in particular, where curators must navigate the intentions and expectations of different artists. In his experience as both the director of the V2_ and a curator, the temptation to think from the perspective of a single artwork is strong for those artists making more traditional media art. A black box might be the spatial configuration that is ideal

for the artwork, because it allows for a very intimate relation between the spectator and the work as well as a kind of uninterrupted focus on the work that is difficult to create in other spaces. However, when the exhibition as a whole, rather than a single artwork, is emphasized, boxing works in is generally not the best solution. Instead, he argues, it is often more interesting to create spaces that allow artworks to resonate with one another or to affect one another positively. Van Dartel states that one should ask how it is possible to create the kind of concentration the artist wants for the spectator while having other works in view, or that perhaps even positively interfere with one another. In his opinion, if a work must truly be preserved, for instance from light interferences, clever solutions can be found that do not necessarily include black boxes.

4. THE EXHIBITION AS A NETWORK OF INTERRELATED KNOTS

The open-ended network is a way of structuring exhibition space that considers the connections between exhibits or groups of exhibits within different parts of the exhibition trajectory. This spatial configuration acknowledges the interplay between various elements an exhibition. The media art exhibition Les Immatériaux curated in 1985 by French philosopher çois Lyotard and design specialist The exhibition, which was one of the first museum exhibitions to include digital technologies, as part of both exhibits and mediation, explored possible convergences between the arts, industrial technologies, and science which continue to evolve today [24]. It presented a large variety of objects ranging from everyday objects, clothing and fashion, technical innovations, architectural models, scientific experimentation and artworks, some of them including digital technologies.

By using new and experimental exhibition techniques materializing the theoretical concept of Lyotard thoughts on post-modernism, on the other. This technique includes the likes of semitransparent metal screens structuring the exhibition space, indeterminate routes, a localized soundtrack distributed on headphones throughout the exhibition, and numerous computer terminals where spectators could access various informational materials [25]. The open circuit proposed by Les Immatériaux abandoned the model of encyclopedic exhibitions previously held at Centre Pompidou, such as *Paris-New York* (1977), *Paris-Berlin* (1978), and *Paris-Moscou* (1979).

The spatial layout was composed out of a loose network of five, occasionally overlapping, paths, all of which had a common starting and endpoint. All five paths, whose nominations derived from the root “mat” (Matériaux, Matrice, Matièriel, Matière, Maternité), followed a common trajectory from body to language, from material to immaterial. The spatial layout consisted of a network—a loose grid of pathways that are interconnected at several nods, which the spectator can walk through and connect in various ways. It thus created an open perceptual situation with multidirectional narratives [5]. This open narrative was mirrored by the exhibition catalogue, that was composed out a of number of loose sheets, that could be re-arranged at will by the reader.

In the network, or maze, conceived by Lyotard and Chaput, each spectator must find their own path through the exhibition, creating an individualized order of objects. The aim of this new type of layout was to steer reflective though on behalf of each spectator, and for fluid connections between the objects on display to emerge. Charles Perraton, who saw the exhibition in 1985, describes the way in which he moved through the exhibition as following: ‘We developed a whole art of the rhetoric of the path (rhétorique cheminatoire), preferring the hazardous route taken at the whim of sensitive experience to that of the rationality and anxiousness of hurried people exited to learn and wanting to know everything.’ [26] This suggests an intuitive mode of visiting, guided by sensory stimuli rather than intellectual pursuits. The recommended approach to experiencing the exhibition was one of drifting—not trying to understand everything, but instead allowing oneself to be absorbed by what was presented, and exploring how one might engage with what was offered. Perraton ‘abandoned the idea of having a global view [of the exhibition in face of its complexity].’ [26] However, it is reported that other visitors were frustrated and destabilized by the exhibition’s unclear spatial configuration and complete lack of visitor guidance [25]. Many spectators did not find their way through the maze and left again through the entrance. Moreover, the spectator’s association of objects was not necessarily completely free. Proximity between objects can be induced by spatial proximity—carefully created view axes and lighting

can prompt a visitor to take a certain direction almost as much as a wall.

The spatial proposition of Les Immatériaux consisted of an uncertain space, where every path seemed possible [27]. The exhibition space becomes somewhat transparent and fluid in a way that encouraged exploration and independent thinking. It was not meant to be experienced as a whole but rather as fragmented. The abovementioned entanglement made travelling each path on its own difficult, and the exploration of the entire exhibition redundant [28]. Common subjects of the exhibition—such as dematerialization in art, design, and architecture, nutrition, the senses of taste and smell, the body, the skin as limit of the body, technical clothing, the relation between the representation and the represented, and the contemporary striving for performativity in science and technology—were spread out through the exhibition in such a way that spectators would come in contact with most of them, even when they did not view every exhibit. Therefore, conclusions about the exhibition as a whole could be drawn from the experience of its individual parts. This fragmentation is another symptom of postmodernity, reflecting the realization that modernity's goal of achieving complete knowledge is unattainable. Transposed to the exhibition, this means there is no singular, complete experience of the spatial proposition; instead, each visit is individually unique and inherently incomplete.

The influence of Les Immatériaux on later artworks and exhibitions is often mentioned, but rarely specified. Besides the increased amount of exhibitions curated by philosophers and the ongoing entanglement between art and science, the influence of the exhibition design creating uncertain spaces with blurred boundaries deserves some investigation. Networked exhibition spaces can be found in many media art exhibitions, such as Bruno Latour's 'thought exhibitions' held at ZKM (Iconoclash: Beyond the Image Wars in Science, Religion and Arts, May 4–September 1, 2002; Making Things Public, March 20, 2005–October 3, 2005; Reset Modernity, April 16– August 21, 2016; and Critical Zones, May 23, 2020–January 9, 2022), but they have also become an important spatial configuration for exhibitions, wanting to avoid linear narratives [29].

5. OPEN SPACES WITH FLUID NARRATIVIONS

The last type of spatial configuration examined here is the open space. Open spaces are exhibition areas with few or no structural elements. This means that the space is primarily shaped by the placement of the artworks themselves, situated not only along the walls but also within the space. These types of spaces enable visitors to see a large number of works immediately upon entering and allow for visual comparison. While the possibility of viewing many works at once could be considered a distraction—as the presence of other works diverts the viewer's attention from a single piece—this oscillation of the gaze can also carry meaning. The open space creates a complex, multilayered mode of perception, allowing various elements to be perceived simultaneously. One of the key stakes of contemporary museology is the multiplication of perspectives and the possibility not only of viewing artworks from different positions but also of attaching multiple, sometimes individual or even conflicting, discourses to them [11]. This open spatial construction allows spectators to choose an individual path through the exhibition and to observe works from many, occasionally unusual, angles. Thus, they allow for the creation of individual narratives based on a pattern laid out by the curators.

Le Fresnoy – Studio national des arts contemporains, an art school offering a postgraduate programme for artists interested in new technologies, gradually reduced structural elements, such as inside walls and black boxes in thir exhibition. In the 2022 exhibition, *Jusque-là* (4 February–30 April 2022), all structural elements were removed from the great nave of Le Fresnoy, resulting in a completely open exhibition space. This trend continued in subsequent exhibitions, such as *Panorama 25* (30 September–31 December 2022), whose curator attempted to open up the space as much as possible but still used some intermediate walls, and *Saodat Ismailova — Double horizon* (10 February–30 April 2023) [30].

The *Jusque-là* exhibition presented a large number of video works, using sound and projection technologies and raising challenges similar to those encountered in many digital media artworks, particularly in terms of projection and sound interferences. The exhibition also contained several sound artworks by Chilean artist

Enrique Ramirez. The artworks were selected for their focus on themes of displacement and travel, especially sea travel and border crossings (between countries, between land and sea, between body and mind, between the human and the non-human). Works were carefully placed within the space depending on their size, their relationship to one another, and the sounds they produced. The sound of several works overlapped, creating an evocative soundscape, yet it remained possible to focus on individual pieces. Lighting in the exhibition was very dim, with spotlights directed at the artworks, resulting in a negation of the physical exhibition space and greater focus on the works themselves.

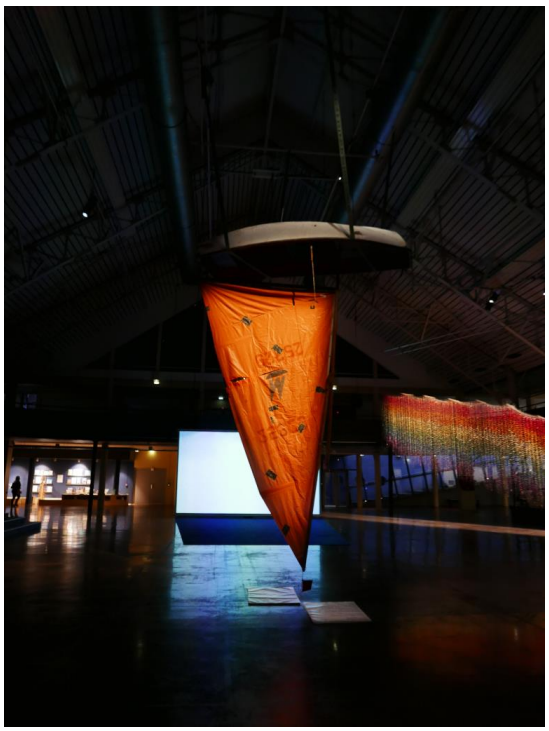

Fig 2: *Jusque-là, Le Fresnoy—Studio national des arts contemporains, Tourcoing, February 4–April 30, 2022. Exhibition View. Photograph by the author.*

Precedents for such open spaces can be found, for example, in the innovative display created by Lina Bo Bardi at the São Paulo Museum of Art (MASP), which was in place from 1969 until 1996. With the aim of creating a non-hierarchical display that contrasted with Western exhibition models, Bo Bardi removed the MASP collection of European and Brazilian modernist paintings from the walls and distributed them throughout the exhibition space. The paintings were placed on so-called 'crystal easels'—glass panes held up by concrete blocks—allowing visitors to see both the paintings and the backs of the canvases. This display, guided by flexibility and openness, blatantly refused artistic classification by chronological or geographical categories and encouraged a 'less passive stance from the observer,' as noted by Sabrina Moura [31]. The openness of Bo Bardi's installation must also be understood in the context of late-1960s institutional critique, with its calls to rethink the museum's relationship to history and society, foster more inclusive curatorial practices, and enhance accessibility. Her blending of works from different art historical periods, styles, and geographical origins can be seen as a precursor to later attempts to construct art-historical discourse from multiple perspectives and to show connections between artists and movements through juxtaposition.

Lina Bo Bardi's open floor plan has influenced exhibition concepts such as the *Galerie du temps* at Louvre-Lens, geographically close to Le Fresnoy. In the *Jusque-là* exhibition, the removal of spatial elements created a strong spatial impression. Rather than being confronted with a series of individual works, the visitor encountered an immersive environment experienced through dynamic movement across space and time. Each spectator could create an individual path through the exhibition. Relationships between artworks were produced through proximity, scale, and overlapping sounds.

The open floor plan worked well in this exhibition owing to the reduced number of artworks and the coherence of the selected pieces. Calm sounds and slow-moving images generated a largely peaceful atmosphere. In other exhibitions—especially those with numerous artworks involving sound, rapidly moving images, or interactivity—this open concept can be more difficult to implement. Open spaces may also generate visual and auditory disturbances that make it challenging to concentrate on a single artwork, and an atmosphere of overstimulation can quickly become tiring for visitors. In their most recent graduate exhibition, *Panorama 27 – Simultanéité* (19 September 2025–4 January 2026), Le Fresnoy curators placed artworks involving sound and moving images on loops in order to reduce interferences and mitigate negative interactions among the works.

6. CONCLUSION

The spatial configurations examined in this article—the linear setting of the white cube, the isolating yet intimate black box, the networked space, and the open floor plan—demonstrate the extent to which exhibition design actively shapes spectator experiences. While digital artworks are often seen as requiring specialized environments, these examples show that they can be meaningfully integrated into a wide range of exhibition models, including those already in place for more conventional artworks.

The white cube offers legibility and historical anchoring but risks reducing complexity through linear narratives. Black boxes provide the controlled, immersive settings for screen-based and interactive pieces but tend to isolate artworks from one another, potentially fragmenting the coherence of group exhibitions. Networked layouts foreground relationality and multiplicity by encouraging visitors to navigate exhibitions in non-linear ways, yet their openness may disorient spectators unused to such fluid structures. Open spaces, finally, privilege simultaneity and individualized pathways, fostering rich cross-views between works but demanding careful control of sound, light, and movement to avoid sensory overload.

These models are not mutually exclusive; rather, they form a toolkit that curators can activate, adapt, and hybridize according to the conceptual, technical, and experiential demands of each exhibition. As digital media art continues to develop—materially in the exhibition space and virtually across networked environments—the challenge for curators is not simply to accommodate technological requirements but to reflect critically on how spatial decisions shape narratives, forms of spectatorship, and the positioning of digital art within broader art-historical discourses. Connections to existing exhibition models allow to re-integrate concerns related to the exhibition of digital media art within a larger art historical framework of exhibition theory and practice.
Ultimately, the exhibition space becomes a laboratory in which relationships between artworks, technologies, and audiences are rehearsed and reimagined. Far from destabilizing existing exhibition models, digital media art pushes them toward greater flexibility, permeability, and responsiveness. In doing so, it invites institutions to rethink not only how art is shown but also how knowledge is produced, how histories are written, and how spectators may inhabit and interpret increasingly hybrid cultural spaces.

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New Orders and Decorations Museum

Pedro Nunes de Brito Serra Vaz[a], Bárbara Lhansol Massapina Vaz[b]

[a] Secretaria-Geral da Presidência da República, Portugal, pedrovaz@presidencia.pt
[b] Faculdade de Arquitectura Universidade de Lisboa, Portugal, blvaz@fa.ulisboa.pt

ABSTRACT: The Museum of the Presidency of the Republic is a presidential museum located in the Palace of Belém in Lisbon. The museum chronicles the history of the Portuguese Republic through the Presidents' official portraits and personal objects, exposing many of them gifts from notable national and international personalities and heads of state.

A new area for Orders and Decorations will be opened in September 2025, and it will host an exposition of all the Portuguese Orders, with a main Chronology Bar, starting its history since the 12th Century. There will be a room dedicated to the Foreign Orders received by the Portuguese Presidents, an area for the artisans who make the decorations with their hands, and a multimedia area for educational movies.

Before this, there was the architectural project, preceded by a 3D laser scan survey, then transformed in AutoCAD drawings, then a 3D model for project support and finally a 3D virtual visit to present and explain. In this project, 3D technology was present in 3 key moments: first as a useful tool to define a rigorous architectural survey, second as a useful tool to better understand the volumes and spaces generated by the project options, and finally as a useful tool to provide the final decision makers a previous knowledge of the estimated result.

1. INTRODUCTION

The first area of the Belem Palace was started by *Jerónimos* monks on the beginning of the 16th century, holding a solid and austere hose perpendicular to the river, over a rocky hill, which roughly corresponds to the area of the now called residence of *Arrábida*. On the North there was a vineyard which King Manuel I had donated to the friars of the Order of St. Jerome, together with the land to the West, for the construction of his *Jerónimos* monastery, whose construction started at this date. The house may have served as a convent whilst the monks accompanied the works of the monastery.

The main halls and gardens were built by Earl *Manuel de Portugal*, when he bought the farm in 1559. After successive changes in ownership Earl *João da Silva Telo*, third Count of *Aveiro*, created the romantic garden around the houses.

Between 1700 and 1701 the count lends the Belem Palace to *Catarina de Bragança*, widow of Charles II of England, on her return to Portugal. Queen *Catarina* was the first monarch to inhabit the palace.

On the 4th of July 1726, King *João V* buys the Count's palace, together with several other properties in the direct neighbourhood. Despite this king never stayed in the Belem Palace, the building's interior was redecorated with paintings and sculptures, and the gardens received new sculptures.

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In 1755 there was an earthquake (magnitude 9.5 in Richter scale) that caught King *José I* in his "farm in Belem". The palace did not suffer with the earthquake, but all the family and servants rushed into the gardens.

Reaching the throne in 1777, Queen *Maria II* started a campaign within the palace and gardens, with lakes and plumbing connections, beneficiations in stonework and balusters for the south balcony of the palace. At the time, the queen stars the construction of two main works: the Royal Riding School built between 1787 and 1792, replacing the existing arena, now

drawn by Giovanni Giacomo Azzolini, and the Bird's Nurseries built between 1780 and 1785, replacing the existing aviary. This last project marked the arrival of the 18th century Romantic sensibility to the palace (Fig.1). From a Lord's House, the Belém Palace became a Royal small palace until the beginning of the 20th century, rarely used by the royal family.

In 1910, after the Republican Revolution, the palace became the Presidential Palace of Portugal. The country never returned to monarchy and so this compound of buildings became the presidential palace ever since, housing the entire History of the Republican Head of State's Office, making it highly relevant for Portuguese culture and identity as a nation.

Being the President's official office, the palace has been for more than a century a political centre, a place for ceremonies for the representation of the State, receiving major political guests from all over the World. Because there is the Presidency's Museum inside, the compound receives public every day, especially on weekends, when all the major ceremonial rooms are open for public visits.

With a modest construction and size, 19.500sqm, the building suited the idea of housing a "cheap and modest President", expressed by the Parliament at the time. It was only in 1967 that the building and its gardens were listed "Building of Public Interest", in order to recognise the relevance of it in the Portuguese context.

After 5 years of major works, including a new Information and Data Centre and a Museum, the compound was upgraded in 2007 to a "National Monument". The addition of contemporary architecture, added to the accumulation of symbolism of the Palace, gave the building a bigger cultural relevance.

2. ORDERS AND DECORATIONS

Next to the Museum Shop and entrance, there was a group of buildings belonging to the National Guard, all of them void and without any use for decade. These houses, originally built in the 16th century for servants of the Belém Palace, and after 1910's Republic Revolution occupied by sergeants of the National Guard, were very changed by their inhabitants and in a very poor state of conservation, some areas very next to ruin.

Next to these abandoned houses was the entrance for the Museum of the Presidency of the Republic. For this reason, and because the houses were historically connected to the History of the Belém Palace (although functionally separated since 1910), the houses were taken by the Secretary-general of the Presidency and targeted to become an extension area for the museum.

In Portugal, the President of the Republic is the Gran-Master for the Honorific Orders. Therefore, the Orders and their specific history should be present in the Presidency's Museum, and the old houses area was appropriated, in dimension and localisation.

To achieve the goal, an architectural project was needed and for that, all the technology available was called to play its part in the overall process.

3. 3D LASER SCAN FOR SURVEY

As Umberto Eco said "after Beethoven, the symphonies could never remain the same", the first 3D laser scans surveys, and the 2D CAD drawing based on that data, became the minimum level of quality and detail requested by the designing team.
In this context, the Secretary-general of the Presidency launched a public consultation, and a 3D laser scan was started. A field work was done for two weeks, taking the 3D pictures, first detecting the volumes and its position in the space, and then the colours of each of those pixels.

Figure 1: *Outside 360º picture, coloured*

Figure 2: *Inside 360º picture, coloured*

After collecting all the separated 3D pictures, all the data was put together in a point's clouds, to build an 3D picture. The colour can be added for presentation, but the main information for project purposes is already present in the uncoloured point´s cloud.

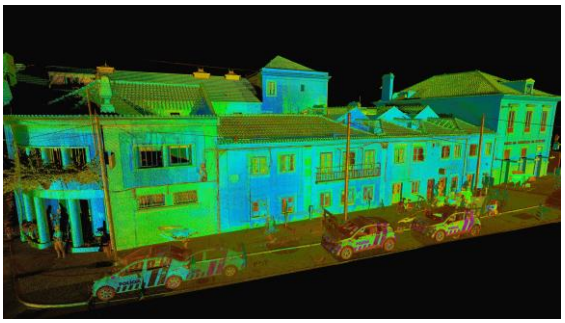

Figure 3: *Point's cloud, without colour*

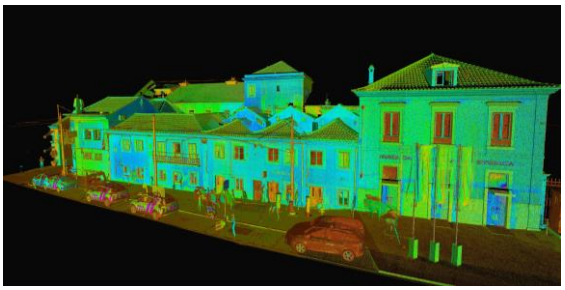

Figure 4: *Point's cloud, without colour*

This model is then used to be sliced horizontally to draw the plans and slice vertically to draw the sections, resulting in accurate drawings, reflecting all the imperfections existing in the real building, crucial information to the project.
The 3D Laser Scan survey was the first step on the dialogue between project and technology.

4. 3D MODEL

The 2D drawings were used to develop the architectural project, organising the new functions and museum circuits. Being a listed structure, this project will focus mainly on exterior conservation and interior rehabilitation, meaning the exterior will mostly remain, unlike the interior spaces that become new.

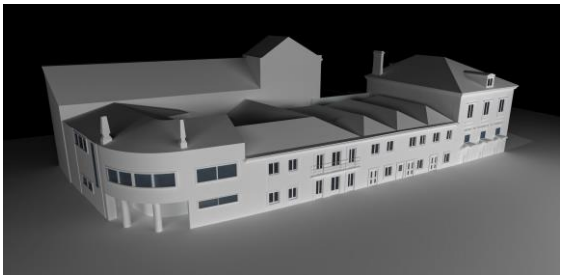

Figure 5: *3D conceptual model, volumes & spaces of the South facade, facing the public space*

Figure 6: *North façade, with a contemporary horizontal window and it's harmony in the context*

The plans, elevations and sections transformed by the project were then used to build a 3D model. The model was made to test the solution and to anticipate the spaces and environment designed in the project, as a useful tool to understand the expected result of each design option. The new model was then „visited" inside and sliced to better understand the proportions of the design spaces, and the balance between the sequential rooms of the new exposition areas.

Figure 7: *longitudinal section, view on the new entrance and 2 floors of the exposition*

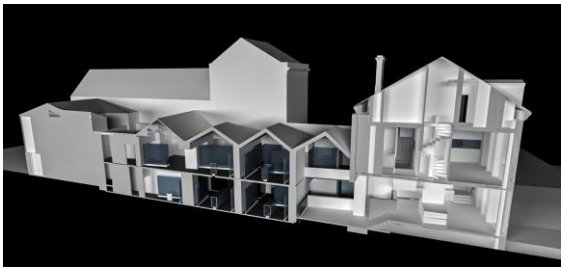

Figure 8: *Idem*

Figure 9: *section on the very tiny exterior space on the rear façade*

On a second phase, the model was also used to communicate the architectural project. To explain the stakeholders involved in the subsequent phases (security, museum staff, etc) the solutions, the circuits, the expected behaviour and the storytelling strategy.

Figures from 10 to 18: *Plans form the 3D model used to explain the visitors circuit dynamics*

5. VIRTUAL VISIT

After the project decisions and during the construction phase, before finalizing the interior covers and the vitrines design, a virtual visit was made to present and deliver the expected final environment of the Orders and Decorations Museum. This time, the idea was to give an idea of the future museum, to provide a virtual visit to the ones living far away or abroad. This was another technological tool, interactive and dynamic, pedagogical and amusing, being extremely relevant and useful.

Figure 19: *Virtual entrance. See the plan on the right to conduct the visitors circuit*

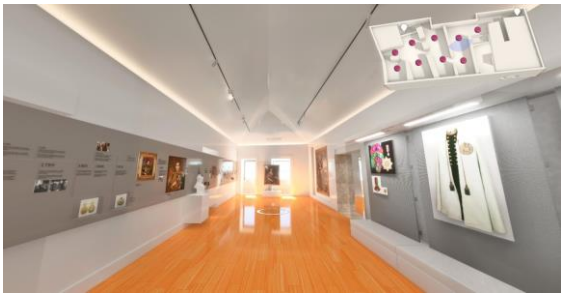

Figure 20: *Virtual first room: Chronology*

Figure 21: *Virtual room: Crist Military Order*

Figure 22: *Virtual room: Former Presidents Foreign Orders collection*

6. CONCLUSION

Architectural creation and project development have always searched for the most competent tools available to make the best job possible, in the most effective and easy way of achieving their goal.

The Orders and Decorations Museum is an example where recent and available technology was used to support and enhance the project: the architectural project was preceded by a 3D laser scan survey, then transformed in AutoCAD drawings, then a 3D model for project support and finally a 3D virtual visit to present and explain. In this project, 3D technology was present in 3 key moments: first as a useful tool to define a rigorous architectural survey, second as a useful tool to better understand the volumes and spaces generated by the project options, and finally as a useful tool to provide the final decision makers a previous knowledge of the estimated result.

7. ACKNOWLEDGMENT

Acknowledgements for the Secretary-general of the Presidency of the Republic, and their decision makers who made this project and this presentation possible.

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The Impact of Journey Mapping on Strategic Planning and Digital Transformation

Jack Ludden

Digital Experience and Innovation Strategist
Balboa Park Online Collaborative
1549 El Prado, San Diego, CA 92101 USA
jludden@gmail.com | jludden@bpoc.com

ABSTRACT: Journey mapping is no longer a static visitor-experience tool—it is a strategic framework for transformation. It helps institutions visualize how workplace activities, innovations, and audience expectations intersect and reveals how technologies and learning environments impact engagement and priorities. By mapping emotional, cognitive, and behavioural interactions, museums can balance mission-driven goals with sustainable growth.

A multi-layered journey map supports perspectives from technologists to curators, aligning digital pedagogy with museums' evolving roles as innovation hubs. It enables assessment of generative AI, data practices, equitable access, and hybrid physical-digital experiences like immersive tours or gamified exhibits.

By applying "value equations" to touchpoints, it exposes gaps, highlights opportunities, and builds tactical roadmaps. Journey maps foster collaboration, shared language, and consistent engagement, creating ethical, inclusive, and human-centered infrastructures. Ultimately, they strengthen resilience, relevance, and long-term success in a rapidly changing digital landscape.

1. INTRODUCTION

Rapid technological change, shifting audience expectations, evolving cultural narratives, and increasingly complex social, political, and environmental contexts are reshaping the landscape in which cultural institutions operate. At the same time, museums face familiar structural challenges: legacy systems and processes, fragmented internal workflows, siloed departments, and funding uncertainties. Strategic planning, once largely a linear exercise focused on three- or five-year horizons, must now evolve into a dynamic, adaptive process capable of integrating internal realities with external forces and emerging innovations.

Within this shifting landscape, journey mapping has emerged as a powerful framework. Journey mapping can visualize interactions that audiences (or staff) have with an organization. By illustrating emotional, cognitive, behavioral, and social dimensions of these interactions, journey maps help institutions understand how key audiences experience their offerings—not just as isolated moments, but as connected, coordinated, consistent journeys that span physical and digital contexts.

Figure 1: *Journey map phases and engagement activities*

When strategically applied, journey mapping becomes a bridge between visitor-centered design and institutional transformation. By integrating journey mapping into strategic planning, museums can align audience experiences with organizational goals, identify operational gaps, explore future scenarios, and prioritize opportunities for innovation. Journey mapping becomes an essential tool for museums seeking to navigate digital transformation in ways that are mission-driven, sustainable, and human-centered.

2.1 WHAT IS A JOURNEY MAPPING?

A journey map visualizes the key stages of the audience experience, mapping their activities and interactions with the organization. Journey maps often include additional layers such as:

- Channels: Distribution mediums through which interactions occur.
- User Goals and Behaviors: What the person seeks to achieve at each stage.
- Emotional States: Feelings such as anticipation, delight, or frustration.
- Institutional Processes: The systems and workflows supporting these experiences.

These elements together provide a multi-layered, temporal view of interactions that can reveal both friction points and opportunities for improvement or innovation.

2.2 WHY JOURNEY MAPPING?

The rise of hybrid physical–digital experiences, coupled with the increasing importance of participatory culture and data-informed decision making, has made journey mapping especially relevant. Audiences now move across platforms—researching online, visiting in person, engaging through social media. They also expect experiences that are coherent, inclusive, and adaptive. Internally, museums must coordinate across increasingly complex systems: content management, digital asset management, CRM platforms, analytics, ticketing, and more.

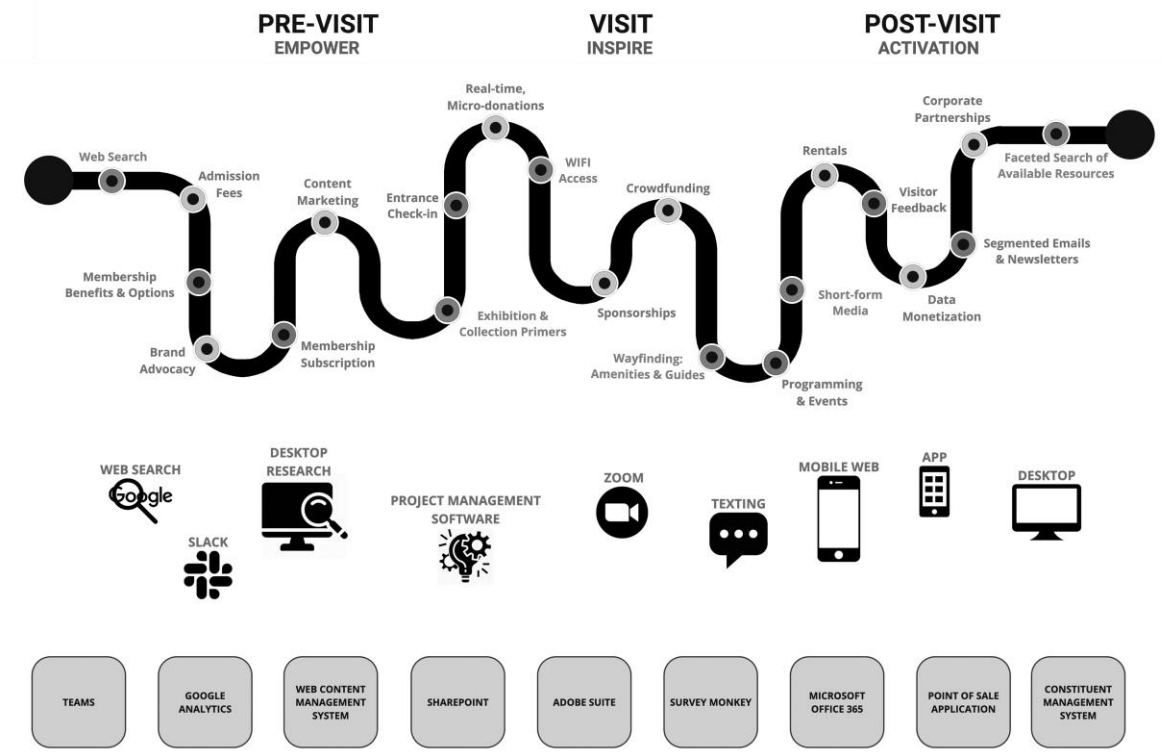

Figure 2: *A journey map that illustrates key audience touchpoints as well as distribution channels and technology systems supporting audience interactions.*

Journey mapping provides a strategic mechanism to visualize and align these complexities. It connects the experiential (what audiences see and feel) with the operational (what staff and systems do), revealing misalignments, leverage points, and opportunities for innovation. These connections support collaborative planning, bringing technologists, curators, educators, marketers, and administrators into shared dialogue around concrete experience pathways rather than abstract strategic goals.

2.3 SUPPORTING INNOVATION

In this context, journey mapping has the remarkable opportunity to highlight solutions by introduction of novel ideas, methods, or technologies that meaningfully enhance an institution's ability to fulfill its mission, engage audiences, or operate sustainably. Moreover, this innovation spans multiple domains: technological (e.g., adopting new platforms), programmatic (e.g., developing hybrid participatory programs), organizational (e.g., evolving governance models), and methodological (e.g., integrating scenario planning into strategic cycles). Journey mapping helps institutions identify where and how these innovations can have the greatest impact, based on audience behaviors, staff needs as well as operational contexts.

Digital transformation is a holistic reconfiguration of how an organization creates value and engages communities through the strategic integration of digital tools, infrastructures, cultures, and practices—not merely technology adoption. These concepts intersect in powerful ways. This digital-first realignment helps catapult museums into perpetual innovation that is embedded in the organization's work environment and workplace activities.

When embedded within strategic planning, journey mapping enables museums to:

- Align strategic foundations with mission, institutional culture, staff, and external audiences.
- Use journey mapping as a strategic framework for cross-departmental alignment.
- Leverage journey mapping internally to build participatory cultures, streamline systems, and strengthen operational capacity.
- Enhance audience experience by designing hybrid, human-centered journeys that integrate personalization, accessibility, participation, and co-creation.
- Identify and prioritize innovation opportunities, linking aspirations to tactics and evolving methodologies.

3. STRATEGIC PLANNING CONSIDERATIONS

Strategic planning provides the scaffolding through which museums articulate their purpose, align their actions, and adapt to evolving social and technological landscapes. In the past, strategic planning in cultural institutions has often been periodic, linear, and document-driven—anchored in five- or ten-year horizons and shaped by leadership, financial forecasts, and curatorial priorities. Today, however, museums operate in a vastly more dynamic environment: Hybrid physical-digital experiences have become the norm; visitor expectations are shaped by personalized on-demand media ecosystems and digital infrastructures underpin everything from ticketing to storytelling. To navigate this complexity, museums need frameworks that are structured yet adaptive, providing shared language and tools to think systematically about both internal processes and external audience experiences.

3.1 STRATEGIC PLANNING FRAMEWORKS: TRADITIONAL VS. ADAPTIVE

Traditional planning assumes stability and fixed milestones. Adaptive planning emphasizes iteration and feedback loops. Journey mapping complements scenario planning and systems thinking by grounding strategies in lived experience. It helps answer:

- How might visitor journeys change under different scenarios?
- Where do systems support or inhibit them?
- Which processes are ready for redesign?

By visualizing interactions across pre-visit, visit, and post-visit phases, museums can align strategic significance (the "why") with operational reality (the "how"). This alignment builds institutional agency—the capacity for individuals and teams to see their roles within the larger system and act intentionally to improve it.

3.2 THE DIGITAL TRANSFORMATION JOURNEY

Digital transformation is often misunderstood as the mere adoption of technology. In reality, it represents a holistic reconfiguration of how an

organization creates value, engages communities, and structures its operations. For museums, this involves weaving digital thinking into the institution's mission, culture, and practices—from collection management and education to visitor services and storytelling.

A digital transformation lens helps museums see how technology interacts with governance structures, workflows, and audience expectations. It also reveals how work is getting done by staff: shifting institutional attitudes toward experimentation, collaboration, and shared ownership. Digital transformation thus becomes both a strategic imperative and a cultural process—not simply a technical upgrade.

Any transformation requires cultural alignment and organizational readiness. Journey mapping serves as a change management tool, fostering shared understanding across leadership, staff, and stakeholders. By collaboratively mapping current and future journeys, museums make implicit assumptions explicit, reveal pain points, and co-create a vision of change. This participatory approach builds trust, supports diverse perspectives, and makes transformation actionable at every level of the organization.

3.3 ENVIRONMENTAL SCANNING: NOISE & PESTLE

Strategic planning does not occur in a vacuum. Museums operate within broader socio-economic, technological, environmental, and political contexts. Tools like PESTLE analysis (Political, Economic, Social, Technological, Legal, Environmental) help institutions systematically assess external forces. Meanwhile, NOISE analysis (Needs, Opportunities, Improvements, Strengths, Exceptions) focuses on internal and immediate external conditions, emphasizing actionable insights rather than high-level trends.
Integrating these frameworks with journey mapping ensures that museums are not only designing for current audiences but also preparing for emerging challenges—whether related to funding shifts, evolving cultural politics, or accelerating AI capabilities. Journey maps provide the connective tissue between environmental signals and strategic responses, allowing institutions to model how external forces might reshape visitor journeys and internal workflows.

3.4 INNOVATION MATURITY MODEL

Strategic planning also benefits from an understanding of institutional capacity. Museums are rarely in the same stage of transformation across all departments and business activities; some may be experimenting with AI-driven metadata while others are still struggling with legacy ticketing systems. The phased innovation maturity model couple with journey mapping offers a clear, progressive pathway. The innovation maturity model [Clayton Christensen, Theory of Disruptive Innovation] requires an organization to step through a systematic approach. There are four phases:

- Discovery: Focus on exploration and identification of current interactions and integrated systems.
- Efficiency Phase: Emphasize streamlining workflows and addressing operational bottlenecks.
- Sustainability Phase: Operationalize key digital practices and procedures across the institution.
- Growth Phase: Support innovation, scaling, and new value opportunities.

Journey mapping supports each stage differently: from surfacing pain points during discovery, to identifying workflow improvements during efficiency, to aligning long-term strategic goals during growth. Ultimately, the success of any strategic framework depends on its alignment with the museum's mission, culture, and values. Journey mapping is not a replacement for strategic planning—it is a bridge. It connects visitor-centered perspectives with institutional structures, helping museums navigate digital transformation in ways that are mission-driven, culturally attuned, and operationally feasible.

4. JOURNEY MAPPING AS A STRATEGIC FRAMEWORK

Journey mapping has long been used as a design tool to visualize visitor experiences across time, touchpoints, and emotional states. By making visitor and staff experiences visible, journey mapping enables museums to interrogate the value, impact, and feasibility of their activities and investments.

One of the most powerful aspects of journey mapping is its capacity to represent multiple perspectives on a single canvas. Museums contain diverse professional communities, each with distinct vocabularies, metrics, and priorities. For example:

- Curators emphasize interpretive narratives, collections stewardship, and scholarly engagement.
- Educators consider pedagogical goals, visitor learning outcomes, and participatory methodologies.
- Technologists focus on systems integration, platform capabilities, and data flows.
- Marketers prioritize audience segmentation, communications, and brand positioning.
- Administrators and managers are concerned with governance, resource allocation, and sustainability.

Traditional planning processes often privilege one perspective—typically administrative or curatorial—while others remain peripheral. Journey mapping brings these perspectives together into a dialogue, revealing how each contributes to, supports, or sometimes inadvertently obstructs the visitor experience. It provides a structured, visual diagram that promotes negotiation and alignment. By mapping these interactions together, museums build a shared strategic vocabulary that fosters interdisciplinary collaboration, breaks down operational silos, and improves decision-making.

4.1 IDENTIFYING VALUE: BALANCING VISITOR IMPACT AND INSTITUTIONAL EFFORT

Journey mapping is not merely descriptive—it is evaluative. Each touchpoint can be examined in terms of its visitor impact (emotional, cognitive, behavioral, sensory, or social) and institutional effort (time, staffing, cost, technological complexity, governance requirements). Mapping these value equations enables museums to identify where high institutional effort yields low visitor impact (potential inefficiencies), where modest effort delivers outsized impact (strategic leverage points), and where investments could be redirected for greater overall value. This approach allows teams to:

- Align strategic significance with operational reality, ensuring that ambitious goals are grounded.
- Identify gaps and redundancies in workflows, content delivery, or audience engagement.
- Surface trade-offs that may otherwise remain implicit, enabling conversations about priorities.

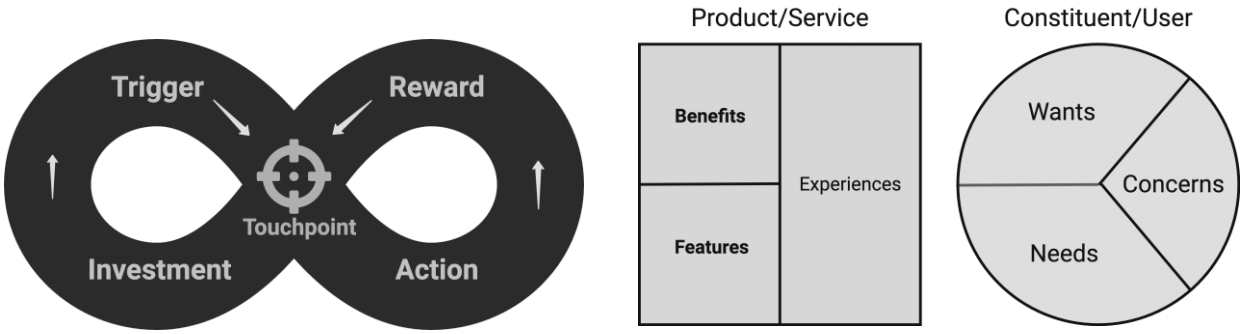

Figure 3: *Models for evaluating audience touchpoints.*

Journey mapping is most powerful when integrated into the institution's broader strategic frameworks, rather than treated as a one-off design exercise. By embedding journey mapping within strategic cycles, museums can continually connect vision to action, ensuring that evolving plans are grounded in both user experience and institutional capability. The journey map provides a structured bridge between tactical experimentation and strategic direction. It becomes a strategic implementation roadmap. Many museums pilot innovative programs, platforms, or audience initiatives, but these often remain isolated rather than scaled institution-wide. By situating tactical interventions within a mapped journey, museums can assess their role in broader strategic narratives, identify dependencies, and plan for integration, scaling, or sunset decisions.

5. DIGITAL TRANSFORMATION: JOURNEY MAPPING IMPROVES INTERNAL WORK

By using journey mapping to make internal operations visible, museums can build shared understanding, streamline systems, clarify roles, and create the cultural and infrastructural conditions necessary for sustainable digital transformation. Successful digital transformation requires an internal culture that embraces participation, transparency, and adaptability. Journey mapping provides a structured way for staff across departments to see their collective work as part of an integrated whole, rather than as disconnected tasks.

When teams collaborate on mapping internal journeys—such as how exhibitions are developed, how content is published online, or how data flows between departments—they uncover pain points, redundancies, and opportunities for alignment. These journey map workshops often lead to "aha" moments (e.g. marketing realizes that their campaign schedules are out of sync with exhibition content timelines; education teams see where data hand-offs could be automated; technologists better understand interpretive priorities.) This shared vision-building fosters empathy and agency, allowing staff to co-own digital transformation rather than feel like they are reacting to top-down mandates.

As museums increasingly rely on data to inform decisions, many lack a clear understanding of how data is captured, cultivated, shared, and applied across departments. Journey mapping exposes where data flows smoothly and where it breaks down. For example, a journey map of a membership renewal process might reveal:

- Marketing collects email engagement data but doesn't share it with the membership team.
- Ticketing data is siloed in a separate system, limiting segmentation.
- Post-visit surveys are conducted manually, with little integration into CRM records.

By mapping these internal data touchpoints, museums can design intentional data pipelines that support evidence-based decision making, while reducing duplication of effort. This also helps identify opportunities to improve data quality, governance, and accessibility across teams.

5.1 INFRASTRUCTURE & PLATFORMS ALIGNMENT

Digital transformation is inseparable from an organization's technical infrastructure: content management systems (CMS), digital asset management (DAM) platforms, ticketing systems, customer relationship management (CRM) tools, and other foundational technologies. These platforms often evolve independently, leading to disjointed user experiences and inefficient internal operations.

Journey mapping can link internal workflows to the underlying technology stack, revealing where systems support or hinder work. For example, an exhibition content journey may illustrate how multiple platforms are connected: a shared drive for image storage, a CMS for publishing, a DAM for metadata, and a CRM for ticketing. Mapping these journeys exposes integration gaps, helps prioritize technical improvements, and ensures that platform decisions are driven by real operational needs rather than vendor hype or departmental preference.

5.2 SHARED VISION & ANTICIPATING EMERGING INNOVATIONS

By clarifying existing workflows and capacities, journey mapping positions museums to anticipate and adopt emerging innovations more strategically, such as generative AI, immersive experiences, or new forms of hybrid engagement. Rather than layering new technologies on top of broken systems, journey mapping ensures that innovation is built on a coherent operational backbone.

6. DIGITAL TRANSFORMATION: HUMAN-CENTERED ENGAGEMENT

At the heart of digital transformation lies a deceptively simple question: How can museums create meaningful, human-centered experiences that resonate across physical and digital contexts? As audiences' expectations evolve—shaped by personalized media ecosystems, social storytelling platforms, and hybrid cultural practices—museums must rethink not only what they offer but also how visitors co-create those offerings. Journey mapping provides a structured way to understand, design, and evaluate these audience experiences in ways that are adaptive, inclusive, and strategically aligned with institutional goals.

Contemporary museum experiences are rarely confined to the physical site. Visitors engage through multiple modalities: researching online before a visit, interacting with content on personal devices during their visit, and continuing to explore and share experiences afterward. Journey mapping allows museums to visualize these hybrid pathways, ensuring that digital and physical touchpoints reinforce one another rather than operate in isolation.

Visitor experiences unfold across multiple human dimensions. Journey mapping makes these layers visible, allowing museums to intentionally design for them:

- Emotional: Visitors bring expectations, curiosities, and feelings to each encounter. Mapping emotional highs and lows—anticipation before arrival, delight at discovery, frustration at logistical barriers—helps institutions design experiences that are emotionally resonant and reduce unnecessary friction.
- Cognitive: Museums support learning and reflection. Mapping cognitive engagement along a journey helps align interpretive strategies with visitor attention spans, literacy levels, and curiosity arcs.
- Behavioral: Understanding what visitors actually do at each stage—searching online, queuing for tickets, navigating galleries, posting on social media—helps museums align infrastructure, signage, and digital tools with real visitor behaviors rather than idealized ones.

This layered approach moves beyond transactional design toward holistic human-centered engagement, where logistical, intellectual, and emotional dimensions are planned together.

6.1 AUDIENCE AGENCY

Digital transformation invites museums to rethink audiences not as passive recipients but as active participants. Journey mapping can illuminate where institutions currently limit or enable agency—whether through rigid ticketing systems, fixed interpretive narratives, or limited personalization. By identifying points where visitors can make choices, contribute content, or shape their own paths, museums can design journeys that support co-creation and participation rather than one-way transmission. This might include enabling visitors to build personalized itineraries, choose interpretive layers based on interest level, or contribute their perspectives to evolving exhibition narratives. Journey maps make visible where these agency points naturally occur—and where they could be intentionally designed.

Museums serve diverse audiences with different goals, abilities, and contexts. Journey mapping enables institutions to design inclusively by foregrounding multiple audience perspectives on a single map or through segmented maps. This might include mapping journeys for families with young children, tourists on a tight schedule, scholars seeking deep research access, or local community members returning for multiple visits. Each group has distinct priorities: families may need clear wayfinding and hands-on engagement; tourists may prioritize efficient navigation and highlight experiences; scholars may seek access to archives and quiet study spaces; community members may value relational, ongoing interactions. By visualizing these journeys side-by-side, museums can identify shared needs, unique requirements, and potential conflicts, informing more nuanced design and strategic decisions.

The pre-visit phase is often the most underestimated part of the visitor journey. Journey mapping highlights how effective onboarding—through websites, ticketing interfaces, pre-visit communications, or orientation materials—can shape expectations and reduce cognitive load on arrival. Poor onboarding (unclear pricing, confusing accessibility information, lack of wayfinding support) can create emotional friction before the visit even begins. By mapping these pre-visit touchpoints, museums can design

clear, supportive onboarding pathways that set visitors up for meaningful engagement.

Transactional experiences—ticketing, membership purchase, retail, donations—are critical junctions in the visitor journey. If these touchpoints are cumbersome, confusing, or poorly integrated with digital platforms, they can undermine otherwise excellent experiences. Journey mapping helps identify pain points and opportunities to simplify and humanize transactions, making them intuitive and aligned with visitor expectations shaped by commercial platforms.

Journey mapping is especially well-suited to identifying and designing participatory interactions, where visitors actively shape their experiences. Examples include immersive tours where visitors choose narrative branches, co-created exhibitions with community contributions, or gamified interpretive layers that encourage exploration and collaboration. By mapping when and how these participatory moments occur—pre-visit prompts, on-site engagement, post-visit sharing—museums can ensure that they are strategically placed, technically supported, and meaningfully integrated into the overall experience arc. This also allows institutions to balance participation with clarity, ensuring that choice enhances rather than overwhelms.

6.2 ORGANIZATIONAL AGENCY

Innovation is most sustainable when it empowers both institutional actors and visiting audiences. Journey mapping identifies points of agency for each: where staff can experiment, where governance models can evolve, and where audiences can actively shape their own experiences. For organizations, this might mean creating cross-functional innovation teams informed by journey mapping insights, enabling educators, technologists, marketers, and curators to co-develop new programs. By embedding journey mapping into organizational practices, museums distribute creative power, fostering cultures of experimentation and shared ownership.

7. INNOVATION OPPORTUNITIES

Museums today are operating in a landscape marked by accelerating change, complex challenges, and unprecedented possibilities. Digital transformation has expanded the terrain on which museums can act—not only in terms of platforms and tools but also in their roles as civic actors, educational spaces, and cultural storytellers. Journey mapping provides museums with a strategic and flexible framework to identify, prioritize, and prototype opportunities for innovation that are grounded in mission, responsive to audiences, and sustainable over time. By linking operational realities to aspirational futures, journey maps help museums transform innovation from a sporadic activity into a structured, iterative practice.

Innovation is not a luxury for museums; it is increasingly a requirement for resilience and relevance. Societal expectations, funding models, and cultural narratives are shifting rapidly. Journey mapping brings to the surface how these external forces intersect with visitor experiences and institutional operations, enabling museums to proactively design for change rather than react to crises.

For example, mapping audience journeys during periods of disruption (e.g., pandemic closures, extreme weather events, or political unrest) can reveal which digital and physical touchpoints remain resilient, where new forms of engagement emerge, and how institutions can future-proof critical experiences. By visualizing these dynamics, museums can build strategies that emphasize adaptability, continuity, and community relevance, even amid uncertainty.

7.1 MAPPING ASPIRATIONS AND STRATEGIC FUTURES

Innovation begins with articulating aspirations—envisioning what a museum might become in a future defined by new technologies, cultural practices, and social needs. Journey mapping supports this process by anchoring aspirational visions in visitor experiences and operational capacities. Instead of abstract future scenarios, museums can imagine how a visitor's journey might unfold in different strategic futures, and then work backward to identify the infrastructure, skills, and partnerships required to make those futures real.

Scenario planning is a powerful method for exploring alternative futures, especially in periods of uncertainty. When combined with journey mapping, it becomes even more actionable. Museums can develop scenarios around key uncertainties—such as funding shifts, climate disruptions, demographic changes, or AI acceleration—and then map how visitor journeys might change in each scenario.

Journey mapping is also a natural precursor to innovation, pilot programs, and rapid prototyping. Once museums identify leverage points or gaps in their mapped journeys, they can launch targeted experiments to test new ideas quickly and iteratively. For example:

- A gap in the post-visit engagement phase might lead to a prototype for a "digital after-visit playlist" that extends learning and storytelling beyond the galleries.
- A pain point in onboarding might spark the development of a chatbot to assist first-time visitors in real time.
- A high-impact touchpoint underserved by current systems might inspire a new hybrid program that integrates live interpretation with augmented reality.

Because journey maps clearly illustrate where prototypes fit within the larger experience, innovation efforts become more strategic and focused, avoiding the common trap of technology-led experimentation without clear goals. Moreover, journey mapping helps institutions evaluate prototypes holistically considering visitor experience, internal workflows, and long-term sustainability simultaneously.

7.2 TRANSMEDIA-FOCUSED ENGAGEMENT

Innovation in audience experience increasingly involves transmedia approaches—storytelling and engagement distributed across platforms, formats, and timeframes. Journey mapping is ideally suited to visualize these layered, distributed experiences. For example, a single interpretive theme might unfold through:

Pre-visit podcasts or short-form videos introducing key questions.
In-gallery AR overlays deepening interpretive content.
Post-visit community storytelling platforms where visitors contribute their own perspectives.

Mapping these transmedia journeys ensures that each component is strategically placed and functionally connected, producing a coherent narrative rather than a fragmented patchwork of digital experiments.

7.3 ORGANIZATIONAL PRIORITIES AND TACTICS-BASED ROADMAPS

Innovation and digital transformation can sometimes feel abstract or disconnected from daily operations. Journey maps themselves function as powerful communication tools. Visualizing innovation opportunities through journey maps helps stakeholders understand not just what is being proposed, but why, where, and how it fits within the larger ecosystem. This clarity can support funding applications, strategic partnerships, and internal alignment, turning innovation narratives from abstract ideas into compelling, evidence-based strategies.

Sustained transformation requires capacity building—training, resource development, and cultural shifts that enable staff to engage in innovation confidently and collaboratively. Journey mapping helps identify where these capacities are needed, whether in data literacy, digital storytelling, or cross-departmental collaboration.

It also supports the creation of iteration infrastructures: regular review cycles, living journey maps, and strategic check-ins that ensure innovation efforts evolve with new information and changing contexts. Quarterly journey mapping reviews, for example, can serve as a lightweight strategic ritual, allowing teams to assess progress, capture lessons, and recalibrate strategies.

8. CONCLUSION

Museums are operating in an era defined by complexity, uncertainty, and opportunity. Digital transformation is reshaping how institutions engage with audiences, manage their operations, and position themselves within broader cultural, technological, and societal ecosystems. At the same time, museums remain grounded in the pursuit of stewardship, education, creativity, and public service. Journey mapping offers a powerful strategic framework for bridging these domains—connecting visitor experience, organizational capacity, and innovation planning into a coherent, adaptive whole.

Journey mapping is more than a design exercise, it is a strategic instrument capable of transforming how museums plan, act, and evolve. The museum sector can no longer rely on static strategic plans. Institutions need adaptive frameworks that reflect the dynamic interplay between audiences, infrastructures, and emerging cultural practices. Journey mapping provides exactly this: a way to see the whole system—people, platforms, behaviors, aspirations—and act strategically within it.

Museums that take this approach will be better positioned to anticipate disruptions, seize opportunities, and design experiences that are coherent, meaningful, and future-ready. At its core, journey mapping links three strategic domains:

Strategy — by integrating institutional mission, planning frameworks, and environmental scanning into an adaptive, shared view of goals and realities.
Innovation — by identifying leverage points, surfacing gaps, and providing structured pathways from ideation to prototyping to scaling.
Audience Experience — by foregrounding human perspectives, emotions, and behaviors in the strategic conversation, ensuring that innovation is rooted in meaningful engagement.

This triadic relationship enables museums to avoid common pitfalls—such as innovation detached from operational capacity, or strategic plans disconnected from visitor realities. Instead, journey mapping provides a strategic backbone that can sustain institutional evolution over time.

As museums look to the future, journey mapping will become even more critical. Emerging trends—including generative AI, immersive and extended reality (XR), transmedia storytelling, climate adaptation, and shifts in civic discourse—will continue to reshape both audience behaviors and institutional operations. Journey mapping can help museums strategically assess where and how these trends intersect with their missions and capacities.

Journey mapping invites museums to see differently: to understand their audiences more deeply, to visualize their internal systems more clearly, and to imagine their futures more expansively. It provides a practical methodology for alignment—between departments, between mission and technology, between aspiration and implementation. As the cultural sector continues to navigate uncertainty, the institutions that thrive will be those that embrace adaptive and participatory tools that connect human experience to institutional goals and objectives. Journey mapping, when embedded into the fabric of strategic planning, offers precisely that.

SESSION IV

“Heritage and Virtual Realm”

Moderation: Dr.-Ing. Oliver Schreer
(Fraunhofer Heinrich-Hertz-Institut (HHI), Berlin)

Tradition and Digital Transition in Cultural Heritage: The Contribution of the Colosseum Hbim Project.

The Digital Infrastructure and Intelligent Analysis
for the Interpretation and Management of Architectural Heritage

Rinaldi, F.[a]; Balzani, M.[c]; Nazzaro, B.[a]; Pujia, A.[a]; Cella, E.[a]; Fumagalli, F.[b]; Rose, D.[b]; Galvani, G.[c]; Raco,F.[c]; Valenti, G., M.[d]; Suppa, M.[c]; Giau, G.[c]; Planu, F.[c]; Rizzi, D.[c]; Griffo, M.[d]; Lucchetti, S.[d]; Barni, R.[d]; Mirandola, A.[d]; Remondino, F.[g]; Mazzacca, G.[g]; Proia, M.[e]; Giovanniello, M.[e]; Settimo, S.[f]

[a] Parco Archeologico del Colosseo, MIC, Italy,
[b] Assistant, Parco Archeologico del Colosseo, MIC, Italy
[c] University of Ferrara, CFR, Consorzio Futuro in Ricerca, Italy,
[d] University La Sapienza, Janus srl, Italy,
[e] ETS srl, Italy,
[f] Geogrà srl, Italy,
[g] FBK, Bruno Kessler Foundation, Italy

ABSTRACT: The HBIM model of the Colosseum was developed through an integrated 3D geomatic survey and digital modelling workflow combining laser scanning and photogrammetry. The resulting high-resolution scan-to-HBIM model accurately reproduces the monument's geometry and structural morphology, forming the basis of a digital twin that serves as an evolving knowledge repository. Heterogeneous datasets—geometric, material, structural, and archaeological—were integrated within a single HBIM environment. Manual segmentation combined with Machine Learning and Deep Learning algorithms improved the classification of construction techniques, materials, and deterioration patterns, enhancing efficiency in thematic analysis and vulnerability assessment. Beyond documentation, the Colosseum HBIM functions as a systemic, cognitive platform that supports preventive conservation, long-term monitoring, and evidence-based decision-making. In accordance with European (Directive 2014/24/EU) and Italian (Legislative Decree 50/2016; Ministerial Decree 560/2017) frameworks for digital transformation and data interoperability, it promotes knowledge creation, informed management, and participatory access within a transparent digital ecosystem for cultural heritage.

1. INTRODUCTION

The study presents a three-dimensional survey of the Colosseum using advanced geomatic techniques within the framework of digital documentation and heritage management. Its primary objective is to build a detailed knowledge base that captures the Flavian Amphitheatre's morphological and material complexities, while providing operational tools for site monitoring and management. The methodology integrates terrestrial laser scanning (TLS) and photogrammetry, followed by data optimisation, semantic classification, segmentation via machine learning and deep learning, and validation against direct measurements and cross-verified datasets. The resulting HBIM model consolidates geometric, material, descriptive, and diagnostic information to support structural analysis, conservation planning, and maintenance. This workflow—from 3D acquisition to advanced segmentation and HBIM integration—ensures metric accuracy, geometric completeness, and semantic consistency, providing a repeatable protocol for other monumental contexts.

In conclusion, the project serves as a platform for interdisciplinary methodological advancement, demonstrating how integrated geomatic techniques and AI-driven tools can enhance the documentation, interpretation, and management of architectural heritage.

2. 3D GEOMETRIC SURVEY OF THE COLOSSEUM: INTEGRATION OF LS3D AND SFM 3D TECHNIQUES

The three-dimensional survey of the Colosseum was conducted through the integration of 3D laser scanning (LS3D) and digital photogrammetry via Structure from Motion (SfM3D), to produce a high-resolution, metrically accurate, and georeferenced model. The methodological approach was guided by three key principles: geometric consistency across different data sources, dataset interoperability, and minimal operational impact on the monument.

The LS3D survey provided the geometric foundation of the project. Data acquisition was carried out using medium- and short-range terrestrial laser scanners, specifically a Leica P40 for the external areas and the cavea, and a Leica RTC360 for interior spaces, capturing instrumental RGB data. In total, 84 laser scanner point clouds were generated: the exterior was captured from 109 stations, yielding approximately 17.16 billion points and 3,052 co-axial images; the cavea was surveyed from 13 stations, producing around 5.8 billion points and 364 images (Fig.1).

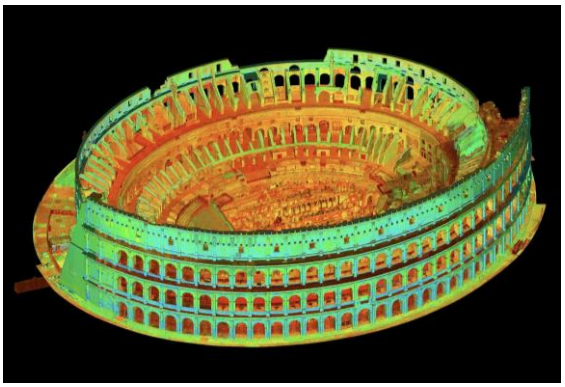

Figure 1: *3D digital model of the Colosseum obtained through laser scanner survey.*

The hypogeum was documented from 703 stations, generating approximately 14.86 billion points, while interior spaces required 1,609 stations, producing roughly 71 billion points. Metric referencing was ensured through a hierarchical topographic network.

The first-order network, composed of static GPS points and fixed targets, established the primary reference system, while second- and third-order networks enabled the densification of scanning stations and the internal orientation between LS3D and photogrammetric data, ensuring spatial consistency across all segments. The photogrammetric survey complemented the laser dataset through terrestrial and aerial imaging, generating 86 photogrammetric point clouds and 90 thematic point clouds. The complete acquisition comprised 208,530 images, including 15,169 captured by drone. Excluding the hypogeum, 181,119 images were acquired—approximately 30% using telescopic poles—and 13,482 drone images; the hypogeum was documented with 27,419 images, including 1,687 drone images. Photogrammetric models were georeferenced using the topographic network targets and control points derived from the LS3D data, resulting in models with an average resolution of 1 cm, fully consistent within the same coordinate system (Fig.2).

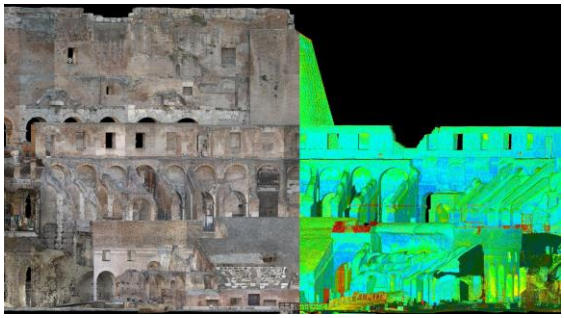

Figure 2: *3D survey comparison: photogrammetry.*

The integration of LS3D and SfM3D techniques enabled the generation of a high-density, metrically coherent three-dimensional morphometric model, which is fully suitable for BIM-based applications [2].

3. IMPLEMENTATION OF HISTORICAL PHASES IN THE HBIM MODEL OF THE COLOSSEUM

The Colosseum, emblematic of ancient Rome, represents both the pinnacle of Roman architectural culture and its social order [3]. Its modular repetition, sectorial organization, and permeability between levels mirror a hierarchical yet dynamic society: senators, equestrians, citizens, and non-Roman residents occupied distinct areas, but social mobility allowed some to access higher tiers [4][5]. These features make the Colosseum an ideal case study for HBIM applications.

On the ground floor, the monument displays complete permeability: alternating bays, voids, staircases, and subspaces enable multiple circulation paths, unlike earlier theatres such as the Theatre of Marcellus, where routes were fixed [6][7]. The modularity and seriality of its components offer a natural basis for parametric modelling, facilitating systematic representation within a digital environment. One key challenge, however, lay in representing historical stratigraphy. Unlike archaeological drawings

that document diachronic development, BIM models require structured metadata to encode temporal information. To address this, the Colosseum HBIM model adopts four macro-historical phases, visually represented through color coding and linked to metadata, ensuring a structure both robust and flexible for future updates. The first phase covers the construction of the Colosseum and its period of full functionality, up to the prohibition of *munera* in the 6th century. The second phase encompasses the period of functional decline during the Middle Ages, continuing through the papal restoration interventions of the 19th century. The third phase concerns the consolidation, and restoration works carried out by Valadier and Stern, while the fourth phase corresponds to the modern period, from 1870 to the most recent interventions (Fig. 3).

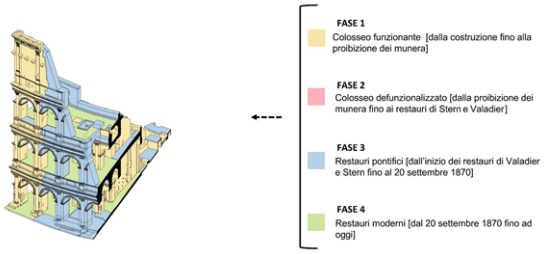

Figure 3: *Detail of a segment of the Colosseum HBIM model, showing the visualization of the historical phases.*

Each modelled element—walls, vaults, corridors, or masonry units—is linked to metadata specifying its phase, construction technique, state of conservation, and degradation type.
This classification, refined through direct analysis and historical research, extends to individual features such as fori, grouped in Revit families by construction and function. Each typology corresponds to specific historical phases, allowing precise temporal cataloguing (Fig. 4). Every element also connects to an information sheet detailing dimensions, phase, references, and spatial location within the model. This structure enables customized queries—for example, isolating specific holes in one sector or identifying elements from 19th-century restorations. Supplementary resources, such as photographs, CAD drawings, and stratigraphic sheets, support the verification of continuity, bonding, and other data essential for reconstructing the relative and absolute chronology of the components.

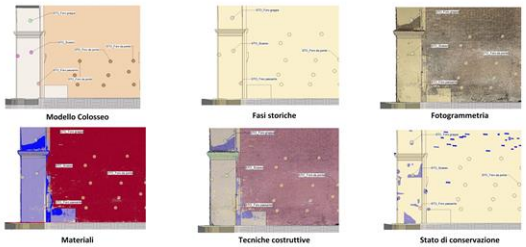

Figure 4: *Example of mapping and classification of different types of holes in the Colosseum HBIM model.*

4. CLASSIFICATION OF MATERIALS, TECHNIQUES, SURFACE DECAY, AND CONSTRUCTIVE SYSTEMS

Thematic abacuses represent a fundamental tool for the classification and documentation of monumental surfaces, based on materials, construction techniques, and conservation conditions. This paper illustrates the process of developing and implementing these abacuses, conceived to integrate qualitative and quantitative data within the framework of digital surveying. Their creation, the result of a multidisciplinary collaboration, enabled a systematic and comparable interpretation of the architectural artifact, supporting both documentation processes and the definition of conservation strategies. The abacuses serve two main functions: to organize and classify data, and to support surveying and digital analysis activities.
From these operational functions, a methodological approach was developed, articulated into three hierarchical levels of analysis. This structure was defined through preliminary in situ observation of the monument and subsequently validated during testing.
1. Material Mapping: Surfaces were classified based on their constitutive materials and material prevalence, treating heterogeneous aggregates as coherent units (e.g., concrete, brick with mortar). Specific categories were created for stratified plasters and extraneous surfaces not relevant for conservation purposes. (Fig. 5)

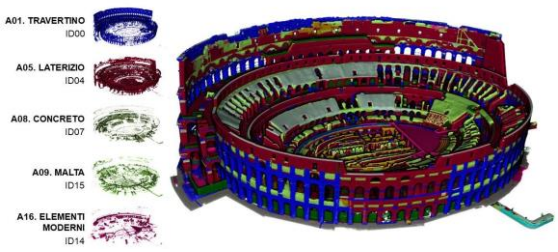

Figure 5: *Example of material-based surface mapping.*

2. Construction Techniques: Methods of workmanship and installation were documented, distinguishing block types, masonry arrangements, and element connections. Restoration interventions and specific techniques (e.g., vaulted intradoses, whitewashing, "frame brick" construction) were also identified, with stratigraphy primarily recorded in 2D drawings (Fig. 6).

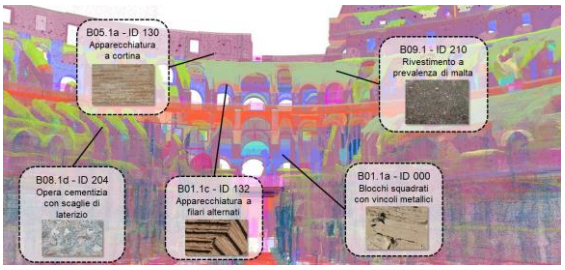

Figure 6: *Example of the identification and classification of construction techniques based on methods of fabrication and on-site installation.*

3. Condition Assessment: Material pathologies were classified consistently with the material mapping. Quantitative surface roughness measurements were conducted for materials such as travertine and tuff, and structural cracks were mapped using 3D polylines verified against the point cloud. (Fig. 7)

Figure 7: *Example of mapping of the conservation state of surfaces, specifically from left to right: biological encrustation, coherent deposit, loss, and washout.*

The introduction of a multilevel classification system through thematic abacuses has made it possible to integrate material, technical, and conservation data into a coherent and comparable framework. This approach has enhanced the analysis and documentation of the architectural artifact, fostering interaction between digital surveying and historical interpretation, while strengthening interdisciplinary collaboration. The development of the abacuses, based on shared criteria, has increased both the accuracy of analyses and the effectiveness of conservation strategies, providing a replicable methodology applicable to other monumental contexts

5. MANUAL SEGMENTATION AND OUTCOME VALIDATION

Manual annotation, within the workflow related to ML, consists of a process in which the operator manually labels the data. This phase is fundamental for the structuring and interpretation of three-dimensional data derived from laser scanning or photogrammetric surveys. Although highly time-consuming, it is essential for training machine learning classifiers and making them operational in order to achieve a semantic classification of the analyzed data. This procedure enables the subdivision of the point cloud into homogeneous portions from a geometric, material, or constructive point of view, assigning each a semantic meaning consistent with the reference domain (for example, architectural elements, materials, or decay phenomena).

In the case of the Colosseum, a representative portion of the entire dataset was selected for manual classification (Fig. 8) — referred to as the pilot area — ensuring that all previously defined classes were included.

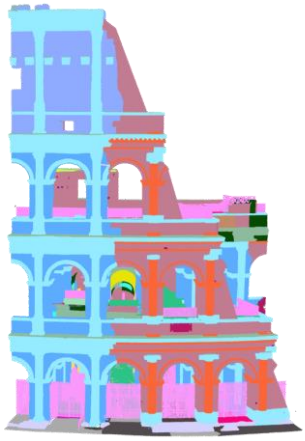

Figure 8: *Portion of the point cloud with annotation of the pilot area's materials*

For a reliable classification process, it is necessary to ensure that the training data are representative of the entire scenario; therefore, the selected samples must contain all the classes under investigation within the complete dataset.

Manual annotation was carried out using the segmentation tool within the open-source software *CloudCompare*, through interactive selection commands that allow the operator to delimit portions of the point cloud by drawing polygons directly on the three-dimensional model. Each extracted segment was then saved as an independent entity within CloudCompare's hierarchical panel, preserving the project's parent–child structure.

Once the segmentation phase was completed, the process moved on to semantic annotation. Each entity was renamed according to the predefined classification system, as reported in the reference tables previously described (for example, "A02. Marble," "B03.2. Tufa masonry," "C01.3. Efflorescence").
An additional level of information was achieved through the thematic coloring of the segments (scalar field): distinct colors were assigned to each semantic class, allowing for an intuitive visualization of the information hierarchy. This operation, although purely visual, facilitates verification of the segmentation's consistency and enhances the communication of results during analysis and presentation phases.

6. AI-BASED SEMANTIC SEGMENTATION

Building upon the definition and purpose of the abacuses introduced in the previous section, which establishes the classification framework for semantic segmentation, a semantic segmentation pipeline for these classes is needed. Due to its exceptional scale, with over 14 billion points in the photogrammetric point cloud and more than 17 billion points in the Terrestrial Laser Scanner (TLS) point cloud, a manual segmentation of these data by domain experts would require an excessive amount of time and effort, making this approach impractical. Therefore, the development of an automated process was deemed essential to accelerate the segmentation task and reduce the time required for its completion.
In recent years, the automation of the 3D semantic segmentation process in Digital Heritage via AI-based approaches has attracted considerable interest, transitioning from standard Machine Learning (ML) methods [8; 9] to the rising prominence of Deep Learning (DL) architectures [10; 11]. Two main branches of methodologies have emerged to tackle this task. The first one revolves around a purely 3D-based pipeline that feeds sensor-based and 3D geometrical features to ML/DL algorithms to perform the semantic segmentation [12; 13]. The second one, harnessing growing interest in recent years, combines both 2D and 3D data into the segmentation pipeline, either by working on textures [14; 15] or by segmenting the images used in the photogrammetric reconstruction [16].
For the Colosseum dataset, most of the designated classes lack a clear 3D geometrical signature, being mostly distinguishable from their surface characteristics (e.g., Tufo/Travertino or different types of brickwork modules); therefore, the usage of 3D geometric descriptors [8] to perform a purely 3D-based Deep Learning semantic segmentation approach is insufficient. To overcome this limitation, a mixed 2D/3D approach was preferred. By leveraging the 2D features extracted from the images and the capabilities of deep learning models in pattern recognition, this approach aims at maximizing the outcome of the segmentation on the Colosseum architectural surface. The large amount of available high-resolution images, featuring significant overlap, guarantees both a complete coverage of the entire dataset as well as a consistent, comprehensive representation of the monument, both useful characteristics for generating a training set to use to train a neural network.
The methodology, similarly to what was presented in [16], is based on the intrinsic connection between the 3D point cloud (Fig.9) and the images used in the photogrammetric reconstruction pipeline.

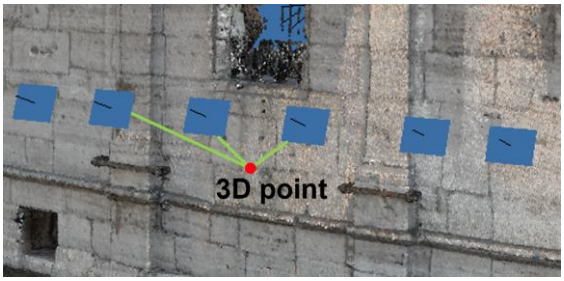

Figure 9: *Visual representation of the connection between images and photogrammetric point cloud.*

Knowing the camera poses, the extrinsic matrix of each image is used to raycast the classes, previously manually labelled by experts on the point cloud according to the abacus definitions, onto the images. This process generates masks that, paired with the corresponding original images, form the training dataset to train the neural network to predict those classes on unseen data (Fig. 10).

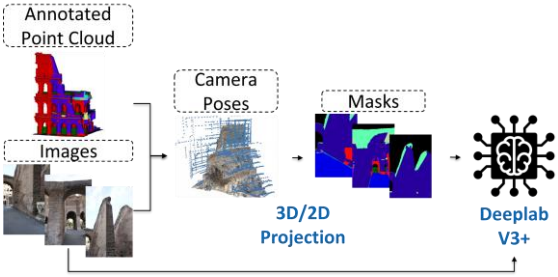

Figure 10: *Training data generation pipeline*

After the training phase, the trained model is deployed to predict the target classes on new images; finally, the predicted classes are cast back

onto the point cloud, using a technique similar to the one used to generate the training data (Fig. 11).
However, the raycasting process presents a significant challenge. In both directions, from the point cloud to images and from images to the point cloud, rays may pass through the intended surface points without proper intersection, potentially hitting points located behind them or extending beyond the point cloud boundaries.

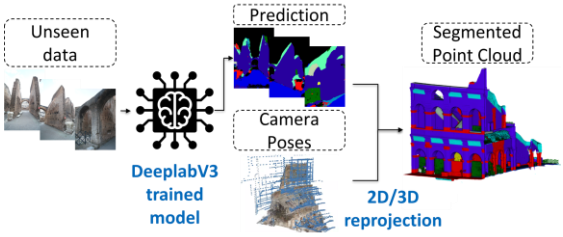

Figure 11: *inference and reprojection pipeline.*

To mitigate this issue, a voxelization approach is adopted. By computing a dense 3D voxel representation of the point cloud, it is possible to calculate the intersection between the voxels and the rays cast from the images, ensuring the proper reprojection of the classes. Yet, voxelization, while correcting intersection errors, introduces a new problem during inference: multiple rays may intersect the same voxel, potentially producing conflicting predictions (e.g., two images having different predictions for the same surface). To address this issue, each voxel records all intersecting ray predictions, and the final class is determined based on the most frequently occurring prediction.
To generate the necessary training data to train the neural network, a comprehensive and representative portion of the Colosseum point cloud was manually labelled by domain experts to serve as the training set. These annotations were then raycast onto the photogrammetric project images, resulting in approximately 2000 labelled masks. By further dividing these masks into smaller patches, the dataset was expanded to around 8,000 masks, each paired with its corresponding image, forming the final training data. The training and inference phases were performed using DeeplabV3+ [17].
The Deep Learning pipeline was applied to the Materials and to the Building Techniques semantic segmentation, while very underrepresented classes were labelled manually. The mapping of architectural systems, as well as of the degradation phenomena, was done manually, requiring a high degree of expert interpretation.
Finally, the automatic segmentation results were manually refined by domain experts to ensure accuracy and completeness.

7. METHODOLOGICAL INSIGHTS INTO 3D MAPPING OF THE COLOSSEUM

The workflow outlined above was designed to integrate not only theoretical and methodological principles but also a broad range of expertise — from architectural historians and archaeologists to architects and computer scientists. This diversity proved essential to achieving both methodological consistency and technical reliability.
The following sections provide a detailed discussion of the main methodological choices that shaped the overall 3D mapping process.

OBJECTIVE READING / SUBJECTIVE READING

The first criterion adopted—common to all thematic mappings—concerns the distinction between features that can be directly identified through a pseudo-objective *visual analysis* of the artefact and those inferred from historical and archaeological *interpretation*. In this respect, the former category was used to map materials, construction techniques, and surface decay, whereas the mapping of structural systems required a more interpretative and subjective analysis.
This approach was motivated by the intention to use 2D and 3D thematic mappings primarily as tools to support critical evaluation, rather than to replace it. However, identifying specific components of certain constructive systems was needed to add a first level of interpretation. For instance, the sockets for wooden structures carved into the travertine blocks and visible along the upper cornice of the attic storey were classified as part of the *velarium* system, rather than as the more neutral category of carved block. This strategy provided a solid foundation for subsequent critical interpretations while also offering a preliminary selection of key features. Moreover, this criterion proved consistent with the aim of testing ML strategies for the automatic recognition of the identified typologies. Indeed, features characterized by distinctive morphological and radiometric attributes in the point cloud can be used for algorithmic training, whereas aspects derived from critical interpretation of visible traces cannot be mapped automatically and therefore required manual annotation. (Fig. 12).

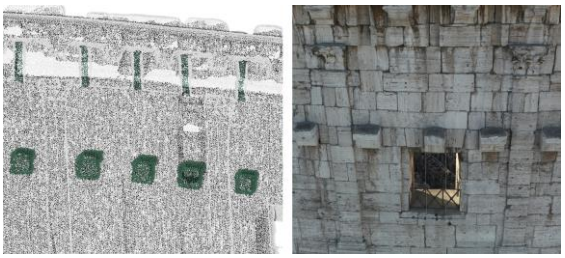

Figure 12: *Velarium system mapped manually.*

SURFACE / STRUCTURE

Regarding construction techniques, the second criterion concerns whether mapping should be based on the surface of each portion or on the construction technique of the entire element. For example, an *opus latericium* wall consists of an external brick facing and an inner concrete core; similarly, vaulted surfaces are made up of multiple layers, each with distinct material and technical properties.

To achieve a high level of detail, the adopted classification focuses on identifying each visible surface layer, accurately describing its technical features. Following this approach, the mapping distinguishes, for instance, the brick facing from the exposed concrete core (Fig. 13), or the bessale (thin brick) cladding of vaults from the underlying concrete.

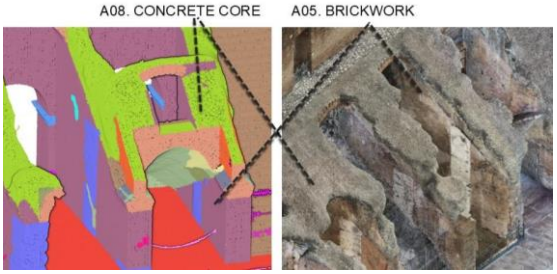

Figure 13: *3D mapping of opus testaceum, distinguishing the concrete core from the brickwork.*

This method aligns with the overall framework, as algorithmic prediction of construction techniques relies on radiometric and morphological data from the point cloud. Hence, classification required defining homogeneous zones identifiable through both color and form.

2D ANNOTATION / 3D ANNOTATION

The third criterion concerns the choice of the most suitable documentation medium for each type of information. Each category in the catalogue is linked to one or more supports through which its mapping can be read.

In this sense, materials and construction techniques are represented similarly in 2D vector drawings and 3D annotations on the point cloud. In contrast, for surface decay, 2D drawings complement the information provided by 3D annotations (Fig. 14).

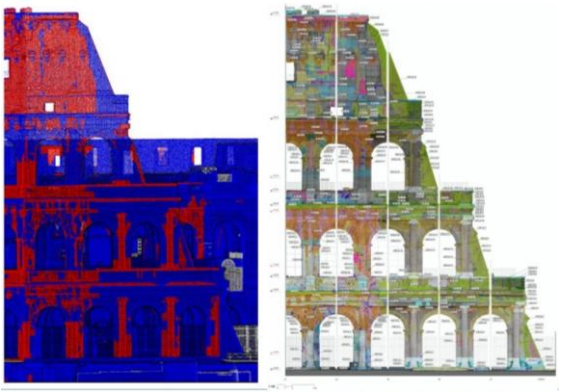

Figure 14: *Left: decay mapping on the 3D point cloud, in red the surface runoff; right: decay mapping on the 2D drawing highlighting decay overlappings.*

The 3D point cloud is conceived as a long-term information archive [18], recording permanent degradation phenomena that define the architectural image, such as colour alterations or extraction holes. Temporary, seasonal, or periodically mitigated degradation forms are represented only in 2D outputs, enabling rapid and updated recording of temporal evolution. This dual 2D/3D approach maintains a continuously updated three-dimensional view of conservation states and the spatial distribution of surface phenomena, complemented by analytically rich 2D documentation; the latter not only provides verification and control but also serves as a fully-fledged interpretative-analytical tool, capable of rigorously conveying material details, stratigraphic complexity, and the evolution of degradation processes over time.

Moving from a preliminary methodological level to an operational dimension, the thematic catalogue and its related 2D and 3D mappings underwent progressive refinement, reflecting the experimental and innovative aspects of the workflow. This evolution aimed to construct a coherent and interoperable system, in which the point cloud functions not only as a surveying product but also as a fully interrogable architectural information system, based on data codified in the catalogues and organised through a multilevel information management strategy. 2D representations proved critical in the thematic restitution process, allowing documentation of the material and stratigraphic complexity of architectural surfaces. Direct processing on orthoimages, derived from photogrammetric data and

in situ observations, enabled precise identification of micro-variations in texture, finishing discontinuities, and stratigraphic overlaps related to plasters, pictorial layers, and stuccoes (Fig. 15). This critical reading, based on morphological and chromatic interpretation, allowed for high-resolution semantic restitution, capable of describing the relationships between material layers and their conservation state.

Figure 15: *2D restitution from the segmented point cloud, integrating undocumented information to provide a coherent reading of the building's constructive evolution.*

The use of specific thematic layers enabled systematic distinction of materials, construction techniques, and decay phenomena, through codifications aligned with the classes defined in the thematised point cloud.

The use of specific thematic layers enabled systematic distinction of materials, construction techniques, and degradation phenomena, through codifications aligned with the classes defined in the thematised point cloud. Each theme was structured using a unique coding system (A for materials; B for construction techniques; C for degradation), consistent with the catalogue and 3D model nomenclature. The mapping of conservation states followed an integrated approach, based on direct surface analysis, high-resolution photography, and 360° video acquisitions. The 2D representation was essential for characterizing degradation morphologies, allowing precise delineation of altered areas.

Degradation classes, defined according to the UNI 11182 standard, include physical-chemical, environmental, biological, anthropic, and structural phenomena. Structural cracks are recorded in the conservation technical drawings, while non-structural lesions are shown in the thematic conservation drawings. Systematic comparison between 2D delineations and 3D annotations verified geometric and semantic consistency, providing cross-checked control over the extent and location of phenomena (Fig. 16).

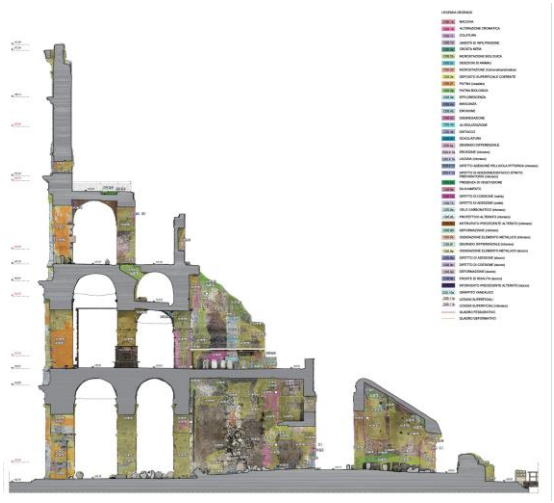

Figure 16: *2D restitution from the segmented point cloud, critically integrating decay analysis to document the Colosseum's current state of conservation.*

8. SCAN TO HBIM PROTOCOLS FOR THE DIGITAL DOCUMENTATION OF ARCHAEOLOGICAL HERITAGE

In the current context, digital documentation for the knowledge, management, and enhancement of archaeological heritage requires collaboration between multiple disciplines and the availability, as well as the capacity, to exchange data and information and to make informed choices both at the scale of the monument and the detail level, supporting individual conservation and restoration interventions.

The increasing possibility of integration between direct digital survey, photogrammetry, and parametric HBIM (Historic Building Information Modelling) enables the correlation of information of various natures with verified, consistent, and time-implementable geometric and measurement models (Fig.17).

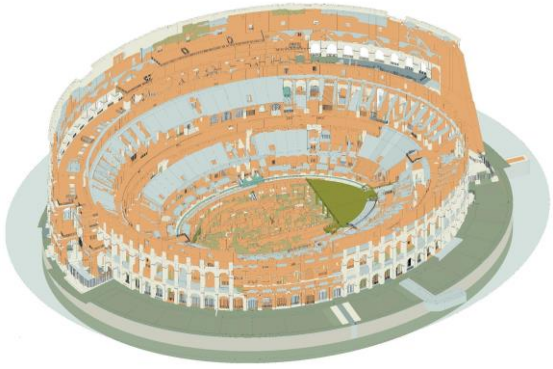

Figure 17: *Digital HBIM reconstruction of the Colosseum from point clouds, enabling detailed documentation and heritage management.*

This integration has enabled the development of a time-implementable and replicable modelling methodology, applicable to the Colosseum and other contexts.
The availability of a knowledge base of the entire Flavian Amphitheater, resulting from the integrated digital surveying activities and the processing of the overall data model, enabled the interdisciplinary group of specialists involved, including the contracting authority and members of the Temporary Grouping of Companies (ATI), to design a multi-scale parametric digital ecosystem that integrates geometric and informational data with reference to the specific uses of the implemented models.
The implemented methodological approach is articulated into four levels:

1. Defining the purpose of use for the model(s).
2. Defining the modelling criteria, and the development and implementation of parametric geometries.
3. Enrichment and informational implementation of the models.
4. Criteria for the organisation, management, and temporal implementation of the developed digital ecosystem.

The goal of monument management, understood as a holistic approach that integrates protection and enhancement actions for one of the world's most visited monumental sites, primarily guided the modelling of the geometries of the total of nine models developed and one coordination model: five models for the "Monument" discipline; one "Accessory" model; one "Systems" model; one "Erratic" model; one "Coordination" model.
The modelling followed the criterion of reference to the Lidar data from the direct digital survey for the understanding and selection of geometric boundaries, and the decomposition of geometries with reference to the "Materials" abacus for defining the implemented objects and families.
An additional "Foundations" model was implemented based on the register of the historical documentation produced, to make a time-implementable parametric environment available to scholars. This model is not intended to assume the role of the critical outcome of historical research that is not the subject of the present study.

The set of models is therefore a relational database. It allows for the correlation of all types of information sources and products documenting the Monument in a single three-dimensional environment:

- Dedicated informational datasets for the categories: "General Information", "Location", "Historical Phases", "Cracking and Instability Framework", "Materials".
- Three-dimensional point cloud models segmented and hierarchized, for the abacuses: "Materials", "Construction Techniques", and "Degradation (Decay)".
- Thematic two-dimensional drawings for the categories: "Materials", "Construction Techniques", "Degradation (Decay)", "Archaeology", "Structure cracking and active damaging processes", "Erratic Items".

In this sense, the following are collectively implemented: 10 models; 27,664 objects/families; 11 categories of dedicated parameters (PSET); 85 dedicated parameters; 6,361 links to the models.

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The Multidisciplinary Cultural Heritage Community: Towards a Definition of Roles

Drew Baker[a], Marinos Ioannides[a], Anthony Cassar[b] and Petros Siegkas[a]

[a]Digital Cultural Heritage Research Centre MNEMOSYNE,
Cyprus University of Technology Cyprus.
Drew.Baker@CUT.ac.cy, Marinos.Ioannides@CUT.ac.cy, Petros.Siegkas@CUT.ac.cy
[b] Heritage Malta Digitisation Unit, Heritage Malta, Malta;
anthony.cassar.1@gov.mt

ABSTRACT: As the interest in, and value of, cultural heritage data has increased exponentially over the past decade, there has been a heightened desire to address the "multidisciplinary user" cultural heritage community's needs. While this should be continued and encouraged, the purpose of digitisation - the why we digitise cultural heritage, for whom, and at which level of quality -is increasingly being lost amongst ambiguous terms such as stakeholders, users, and data reuse(rs). These terms have evolved organically over time, borrowing from established business models, often aligning with circular economy concepts. This is challenging, as such economic models are strongly connected with physical manufacturing processes with tangible outputs (through Digital Twins), while cultural heritage digitisation is seen as part of the 'knowledge economy' as an enabler of innovation within the circular economy model as Memory Twins.

In this paper, we present a clarification of the terms and roles of those multidisciplinary actors who use information and data within digital documentation of cultural heritage to minimise the risk of misunderstanding and the potential to unnecessarily address needs outside the scope of the digitisation effort's aims and objectives. Further, through understanding these roles within the context of the circular economy, we consider how reframing cultural heritage information and data as a highly valuable raw material rather than a product or service can produce higher quality results, impact, and sustainability.

1. INTRODUCTION

Defining why, what, when, where, and whom we digitise cultural heritage for is fundamental to the success of the digitisation process. If we lack clarity on why we are digitising, a project runs a very high risk of becoming unfocused and unclear about what the outputs will be; if we do not know when, where and what we are digitising, a project is in danger of over/underestimating the allocation of resources invested into the digitisation effort; if we do not understand for whom we are digitising, we cannot provide a product or service that is meaningful and impactful.

Within the context of small-scale projects, it is arguably easier to establish such boundaries; there is a need or interest that motivates the digitisation of a cultural heritage resource with a defined use case and known outputs to satisfy the identified needs. This can be seen as similar to the take-make-consume model of the Linear Economy; however, a more circular approach to digitisation and the creation of cultural heritage assets has become increasingly advocated. This shift incorporates the language and principles of the Circular Economy, highlighting the potential and benefits of enriching digital objects (in the broadest sense - not just artefacts, but buildings, monuments, sites and cultural landscapes), with supplementary cultural heritage data (both tangible and intangible), transforming single digital records into comprehensive and contextualised, multivocal, documents which reflect a deeper meaning, significance, or memory of cultural heritage.

The holistic approach to the digital documentation of cultural heritage, while clearly increasing the value and return on investment of the initial digitisation effort, inherently increases and complicates the demarcation of boundaries of the 'why, what, when, where, and for whom' we are digitising. This dichotomy is discussed in the EU VIGIE 2020/654 Study on Quality in 3D Digitisation of Tangible Cultural Heritage**Fehler! Verweisquelle konnte nicht gefunden werden.**, which seeks to approach a holistic documentation by reducing Complexity through risk management and recording of paradata – the processes by which a digital record is created**Fehler! Verweisquelle konnte nicht gefunden werden.** – to understand the context of a cultural heritage resource from a multidisciplinary viewpoint.

2. TOWARDS AN UNDERSTANDING

While the recommendations of the EU VIGIE 2020/654 Study address the specific issues of digital documentation, there is still a disconnect with fundamental terminology and meanings, with each discipline bringing its own understanding, interpretation, and priorities of terms to a digitisation effort.

With more potential actors involved and diversity of outputs envisioned, the need for clarity regarding who those actors are and what roles they play is of pressing concern. This can be considered a function of project management – and to an extent it is – however, while there are guidelines and good practice documents for specific management of multi-disciplinary digitisation project tasks, the literature for an overarching approach to such projects is weak.

While great efforts have been made within sections of the digitisation workflow to harmonise terms, this apparent lack of approach to management is curious, with definitions being interpreted on a project-by-project or institutional basis. The following observations are drawn from the experience of working within four high profile, high impact, multi-disciplinary, and trans-sectorial digital cultural heritage EU projects; ERA Chair Mnemosyne, EUreka3D, EUreka3D-XR, and HERITALISE, and is an attempt to reconcile the diverse definitions of core terms used within digital cultural heritage workflows.

2.1 RECONCILING THE LINEAR & CIRCULAR APPROACHES

There are many models describing the Knowledge Economy, but all are based on the principle of the distillation of data into actionable intelligence. This approach is typified by the scientific method and is essentially a linear approach transforming data to information, information to knowledge, and knowledge into wisdom, or 'actionable intelligence'[3]. The output of the process is not a product *per se* but an endpoint, the conclusion being used to inform and support decision-making, with data being discarded or extracted in the refinement process. This can be seen as a wasteful process, as data is potentially lost. Paradata attempts to document the process of data refinement, allowing the relevance of data, the decisions to discard data, and its transformation to be understood and, if necessary, reviewed or revisited, reducing data loss. However, paradata does not provide data circularity; it only *allows* for it.

By comparison, the Circular Economy model is product-orientated, seeking to eliminate waste through planning the efficient use of raw materials through all points of the product lifecycle, typified by sustainable design, production methods, and recycling practices to minimise pressure on finite materials. This poses a more significant challenge as data is transformed into actionable information and ultimately a product, raising the question of which digital asset we are attempting to conserve: the raw data acquisition of the heritage resource, the processed data of the object, the enriched digital asset, or the final product?

This question is non-trivial and intrinsically connected to the long-term preservation of digital data and what should be considered as 'valuable' to the long-term view of exploitation potential. Here, paradata can be used to assist in understanding the priorities for preservation on a short- or long-term return on investment. While in an ideal world everything should be archived and available for exploitation, pragmatically speaking, those archives must be maintained, financed, and accessible - often beyond the lifespan of a project – and it must be accepted that not everything can be kept in perpetuity.

By rethinking our approach to data as a primary raw material rather than the product of digitisation, the two approaches can be better aligned. The end product of a digitisation – for example, an interactive extended reality exhibit, may be ground-breaking in terms of implementation or engagement - will have a shelf life as technology progresses, consumer digital literacy (and expectations) increases, and the applicability fulfils the needs of the digitisation use case change ultimately becoming redundant, whereas the data used to create the product is likely to still retain value beyond the product itself and available for re-use.

Through the paradata record, both an estimation of the Quality of the digital documentation process and its results can be established, and the motivation/needs of the final output assessed for digital preservation strategy planning and archiving priorities. Moreover, as paradata records the interconnections between and rationale for selection/inclusion of data during the creation of the product, it can assist in identifying those components that are more viable than others for remastering/reprocessing, potentially extending the shelf life of the product. Critically, paradata and metadata drive the Complexity and Quality assessment of digital documentation proposed within the EU VIGIE Study 2020/654 and are seen as a route by which a certification of Quality can be established for digital cultural heritage assets.[4]

Acknowledging this has profound implications for cultural heritage multidisciplinary professionals; data must be stored, maintained and monitored, the principles of FAIR data[5] upheld and have an overall positive net effect contributing to the goals of the UN 2030 Agenda for Sustainable Development[6] and EU aspirations for research and innovation driving transformative change expressed through the European Commission's recommendation on a common European dataspace for cultural heritage[7].

2.2 USE, REUSE, OR REPURPOSE?

Arguably, the misalignment of the linear and circular approaches has led to the misinterpretation of the phrase "use and reuse" within the *zeitgeist* of digital cultural heritage, with reuse being used synonymously with repurposing or recycling. The Oxford English Dictionary defines 'reuse' as "*to use something again or more than once*"; this is different from 'repurposing', which is "*to adapt for use in a different purpose*".

This small but important distinction implies that digital assets created for one purpose can segue into another. For example, the EC recommendation states, "*Advanced digitisation of cultural heritage assets and the reuse of such content can generate new jobs not only in the cultural heritage sector but also in other cultural and creative sectors, including, for instance, the video game and film industries.*" (page 1 point 4). This is not the reality. 'reuse' has a specific term within research, and the subject is explored in depth in van de Sant et al. The Definition of Reuse[8], argues that any use of data beyond that for which it was originally intended is reuse. This opinion aligns with the circular economic model of reuse defined in the EU Waste Framework Directive[9] Article 3 point 13, defining reuse as "*any operation by which products or components … are used again for the same purpose for which they were conceived.*". While it is acknowledged that this definition refers to physical rather than digital matter, the point is still valid. The data created from a digitisation effort is undertaken with a clear intent to address a need specified by the stakeholders.

While this may seem pedantic, it has ramifications for cultural heritage professionals involved in digitisation if there is an expectation that the output of a digitisation effort is 'ready for use' in another sector with different objectives. This needs to be emphasised to stakeholders at the inception of the digitisation, and, if a requirement, it must have the appropriate level of resources and planning allocated to fulfil the need, like any other requirement of the stakeholder/purpose of digitisation.

Indeed, it appears *prima facie* that the Common European Dataspace for Cultural Heritage is the only infrastructure of the 17 dataspaces where 'content' provision rather than data-sharing with external sectors (explicitly creative, tourism, and education), with the implication of direct exploitation of said content. While this may not be the case, the potential for misunderstanding of the use of data from a digitisation effort, its subsequent reuse for its intended purpose, or its repurposing beyond its context, is high. Of particular concern is the potential for the context of the digitisation, and the heritage resource it represents, to be lost, altered, or misappropriated unintentionally or otherwise through reuse.

2.3 STAKEHOLDER, USER, OR RE-USER?

In the previous two sections, we have referenced three terms for actors in the digitisation processes: stakeholders, users, and re-users. A simple definition based on the previous discussion is: 1) Anyone who engages with datasets created by the digitisation effort, *as intended*, is a user. 2) Anyone using that data for another purpose is, by definition, a (re)user. 3) By implication, the stakeholder is the actor who identifies and defines the need for the digestion to be undertaken.

Mapping this back to the circular model, the role of inception and design falls under the purview of the stakeholder (as the vision holder), the role of the consumer is taken by the user (the intended audience), and those who will reuse the data fulfil the role of the recycler (secondary use). These assignments lack one key role, the actor who undertakes the digitisation of the cultural heritage resource on behalf of the stakeholder, transforming the data into a cultural heritage asset that can be deployed to the user in fulfilment of the identified needs and for potential repurposed secondary use elsewhere. This fourth actor maps to the circular model roles of production and dissemination, and can be defined as a **Contributor**.

The Stakeholder

There is no single definition of what a 'stakeholder' is. The term can range from the broadest definition: "*Individuals or groups of people, institutions or companies that may be significantly affected, positively or negatively, by the success or failure of an intervention.*" [10] In contrast, some use highly granular definitions for stakeholder identification and analysis for risk management[11]. Most definitions unsurprisingly focus on business or commercial activities, not scholarly research. If cultural heritage is a universal right[12], then everyone becomes a stakeholder to be considered in the equation.

Reflecting on these and framed within cultural heritage digitisation, it is possible to identify a stakeholder as an actor with an investment in the cultural heritage resource, which may be prejudiced through its digitisation. This investment may be financial, legal, moral, or ethical. Stakeholders *actively* contribute to the development of the preconditions, requirements, and needs defining the digitisation use-case specification (*why* the cultural heritage resource is being digitised, *what* the expected outcomes of digitisation will be, and *how* and *for whom* the results will be used).

By considering the prejudicial impact of the digitisation of a cultural heritage resource on potential stakeholders, this working definition allows both FAIR and CARE[13] data principles to be considered, both identifying and engaging with the stakeholder(s) before any digitisation takes place.

A further distinction can be made between internal and external stakeholders: Internal stakeholders refer to those who identify directly as heritage professionals or are part of a project consortium and actively contribute to the project or digitisation process. External stakeholders are those whose primary activity lies in other sectors but whose actions significantly impact cultural heritage; they do not actively contribute to the digitisation process but may affect or use the results of the project. This distinction is relevant as it highlights that cultural heritage values and impacts extend beyond traditional heritage fields. Stakeholders may include actors such as:

- The owner of the cultural heritage resource (the legal owner, individual or organisation)
- Governmental or State departments responsible for the cultural heritage resource (Ministry for Culture, Department of Antiquities, Superintendente, etc.)
- The stewards of the cultural heritage resource (cultural heritage resource held in trust, e.g., items in a museum collection on loan or held on behalf of the nation)
- The traditional owners/custodians of the cultural heritage resource
- The community surrounding the cultural heritage resource (in the case of a site or monument, e.g., land owners, monastic communities, inhabitants)
- Funders of the digitisation effort

The Contributor

The role of the contributor within the circular data model is taken by the actor tasked to fulfil the identified needs within the specification provided by the stakeholder. By this, we mean the process of creating a cultural heritage asset through digitising the analogue resource. This includes data acquisition, data processing, data

interpretation, data enrichment, and data presentation.

The contributor is responsible for ensuring that the data quality conforms to the expectations of the stakeholder and complies with the agreed formats, metadata, paradata, and licensing required to fulfil the project's FAIR, CARE, or other identified prerequisites before release. As such, this includes managers and administrators who ensure adherence to the agreed specifications and timescales and resource management within a digitisation project. Examples of contributors include:

- Project planners and facilitators
- Digital acquisition team members
- Researchers
- 2D/3D Modellers and post-production designers
- Specialists required to realise the project specification (e.g., Conservators, Archaeologists, Architects, Material Scientists, Civil Engineers, Chemical Engineers, Traditional Knowledge Holders, etc.)

The User

'User' is a generic term, as anyone who makes use of the data produced by the digitisation effort is, by definition, a user. As noted in [1], there is a need to distinguish between user 'types' if a digitisation is to achieve its goals – in short, there must be an audience to whom the results will be addressed and an identified need that the digitisation fulfils for that audience. As the stakeholder role defines the "Why is" and the "Who for" definition of the digitisation effort, this should provide a more focused identification of the user actor.

The boundary between data and product becomes less clear when considering the role of the user. The digital asset may be deployed as a product (e.g., an educational game, museum interactive, etc.), data sets that will be consolidated into other works (e.g., as a component part or asset purposely designed for specific reuse), or a combination of both (e.g., as a focal object for exploring a Memory Twin, being both representational and providing access to underpinning data).

As noted previously, the role of the user can be mapped back to the circular model as a consumer. In other words, the user is the primary beneficiary of the digitisation output as defined by the stakeholders. Examples of users include:

- Researchers/Scholars
- Policymakers
- Promotors (i.e., the cultural heritage resource was digitised to promote engagement with cultural heritage and/or its wider context, such as tourism)
- Educators (i.e., the cultural heritage resource was digitised for educational use)
- Students (Learners of all types, formal, informal, or casual, as specified)

This does not preclude multiple beneficiaries from a digitisation but rather, by identifying need, helps to distinguish the critical aspects the digitisation must address and be balanced against practical constraints of time, finance, and required quality to meet those needs.

By placing the emphasis on the intent of the digitisation, the process of dissecting the thorny phrase "multidisciplinary user community". If the intended outcome is to support an identified need within the cultural heritage community, the specific group can be identified. The history of cultural heritage is littered with projects (both analogue and digital) where, with good intentions, they assumed that their work would be useful to others based on the "*If you build it, they will come*" fallacy.

If we stop viewing the multidisciplinary user community as something we are in the service of and consider it to be a multidisciplinary team of which we are just one part, we are better placed to identify opportunities where digitisation may support another group and explore if and how digitisation may support a need rather than creating one. Moreover, this change in perspective provides the opportunity to evaluate if the identified user should (or, more likely, to what extent) be involved in defining the needs and shaping the solution as a stakeholder or contributor in their own right.

This is particularly relevant where a holistic approach to the digitisation of cultural heritage is being considered. Holism attempts to integrate all relevant components and their relationships, enabling better identification and interpretation of knowledge gaps, interconnections, and interdependencies. Knowing when, where, and how to stop the digitisation process is key to delivering meaningful and efficient results to fulfil the

user needs, reducing the addition of new features/content to a project, leading to delays, increased costs, and a more complex or unfocused final output.

Those for whom the digitisation, data, and outputs may have benefit outside the intended scope defined by the intention of the stakeholder are considered secondary users and therefore reuse the data.

The Reuser (secondary users)

Reusers are the most difficult of the actors to quantify, as they fall outside of the intent of the digitisation process. Their motivation for engaging with the data from a digitisation effort and how they may repurpose it is *de facto* unexpected and unknown. The common statement that the digitisation of a cultural heritage resource is to "*preserve the asset for future generations*" is a prime example of the reuse argument, but it is impossible to predict how future generations may engage with the digital asset.

This, however, does not mean that the Reuser should be dismissed from the considerations of the project. Meaningful and sustainable reuse of data can occur, and even be encouraged, if the Reuser is provided with mechanisms that facilitate reuse. Reusers must, for example, know how (and if) the data may be reused through IPR and licensing agreements, understanding why and how the dataset was created, and, of course, provision must be made to allow data to be accessible and interoperable through standardisation of data formats.

This additional information must accompany the asset as part of the certified metadata paradata record if the dataset is to be understood, contextualised, and available for impactful reuse. Such information is vital for the scientific and research community if future (re)users can contribute to the digital asset through their own research, by citation, data linking and thereby enhancing the extant corpus, improving the holistic documentation and capitalising on existing work.

The key to providing reusability of datasets is the preservation and archiving strategy for the digitisation. The importance of this cannot be overemphasised if the reuse of cultural heritage data is to be realised. The opening section of this paper considered data as a primary raw material to be protected and conserved. Regardless of how that data may be realised as a product to fulfil the primary user needs, without a long-term plan for preservation of data, sustainable reuse is impossible.

The view that long-term digital preservation of data is something that occurs at the end of a project (if at all) is in direct conflict with the circular model. Rather, by assigning responsibility for defining at which levels adherence to FAIR data principles is given to the stakeholders, sustainable data management is built into the entire workflow, enabling datasets to continue to be available for future (re)use.

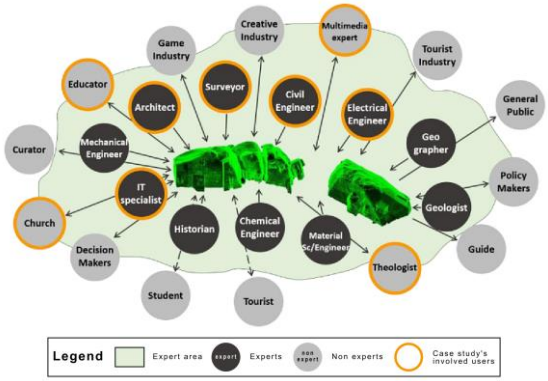

Figure 4: *Identified Multidisciplinary Community for St Neophytos' Enkleistra, Cyprus*

Multiple Role Actors

It is recognised that a single actor may well undertake multiple roles within a digitisation effort, especially on smaller-scale projects. For example, a community wishing to commission a digitisation to record their community memory would take on the role of Stakeholder as the 'owner' of the heritage resource and User as the digitisation is being undertaken to serve the community. Depending on what is to be digitised and how that digitisation will occur, they may also take on the role of contributor. Similarly, through assigning actors roles within the digitisation project, it may be discovered that their participation may be advantageous or required in another role (see the discussion on users and engagement previously).

Only those actors from the Reuse category cannot participate in multiple roles, as their motivations are unknown. If the anticipated reuse needs go beyond the fundamental data certified within the cultural heritage asset, then the actor's role changes from Reuser to User, albeit a *potential* user. This dichotomy was partially addressed within the Mnemosyne Project, making

a distinction between users and experts involved in a digitisation assigning the roles of 'contributor' and 'user' or 'interested party' (see **Figure 4**).

If the project specification states that the cultural heritage asset will be available for reuse by the video game industry, then the video game industry becomes the *de facto* new user, for which part of the project budget must be invested. The Complexity[1] of the project will increase as a result - the needs of the video game industry must be understood, the asset (or derivative) prepared for the new use (a case of redeployment) and in line with any preconditions established by the stakeholders. If this does not occur, time and effort will be wasted in either preparing or converting data on the assumption that the data is fit for the purpose claimed within the digitisation project specification.

3. REFINEMENT & NEXT STEPS

In the digitisation process, the relationship between the roles of Stakeholder, Contributor, and User is a complex interplay of economic and sociocultural interests that shape the planning phase, define the final outputs, and set the boundaries of what is achievable. This is not a straightforward task; as each digitisation effort is unique, it follows that the process will require different (if similar) skills from the multidisciplinary group assembled.

This is not simply just putting a job title to an actor but understanding what it is the that actor brings to the role and the process as a whole, helping to both clarify expectations across the diverse actors involved in the digitisation effort and to assist in the identification of gaps (and opportunities) that are available, or missing, from the undertaking. For contributors in particular, this identifies the skills considered necessary to undertake the digitisation to fulfil the needs of both the stakeholder and user.
As seen in **Figure 4**, the categorisation of user/expert and contributor/user defines the broad scope of the digitisation needs, but lacks a degree of specificity that may be beneficial to the undertaking. For example, the expert contributor 'Surveyor' covers a myriad of definitions and associated skill sets depending on the individual community terms of reference (civil, mechanical, and electrical engineers, cartographers, draughtsmen, archaeologists, architects, environmental protection professionals, etc.).

To help refine and clarify our common understanding, we can reference the European Skills, Competences, Qualifications and Occupations (ESCO) [15] . The ESCO is a comprehensive taxonomy of occupations cross-linked to expected skillsets and qualifications relevant to the EU labour market and education and training strategy.

By using this refinement, we can better match the needs/skills of digitisation and identify gaps/duplication of skill sets. As an EU initiative, the ESCO has advantages over the more widely known ISCO-08 profession taxonomy [16]: it is connected to skills and qualifications, it considers both vocational and academic skills, and it is translated into 32 languages with an accompanying thesaurus of synonymous job titles. Further, ESCO is dynamic, better reflecting the changing needs of the community, and allowing the different sectors to assess the classifications provided from both a practical and theoretical viewpoint (see Creative FLIP's report on improving the ESCO for the Cultural and Creative Sectors [17]).

Through focusing on shared skill competence rather than occupation designation (i.e., the actor's role within the digitisation), the described method emphasises a human-centred approach that crosses disciplines and sectors, fostering the principles of holistic documentation by establishing links between diverse data sources.

This approach is not perfect, as it necessarily geared towards occupations, and how we integrate less well defined non-occupational actors (students, tourists, communities, etc.) into the wider cultural heritage community is a subject of ongoing and proposed research.

4. CONCLUSION

This paper has examined some of the common terms used within digital cultural heritage projects, for which there is a tacit understanding but which anecdotally cause misunderstandings or blockages when developing proposals, planning projects, and establishing common frameworks within the diverse multidisciplinary community of cultural heritage practice.
Through exploring these terms using a role-based approach, we have shown how the digitisation process, traditionally oriented towards the knowledge economy, can be better aligned with the circular economy model. Using the actor role approach, we can start to see more

clearly the importance and value of the data we collect as a long-term investment rather than short-term product-oriented projects through data circularity (whether that be through repurposing, reuse of data, or recycling of components based on created data) while still maintaining integrity and intellectual transparency through good data stewardship.

In turn, clarity of role responsibilities opens up the possibility for more cooperative and inclusive participation by focusing on the fundamental questions of why we digitise cultural heritage, what needs to be digitised, and who we digitise for, allowing earlier identification of critical tasks such as long-term preservation, resource allocation, and more targeted results.

This is by no means a comprehensive document, and further collaborative research will be needed to establish a consensus on common definitions of roles, responsibilities, and meanings within the community at large.

As the multidisciplinary and trans-sectorial importance of digital cultural heritage grows, it will become more necessary to harmonise and coordinate our efforts. This should apply not only to establishing good working practices, protocols for digital archiving and preservation, standards for data acquisition formats, digital documentation and establishing internationally recognised principles for ethical and sustainable use of the cultural heritage assets we create, but also to how we conduct, plan, and manage our collaborative digitisation work.

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Methodology Over Machinery: Evaluating Low-Cost 3D Acquisition for Cultural Heritage Digitisation

Anthony Cassar [a], Drew Baker[b] and Marinos Ioannides[b]

[a]Heritage Malta, Dawret Fra Giovanni Bichi, Il-Kalkara KKR 1280, Malta, PhD fellow UNESCO Chair on Digital Cultural Heritage at the Cyprus University of Technology, digitisation@gov.mt
[b]Digital Cultural Heritage Research Centre MNEMOSYNE, University of Technology, Cyprus, drew.baker@cut.ac.cy; marinos.ioannides@cut.ac.cy

ABSTRACT: This paper advocates for a methodology-first approach to cultural heritage digitisation, emphasising structured workflows over technological sophistication. Anchored in the Memory Twin framework, it demonstrates that lower-cost tools, when deployed within rigorously planned and documented processes, can still produce scientifically valid and culturally meaningful outcomes. Drawing on the STECCI Horizon Project and supported by findings from VIGIE2020/654 and HERITALISE, the study challenges technology-centric models by promoting participatory methods, semantic documentation, and strategic training. It argues that digitisation must be guided by purpose, context, and interpretive transparency to ensure the epistemic integrity of digital heritage. As digitisation becomes central to preservation, education, and cultural resilience, this paper calls for a shift in practice: placing methodological integrity at the heart of digitisation strategies, regardless of institutional scale or resource availability.

1. INTRODUCTION

Cultural heritage faces mounting threats from climate change, armed conflict, urbanisation, overpopulation, over-tourism, and digital obsolescence. These pressures not only endanger physical assets but also disrupt the transmission of knowledge, memory, and identity across generations. In response, digitisation has emerged as a strategic tool for safeguarding both tangible and intangible heritage. The Memory Twin framework (Cassar, Baker, & Ioannides, 2025) advocates for ethically grounded, holistic, digital representations that integrate narrative, community memory, and technical precision.

The European Union plays a pivotal role in shaping digitisation policy. The ViMM Action Plan under FP7 laid the groundwork for a coordinated European approach to Digital Cultural Heritage (DCH), emphasising accessibility and innovation. This was reinforced by the Digital Day 2019 Declaration, which launched a pan-European initiative for 3D digitisation of at-risk cultural assets (European Commission, 2020). These efforts culminated in the European Commission Recommendation (EU 2021/1970), which calls for the 3D digitisation of all endangered monuments and 50% of the most visited sites by 2030 (European Commission, 2021).

These initiatives align with the UN Sustainable Development Goals, particularly SDG 11.4 (heritage protection), SDG 9 (innovation), and SDG 4 (education). Digitisation supports preservation, education, and cultural resilience, making it central to contemporary heritage policy. The Twin it! and Twin it! Part II campaigns, facilitated through Europeana, exemplify this strategy by encouraging the contribution of high-quality 3D assets and enriched metadata. Europeana serves as a digital infrastructure offering access to over 59 million cultural items and promoting interoperability and reuse across sectors (Europeana Foundation, 2025).

The STECCI Horizon Project illustrates the practical application of these policies. Focusing primarily on medieval limestone tombstones (stećci) across Eastern Europe, the project prioritises digital documentation through its WP4 digitisation work package, led by Heritage Malta. This work is informed by the VIGIE2020/654 study, which provides a framework for assessing digitisation quality based on

object complexity, intended use, and methodological design (Ioannides et al., 2022). STECCI critically evaluates low-cost digitisation techniques, demonstrating that methodological rigor, through structured planning and documentation, can yield high-quality results even with modest equipment (STECCI Consortium, 2025).

This paradigm shift positions digitisation not as a technical add-on but as a core strategy for cultural resilience. It enables the activation of heritage, supports inclusive memory systems, and responds to environmental, political, and epistemic pressures. The Memory Twin framework, being developed by Heritage Malta and the UNESCO Chair for Digital Cultural Heritage, contributes to this shift by integrating high-fidelity visuals with metadata, paradata, and intangible values. It promotes participatory, value-driven preservation, and offers a scalable model for safeguarding heritage in the digital age.

2. GROUNDING DIGITISATION IN METHODOLOGY TO ENSURE THE AUTHENTIC IDENTITY OF DIGITISED ASSETS

Digitisation of cultural heritage is not merely a technical exercise - it must be grounded in methodological integrity to ensure the authentic identity of the assets being represented. Cultural heritage is inherently complex, layered, and context-dependent. Without a clear methodological framework, digitisation risks producing outputs that are visually accurate and interesting but epistemically hollow, lacking interpretive depth and cultural fidelity.

The VIGIE2020/654 study (Ioannides et al., 2022) provides a foundational framework for ensuring methodological integrity in 3D digitisation. It argues that quality is not determined by equipment sophistication alone but by clarity of purpose, asset complexity, and documentation rigor. Central to this is the concept of paradata, which captures interpretive decisions, workflows, and contextual reasoning. This layer is essential for transparency, reproducibility, and authenticity.

These principles have been operationalised in projects like STECCI, where paradata is embedded into digitisation workflows to support both technical and interpretive fidelity. Heritage Malta's national strategy has formally adopted the VIGIE framework, reflecting a broader recognition that methodology is central, not ancillary, to digitisation, especially for complex cultural assets requiring nuanced representation.

Recent scholarship reinforces this methodology-first approach. Storeide et al. (2023), in a review of 45 digitisation projects, highlight recurring issues with standardisation, interoperability, and workflow coherence. Their findings underscore the need for robust frameworks to ensure cultural and epistemic integrity.

Gautier et al. (2020) demonstrate that SLAM-based systems, while technically efficient, require structured workflows to ensure data reliability. Their work shows that low-cost solutions can be viable only when embedded within disciplined methodological contexts.

Pepe et al. (2022) advocate for context-sensitive digitisation, where tool selection and workflows are driven by the asset's characteristics and intended use. Their review of UAV-based SfM-MVS workflows emphasises that platform choice, image acquisition strategy, and processing pipelines must be tailored to documentation goals.

Ahmad et al. (2025) introduces a dual-robot scanning system that automates viewpoint planning and surface coverage. Although technologically advanced, their system embeds methodological logic to reduce reliance on expert operators—supporting the argument that reproducibility and documentation are more critical than hardware sophistication.

The role of paradata is further elaborated by Ioannides et al. (2025), who warn that without transparent documentation, digital heritage risks becoming opaque and unreplicable. Their volume, 3D Research Challenges in Cultural Heritage V, presents comprehensive guidelines for integrating paradata, metadata, and data, especially in immersive and participatory heritage experiences.

Bajena (2025) contributes to this discourse with OntPreHer3D, an ontological extension of the CIDOC CRM. This framework enables semantic documentation of 3D models, including hypothetical reconstructions, by capturing not only what was modelled but also why and how. It integrates interpretive reasoning and quanti-

fies uncertainty, ensuring that digital representations remain transparent and scientifically rigorous.

Together, these studies advocate for a methodology-first approach to 3D digitisation. Before selecting tools or assessing cost-efficiency, practitioners must define the purpose of digitisation, the nature of the asset, and the intended use of the output. This clarity informs the selection of technologies, workflows, and documentation strategies, ensuring that digitised assets retain their authentic identity, are fit for purpose, and remain accessible for future reuse and reinterpretation.

3. METHODOLOGICAL FRAMEWORK

Digitisation of cultural heritage is not merely a technical task, it is a methodological process requiring clarity, transparency, and contextual sensitivity. As demonstrated in the VIGIE2020/654 study (European Commission, 2022) and further developed by Cassar (2026) and Ioannides et al. (2024), the quality of a digital asset depends on the complexity of its acquisition and the integrity of its documentation.

A key aspect of methodological rigor is the dual-axis framework introduced by the VIGIE study, which evaluates digitisation through the lenses of complexity and quality. Complexity encompasses environmental conditions, object morphology, stakeholder needs, and technological constraints. Quality is assessed based on how effectively the digitisation meets its intended goals while managing these challenges (European Commission, 2022). This approach shifts focus from product-centric metrics to process-centric indicators such as reproducibility and fitness for purpose, enabling tailored strategies for conservation, education, or public engagement.

Central to this framework is the articulation of owner requirements; expectations and constraints defined by heritage stakeholders. As Cassar (2026) notes, the Memory Twin framework begins with participatory dialogue that captures technical specifications alongside cultural narratives and ethical priorities. These requirements guide technology selection, metadata schema, and certification processes, ensuring that digital outputs align with community values and avoid producing culturally hollow representations.

Site-specific planning is equally critical. Pre-acquisition surveys, as emphasised in both the VIGIE study and the STECCI Horizon Project, assess terrain, access logistics, environmental risks, and legal constraints (European Commission, 2022; Cassar, 2026). These inform operational plans that anticipate challenges and optimise resources. Structured documentation across strategic, tactical, and operational layers ensures consistency and supports harmonisation of datasets for reuse and comparative analysis.

Digitisation must also be object-centric. As Ioannides et al. (2024) argue, methodology should adapt to the asset's size, material, surface complexity, and cultural significance. For example, a weathered limestone stećak requires different techniques than a polished bronze sculpture. The Memory Twin framework promotes hybrid approaches that combine high-resolution imaging, multispectral analysis, and narrative documentation to capture both physical and symbolic attributes.

Environmental assessment plays a vital role in ensuring data quality. Conditions such as lighting, temperature, and vegetation affect acquisition outcomes. The VIGIE study identifies environmental metadata as essential for quality assurance and conservation monitoring (European Commission, 2022). The Memory Twin framework integrates this data with cultural context to provide a holistic view of the asset's condition.

Documentation must span the entire digitisation lifecycle. Structured templates for capturing paradata, interpretive decisions and workflow annotations, support transparency and reproducibility (European Commission, 2022). Paradata also underpins certification mechanisms. As Cassar (2026) and Ioannides et al. (2024) argue, it transforms digitisation into a scholarly and ethical practice. The Memory Twin framework treats paradata as a dynamic layer that evolves with the asset, enabling validation through instruments such as the Paradata Quality Certificate.

Finally, workflow design must prioritise clarity and modularity. Documenting software versions, processing parameters, and decision rationales ensures replicability. Transparency also includes interpretive openness. Co-designed workflows involving curators, conservators, and community stakeholders ensure that digitised assets reflect diverse perspectives. Standardised practices, such as CIDOC-CRM

for metadata and emerging paradata ontologies, support semantic interoperability and long-term preservation, facilitating integration into platforms like Europeana and the Common European Data Space for Cultural Heritage.

4. CASE STUDY: STECCI HORIZON EUROPE PROJECT

To illustrate the practical application of the methodology, the following case study examines how it was applied to the STECCI Horizon Europe Project (steccihorizoneu.com). This project focuses on the safeguarding, conservation, preservation and digital documentation of medieval limestone funerary monuments known as stećci, which are distributed across the Western Balkans and similar limestone monuments in parts of Central Europe. These monuments are of considerable historical significance due to their unique iconography and inscriptions, which reflect the spiritual and socio-cultural identities of medieval communities. The project also looks at other limestone funerary monuments in central Europe and the Mediterranean. Increasingly threatened by environmental degradation, biological growth, and pollution, these heritage assets require urgent intervention. Digitisation offers a sustainable, non-invasive means of capturing their current condition, enabling long-term monitoring of surface deterioration and facilitating comparative analysis across time and geography.

The project spans fifteen heritage sites in eight countries, each presenting distinct environmental and logistical challenges. Acquisition strategies were developed through pre-acquisition surveys and collaboration with local stakeholders to ensure methodological appropriateness. In addition to preservation, STECCI promotes accessibility and knowledge dissemination by transforming remote and fragile monuments into digital assets. These assets support academic research, educational initiatives, and public engagement through interactive platforms, virtual tours, and digital learning environments. The project also contributes to methodological innovation by evaluating both professional-grade and low-cost documentation technologies, thereby promoting scalable digitisation approaches suitable for institutions with varying capacities.

Due to the inability to conduct preliminary site visits, detailed planning was essential. A standardised Acquisition Survey was implemented to gather data on terrain morphology, climate conditions, vegetation density, access limitations, and legal constraints. This information enabled risk mitigation and informed context-sensitive technical decisions. The digitisation methodology employed a dual-tier technological framework to balance precision and accessibility. Professional documentation included aerial photogrammetry using the Autel EVO II Pro drone and terrestrial LiDAR via the Leica RTC360 for sites where drone operation was restricted. Close-range DSLR photogrammetry with controlled lighting was used to capture fine iconographic details. In parallel, mobile-based tools such as Polycam and RealityScan, along with experimental Gaussian Splatting techniques, were deployed to assess the feasibility of low-cost, AI-driven workflows. This comparative approach allowed for the evaluation of accuracy, usability, and portability under real field conditions.

The acquisition phase followed a structured workflow beginning with on-site reconnaissance to verify environmental conditions and refine capture parameters. Ground control points and survey targets were placed strategically, particularly around priority monuments. Roles were clearly defined to coordinate drone and LiDAR operation, photogrammetric capture, and paradata documentation. The workflow typically progressed from aerial photogrammetry to individual monument documentation, followed by ground-based site capture. In cases where drone use was not feasible, terrestrial LiDAR was employed, as at the Križevići site in Bosnia and Herzegovina, where dense forest cover restricted aerial access. Site-specific adaptations were employed to address environmental and logistical constraints. For example, steep terrain and reflective surfaces at Hundskirche in Austria required repeated exposure adjustments, while high visitor traffic at Žugića Bare in Montenegro necessitated early morning capture sessions. Legal restrictions near diplomatic zones at the National Museum of Bosnia and Herzegovina led to the use of fully manual drone flights at controlled altitudes. These adaptations ensured comprehensive coverage and data integrity despite variable field conditions.

Paradata played a central role in ensuring transparency and reproducibility. Structured records were completed for each session, documenting personnel, environmental conditions, equipment settings, and any procedural deviations.

Decision rationales, such as workflow modifications due to heat or equipment malfunction, were formally logged, ensuring that future users could understand the context and reasoning behind each dataset.

Post-processing transformed raw data into usable digital assets. LiDAR and photogrammetric datasets were integrated using Leica Cyclone, RealityCapture, and Metashape through alignment, registration, and bundle adjustment. Point cloud cleaning removed transient artefacts, and mesh generation with selective decimation produced outputs suitable for archival preservation, research, and online dissemination. A structured quality control protocol verified geometric accuracy, scale fidelity, and texture continuity. Post-Processing Reports documented software parameters, corrective actions, and encountered challenges, supporting transparency and future reuse.

The acquisition phase concluded with the successful creation of a comprehensive digital archive covering fifteen sites. Despite environmental and logistical constraints, no critical data loss occurred. The project has now entered the post-processing phase, where raw datasets are being converted into archival formats, web-ready assets, and analytical models. These outputs will be integrated into the STECCI digital platform, providing a robust foundation for future interpretive work, including studies on material degradation, typological classification, and cultural significance.

5. CONSIDERATIONS IN LOW-COST DIGITISATION

While STECCI employed both professional and low-cost tools, the following section expands on broader considerations for low-cost digitisation across varied heritage contexts

The concept of low-cost digitisation is relative and depends on institutional resources and infrastructure. Smartphones are often assumed to be inherently low-cost due to their accessibility, yet a basic DSLR camera may be more affordable and offer superior control over exposure, focus, and image quality (Jasińska et al., 2023). In the STECCI case study, smartphones were selected for evaluation under the assumption that most users already possess one and would incur no additional expense. However, based on observed performance difference, output quality varies considerably, as devices such as an iPhone Pro 17 (released in 2025) differ greatly from older models like the Samsung Galaxy S8 (released in 2017). Thus, technology choice must be contextualised rather than universally defined as “low-cost.”

Successful digitisation relies more on a structured methodology than on equipment type. The decision to use low-cost tools must be informed by the model’s intended purpose. Critical questions include whether millimetric accuracy is required, whether the model is for conservation or visual interpretation, and whether georeferencing is necessary. If precision is essential and only a smartphone is available, limitations must be acknowledged. For purely visual outputs or public engagement, well-planned low-cost workflows can be effective, provided documentation is thorough and transparent.

Not all acquisition methods are equally compatible with low-cost tools. Architectural documentation requiring plans or sections demands terrestrial LiDAR and georeferencing instruments such as GNSS, which remain beyond low-cost scope. While smartphones increasingly feature LiDAR, they are suitable only for rapid visual assessment. Aerial photogrammetry requires UAVs, though drone accessibility is improving. Photogrammetry remains the most adaptable low-cost method; provided image quality is managed. However, free mobile applications may impose limitations, such as restricted export formats. Therefore, adaptation through desktop processing applications may be needed.

Gaussian Splatting, which reconstructs 3D data from video, is accessible but limited. It produces splat-based representations without true meshes or textures and lacks metric accuracy, reducing suitability for scientific use. Nonetheless, it offers potential for rapid visualisation.

Low-cost digitisation is viable when guided by clear objectives, rigorous planning, and full documentation. Success depends on methodological integrity rather than equipment expense, ensuring outputs remain meaningful, usable, and transparent in their limitations.

6. IMPLICATIONS FOR PRACTICE

This study underscores a critical shift in cultural heritage digitisation, from technology-led approaches to those grounded in methodological rigor. This transition carries significant implications, especially for institutions with limited resources, constrained technical capacity, and a need for inclusive community engagement. The STECCI Horizon Project and the Memory Twin

framework exemplify how structured, transparent, and purpose-driven methodologies can support scalable and sustainable digitisation practices.

In underfunded heritage contexts, the absence of digitisation is often due to lack of access to high-end equipment and expertise. However, the STECCI project demonstrates that low-cost digitisation, when embedded within a robust methodological framework, can yield scientifically valid and culturally meaningful results. The VIGIE2020/654 study reinforces this by asserting that digitisation quality depends more on clarity of purpose and documentation rigor than on technological sophistication (Ioannides et al., 2022). Even basic tools such as mobile photogrammetry or consumer-grade LiDAR can serve as effective preservation measures when supported by structured planning and paradata documentation. Thus, low-cost digitisation should be viewed not as a compromise, but as a strategic entry point into broader digitisation ecosystems.

Crowdsourced digitisation offers a powerful mechanism for expanding access and participation. By enabling the public to contribute images, metadata, or contextual narratives, institutions can enhance documentation capacity while fostering community ownership. This participatory model aligns with the Memory Twin framework's emphasis on integrating intangible values and community memory into digital representations (Cassar et al., 2025). However, such efforts must be guided by clear standards and validation protocols. Without methodological oversight, public contributions risk introducing inconsistencies. Structured paradata templates, as used in STECCI, provide scalable solutions for capturing interpretive decisions and ensuring transparency. Training modules and open-source tools further empower contributors to adhere to best practices, enhancing both quality and inclusivity.

Technological advancement should amplify, not replace, methodological integrity. Emerging tools such as AI-driven reconstruction, SLAM-based systems, and dual-robot scanning offer new capabilities, but their effectiveness depends on embedded logic and documentation. As Ahmad et al. (2025) demonstrate, reproducibility and interpretive fidelity remain contingent on methodological design. Ontological frameworks like OntPreHer3D (Bajena, 2025) support semantic transparency, enabling users to understand not only what was digitised, but how and why.

For small institutions and community archives, the methodology-first approach offers a replicable model. Structured workflows and low-cost tools allow these entities to initiate digitisation programmes that are both scientifically robust and culturally resonant. Participatory digitisation fosters cultural resilience and intergenerational knowledge transfer. The STECCI project's collaboration with regional partners illustrates how site-specific planning and community engagement enhance both logistical feasibility and interpretive depth. Moreover, digital documentation transforms remote or fragile assets into accessible resources for education, tourism, and diplomacy.

Finally, the HERITALISE study highlights a widespread lack of strategic training and awareness of available resources. Many practitioners remain unaware of existing guidelines, templates, and open-source platforms. Addressing this gap requires coordinated training programmes that emphasise methodological literacy, paradata integration, and workflow design. Standardised documentation and certification mechanisms ensure that digitised assets meet quality benchmarks and remain interoperable across projects. Digitisation should be understood as a foundational process, initiating long-term preservation and interpretive engagement. Long-term preservation demands robust data management, including archival formats, metadata integration, and redundancy protocols. Paradata and post-processing documentation ensure that each asset retains a transparent lineage, supporting future verification and reinterpretation.

7. CONCLUSION

This paper affirms that the accuracy of cultural heritage digitisation depends not only primarily on technological sophistication but on methodological integrity. Across diverse contexts, from well-funded institutions to community archives and underfunded NGOs, The Memory Twin framework and the STECCI Horizon Project demonstrate that structured, transparent workflows can yield scientifically robust and culturally meaningful outcomes, even with lower-cost tools. Paradata, semantic documentation, and participatory planning ensure that digitised assets retain interpretive depth and reflect authentic identity. As digitisation becomes a cornerstone of preservation, education, and

engagement, the vision must evolve methodology must precede machinery. Foregrounding purpose, context, and documentation, digital heritage can serve as a trustworthy vessel for memory, identity, and future reuse.

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DAY 3
“AI, Visualisation and Digitality”

Friday March, 20 2026

SESSION I

“Artificial Intelligence and Visualisation”

Moderation: Jacopo Spinelli M.Sc.
(Brandenburg University of Technology Cottbus-Senftenberg)

Drawing the Absent: AI, Restoration and the Hypothetical Image

Irene Ruiz Bazán[a], Gianluca Emilio Ennio Vita[b]

[a]Dipartimento di Architettura e Design, Politecnico di Torino, Italy, irene.ruizbazan@polito.it
[b] Accademia di Belle Arti di Urbino, Italy, gianluca.vita@accademiadiurbino.it

ABSTRACT: This paper explores the epistemic transformation of architectural restoration in the age of artificial intelligence (AI). Building on Cesare Brandi's theory of restoration, it examines how generative AI redefines the concept of the lacuna—the perceptual and ethical space between material loss and historical reconstruction. Traditionally, the lacuna has embodied an interpretative tension, where absence reveals the limits of knowledge. With AI-driven reconstruction, this boundary shifts from the material to the digital, producing forms of predictive realism that risk concealing uncertainty under hyper-real coherence. Through domain-specific AI systems trained on validated heritage datasets and supported by metadata of doubt, this study proposes a responsible framework for digital restoration. Rather than eliminating incompleteness, AI can expose and formalize uncertainty as a visible design parameter. The lacuna thus becomes an epistemic frontier where material evidence, algorithmic inference, and ethical interpretation converge—opening a new possibility of critical imagination.

1. INTRODUCTION. THE CONCEPT AND THE POTENTIAL OF THE *LACUNAE*

The integration of AI into architectural restoration marks a profound shift in how loss, absence, and reconstruction are conceptualized. The discipline has long relied on optical and metric documentation—photogrammetry, laser scanning, and 3D modeling—to record the existing state of built heritage [1]. These technologies have strengthened the indexical bond between the physical artifact and its digital representation. However, the rise of generative AI, capable of synthesizing missing parts through algorithmic inference, disrupts this paradigm.

From Cesare Brandi's perspective, restoration is the moment in which a work of art reclaims its potential oneness without falsifying its historical or aesthetic truth ("the methodological moment in which the work of art is recognized, in its physical being, and its dual aesthetic and historical nature, in view of its transmission to the future") [2]. The lacuna—the perceptual void left by material loss—has always been central to this process. It represents both an absence and an ethical boundary: a zone where the restorer negotiates between what is known and what can only be imagined. The introduction of AI expands the lacuna into the digital realm, transforming it into an epistemic frontier where uncertainty itself becomes a design material.

2. THEORETICAL FRAMEWORK: BRANDI AND THE ETHICS OF THE *LACUNA*

The theory of restoration formulated by Cesare Brandi remains a cornerstone of conservation philosophy. Published in 1963, Teoria del restauro provided the first systematic aesthetic and phenomenological framework for understanding the restoration of works of art as acts of cultural interpretation rather than mere technical repair. Within this framework, the concept of the lacuna—the gap, absence, or discontinuity—emerges as one of the most subtle and revealing aspects of Brandi's thought. It is precisely through the notion of the lacuna that the dialectic between material integrity and aesthetic unity becomes visible.

While Brandi's examples often refer to the restoration of paintings and frescoes, the lacuna as a conceptual category can be fruitfully transposed to architectural heritage, where the fragmentation of historical continuity, the erosion of material, and the loss of spatial coherence demand a nuanced theoretical response.

For Brandi, the act of restoration must "re-establish the potential unity of the work of art, provided this does not result in an artistic or his-

torical falsification". The lacuna therefore designates that part of the work where this unity is broken, whether by material loss, chromatic alteration, or structural disintegration. The lacuna is not merely a void to be filled but an area of tension where the work's physical reality and its aesthetic perception diverge.

Brandi distinguishes between the material authenticity of the work—its historical document value—and its aesthetic authenticity, understood as the perceptual and interpretative coherence of its form. The restorer's intervention on the lacuna must negotiate these two registers, ensuring that any reintegration remains clearly distinguishable upon close inspection (recognizability) and can be removed without harming the original (reversibility).

Thus, the lacuna functions as a conceptual boundary: an area of loss that makes visible both the fragility of the artwork and the ethical responsibility of the restorer.

In architectural restoration, the lacuna takes on new meanings. It may appear as a missing architectural element, a destroyed volume, or a discontinuity in the building's spatial logic. The architect-restorer must confront these absences not as deficiencies to be negated but as historical conditions that testify to the monument's temporal stratification.

The architectural lacuna is therefore both physical and narrative. It manifests the passage of time, the accumulation of historical events, and the successive transformations that define the building's identity. Interventions aimed at "filling" or "completing" such gaps risk falsifying the document, while leaving them unmediated may render the monument illegible. Following Brandi's principles, the task is to re-establish the potential oneness of the architectural work—its capacity to be perceived and understood as a coherent whole—without effacing the signs of its evolution.

The treatment of lacunae in architecture thus becomes an ethical question of visibility. To make absence visible is to acknowledge the integrity of history; to conceal it entirely is to erase the work's temporal depth. The restorer's challenge lies in transforming the lacuna into a space of mediation—neither an imitation of the lost parts nor a radical void that isolates the building from meaning.

Architectural restoration projects that consciously express lacunae—for example, through minimalist insertions, transparent materials, or contrasting textures—reflect this ethical stance. They embody what Brandi termed the "critical restoration": an intervention grounded in the awareness that every act of restoration is also an act of interpretation.

The lacuna represents one of the most enduring and productive concepts of Brandi's restoration theory, serving as a bridge between the material and the immaterial, the historical and the aesthetic. In architectural restoration, it offers a framework for approaching loss and incompleteness not as problems to be solved but as intrinsic components of heritage value.

Recognizing the lacuna as a space of dialogue between past and present enables a restoration practice that is both intellectually rigorous and ethically grounded. The lacuna, in this sense, is not the absence of form but the presence of time.

3. ARTIFICIAL INTELIGENCE, VISUAL UNCERTAINTY, AND THE NEW EPISTEMOLOGY OF RESTORATION

In the field of architectural restoration, the rise of generative Artificial Intelligence (AI) opens new possibilities for reconstructing damaged or incomplete heritage. Digital models can now fill lacunae with stunning realism, offering simulations of missing parts that go beyond traditional documentation. However, this shift from indexical recording to predictive generation raises critical questions about epistemological reliability and the ethics of intervention.

From a Brandian perspective, such digital reconstructions radically challenge the notion of potential oneness. In Brandi's framework, restoration must never falsify the historical document, and the reintegration of lacunae should remain clearly distinguishable from the original fabric. Generative AI, by contrast, blurs the distinction between documentation and invention: its outputs are not derived from the physical object itself but from algorithmic inference based on datasets, typological analogies, and stylistic patterns. The result is a form of synthetic authenticity, where the perceived coherence of the reconstruction may conceal the absence of empirical grounding.

Epistemologically, this shift implies that knowledge of the monument becomes probabilistic rather than evidential. The algorithmic generation of missing architectural elements produces a model that is plausible but not verifiable in historical terms. The authority of the image, traditionally rooted in its indexical relation to the material artifact, gives way to a regime of predictive realism—a visual truth that persuades rather than demonstrates. In this sense, generative AI may risk transforming the lacuna from a space of critical awareness into a site of illusion, undermining the dialectic between absence and presence that Brandi considered essential to the ethics of restoration.

Nevertheless, if critically employed, AI can also serve as an instrument for interpretative exploration rather than replacement. Digital reconstruction can be used to visualize hypotheses, simulate restoration scenarios, or analyze the perceptual impact of alternative interventions without materially altering the monument. When clearly identified as virtual speculation, such models can enrich historical understanding and public communication of heritage, expanding the epistemological scope of restoration practice while preserving the non-finiteness of the lacuna.

4. THE LACUNA AS EPISTEMIC FRONTIER

The lacuna, in this digital context, becomes an epistemic frontier where the limits of knowledge are made visible. Generative AI shifts the epistemology of restoration from evidential to probabilistic reasoning: reconstructions are generated not from material traces, but from statistical inferences based on stylistic or typological datasets. The resulting image is thus plausible rather than verifiable—a simulation that may obscure its own speculative nature.

This form of *predictive realism* [3] resonates with what Manovich [4] describes as the emergence of an *AI aesthetics*—a regime of visual coherence where algorithmic inference can conceal uncertainty beneath hyper-real consistency. This risks undermining the dialectic that Brandi considered essential: the tension between presence and absence. By producing seamless completions, AI may conceal the lacuna instead of revealing it, erasing the perceptual and ethical distance that ensures the work's authenticity. Yet, if employed critically, AI can also become a didactic device that visualizes uncertainty and multiplicity, rather than imposing a single authoritative version of the past.

We argue that to responsibly use AI in restoration, it is necessary to move away from general-purpose, web-trained models and develop domain-specific AI systems based on curated, validated datasets: architectural typologies, historical drawings, treatises, and restoration archives. Such systems could improve the trustworthiness and cultural coherence of AI-generated completions, avoiding stylistic mismatches or historically ungrounded reconstructions. In this sense, AI becomes not a tool of arbitrary invention, but a method for reasoning with precedent.

To ensure transparency, we propose visual annotation protocols for AI-generated reconstructions, making visible the levels of certainty, the origin of references, and the scope of algorithmic interpretation. These "metadata of doubt" aim to preserve a space for critical assessment within otherwise hyper-real digital models. Drawing on restoration theory—from Cesare Brandi to contemporary digital ethics—we suggest that embracing visual uncertainty is not a flaw, but a necessary virtue in a discipline where doubt, reversibility, and legibility are central principles.

The ethical challenge of AI-assisted restoration lies in maintaining the visibility of doubt. Brandi's call for recognizability and reversibility must be translated into digital terms. Just as physical interventions should remain distinguishable from the original, AI-generated reconstructions must expose their artificiality—through metadata, visual cues, or layered interfaces that reveal the hierarchy of sources and the confidence of algorithmic inference.

This approach transforms digital reconstruction from a process of replacement into a critical apparatus, allowing scholars and the public to navigate between verified evidence, plausible hypotheses, and speculative projections. In this framework, uncertainty is not an error but a parameter—an explicit part of the model that preserves the cognitive and ethical transparency of the restoration process.

To operationalize this frontier, a scientific framework for AI-assisted restoration could evolve along three main axes: data curation, uncertainty visualization, and epistemic validation.

(a) Data Curation and Domain-Specific AI Models

A first research direction lies in the development of domain-specific AI models trained on curated, validated heritage datasets. Instead of relying on general-purpose image generators, such systems would be trained on architectural typologies extracted from high-fidelity archives: for instance, datasets of Romanesque vault typologies, Renaissance ornament catalogues, or Gothic structural tracings derived from digitized treatises (e.g., Serlio, Palladio, Vignola). This approach parallels ongoing work in digital humanities and cultural heritage computing, where knowledge graphs and semantic ontologies [5] [6] are used to encode architectural knowledge in machine-readable form. The resulting AI models could then reason with architectural precedent rather than merely extrapolate from surface-level patterns, ensuring that generative inferences remain culturally and historically coherent.

(b) Visualization of Algorithmic Uncertainty

A second dimension involves the visual communication of epistemic uncertainty—what may be termed the "metadata of doubt." Each AI-generated reconstruction could include embedded uncertainty layers that visualize algorithmic confidence through color gradation, opacity levels, or dynamic interfaces. For instance, heat maps of confidence could reveal the algorithm's varying degrees of reliability across the reconstructed surface, while provenance tags could link each generated element to its dataset of origin. Such visualization strategies could be empirically evaluated through perceptual studies measuring how experts and lay audiences interpret uncertainty in digital reconstructions [7]. This would provide measurable data on how transparency affects trust, comprehension, and perceived authenticity—key ethical dimensions in digital heritage communication.

(c) Epistemic Validation and Experimental Design

The third axis concerns the validation of AI-generated hypotheses. A scientifically grounded methodology could employ "blind reconstruction tests", where AI-generated completions of intentionally occluded areas are compared against known originals. This allows quantitative evaluation of reconstruction accuracy (e.g., geometric deviation metrics, structural coherence indices). Complementary qualitative assessment frameworks—drawing from restoration ethics—could be developed to measure the interpretative plausibility of AI completions against expert consensus. These experiments would make it possible to calibrate models not only for visual fidelity but for epistemic reliability, thus preserving Brandi's distinction between authenticity as historical truth and authenticity as perceptual coherence.

Finally, participatory epistemic interfaces could be developed in which AI-generated reconstructions are presented as navigable hypotheses, enabling scholars, conservators, and the public to toggle between alternative versions or levels of confidence. This multi-scalar approach transforms AI-assisted reconstruction from a final product into a process of ongoing interpretation, where uncertainty becomes a structured form of knowledge rather than an error to be eliminated.

In this light, the lacuna ceases to signify a mere void or absence; it becomes a computational field of experimentation—a controlled environment where the limits of algorithmic inference, historical evidence, and human interpretation are systematically tested and visualized.

By situating AI within a transparent epistemic framework, restoration practice can reclaim its critical autonomy: the lacuna becomes both an instrument of inquiry and a reminder of the ethical imperative to keep doubt visible.

5. CONCLUSION

By reframing AI-assisted restoration as a discipline of doubt, this paper advocates for an interpretative and historically grounded approach to digital heritage. The aim is not to eliminate uncertainty but to formalize it—to transform doubt into a visible and accountable element of design. Such a perspective preserves the potential unity of the monument without erasing the traces of time or the limits of knowledge.

Generative AI, when critically constrained by curated datasets and transparent annotation, can act as a cognitive partner rather than a creative substitute. The lacuna, redefined for the digital age, becomes a site of epistemic negotiation between material evidence and computational inference. In this dialogue, restoration retains its disciplinary autonomy: it remains a science of interpretation, a practice of ethical imagination,

and a testament to the enduring balance between truth and possibility.

The methodological implications of integrating generative AI into restoration demand a fundamental shift in how digital reconstruction is conceived. Restoration must be reframed as a process of hypothesis rather than fact. AI-generated proposals for missing architectural elements should be regarded as provisional interpretations—subject to calibration, evaluation, and revision—rather than definitive completions. This epistemic stance aligns with Brandi's conception of the lacuna as a space of interpretative tension, where knowledge is partial, situated, and revisable.

Digital restoration workflows should therefore adopt layered modelling systems that explicitly encode uncertainty. Embedding metadata such as confidence scores, provenance tags, and version histories allows each inferred element to remain visibly distinct from verified fabric. These annotations transform uncertainty into an operational variable, preserving the interpretative transparency of the model. A human-in-the-loop approach remains essential: AI may assist in generating hypotheses, but professional expertise—architectural, historical, and conservation-based—must guide all curatorial and design decisions. Human judgment ensures that interventions remain recognizable, reversible, and ethically accountable.

To guarantee epistemic robustness, restoration research should adopt interdisciplinary validation frameworks. Experimental protocols such as blind testing, comparative metric analyses, and expert assessment can evaluate the reliability and biases of AI-generated reconstructions. These methods transform restoration into a reflexive science of testing and verification. Equally, communication practices must evolve: AI-generated visualizations should include explanatory layers that clarify what is original, reconstructed, or speculative, and indicate the confidence levels and data sources underlying each element. Such transparency fosters public trust and critical literacy in the interpretation of digital heritage.

The ethical dimension of AI-assisted restoration extends beyond methodological precision to encompass authenticity, transparency, and inclusivity. In accordance with Brandi's theory, any digital reintegration must safeguard the historical document value of the monument. The lacuna must remain perceptible—either visually or through metadata—so that temporal stratification and the traces of loss continue to testify to the building's history. Erasing absence in pursuit of aesthetic completeness risks falsifying the document itself. Equally critical is the governance of datasets and algorithms: domain-specific AI models must rely on curated and validated sources, with full documentation of dataset provenance, algorithmic parameters, and bias audits. Transparency in data governance is integral to the ethical legitimacy of digital restoration.

The classical principles of legibility, recognizability, and reversibility must be reinterpreted for the digital domain. Even within virtual models, reconstructed elements should remain clearly identifiable and removable without compromising the integrity of original data. These principles ensure that the digital act of restoration remains faithful to its ethical lineage. Moreover, AI systems must promote cultural diversity and inclusivity: generative reconstructions should not reproduce a single stylistic canon or dominant historiographical narrative. The lacuna signifies the plurality of possible readings; digital reconstructions should therefore embrace multiplicity and reflect the diversity of cultural memory.

Public trust in AI-assisted heritage interpretation depends on fostering critical literacy. Institutions should accompany digital exhibitions and reconstructions with explanatory content about the speculative and interpretative nature of AI outputs. By making uncertainty visible, restoration reaffirms its role as a discipline of critical awareness rather than technological illusion.

The integration of AI into architectural restoration also opens significant opportunities for methodological refinement and empirical research. A key priority is the development of benchmark datasets specifically designed for heritage restoration tasks. Such datasets, incorporating ground-truth cases with intentionally masked zones, would enable the calibration of AI models and facilitate standardized comparisons of predictive performance. This would establish a rigorous foundation for assessing the reliability and limitations of AI-generated reconstructions.

Equally important is the need to explore user perception studies. Visual cues for uncertainty—such as color coding, opacity gradients, or provenance annotations—may strongly influence how both experts and non-experts interpret reconstructed heritage. Systematic studies on perceptual and cognitive responses can inform best practices for interface design, ensuring that uncertainty remains perceptible and meaningful. AI workflows should also support multi-scenario reconstructions: instead of a single "restored" version, systems could generate multiple plausible alternatives, transforming the lacuna from a void into a generative field that invites interpretative exploration.

Longitudinal research is needed to understand how digital reconstructions evolve over time. Data decay, model updates, and new historical findings may alter the accuracy and relevance of previously generated reconstructions. Heritage institutions must therefore develop strategies for versioning, obsolescence management, and systematic updates of AI-derived assets to maintain authenticity and transparency. Finally, policy and standardization frameworks should align conservation principles—such as those articulated in the Nara Document on Authenticity—with emerging norms in AI ethics, data governance, and digital preservation. These guidelines will bridge technical innovation and disciplinary ethics, ensuring responsible and culturally sensitive practices in AI-assisted restoration.

In conclusion, generative AI—when constrained by curated datasets, transparent metadata, and human-centered workflows—can serve not as a creative substitute but as a cognitive partner in restoration. The lacuna, redefined for the digital age, becomes a site of epistemic negotiation between material evidence and computational inference. Restoration thus retains its disciplinary autonomy: a science of interpretation, an ethics of imagination, and a balance between truth and possibility. The ultimate goal is not perfect visual completeness but intelligible incompleteness—a heritage that preserves its temporal depth, its provisionality, and the visible tension between what we know and what we infer. In this sense, the lacuna, whether material or digital, remains a fundamental dimension of architectural heritage—an enduring reminder of loss, time, and the limits of knowledge.

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Architectural Representation Conditioning Stack (Arcs): Generative Process Multimodal Control

Enrico Pupi[a], Piergiuseppe Rechichi[b]

[a] Department of Architecture and Design, Politecnico di Torino, Italy, enrico.pupi@polito.it;
[b] Department of Energy, Systems, Territory and Buildings Engineering, Università di Pisa, Italy, piergiuseppe.rechichi@phd.unipi.it

ABSTRACT: This research addresses the limitations of the Text-to-Image (TTI) paradigm in the domain of Generative Artificial Intelligence (GenAI) architectural representation, which relegates designers to a passive human-on-the-loop (HOTL) role. We propose the Architectural Representation Conditioning Stack (ARCS), a hybrid, multimodal framework promoting a human-in-the-loop (HITL) workflow. ARCS integrates three conditioning layers to inference Diffusion Models (DMs) with precision: geometric (L1) via 3D models and ControlNet for spatial coherence; semantic (L2) via Large Language Models (LLMs) for prompt engineering; and stylistic (L3) via Low-Rank Adaptation (LoRA) fine-tuning to encode a specific visual lexicon. Incremental benchmarking demonstrates the framework's success in aligning generated outputs with user intent and expectations. The research further investigates an iterative feedback loop through contextual editing and explores frontiers, such as Image-to-3D/Video, to overcome the limitations of static representation, pointing towards a future of interactive spatial simulation. ARCS offers a draft methodology to transform GenAI from a black box into a creative partner, thereby fostering the algorithmic literacy necessary for contemporary architectural practice.

1. BEYOND THE TEXTUAL PARADIGM: THE WEAKNESS OF THE PROMPT

The integration of Generative AI (GenAI) into architectural representation is driving a profound transformation. Recent literature has systematically documented its potential across all design phases [1], establishing a new upskilling imperative for the Architecture, Engineering, and Construction (AEC) industry and raising fundamental pedagogical questions [2]. In the architectural domain, Diffusion Models (DMs) have opened new possibilities for conceptual exploration and visualization [3]. However, current applications are predominantly confined to the Text-to-Image (TTI) paradigm, especially during initial creative stages [4]. Research has focused on this approach for ideation, praising its capacity for serendipitous discovery [5] while also noting the risks associated with design fixation [6]. This line of inquiry has extended from specific form-finding processes [7] to generating master-quality drawings directly from text prompts [8].

This approach, while democratizing access to powerful visual tools, presents an epistemological disconnect between design intent and its representation. The fundamental research problem lies in the inadequacy of verbal language as the sole means of conveying architectural intent. Natural language, being inherently polysemic [9], excels at describing image semantics but fails to define the spatial and relational syntax central to architecture rigorously. This limitation undermines scientific representation and raises issues of shared authorship [10].

Consequently, the designer is relegated to a passive, human-on-the-loop (HOTL) role, iterating through prompt-crafting with little precise control. This dynamic fuels concerns that an uncritical reliance on AI may lead to a de-skilling of human thought and a loss of personal character in design [11].

The central thesis of this research is that significant progress lies not in refining this flawed approach, but in superseding it. We posit the necessity of a transition towards hybrid, multimodal workflows that shift the designer from a passive HOTL role to an active Human-in-the-

Loop (HITL) one [12]. In this model, human intervention is an integrated, strategic component that orchestrates the generative process, fostering a synergy between design thinking and GenAI [13] to achieve an augmented intuition where intent is encoded directly into the computational process [14].

Therefore, this research defines, implements, and critically analyzes an operational framework named the Architectural Representation Conditioning Stack (ARCS). ARCS enables designers to exert layered control over the output by superimposing geometric (from 3D models), semantic (from text prompts), and stylistic (from fine-tuned visual lexicons) conditioning channels. The primary objective is to demonstrate how this multi-layered conditioning aligns the computational power of GenAI with human intentionality, transforming the generative model from a black-box into a precise and directable computational partner.

This investigation is contextualized within the wider educational program at the Department of Architecture and Design of the Politecnico di Torino. This setting is not incidental; it builds upon a pedagogical trajectory established in teaching parametric modeling at the same institution [15], positioning the ARCS framework as a necessary pedagogical evolution.

The contemporary educational challenge is not merely to teach new software, but to design new processes [16]. This requires training professionals who can balance technology adoption and adaptation [17] and possess a sophisticated algorithmic literacy—the critical competence to deconstruct, assemble, and direct complex systems, for instance, by using semantic AI models to guide ideation [18]. Through the development and analysis of the ARCS framework, this research aims to provide an applied contribution, outlining an approach that promotes a conscious and critical use of emerging generative technologies.

2. DEFINING THE STACK: THE THEORETICAL MODEL OF LAYERED CONDITIONING

The transition from the TTI paradigm to multimodal workflows is no longer a theoretical postulation but an established trajectory, driven by the convergence of academic research and enterprise-level solutions. Before detailing its technical structure, the ARCS framework must be situated within the broader context of architecture's digital turn.

Mario Carpo [19] described the first digital turn as a shift from the alphabet to the algorithm, enabling non-standard seriality. More recently, he theorized the second digital turn as design beyond intelligence [20], where computational power generates solutions so complex they appear alien to human logic, compelling the designer to accept outputs that are no longer intuitively understood. This prospect of an alien intelligence echoes critical concerns about the loss of personal authorship in design [11].

The ARCS framework stands as a direct rebuttal to this thesis. It aims not to operate beyond intelligence but to establish a model for Human-Machine Co-Intelligence. It is a deliberate attempt to re-inject human intentionality, semantics, and stylistic authorship—via its three conditioning layers—into a process that would otherwise become alien.

The state-of-the-art is actively moving beyond an exclusive reliance on language by integrating geometric and spatial inputs as primary constraints for compositional control. Current research is mapping this territory, identifying Transformer Models as having the most significant potential for early-stage design [21] and framing this evolution as a shift from generative algorithms to architectural intelligence within Computer-Aided Architectural Design (CAAD) [22].

Emblematic of this trend is the recent NVIDIA AI Blueprint for 3D-guided generative AI [23]. This pre-configured workflow utilizes a 3D scene as a control scaffold to generate conditioning maps, fundamentally shifting the 3D model's role from a final artifact to a generative input. Industry leaders are developing it, confirming that explicit geometric control is the recognized solution to the compositional uncertainty inherent in TTI approaches.

However, while solving spatial control, such workflows only partially address stylistic and tectonic authorship. Reliance on a pretrained model's intrinsic knowledge or generic prompts often yields results that are aesthetically plausible yet lack authorial nuance. This is the gap ARCS is designed to fill. It does not aim to invent multimodal control but to systematize and extend it. The ARCS framework, therefore, formalizes and stratifies these emerging trends, defining an approach that integrates explicit geometric conditioning with equally explicit complementary controls for the representation style and semantics.

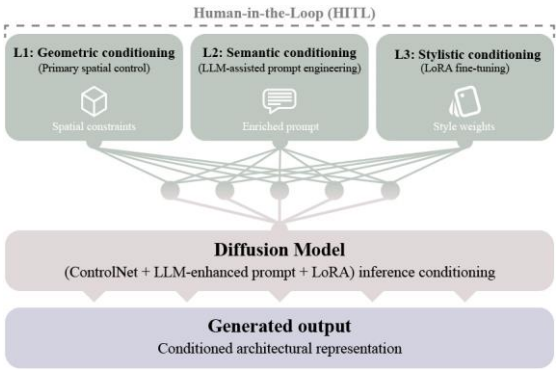

Figure 1: *The ARCS conceptual diagram illustrates how the three conditioning layers are linked to guide the diffusion model's inference process.*

The proposed stack consists of three hierarchical layers that progressively increase the degree of conditioning (Fig. 1):

Primary geometric conditioning (L1): This foundational layer implements the principle demonstrated by solutions like the NVIDIA Blueprint. It imposes spatial structure and ensures architectural coherence via control maps extracted from a 3D model. This approach parallels research on fusing parametric models for architectural design [24].

Assisted semantic conditioning (L2): At this level, the prompt's function is redefined and enhanced through LLM-assisted engineering. The resulting prompt, a product of a hybrid human-LLM dialogue, defines the scene's residual content and atmosphere, establishing a robust semantic base for the final layer.

Authorial stylistic conditioning (L3): This is the core contribution ARCS systematizes, superimposing a precise stylistic intent over the geometric control. This is achieved via Low-Rank Adaptation (LoRA) fine-tuning on a curated visual corpus. The method is validated through parallel research, which defines it as a framework for learning a curated architectural lexicon [25]. Here, the curator's role becomes a fundamental meta-representational act: designing how the project is represented. The critical selection of references is encoded into a computational artifact that infuses the generative process with a specific materiality, atmosphere, and visual language. This enables augmenting large-scale language-image models with a synthetic architecture that is absent from the original training datasets [26]. This research trajectory is rooted in earlier experiments using Generative Adversarial Networks (GANs) [27] for architectural layout generation [28].

Adopting such a layered approach thus requires advanced algorithmic literacy. The architect's required competency shifts from that of a tool user to a process designer, capable of deconstructing, understanding, and consciously orchestrating these complex workflows. This implies a critical understanding beyond functional labels, recognizing that internal mechanisms like self-attention in transformers operate not as human-like focus but as perceptual grouping processes based on feature similarity [29]. In this sense, ARCS is not merely an operational methodology but a framework for exercising critical and intentional control over a process whose computational nature, though complex, can be discretized and directed.

3. PROCESS ARCHITECTURE: TOOLS AND LOGIC OF THE ARCS MULTIMODAL WORKFLOW

The experimental protocol implemented to validate the ARCS framework constitutes the research's technical core, defining the multimodal workflow architecture, tool selection, and operational logic. The protocol was developed entirely within the ComfyUI environment, chosen for its modular and open-source nature. This Visual Programming Language (VPL) environment provides detailed control over every generative parameter, enabling the construction of complex, customized pipelines.

The methodology is founded on the exclusive use of open-weight DMs, specifically FLUX.1-dev [30] by Black Forest Labs. This choice deliberately eschews API-based solutions, as direct access to network weights is a prerequisite for reproducible and extensible academic research. Indeed, only open-weight models permit local fine-tuning—the core operation for authorial stylistic conditioning, as defined by the ARCS framework.

Within ComfyUI, the input is designed as a flexible cluster capable of integrating diverse information sources for a potentially real-time generation process. Geometric intent from 3D modeling software can be fed into the system via two modes: asynchronous loading of pre-rendered views or, more dynamically, using Mixlab's Screen Share node. The latter is particularly significant for experimentation, as it enables a real-time workflow by directly capturing the modeling software's viewport. While constrained by computational power and DM inference times—which could be optimized with lighter models requiring fewer steps (e.g., FLUX.1-schnell)—this approach enables a continuous production cycle and an interactive dialogue between modeling and generation. Notably, this same node can capture input from an

external camera, enabling a significant alternative workflow that involves physical scale models and bridges generative digital representation with traditional plastic modeling practices.
The inference process is managed by the X-Labs sampler, which is selected for its efficiency and compatibility with FLUX.1-dev. The final output is a 2D image that synthesizes the information from the various input channels, processed through the three conditioning layers of the ARCS framework (Fig. 2).

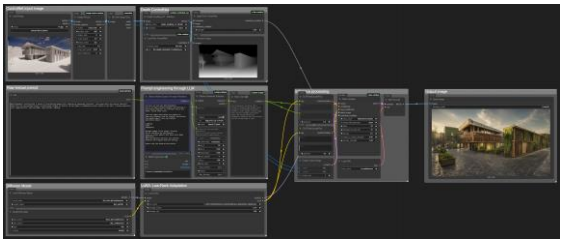

Figure 2: *The nodal interface of the ARCS workflow implemented in ComfyUI. This visual programming environment enables the construction and control of multimodal generative pipelines.*

3.1 GEOMETRIC CONDITIONING: THE 3D MODEL AS A SPATIAL MATRIX

The foundational layer of the ARCS framework is geometric conditioning (L1), which anchors the stochastic generation of the DM to an explicit and controlled spatial and compositional intent. Its function is to translate the three-dimensional architecture into a set of two-dimensional information that acts as the primary constraint for inference, guaranteeing the coherence of form, perspective, and inter-element relationships.
The selected case study is the redevelopment project of Plaza Ponce de León in Seville, originally a 2019 undergraduate thesis by Enrico Pupi. This project was strategically selected for two reasons. Firstly, its intermediate scale—a public space intervention integrating a new building—allows for testing the workflow on a significant yet manageable level of architectural and urban complexity. Secondly, the dense, layered context of Seville provides a robust testbed for evaluating the system's ability to manage the relationship between new interventions and pre-existing heritage, a central challenge in contemporary architectural practice.
The process begins by defining key views within the modeling software. From each view, multiple ControlNet preprocessors can be employed to generate distinct control maps [31]. For this experiment, three types of ControlNet preprocessors in ComfyUI were tested:

Depth Map: This grayscale map encodes the distance of each pixel from the camera. It is the most powerful control for defining the overall volumetrics, scene depth, and spatial arrangement of elements. Even a simple 3D massing model is sufficient to generate an effective depth map that guides the AI in correctly placing objects.
Canny Edge Map: This processor detects sharp contours and discontinuities, making it ideal for imposing the main compositional lines, defining building silhouettes, and precisely constraining well-defined architectural elements.
SoftEdge Map: Preprocessors such as HED (Holistically-Nested Edge Detection) yield softer, more pictorial edge maps resembling freehand sketches. These maps are helpful in the early exploratory phases, providing a less rigid compositional guide that suggests the scene's lines of force without imposing overly restrictive geometric detail.
The selection of these maps within the ComfyUI workflow is the primary method for resolving the compositional randomness inherent in the TTI paradigm, ensuring that every generated image, regardless of its style or content, adheres to the established spatial and formal intent.

3.2 SEMANTIC CONDITIONING: PROMPT ENGINEERING VIA LLM

The second layer of ARCS (L2) is assisted semantic conditioning, managed through LLM-driven text prompt engineering. Within this framework, the prompt is not the sole driver of generation but acts as a control layer, guiding aspects not defined by other conditioning levels. Its importance, however, remains, as prompt quality significantly influences the final image output.
To systematically explore the descriptive potential of language, this protocol integrates an assisted prompt-crafting approach. This aligns with emerging research aimed at enhancing prompt comprehension in DMs through the integration of LLMs [32]. The objective is not to delegate creativity but to leverage an LLM as a tool to expand a core idea into a richer, more varied prompt that is stylistically consistent with the linguistic conventions learned by DMs.
For automated prompt generation, the Llama 3 model was employed [33], specifically its 3-billion-parameter (3B) variant, selected for its optimal balance between linguistic capability and computational efficiency. The 3B model proved sufficient for lexical enrichment, while ensuring

entirely local execution and rapid inference times that are compatible with the overall workflow.

Practical implementation was managed via the Ollama framework, which simplifies local LLM deployment. Integration into the ComfyUI pipeline was achieved using custom nodes that act as a bridge, allowing the ComfyUI interface to send basic descriptive inputs to the locally running Ollama service and receive a standardized, enriched prompt in return.

To automate and standardize this engineering process, a system prompt was defined to instruct the Llama 3 model to act as a prompt design expert for DMs. This system prompt enforces precise rules: the model must enrich a user-provided description by adding details on lighting, style, and atmosphere without introducing unsolicited new elements. Formal constraints, such as a maximum length, ensure a clean, directly usable output. Furthermore, the system prompt instructs the LLM to always include the specific trigger word for the intended LoRA, ensuring the generated text is pre-configured to activate the correct stylistic filter in the next layer of the stack. This transforms prompt writing into a hybrid dialogue, where initial human intent is augmented and structured by an LLM before being integrated with the other conditioning layers in the workflow.

3.3 STYLISTIC CONDITIONING: REFERENCES AS A META-REPRESENTATIVE ACT

The third and final layer of ARCS (L3) implements authorial stylistic conditioning. This layer aims to overcome the aesthetic genericity of DMs by injecting a controlled stylistic intent into the process. This is achieved via Parameter-Efficient Fine-Tuning (PEFT), a set of methods designed to adapt large-scale models to specific tasks while minimizing computational costs [34].

Among the available PEFT techniques, including Dreambooth [35], Hypernetworks [36], and Textual Inversion [37], Low-Rank Adaptation (LoRA) was selected due to its superior efficiency [38]. LoRA transforms a reference image set from a moodboard into a tool for transferring specific aesthetic qualities.

The process begins with dataset curation, which is framed here as a meta-representative act. This aligns with emerging CAAD research on teaching designers a curated architectural lexicon [25]. The critical selection of images is not a random assembly but a declaration of intent—an operation that distills the visual essence to be encoded.

To validate the framework's versatility, three distinct datasets of 40 images each were curated, each representing a well-defined stylistic domain:

ARCS-Biomimetic: Focuses on the symbiotic relationship between architecture and nature, featuring green facades and ambiguous indoor-outdoor boundaries.

ARCS-Hightech: Centers on the celebration of technology and construction detail, highlighting tectonic precision through steel nodes, exposed joints, and technological facades.

ARCS-Brutalist: Explores mass and monumentality, emphasizing the plasticity of exposed reinforced concrete, powerful chiaroscuro effects, and raw textures from formwork.

Once assembled, the technical process was executed within the FluxGym infrastructure. The first step is image captioning. Instead of a manual process, the multimodal model Florence-2 [39], integrated into FluxGym, was used to automatically generate detailed, descriptive captions. These captions were then supervised and refined, with a unique trigger word added to each to activate the specific LoRA during the inference phase.

Using the FluxGym interface, each dataset was used to fine-tune the base FLUX.1-dev model, creating three distinct LoRA files. Training parameters were standardized for comparability. All dataset images were pre-processed to a 512x512 pixel resolution. Training was configured with 10 repeats per image and a maximum of 16 training epochs. This resulted in 6400 training steps for ARCS-Biomimetic (avg. loss 0.33, time ~2h 6m) and ARCS-Brutalist (avg. loss 0.279, time ~2h), and 6240 steps for ARCS-Hightech (avg. loss 0.29, time ~2h 4m). Each fine-tuning process utilized 20 GB of VRAM. Due to LoRA's efficiency, training required relatively modest computational resources and did not alter the original model's weights. The result is three lightweight, portable authorial filters—computational artifacts ready for integration into the ComfyUI workflow, completing the ARCS stack.

4. RESULTS, ANALYSIS, AND ARCS FRAMEWORK ASSESSMENT

The critical analysis of the results from ARCS focuses on a systematic and comparative examination of the generative process itself. The aim is to empirically demonstrate how each layer of the framework progressively aligns the output

with the design intent, evaluating the degree of control and adherence that each additional stage provides.

To this end, an incremental benchmarking approach was adopted: a series of controlled generative tests where conditioning layers are activated sequentially, allowing the specific impact of each stack component to be isolated and evaluated. All computational operations, from DM inference to LoRA fine-tuning and LLM execution, were performed on a workstation equipped with an Intel(R) Core(TM) i9-14900K processor, 128 GB of RAM, and an NVIDIA GeForce RTX 4090 GPU with 24 GB of GDDR6 VRAM.

The following analysis is structured in three experimental phases:

Phase 1 tests the efficacy of geometric conditioning alone, establishing a baseline to demonstrate how L1 ensures spatial coherence while retaining the base model's generic style.

Phase 2 investigates LLM-assisted semantic conditioning, evaluating how the integration of L2 influences the richness and atmosphere of the image.

Phase 3 presents the complete ARCS results, integrating authorial stylistic conditioning via LoRA. This final stage critically analyzes the synergy between L1, L2, L3, and discusses the balance of their relative weights.

4.1 THE EFFECTIVENESS OF SPATIAL CONTROL VIA CONTROLNET

The first benchmarking phase isolates the efficacy of L1 to establish an operational baseline. In this stage, the workflow exclusively uses Depth Maps as the primary ControlNet input, paired with simple, user-formulated text prompts that indicate a basic stylistic intent. Depth Maps were selected to maximize spatial and volumetric fidelity, as preliminary tests demonstrated their superior capacity to convey the scene's three-dimensional layout to the DM.

The results from this phase are summarized in a visual matrix (Fig. 3). The grid is organized for a direct comparison of inputs and outputs. The top row displays the four source views extracted from the 3D model, rendered as clay models to emphasize their pure geometric form. The subsequent rows display the conditioned generation results for each view, utilizing a distinct stylistic intent via its corresponding text prompt.

Figure 3: *The top row displays the source 3D views. Subsequent rows display outputs generated using only ControlNet conditioning (L1), exhibiting high spatial coherence but yielding generic stylistic results based on simple text prompts.*

Analysis of the results reveals a twofold outcome. On the one hand, the success of geometric conditioning is unequivocal. As a vertical comparison across the columns demonstrates, the spatial and compositional structure of each view is imposed with high fidelity across all stylistic variations. The building's volumetrics, its urban context, and furnishing layouts are accurately reproduced. This confirms that L1 achieves its primary objective: ensuring stable geometric control and producing an architecture that is spatially coherent with the design intent defined in the 3D model. On the other hand, the results are only partially stylistically convincing. A horizontal analysis of the rows reveals the DM's limitations when guided solely by simple prompts. In the biomimetic variations, the model correctly applies textures and vegetation but fails to capture the style's deep material sensibility. Similarly, for the high-tech style, it translates the input into metallic and glazed surfaces. However, it fails to render the tectonic details that are its essence, resulting in largely generic architecture. The brutalist style yields a more plausible result; nevertheless, it often lacks the intended monumentality, mass, and dramatic chiaroscuro, at times appearing more unfinished than intentional.

In conclusion, L1 proves to be a necessary and sufficient condition for guaranteeing spatial coherence. However, it also demonstrates that text prompts alone are an insufficient tool for achieving in-depth stylistic control. This finding empirically confirms literature observations that GenAI outputs often require significant manual interpretation and post-processing [2].

4.2 THE ADDITION OF SEMANTIC CONDITIONING VIA LLM

The second benchmarking phase introduces the second ARCS layer, assisted semantic conditioning (L2), while maintaining the constant L1 geometric control. This test aims to evaluate the degree to which text prompt enrichment, driven by the Llama 3 model, can overcome the aesthetic genericity observed in the baseline. The sole variable introduced is the formulation of the prompt, shifting from a simple, direct human input to one engineered by the LLM.

***Figure 4**: Results from integrating LLM-engineered prompts (L1+L2). Compared to the baseline, the outputs exhibit greater semantic richness and more sophisticated material and lighting qualities.*

A comparative analysis (Fig. 4) reveals a significant qualitative improvement over the baseline. While maintaining formal fidelity, the generated images exhibit superior chromatic richness and a more sophisticated material rendering. The engineered prompt, being more specific in describing light conditions, atmospheric effects, and surface qualities, acts as a semantic amplifier, guiding the DM toward more complex and targeted interpretations of the requested style. This second phase demonstrates that L2 is an effective tool for enhancing the quality of the output and stylistic coherence, serving as a refined layer of semantic control. However, it is essential to note that this is still an interpretation—albeit a more sophisticated one—of the base model's intrinsic stylistic knowledge. The result is an improved version, but not one necessarily aligned with a specific reference lexicon.

4.3 COMPLETE CONDITIONING VIA LORA

The third and final experimental phase represents the full implementation of the ARCS framework, integrating L1, L2, and L3. Building upon the preceding layers, this test introduces authorial stylistic conditioning (L3) by activating specific LoRA models. The objective is to evaluate the capacity of ARCS to produce images that faithfully adhere to a predefined and designer-curated visual lexicon.

***Figure 5:** Results from the complete ARCS workflow (L1+L2+L3), integrating stylistic conditioning via LoRA. The outputs show high adherence to the specific visual lexicon of each curated dataset.*

The analysis of the results (Fig. 5) demonstrates the success of the ARCS framework. Images produced in this phase achieve a level of detail and stylistic adherence markedly superior to that of the previous stages. The synergy among the three conditioning layers yields an output where geometric coherence is preserved, semantic richness is maintained, and stylistic adherence is specific and intentional. Comparing these results with previous ones, where the DM merely interpreted a style, it now applies a precise visual pattern learned from the reference corpus.

This result directly addresses critical concerns from the literature regarding the loss of personal character [11] and the issue of shared authorship [10]. The complete ARCS workflow proves to be a practical methodology for preserving and embedding authorial intent. The results embody the synthetic architectures for which theoretical research argues—the creation of stylistic and formal syntheses that do not exist in the original training datasets [26].

However, this operational success introduces a further dimension of control: the balancing of weights. Generation is not a static but a dynamic act of orchestration. The architecture of DMs is designed for such control, primarily through mechanisms like Classifier-Free Guidance scale (CFG), which allows manipulating the model's adherence to provided conditioning [40]. Within ComfyUI, the designer can leverage this principle to adjust the influence of each component. For instance, the ControlNet weight can be increased for higher geometric fidelity—at the risk of overpowering the LoRA's influence—or slightly decreased to allow the DM to propose style-coherent micro-variations. Similarly, the LoRA weight can be modulated for stricter or

looser stylistic adherence, even enabling the exploration of stylistic hybrids.

5. BEYOND THE STATIC IMAGE: REVIEWING OUTPUT AND THE FRONTIERS OF REPRESENTATION

While the ARCS framework demonstrates the potential for multimodal control over the generative process, the workflow described thus far culminates in an intrinsically static artifact: the 2D image. Architectural practice, by contrast, is not a linear process ending in a single representation, but an iterative cycle of proposal, analysis, and revision. Therefore, the generated image, however faithful to the initial intent, is not an end-product but a visual hypothesis that must be subjected to critique, discussion, and refinement.

We therefore propose two complementary research directions (Fig. 6). The first aims to investigate technologies that enable direct interaction with and refinement of the generated output, eliminating the need to restart the entire process.

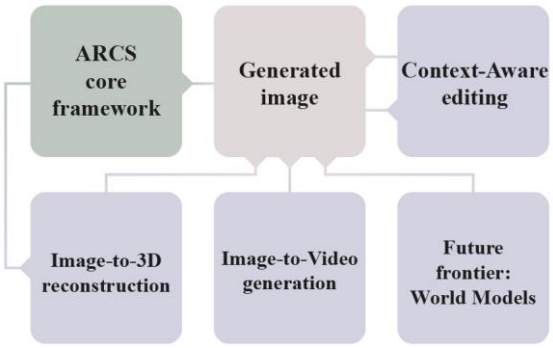

Figure 6: *This diagram illustrates the research trajectories beyond the static 2D image, including an iterative refinement loop (context-aware editing) and explorations into dynamic and three-dimensional outputs.*

The second direction explores emerging technologies designed to overcome the fundamental limitations of 2D representation. The production of conditioned yet static images constitutes a cognitive and operational bottleneck for a discipline that is inherently spatial and temporal in its nature. Consequently, advanced research is shifting its focus from static outputs to experiential simulations and the generation of three-dimensional content.

5.1 ITERATIVE REFINEMENT: CONTEXT AWARE EDITING

The high-quality image produced by the ARCS framework is not the endpoint of the design process, but rather the starting point for a critical phase of revision and refinement. Effectively closing this feedback loop requires tools that enable a dialogic interaction with the output, allowing for targeted modifications without regenerating the entire scene from scratch. This section explores this possibility through the use of FLUX.1-kontext [41], a next-generation contextual editing DM. Unlike simpler techniques such as inpainting, FLUX.1-kontext exhibits an advanced contextual understanding of the entire image, enabling complex and coherent modifications via text-based instructions. The selection of FLUX.1-kontext is, once again, driven by the open-weight principle. Although proprietary alternatives like Gemini 2.5 Flash Image (Nano Banana) exist, access to the model's weights is essential in a research context, as it enables future fine-tuning of the editing model itself for specialization in the architectural representation domain.

Inference was handled locally via a dedicated ComfyUI workflow (Fig. 7), using the 12 final ARCS-generated images as input. Interaction with the model was conducted through text prompts describing the desired modification. Tested interventions spanned various scales of complexity, including altering lighting conditions, modifying the materiality of specific elements, and reconfiguring the interior space by adding or removing components.

Figure 7: *The ComfyUI pipeline for iterative refinement using FLUX.1-kontext, which takes an ARCS-generated image as input and allows for targeted modifications through text-based instructions.*

Analysis of the results (Fig. 8) demonstrates the high capability of FLUX.1-kontext to interpret instructions correctly and apply them coherently, preserving the overall style and visual quality previously established by the ARCS framework. The modifications integrate seamlessly into the image, confirming the efficacy of this approach for an efficient iterative refinement phase.

Figure 8: *Results of contextual editing. This matrix displays examples of targeted modifications, demonstrating the model's ability to refine elements while preserving overall stylistic coherence.*

However, the technology's current limitations must be acknowledged. While excellent for in-scene edits, spatial coherence may degrade in response to requests for radical viewpoint shifts. Consequently, future research should explore the integration of complementary models, such as SeeDream 4.0 [42], which excel specifically in maintaining spatial consistency across multiple viewpoints, thereby prefiguring more advanced refinement workflows.

5.2 TOWARDS DYNAMIC REPRESENTATION: IMAGE-TO-VIDEO AND IMAGE-TO-3D EXPLORATIONS

While the iterative loop based on 2D image editing has proven effective for compositional refinement, it remains confined by the intrinsic limitations of static representation. Architecture is inherently an experience that unfolds in space and time, and project evaluation cannot be detached from these dimensions. The final phase of this research thus extends beyond the static image, exploring two emerging technological frontiers that aim to reintroduce temporality and three-dimensionality into the generative process.

The first frontier is Image-to-Video generation. These tools animate a static image by simulating limited camera motion or dynamic environmental effects, enabling a pre-visualization of the *promenade architecturale* to convey a sense of spatial experience. The experiment involves testing various models to map the state-of-the-art, including LTX-Video [43], Hunyuan Image-to-Video [44], and Tongyi Wanxiang 2.2. While proprietary alternatives, such as VEO3 [45] or SORA 2 [46], demonstrate remarkable capabilities, preliminary tests show that even more accessible solutions can provide short clips useful for evaluating spatial dynamics.

The second, and arguably most promising, frontier is Image-to-3D reconstruction [47, 48]. These models reverse the rendering process by inferring three-dimensional geometry from a single 2D image. This capability is critical for closing the design loop: an image generated and refined via ARCS can be converted back into a preliminary 3D model for re-import into modeling software, creating a bidirectional bridge between 2D generation and 3D modeling. The experiment involves testing state-of-the-art solutions, such as Hunyuan3D-2 [49], TripoSR [50], PartPacker [51], and Stable Point Aware 3D [52]. Their ability to reconstruct an approximate point cloud or polygon mesh from the ARCS workflow output prefigures a future where 2D stylistic and material exploration can directly and rapidly inform the subsequent digital modeling phase. While this mapping includes closed-source solutions, the long-term research trajectory must pivot towards the adoption and development of open-source or at least open-weight tools. Only an open approach ensures the transparency, reproducibility, and, most importantly, the ability to specialize and refine these models for the specific needs of the architectural domain, guaranteeing they remain user-controllable and manipulable tools.

6. THE PARADIGM SHIFT: CONCLUSIONS AND FUTURE OUTLOOK

This research has systematized generative conditioning in GenAI-assisted architectural representation. Incremental benchmarking demonstrates that the ARCS framework, proposed here as a draft operational model, is a practical methodology for overcoming the limitations of the TTI paradigm.

A critical analysis of the results reveals a fundamental paradigm shift: architectural representation is transformed into a design process that is hybrid, iterative, and multimodal. The ARCS framework, in particular, offers a direct technical and methodological response to urgent critiques in recent literature. This technical demonstration shows that the process designer can avoid depriving individuals of their thoughts and personal character [11]. The adoption of such multimodal frameworks appears to be a primary pathway toward a sustainable balance between technology adoption and adaptation [17] for both the profession and academia.

The implications for the discipline of representation are profound. Future architects must be trained as professionals possessing a critical algorithmic literacy, capable of deconstructing,

assembling, and directing these complex systems. The ARCS framework actualizes the synergies between design thinking and AI [13]. It provides an operational protocol for building augmented intuition [14], which must be the goal of our interaction with such systems.
It must be emphasized that ARCS is a work-in-progress framework, a model that is undergoing consolidation, whose evolution is intrinsically linked to the accelerated development of technology. Looking beyond the current horizon, the most compelling trajectory lies not in refining the generation of images, videos, or 3D models, but in the emergence of World Models [53]. State-of-the-art technologies, such as DeepMind's Genie3 or Word Labs' Marble, prefigure a future where AI simulates interactive experiences rather than merely representing space. The revolutionary characteristic of these models is their ability to generate experiential and freely navigable 3D environments without underlying 3D geometry, with each frame generated in real-time. Although open-source alternatives like Matrix-Game by SkyworkAI or Hunyuan-GameCraft by Tencent are still in their infancy, their potential for architecture is notable. The focus will no longer be on generating static artifacts, but on dynamic, interactive environments for testing the perception, movement, and experience of a space at a preliminary conceptual stage. This frontier shifts the focus from the representation of form to the simulation of experience, holding the potential to become one of the most effective tools in architecture in the GenAI era.

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From Early Design Geometry to Architectural Vision: Open-Source Generative Workflows for Speculative Design

Giulio Lucio Sergio Sacco and Carlo Battini

DICCA, Dept. of Civil, Chemical and Environmental Engineering, University of Genoa, Italy,
giuliolucio sergio.sacco@edu.unige.it, carlo.battini@unige.it

ABSTRACT: Recent advances in generative AI have introduced powerful tools for creating architectural imagery, yet most workflows remain opaque, uniquely prompt-driven, and stylistically biased. This paper uses an open workflow for guiding text-to-image generation using Blender and ControlNet-based conditioning, integrating parametric modelling with textual input through depth maps. The result is a controlled, reproducible, and locally executed rendering pipeline that can combines design logic with speculative visual output in an autonomous, non-proprietary environment that could be used in early design phases for the exploration visual possibilities.

Beyond illustrating this workflow, this research proposes a reflection on the current limitation of generative AI in architectural field. It compares a gallery of outputs generated referencing distinct artistic styles, like the ones of Piranesi or Bosch, and more general stylistic categories to preliminary assess recurrent compositional biases, visual stereotypes and limited stylistic fidelity that could constrain architectural imagination and may homogenise visual culture, urging designers to engage critically with its aesthetic boundaries.

1. INTRODUCTION

Over the past few years, generative artificial intelligence has profoundly transformed the way visual content is conceived, produced, and disseminated. Diffusion and transformer-based image models now allow users to produce complex imagery from natural-language prompts alone, reshaping creative workflows across arts, design, and architecture. With the announcement of Sora 2, OpenAI also released a self-contained social platform complete with feed exclusively dedicated to AI content creation and fruition. Yet, despite their accessibility, these systems remain opaque in both their training and operation, offering
limited transparency about how specific styles, compositions, or iconographies are learned and reproduced. This issue has already been highlighted in social and media studies, both regarding text-to-image models and LLMs [1, 2]. In the same way, in visual representation, they risk of narrowing rather than expanding the range of visual expression available to their users.

The aim of this paper is to start an investigation on how AI models may present and, therefore, reproduce stylistic biases impairing their rendering capabilities, and consequently influence the aesthetic palette available for architectural visualisation and speculative design. The research question arises during the development of a hybrid 3D/text-to-image workflow aimed at generating prompt guided architectural rendering. Here we describe the workflow and propose some rendering examples to problematize how such stylistic biases could gradually shape our shared visual culture by privileging certain canons, atmospheres, or compositional logics over others.

To highlight this issue, two artists with very distinctive styles were selected: Giovanni Battista Piranesi and Hieronymus Bosch, that could be exemplified by their famous *Carceri d'Invenzione* [3] and *The Garden of Earthly Delights* [4] respectively. Both are highly recognisable, historically unique, and likely underrepresented in training datasets, making them ideal references for prompt generation with the goal of evaluating the capacity of generative systems to

emulate stylistic intent without prior overexposure. Subsequently, more prompts were used to generate images with definite but less specific styles.

A comparative test was conducted using a set of several open-source diffusion and transformer models executed locally through ComfyUI, (e.g. Stable Diffusion Family, Flux, Hunyuan) and a proprietary one (DALL·E 3). Each model was prompted using identical textual inputs, both in prompt-only configurations and in geometry-conditioned mode, where depth maps generated from parametric 3D geometries in Blender were employed through ControlNet conditioning. This dual setup allows qualitative assessment of the compositional capabilities of the different models and how 3D derived depth conditioning could be used in early design phases analysing spatial composition and stylistic adherence

This research, therefore, positions itself as both a technical and critical reflection: it outlines an open, reproducible workflow for geometry-guided image generation, while questioning the possible cultural consequences of its use for design purposes due to lacks in stylistic representation.

2. MAIN ASPECTS

The proposed mixed workflow aims to directly bridge Blender parametric modelling, or, in principles, any 3D software capable to render required the required images, with ComfyUI. This integration leverage ComfyUI's flexible node-based interface to orchestrate the generation process, enabling users to structure complex AI pipelines and access ControlNet-based conditioning [5] for most diffusion models. It runs locally on the user's machine and hosts a lightweight web server, enabling seamless communication with Blender.

The architectural geometry used as conditioning input was modelled parametrically in Blender Geometry Nodes. It represents an imaginary complex structure loosely inspired by Piranesi's Carceri, defined only in broad compositional terms. The depth map (Figure 1.a) of the scene was rendered from the camera view using Cycles engine, then the compositor Z-distance output was normalised and saved as a PNG. Other possible conditioning inputs, such as normal maps (Figure 1.b), Canny edge maps and semantic segmentation maps were tested but gave unstable or less coherent results compared to the depth maps; therefore, only the latter were eventually used.

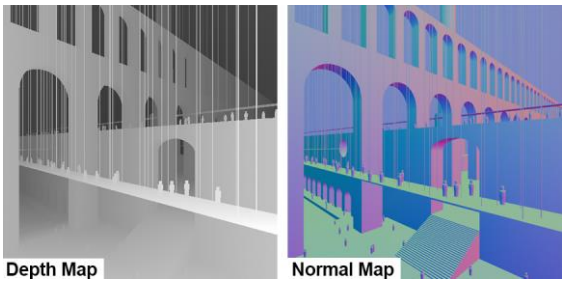

Figure 1: *Example of Depth and Normal maps representing a preliminary volumetric model.*

The models listed in Table 1 were chosen to represent both the historical evolution of diffusion models (stable diffusion family) and the current state of the art. The main Stable Diffusion models were included from version 1.5, released in August 2022 to 3.5, released in October 2024, while Flux.1 Dev and Hunyuan 1.2 DiT were added as examples of most recent open-source systems. These models were used locally through the latest version of ComfyUI. Additionally, to represent the most accessible prompt-only systems available to the average user, the same prompts were provided to DALL·E 3 accessed through ChatGPT browser interface. Microsoft Copilot and Grok were also tested but running a derivative of DALL·E 3 and Stable Diffusion 2.1 their results were considered redundant and omitted here. In the latter three cases, ControlNet was no available; therefore, only the pure text-to-image configuration was used for testing.

Model	Architecture	Size	Training dataset	Release date	Owner licence
SD 1.5	LDM	1B	LAION-2B	Aug '22	Stability AI open source
SD XL	LDM	2B	Nd	Jul '23	Stability AI open source
SD 3.5	LDM	nd	LAION + licensed	Oct '24	Stability AI open source*
Hunyuan 1.2 DiT	DiT	nd	Nd	Jul '24	Tencent open source
Flux.1 Dev	DiT	12B	LAION + licensed	Aug '24	Black Forest open source°
DALL·E 3 ChatGPT	Transformer	nd	Nd	Oct '23	OpenAI closed source

Table 1: *Summary of models tested. * community licence; ° Dev version only; nd = no data disclosed.*

The offline image generation were carried out on a workstation equipped with an NVIDIA RTX 4080 using CUDA acceleration. Each image was produced with 25 sampling steps and a random seed. ControlNet-Depth was used with a strength of 0.66, without any post-processing or compositing applied afterwards. Reducing the strength of the depth conditioning was needed to allow the model to apply variations to

the input flat surfaces. All input maps and resulting images were square and kept at 1024 × 1024 pixels for standardization and consistency, except for Stable Diffusion 1.5, which was limited to 512 × 512 pixels due to its native architecture.

Each model was prompted with the same textual prompt for the two main stylistic targets (i.e. Piranesi and Bosch). Three additional prompts were added to generate "renaissance" and modern architecture, and cyberpunk scenery for a comparison baseline. For each case, 32 images were generated both using the text prompt and depth map, and with textual prompt only as a reference. When reported in the paper, out of the 32 images generated only the one considered most representative of the group for style, architectural and rendering quality was arbitrary selected and reported. This choice was made through direct visual judgement rather than quantitative scoring, in line with the qualitative and exploratory nature of the research.

2.1 ARTIST-SPECIFIC PROMPTING

The pictures in Figures 2 and 3 were generated with the following prompt, explicitly reporting the desired style by the author's name: *"A vast, imaginary prison interior rendered in the style of Piranesi's Carceri d'Invenzione. Etched textures, dramatic chiaroscuro, and intricate hatching define staircases, arches, and suspended bridges fading into shadow. The architecture expands infinitely in every direction, a visionary depiction of confinement, scale, and sublime architectural imagination".* The first set of images is reported in Figure 2 and shows a certain adherence to the desired style of Piranesi's Carceri, however, excluding DALL·E which provide a coherence both in terms of composition and rendering style, the other models show a significant bias towards realistic rendering, especially in lights and shadows. A significant bias for central perspective, not representative of Piranesi's works, was observed in the composition across all models: 25, 21 and 29 central perspective compositions out of the 32 images generated for each model were observed in Stable Diffusion 1.5, XL and 3.5 respectively, and 25 and 18 over 32 for Flux and Hunyuan. Out of the remaining, two-point perspective is the most represented, but three-point perspectives were present as well. This significant deviation from Piranesi's style [6] could be motivated by a lack of references in the training sets.

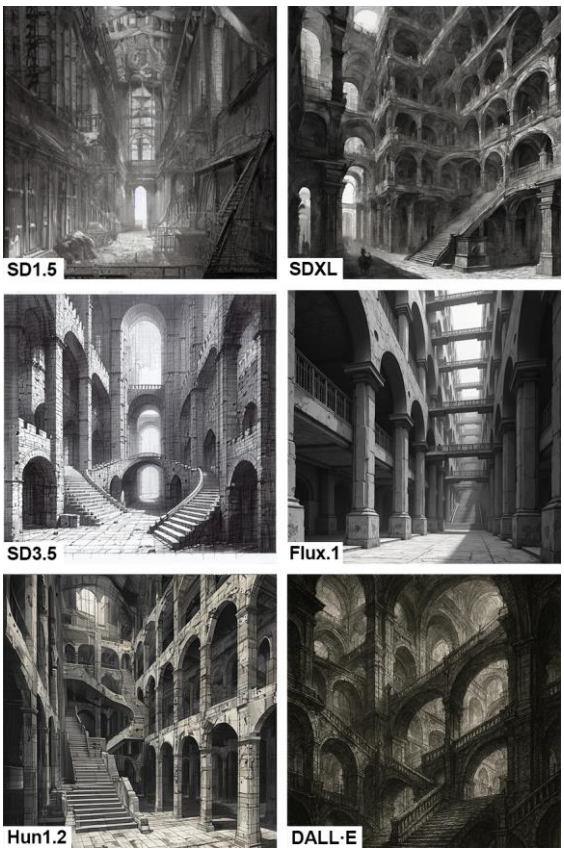

Figure 2: *Images generated with "Piranesi" prompt and different models.*

The images in Figure 3 were generated using depth conditioning. The use of a depth ControlNet adds a complexity layer that makes the direct comparison between the models less direct as the control networks interact differently with each one. For this reason, a fixed strength value was adopted only for consistency, but better results would be obtained adjusting this parameter for each case. However, the previous observation regarding the overall style adhesion holds also for this image set: Stable Diffusion models seem more capable of recreating a drawing rendering; among the three Stable diffusion 3.5 is the best in reproducing an hatch-like texture as it tends to produce finer and more intricate details and texture in general; and Flux and Hunyuan seems more biased toward photorealism, although preserving a stylized drawing rendering. Regarding composition, satisfactory results were obtained in all case; however the adherence to Piranesi style was further reduced likely due to conditioning competition.

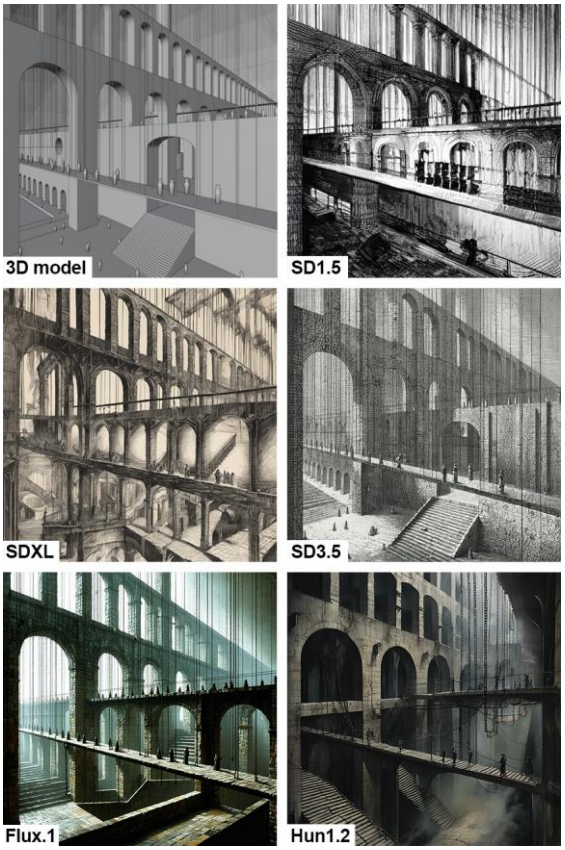

Figure 3: *Images generated with "Piranesi" prompt and depth ControlNet. The first picture reports the reference 3D model.*

Figure 4: *Images generated with "Bosch" prompt and different models.*

The same approach was adopted to generate the second set of images based on the style of Hieronymus Bosch using the following prompt: *"A labyrinthic interior drawn in the style of Hieronymus Bosch, filled with surreal staircases, arches, and bridges twisting through dreamlike chambers. Hybrid figures and mechanical relics inhabit the architecture, fusing the organic and the artificial. The atmosphere is both sacred and grotesque, evoking a visionary world of allegory and chaos where architecture becomes a living, moral landscape".* The results are reported in Figure 4 and 5. Overall, no model was able to replicate the required style nor compositionally nor chromatically and the addition of depth conditioning further worsened the issue. This is probably due to the fact that the prompt is explicitly requiring a subject and a composition which is not represented in Bosch corpus. It is noteworthy that using the prompt *"Hieronymus Bosch painting and compositional style"* only the Stable Diffusion models generated outputs approximating Bosch's style, while only SDXL consistently recreated its characteristic colour palette.

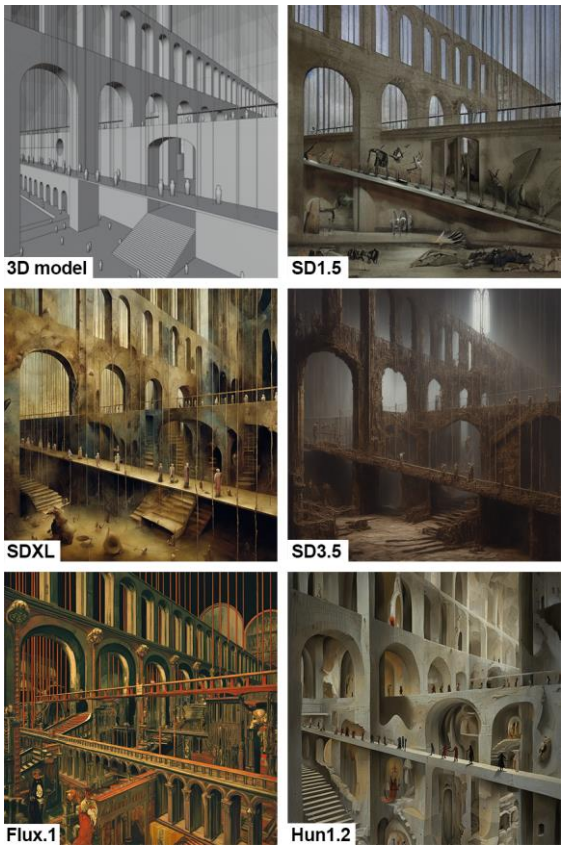

Figure 5: *Images generated with "Bosch" prompt and depth ControlNet. The first picture reports the reference 3D model.*

2.2 GENERALISED STYLE PROMPTS

To test less restrictive and broader stylistic conditioning a set of three prompts were generated using ChatGPT-5 providing the previous two prompts as a reference and asking for a renaissance, a contemporary with curtain walls and vegetation, and a cyberpunk variation. As a further restriction it was asked not to include names of architects or illustrators in the prompts. The resulting prompts and the corresponding images are reported below and in Figure 6 respectively:

A grand vaulted hall with staircases winding between columns and arches, connected by bridges beneath a coffered ceiling. Sunlight reveals proportion and harmony across the stone geometry. The composition evokes mathematical order and perspective, a spatial manifestation of Renaissance ideals where structure and ornament coexist in perfect equilibrium;

A vast atrium with staircases, suspended walkways, and open terraces surrounded by glass curtain walls and vegetation. Sunlight filters through transparent façades, reflecting greenery and metal. The composition blends precision and organic growth, expressing contemporary ideals of sustainability, openness, and integration between architecture, light, and nature;

A sprawling futuristic cyberpunk cityscape of layered bridges, vertical staircases, and dense infrastructure illuminated by neon and fog. Towers and platforms overlap in endless depth, merging technology and chaos. The air shimmers with reflections and holographic light. A high-detail composition where architecture becomes both machinery and metropolis, vast and luminous.

In the first two cases (i.e. “renaissance” and contemporary style) the quality of the composition, in terms of architectural plausibility and photorealism increases with the AI models evolution however a significant consistency was observed among all the models, except SD1.5 which showed a significant variation. As in the previous cases, central perspective was overrepresented; moreover, blooming and volumetric effects are prominent in the most recent models and, especially, in Flux, up to decreasing the photorealism of the composition.

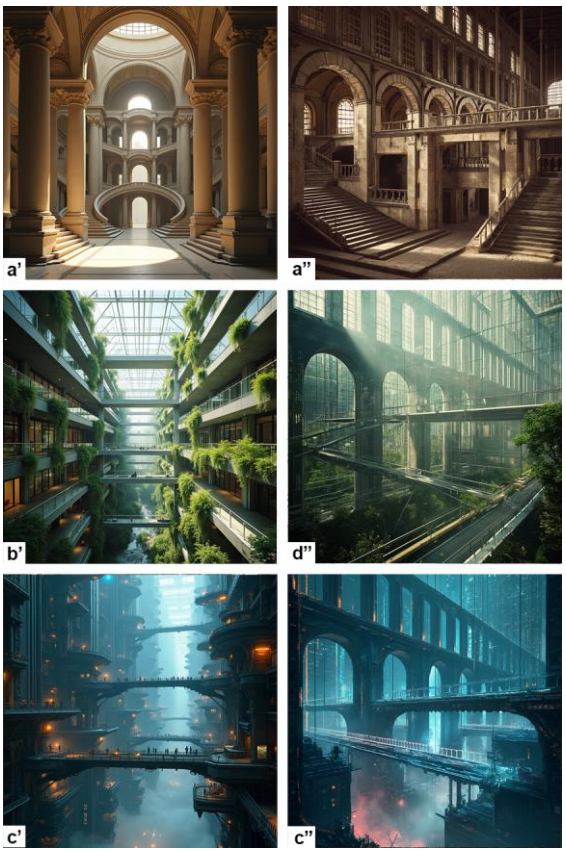

Figure 6: *Images generated with Flux and generalised prompts without and with depth ControlNet: a) “renaissance”, b) contemporary and c) cyberpunk styles.*

In the case of the cyberpunk inspired prompt, however, significant stylistic differences emerged among the models tested. While in the two previous cases it was not possible to establish a likely stylistic reference or bias for each model and the results were mostly homogeneous in colours and similar in composition, Figure 7 shows how the interpretation of the prompt changed significantly in this case. This could be attributed to the different authors and styles most represented in the training datasets and, possibly, to the presence of licensed images in some datasets, which in this case could have a significant impact in the training. This results, for instance, in reminiscences of the drawings of Syd Mead and ’80 oriented style in SD3.5 results or in the more modern and videogame-rendition of Hunyuan. Lastly, the similarities between the DALL·E composition in this and in Piranesi case (Figure 2) is surprising and notable and was confirmed providing the different prompts on different account, to avoid any possible interference of previous image generations from ChatGPT memory system.

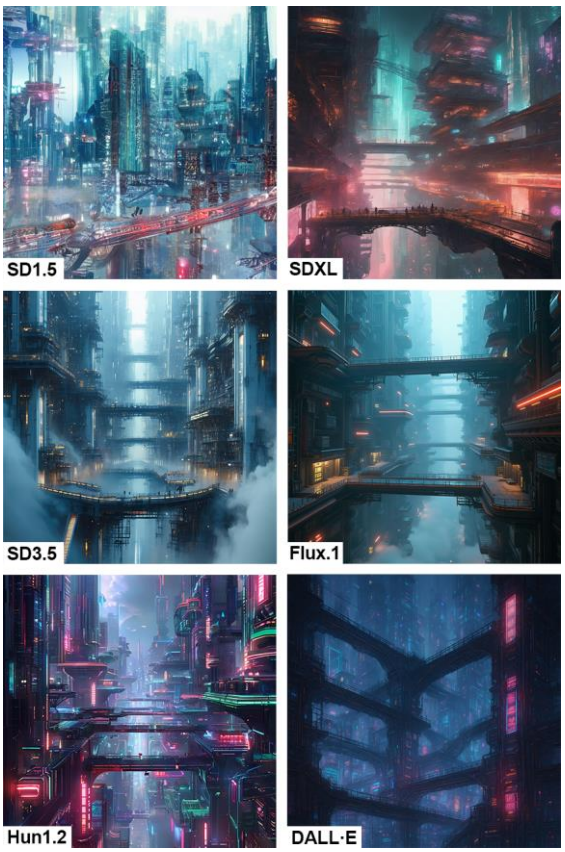

Figure 7: *Images generated with the cyberpunk prompt (c) highlighting different stylistic references.*

3. DISCUSSION AND CONCLUSIONS

The proposed workflow allows geometry-guided image generation connecting Blender and diffusion models using depth maps and ControlNet in ComfyUI. It proved to be capable of producing architectural visions coherent with the input compositions yet stylistically limited by the model adopted. It represents a technical framework for controlled non-proprietary image generation which could be used for rendering in early design stages. Furthermore, it could be extended with the use of LoRAs or specifically trained models to enhance the adherence to desired styles and purposes. Figure 8 represents a possible application in this regard which is generated with a highly specialized model tailored for modern architecture only.

Figure 8: *Example of Ai rendering generated with ArchitectureRealMix v11 [7].*

However, while this paper only presents a preliminary and qualitative analysis, it suggests that the use of general-purpose models to generate a specific style could introduce biases in composition, style, consistency and overall atmosphere. While the composition can be guided to obtain renderings of the desired architecture or scene, the qualities of the final rendering are model-dependent and less controllable. Moreover, they are deeply influenced by the curators of the training databases that directly shaped the visual quality of their models.

The comparisons between the pictures generated without depth control showed a significant bias toward recurring compositions like central perspective across all models, and specific biases like the prevalence of larger compositions and small details. SD3.5 and especially Flux, showed a significant recurrence of bloom, volumetric effects and high contrast rendering which convey a more “cinematic” look, but also cause a certain homogenization of the images generated which results in a short of model-specific visual quality. This is far less noticeable in SD1.5, which showed higher variability (or less prompt adhesion) and partially in SDXL.

Such observations suggest a broader reflection on AI’s role in shaping our visual culture. Thought capable of producing new images and sometimes to successfully mix different inputs to create genuinely new content, AI can also shows significant signs of stereotyping which could lead to the overrepresentation of stylistic and visual tropes, the marginalization of underrepresented visual languages and the consequent narrowing of architectural imagination. The issue explored in this study, and the consequent envisioned threats, is that from the possibility of the *mechanical reproduction* that actually disseminated diverse visual culture, AI could cause a shift toward a *mechanical production* of images that nevertheless remain confined within the limits of their inherited data and risk to educate the public and the designer to an aesthetic homogenization which is, in fact, a “huge average” of a selected visual corpus adopted as training set.

Lastly, it should be noted that through careful prompt design, parameter tuning, and iterative generation, it is indeed possible to improve adherence to a desired style or compositional logic. Achieving this, however, often requires a high level of critical awareness and the ability

to deconstruct a style into its constituent elements (i.e. lighting, details, texture, composition, perspectives, etc.) so that they can be explicitly articulated and incorporated into the prompt. Tools like ControlNet conditioning can assist in this process, but their effective use still depends on an informed, reflective engagement with the system.

This implies that while researchers and expert designers could be capable of leveraging such strategies to overcome some of the biases inherent in generative models, the majority of users (i.e. students, novices, or general practitioners) remain vulnerable to reproducing these limitations uncritically. Consequently, since all categories of users should engage critically with these technologies, balancing technical workflow strategies with reflective practice, there is a clear need for education and dissemination on the capabilities and constraints of AI tools, promoting awareness of how training datasets, model biases, and algorithmic tendencies shape the aesthetic outcomes of generated imagery.

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AI Shakespeare: Mitigating Hallucinations in Co-Creative Animation

Hannes Rall, Alice Osinska and Aaron Zhi Qiang Lim

School of Art, Design and Media, Nanyang Technological University, Singapore,
Rall@ntu.edu.sg, alicja.osinska@ntu.edu.sg, aaron.limzq@ntu.edu.sg

ABSTRACT: Hallucination has long been a subject of research and scholarly debate. Based on an AI animation project inspired by Shakespeare, this paper adopts the concept of hallucination and frames it within an artistic context, specifically animation. Through an analysis of how hallucination has been defined in studies on AI and how it can be contextualised within animation, the paper identifies three major issues encountered during the animation process: stylistic inconsistency, narrative misalignment and motion disruption. The case study examines the style of the historical artist Eugène Delacroix, transforming his static illustrations into animated format. The process revealed several challenges arising from the incorporation of AI, which were mitigated through the use of reference images, hybrid storyboarding combining sketches and AI, and manual artistic intervention within the AI-generated animation. Framing the concept of hallucination within this field prompts a discussion on what is actually required from AI in artistic practice.

1. INTRODUCTION

AI advancements have shed light on the ethical and technical aspects of creative practice since the launch of Midjourney and ChatGPT in 2022. Since then, AI models have produced visually appealing outputs full of realism, often becoming difficult for humans to distinguish [1]. However, AI's hyperreality does not come without constraints, as its artistic variability remains limited. The shortcomings include misalignments, copyright issues, and unexpected generations, all of which have become subjects of public debate. As a result, the term hallucination has gained prominence, originating from the idea of something existing only in one's mind but not in the real world, and now describing AI's current inability to discern what is real or intended, existing solely within the state of AI itself.

The randomness of AI generation is largely dictated by an insufficient or faulty training process, which remains inaccessible for human intervention. Therefore, when creating with AI, detecting and mitigating hallucination becomes one of the essential tasks of the human author. The question is no longer whether AI should be used in the creative sector, but rather how it should be used.

While mitigating distortions in AI output has been addressed by some scholars [2], relatively little research has examined this issue in the context of artistic creation, particularly within animation practice. The overarching aim of this study is to extend the discussion on conceptualising hallucination beyond existing definitions such as: *'non-existent objects are erroneously detected or incorrectly localised at their anticipated positions'* [3], *'generative AI software systems generate fabricated or false information'* [4], and '*patterns or objects that are non-existent or imperceptible to human observers, creating outputs that are nonsensical or altogether inaccurate'* [5], and to move this discourse towards the domain of creative practice. Moreover, there may be more to hallucination than its pejorative connotation. Some authors interpret distorted output as a trigger for creativity and storytelling, emphasising its positive associations [6][7][8].

Our interest, however, lies in defining hallucination within the context of animation, with the aim of mitigating such outputs. For this reason, the paper investigates how AI can support the adaptation process within ethical constraints and how hallucination can be controlled in artistic practice to achieve specific outcomes. Following this statement, *how do we perceive hallucination in the animation field? And how can such a situation be mitigated by co-creative practices?*

In an ongoing Shakespeare animation project, we employ AI to translate classical illustrations into motion, demonstrating both the indispensable role of human direction and the potential of generative AI through a co-creative, sketch-based approach. This practice-based study not only addresses the question of how, but also provide a framework for animators working in the AI era. Consequently, through this case study, we seek to elucidate how GenAI can be integrated into creative practice without compromising artistic integrity.

2. DEFINING HALLUCINATION

The origins of the term ‚hallucination' refer to a person who constructs imaginative perceptions [9]. However, the emergence of AI has redefined the concept within a new framework. Terms such as 'distortion', 'AI fabrication', or the more commonly used 'AI hallucination' describe the information that is missing within images and is filled with random data by AI [10]. While the term initially arose from falsified information produced by Large Language Models (LLMs), it has recently gained more attention in broader studies of AGI, where it is conceptualised as *'model outputs that do not align with the contemporary empirical realities of our current world'* and is categorised into various types depending on the field of study [11].

Some scholars interpret AI hallucination in a more explicit and straightforward manner, such as *'instances where non-existent objects are erroneously detected or incorrectly localised at their anticipated positions'* [3], while others emphasise the term's fluid nature, stating that *'hallucination includes not only misalignment between text prompts and generated images but also the generation of factually defective images'* [12]. Moreover, some definitions take a more less straightforward and direct approach, explaining that *'hallucinations may seem to be plausible while they are in fact unacceptable'* [13], which may directly relate to misalignment at the artistic level.

Therefore, a creator with a specific concept in mind works toward a defined goal, yet within the AI setting, even when the output does not significantly distort the form or narrative, it may still diverge from the creator's intended outcome. As a result, this paper seeks to take the discussion one step further by exploring the connotations of AI distortions, that is, AI hallucination in the context of animation.

2.1 HALLUCINATION IN ANIMATION

Originating from human experience, hallucination brings forward the relationship between human imperfection and AI hallucination, as humans also tend to falsify truths and manipulate content, often described as 'subjectivity', 'bias', or 'stereotyping' [14]. This behavioural pattern, observed in both humans and AI, suggests that continuous reflection and improvement are necessary, analogous to the supervision and art direction required for AI-generated output.

The issues at the intersection of animation and AI can therefore be summarised within the framework of hallucination. As demonstrated, hallucination does not only feature implausible situations but is also associated with unacceptable outputs. In some cases, it can be related to 'caption hallucination', described by as *'producing descriptions or captions that either contain elements inconsistent with the image or omit important aspects of it'*. [2] Our case study encounters precisely this issue, as even with image-based generation, AI can still produce incorrect or unacceptable content. While the term hallucination has become well established in describing AI-induced distortions, its meaning and potential relevance to visual practice remain underexplored.

Following existing definitions, we divide hallucination into three categories which we encountered during the animation process:

- Stylistic inconsistency – when a model diverges from the given stylistic instruction
- Narrative misalignment – when AI misunderstands the atmosphere and reshapes the narrative
- Motion disruption – when behavioural aspects misalign with the rules of animation, whether in gestures, storyboarding, or scene timing

These three types of hallucination are examined through the project of readapting Shakespeare from static historical works into animation. The case study is grounded in the lithographs of Eugène Delacroix, the renowned nineteenth-century artist who illustrated Shakespeare's play Hamlet in the lithographic medium.

Figure 1: *The examples of the famous Shakespeare illustrations by Eugène Delacroix serving as a base for animation readaptation.*

3. STRATEGIES TO MITIGATE THE HALLUCINATION IN ANIMATION

To begin with, it is worth introducing the reasons for hallucination encountered when utilising AI. An animator working with open-access models has limited control over the generation process, including stylistic consistency and the subtle gestures of characters. In a classical setting, the animator constructs the environment and, through the use of animation software, guides the narrative. This changes entirely in the context of AI. For instance, when animating with a single model, it may be difficult to achieve a specific outcome, as publicly available models differ significantly in their strengths and weaknesses. Moreover, the challenges vary depending on the stage at which AI is incorporated. During the ideation phase, ethical concerns arise since AI, trained primarily on internet-sourced data, can probe one's visual development. Additionally, the photorealistic bias in training data often fails to meet the expressive needs of animation. On the other hand, even with a well-prepared base input, hallucination may occur once the image is set in motion by AI. The project of animating Shakespeare with AI confronts precisely these challenges, including stylistic misalignment as well as narrative and motion distortion.

3.1 HISTORICAL REFERENCE

Shakespeare's plays have been adapted across diverse mediums, including animation and illustration. Although the practice of animating still images has been explored and is often viewed as an act of creative reinterpretation [15], its implications in relation to AI-induced distortions remain insufficiently examined. To align with principles of ethical AI use, this project adopts the strategy of working with public domain materials as a foundational source. By employing a model for readaptation rather than relying solely on AI-generated outcomes derived from training data, the approach mitigates risks of copyright infringement. Nevertheless, this process presents notable challenges, as stylistic distortion frequently alters the intended aesthetic once the image is animated.

Figure 2: *Comparative example demonstrating stylistic hallucination and its mitigation through prompt intervention. The original input (left) produces a hallucinated output (centre), which is subsequently corrected through prompt-based intervention (right).*

In this context, hallucination can be understood as the tendency of AI models to transform a distinct visual style into a three-dimensional aesthetic. This phenomenon corresponds to a form of 'stylistic inconsistency', in which the model disregards the provided stylistic parameters. Unlike a human animator who, when following a specific instruction, can refine and adjust decisions through critical judgment, AI lacks the capability for aesthetic evaluation inherent in a human artist. This absence underscores the indispensable role of the animator within AI-assisted workflows. In such cases, hallucination does not manifest through the creation of 'non-existent', 'nonsensical', or 'inaccurate' objects but rather through the deviation of the output from the intended stylistics toward a more realistic, film-like mode of representation. This form of stylistic inconsistency can be regarded as a deliberate manifestation of hallucination resulting from the biases embedded in training data. Within artistic practice, therefore, we define this occurrence as a type of hallucination in which AI modifies given instructions under the influence of its data-driven predispositions. Consequently, how to mitigate such a situation?

'Prompts' refer to the textual inputs provided by users. Their modification is conceptualised as an 'engineering' process. With the increasing availability of advanced and more accurate models for creative professionals, prompt engineering has become a highly valued skill, ensuring more precise outputs [16] and serving as one of the key methods for mitigating potential misalignments.

When text-to-image models such as Midjourney and DALL·E were first introduced, they astonished the creative community; however, their capabilities in generating specific styles at that time remained limited. Merely two years later, generative models now differ significantly in their training techniques and offer a greater variety of stylistic options. Therefore, beyond prompt engineering, knowledge of new models and their potential applications is essential for maintaining a smooth AI workflow. A relevant example is the growing practice of combining Depth and Canny within ControlNet. While Canny primarily focuses on edge detection, Depth preserves the spatial structure of the image. Through a combination of careful prompt design and the use of Canny, two-dimensional stylistics tend to produce more consistent results while avoiding unwanted realism.

One further aspect that must be emphasised is the role of source input as a base for readaptation. Minimal or absent human intervention is often criticised by practitioners as a form of AI theft [17]. This issue becomes particularly evident when visual outputs are generated solely from textual prompts, especially when these outputs attempt to represent recognisable characters or established narratives. In such cases, hallucination not only pertains to stylistic distortion or narrative misalignment but may also extend to ethical concerns of artistic appropriation. To address this, our case study employed public domain illustrations as the foundational inspiratoin base for creative readaptation.

3.2 HYBRID APPROACH

Online AI-generated videos are often recognised for their close resemblance to reality, which diverges significantly from what animators usually aim to achieve. But what happens when an animator works with limited source material? This particular situation arises as the original selected as an inspiration artist did not create illustrations for all scenes.

In *Act 4* of Shakespeare's *Hamlet*, the scene in which Hamlet is sent away to England is visualised through the animation of a sailing ship. Instead of generating an image directly from a textual prompt, the process first included a traditional hand-drawn sketch. This rough sketch served as a base, while a trained LoRA (Low-Rank Adapter), developed using all available lithographs by Eugène Delacroix, was employed to generate the appropriate style. From this image ideation process, another aspect emerges: filling the undefined space of a sketch may potentially enrich the overall storyboard process. Of course, it remains the artist's role to utilise such outputs and evaluate their aesthetic quality. This experimental observation suggests that hallucination, despite its negative connotations, may also carry creative potential.

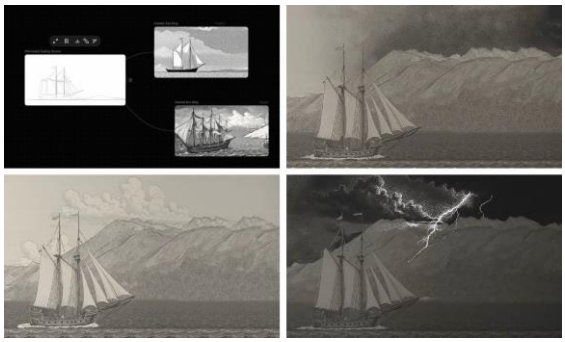

Figure 3: *Stages of visual development based on sketch generation with Canny.*

The situation changes, however, when generating images that depict characters or capture the specific atmosphere of a narrative. When provided with a sketch, AI often reshapes the narrative by adding additional characters, altering facial expressions, modifying age, or changing the overall tone of the scene. This example illustrates '*narrative misalignment'*, which can be framed within the concept of hallucination. In a traditional setting, an animator maintains consistency of character and scene, whereas AI may misalign previously established visual content.

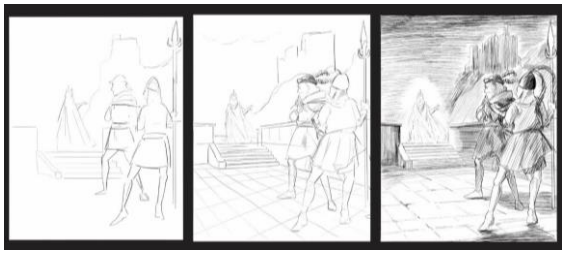

Figure 4: *Sketches used for AI generation, ranging from minimal detail (left) to complete drawing (right).*

Through the sketch-based experiment, we observed that the most effective AI style generation occurred when sketches contained only basic outlines, as fully detailed drawings with shading resulted in 'over-information' for the model. For this reason, further scenes development involved minimal linear drawing.

Figure 5: *Example of scene generation based on a sketch input, illustrating hallucination of environmental and character inconsistency*

Nevertheless, the inclusion of a sketch does not guarantee full consistency. On multiple occasions, AI generations based on sketch input produced various hallucinated outputs, including inconsistencies in style, character appearance, environmental setting, and even the number of characters within a scene. While in experimental practice such distortions might result in 'happy accidents', these evident flaws cannot persist in narrative-based animation, where they risk disrupting audience attention and undermining the coherence of the plot. For this reason, manual artistic intervention remains crucial in mitigating such occurrences, as explained in the following section.

3.3 CONTROLLING MISALIGMENT BY CO-CREATION

As outlined above, the sketch-based workflow does not ultimately guarantee successful output. Therefore, another strategy involves adjusting the scenes manually through the use of traditional animation software. The co-creation between fully automated AI processes and traditional tools not only enables greater control over the overall aesthetics but also mitigates hallucinated outputs. By combining AI-generated elements with manual storyboarding and animation techniques, the process remains within an ethical framework.

One significant case of misalignment was encountered in Act 2, where the character of Polonius sends a spy. While animation does not necessarily aim for complete realism in character movement, a professional animator is capable of establishing a baseline for cohesive motion. In this regard, AI does not suffice, as hallucination becomes evident in perspective shifts and motion timing.

Figure 6: *Example of motion hallucination persisting through multiple iterations, marked by inconsistencies in running speed, behavioural narration, and gesture alignment*

The chosen solution for this issue was artistic intervention, which did not eliminate AI input but rather integrated it with manual techniques. The intervention primarily addressed changes in perspective and running motion. In summary, the sketch base and running sequence were produced through manual animation, while the LoRA model generated the visual style of the base image and the secondary character animation. This process effectively resolved the motion misalignment that had originally appeared as hallucination in the form of distorted running speed and perspective.

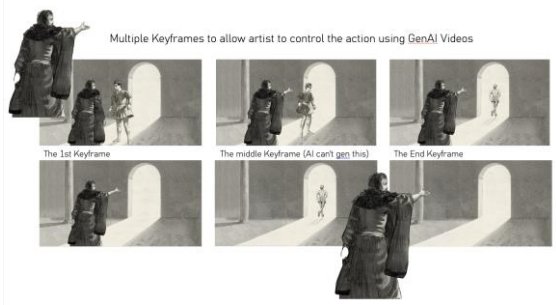

Figure 7: *Process of mitigating hallucination through a co-creative approach, where the overall scene remains AI-generated while motion is refined using manual animation techniques*

4. CONCLUSION

From the presented case study, three major conclusions can be drawn. First, the definition of AI hallucination has not yet been firmly established within the artistic context. What may be considered plausible in photorealistic image generation is not perceived in the same way within the arts, and particularly not within animation. By framing the concept of AI hallucination around three categories, this paper aimed to elucidate the notion of AI misalignment.
Second, AI-assisted animation requires continuous supervision of both its aesthetic and narrative outputs. Although the development of new

models in recent years has contributed to a reduction in visual and motion distortions, these improvements do not fully meet the needs of artistic practice. Creators often move away from realism, favouring more experimental and aesthetically engaging approaches.

Lastly, the strategy of using historical references within the public domain, alongside a hybrid approach that integrates hand-drawn methods, AI generation, and manual intervention, ensures that AI animation remains within an ethical framework.

5. ACKNOWLEDGMENT

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SESSION II

“Immersive Virtuality”

Moderation: Prof. Dr. Andreas Bienert
(form. Staatliche Museen zu Berlin)

Virtual Tour for Heritage Accessibility: The Case of Palazzo Carignano Museum

Roberta Spallone[a], Michele Russo[b], Marco Vitali[a], Fabrizio Natta[a], Enrico Pupi[e], Martina Casciola[b], and Martina Rinascimento[a]

[a]Department of Architecture and Design, Politecnico di Torino, Italy,
roberta.spallone@polito.it, marco.vitali@polito.it, fabrizio.natta@polito.it,
enrico.pupi@polito.it, martina.rinascimento@polito.it
[b]Department of History, Representation and Restoration of Architecture,
Sapienza Università di Roma, Italy,
m.russo@uniroma1.it, martina.casciola@uniroma1.it

ABSTRACT: The digital transformation in the cultural heritage sector has led to the widespread adoption of Virtual Tours (VTs), which are intended as interactive simulations of real-world locations that allow users to explore and navigate spaces remotely. This trend was significantly accelerated by the global pandemic, which compelled cultural institutions to reassess their accessibility models and has produced a diverse landscape of technological solutions, revealing a critical need to move beyond simple digital replicas toward more integrated and meaningful interactions. In this paper, VT has been created to offer the public new visualizations of rooms and panoramas that are partially or fully inaccessible inside the Palazzo Carignano Museum. Therefore, VT faced the central goal of reducing obstacles, inequalities, and gaps that limit citizens' participation in cultural life and heritage, favoring accessibility to rooms that are not accessible by the mobility-impaired or not visitable by the public due to safety reasons. A sequence of spherical images linked together by graphic elements that allow the photographs to be visited and scrolled makes up the VT. It will be available on the museum's website and usable on-site via totems and handheld devices.

1. INTRODUCTION

This proposal is rooted in a broader project aimed at enhancing the physical and cognitive accessibility of the Carignano Palace and Museum, which was commissioned by the Direzione Regionale Musei (DRM) - Museo di Palazzo Carignano. The project has been funded as part of the PNRR (National Recovery and Resilience Plan) in the Accessibility sector and concluded in February 2025.

The overall project is divided into two activities: analysis, conducted through an integrated digital survey, and interpretive modeling, of the museum and the XVII-century façades, performed using the H-BIM process. At the same time, communication strategies, methodologies, and tools ranged from reconstructive digital modeling and physical modeling to virtual tours (VT), virtual reality (VR), and augmented reality (AR). Within the scope of intervention, museum spaces, missing structures, and architectural elements are presented using certain above-mentioned techniques, selected on a case-by-case basis according to the project objectives. The phygital products will be integrated into the new installations and devices envisioned in the overall communication plan, as well as the new exhibit for the Palazzo Carignano Museum.

2. MAIN OBJECTIVES AND PROJECT OVERVIEW

VT faced the central goal of the project, which was to reduce obstacles, inequalities, and gaps that limit citizens' participation in cultural life and heritage, thereby favoring accessibility to rooms that are not accessible to the mobility-impaired or not visitable by the public due to safety reasons.

Another aim is to expand the number of visitors, not only by promoting accessibility, but also by

communicating to tourists planning a visit to the city the quality of the Museum's interior spaces. Indeed, Palazzo Carignano, designed and built by Guarino Guarini from 1679, is an acknowledged masterpiece of Baroque architecture. The building was originally the residence of the cadet branch of the House of Savoy-Carignano. In 1848, the main hall was transformed into the chamber of the First Subalpine Parliament, while one room housed Camillo Cavour's study. The museum tour offers visitors the chance to admire 17th-century rooms decorated with frescoes, wood paneling, stucco work, and mirrors, and furnished with original pieces of furniture.
However, the palace is mostly explored from the outside, or by walking through its entrance hall, atrium, and courtyard, which are freely open to the public and connect two monumental squares, Piazza Carignano and Piazza Carlo Alberto.
Few are familiar with its vestibules, double staircase, and the precious apartments of Mezzanotte and Mezzogiorno, which housed the Princes of Carignano and are now home to the Museum of Palazzo Carignano.
Moreover, some rooms and open spaces, such as the lantern that covers the main hall, and the terraces on the roof, are not accessible to the public.
For these reasons, a virtual tour was created.
Three main phases characterized the work: the design of the spherical camera shoots and its implementation, the processing of the photographs to create a continuous path, and the creation of the user interface, equipped with a navigator.
A sequence of spherical images linked together by graphic elements that allow the photographs to be visited and scrolled makes up the VT. It will be available on the museum's website and usable on-site via totems and handheld devices.
Particular attention was paid, right from the initial stages of shooting with the spherical camera and then in the construction of the paths between interior and exterior spaces. Numerous meetings of the research group were devoted to examining the different possibilities of movement, with the aim of providing the public not with a paratactic visualization of the individual rooms, but with a syntactic understanding of the architectural complex in its morphological and decorative values. Equally, attention was paid to the display options for the main station points, route directions, access from ground level to upper floors, and points of interest accompanied by multimedia information.
Following a thorough benchmarking of international cases, VT is characterized by:
• continuity of the path, based on the principle of the intervisibility of station points,
• careful construction of the user interface, which offers alternative ways of routing while avoiding redundancies or loss of orientation,
• possibility of inserting hotspots through which multimedia content can be accessed.

3. VIRTUAL TOUR AND MUSEUMS: AN OVERVIEW

The digital transformation of cultural heritage has led to a widespread adoption of Virtual Tours, a trend significantly accelerated by the global pandemic, which forced cultural institutions to rethink their accessibility models [1]. This evolution has produced a diverse landscape of technological solutions, revealing a critical need to move beyond simple digital replicas toward more integrated and meaningful interactions [2]. An overview of the current state of the art reveals key trends and challenges, particularly concerning the representation of museums not just as collections, but as significant architectural heritage in their own right.
A primary distinction in the museum VT landscape lies in the technological platform. Many institutions, like the Musei Capitolini (Rome) and the British Museum (London), rely on third-party platforms such as Google Arts & Culture. This ensures broad visibility and a standardized user interface but often limits customization. Conversely, institutions such as the Louvre (Paris), the Rijksmuseum (Amsterdam), and the Museo Egizio (Turin) have developed bespoke platforms. These solutions offer greater control over the user experience, allowing for sophisticated navigation and deeper content integration. A third category utilizes specialized software like PANO2VR or Matterport, as seen in Turin with the Museo di Arte Orientale and the Apartment of Mezzogiorno in Palazzo Carignano. These tools offer advanced features, including photogrammetry-based 3D models and VR compatibility, providing a balance between custom development and off-the-shelf solutions [3].
Beyond the platform, the user's journey is defined by the navigation model, which becomes critical when the focus is the architectural "container". Many VTs favor a guided, cinematic experience – as seen in tours of the Palace of Versailles – that prioritizes storytelling over free exploration. While narratively effective, this can hinder a user's grasp of spatial relation-

ships. A frequent challenge in VTs is poor navigation design, which can lead to user disorientation [4]. In contrast, the new project for Palazzo Carignano emphasizes spatial continuity, a crucial element for allowing users to assess the whole spatiality of the place. Unlike tours that present disconnected rooms, this approach is built on the intervisibility between observation points, enabling a coherent perception of the palace's architectural sequence. This method transforms the VT from a mere gallery into a tool for architectural comprehension, effectively communicating the building's spatial dimensions and proportions [5]. This focus on the building itself represents a significant step forward, using technology not only to overcome physical barriers but to offer a deeper, more holistic understanding of cultural heritage [6].

4. VIRTUAL TOUR TECHNICAL SPECIFICATIONS

The Virtual Tour (VT) of Palazzo Carignano was developed by balancing and optimising the acquisition of spatial data with the use of data visualisation tools, achieving a specific communicative effectiveness.

As mentioned in paragraph 3, the acquisition was planned initially by identifying the main trajectories with respect to the areas to be covered (Fig. 1). This preliminary plan was validated in situ and integrated with respect to the space morphological complexity. The latter was decisive in determining the number of interesting points, aiming to preserve the continuity of the route while also adapting the level of information from a specific perspective. Complex spaces, therefore, required more viewpoints, thereby allowing for a more exhaustive exploration. However, attention was also paid to optimising the data, limiting the viewpoint redundancy. It would have slowed down the visit and made the tool more complex to manage. In open or huge spaces, acquisitions were planned at greater distances, allowing for rapid movement while preserving the observation of the context.

The photo acquisition was conducted using an INSTA360 X4 camera, capable of simultaneously capturing two hemispherical images that are automatically stitched together into a 360° image (Fig. 2). The camera is equipped with a 1/2" sensor, an f/1.9 aperture, a focal length equivalent to 6.7 mm (35 mm) and the ability to capture images up to 72 MP (11904×5952 px). In the Palazzo Carignano VR, the maximum resolution was set, considering the average acquisition distance, to ensure an adequate level of detail (Ground Sampling Distance) for immersive navigation.

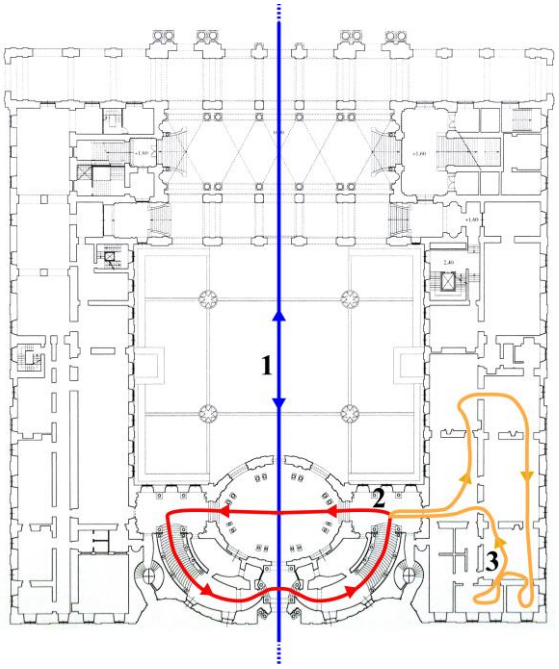

Figure 1: *Floor plan of the building with layout of some VT routes (Editing by M. Russo)*

A critical issue addressed in image acquisition was the variable lighting conditions. The need to define in advance set-ups suitable for specific conditions led to the identification of four main types of spaces: open (natural light only), semi-open (covered but with a predominance of natural light), closed with mixed light (natural and artificial) and closed (predominantly artificial light). Specific parameters for ISO, shutter speed and white balance were defined for each of these, ensuring colour uniformity between images. All 57 photographs were taken with the aid of a tripod.

5. VIRTUAL TOUR PROCESSING

The first step in post-production of the images was colour equalisation using Adobe Photoshop's Camera Raw plugin tools. It allows control of specific lighting issues while preserving the actual environmental conditions. The effects of different light sources, both natural and artificial, in interior spaces were mitigated, improving the overall readability and perceptual homogeneity of the spherical photographs.

The modified images (Fig. 2) were imported into the Virtual Tour PRO (3DVista) software, a platform that allows the user interface (UI) to be configured and customised (see paragraph 6) to adapt the virtual tour experience to different user needs. An initial assessment focused on simplifying and selecting the content to be included on the platform. As will be described in

detail in the following paragraph, the VT is the result of a delicate balance between the accessibility of the content, the clarity of the information, and the completeness of the data conveyed. In line with this process, the building's floor plans were simplified to provide VT *containers* that were immediately understandable in terms of positioning in the Palazzo system, highlighting only the spaces involved in the routes.

For the same reason, the number of points of interest has also been reduced in the key plan to avoid excessive overlapping of information (Fig. 3). Visitors, therefore, have the opportunity to explore new stations within the VT that are not included in the key plan but are helpful in the transition between stations.

This transition is supported by the inclusion of simplified icons, which must ensure recognisability while preserving graphic continuity. Some icons only appear when the mouse hovers over them, optimising the image visualisation.

The last development process focused on the portability of the VT. The interface was designed based on a Full HD (1920×1080) reference scheme.

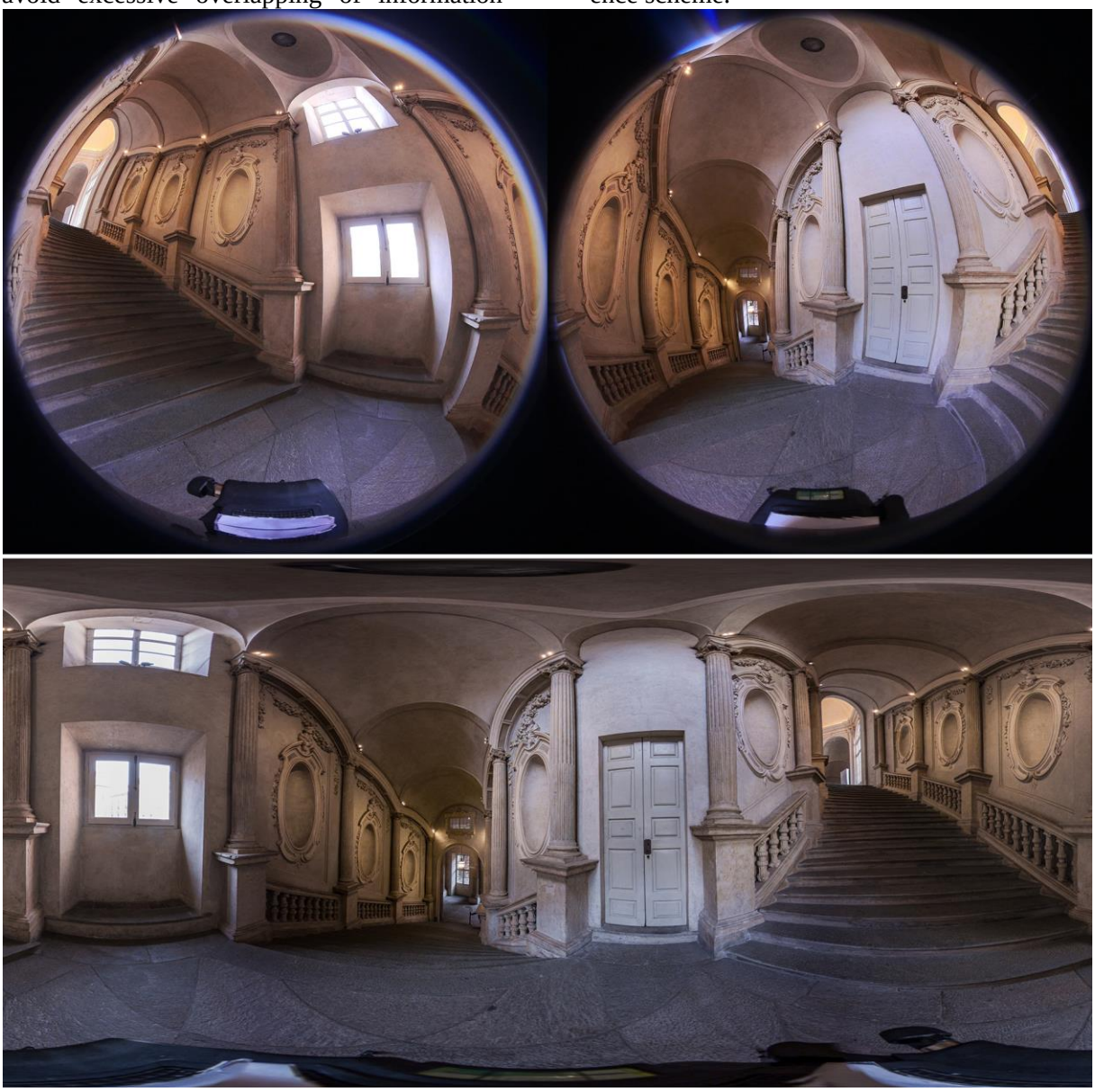

Figure 2: *Images from the two hemispherical photos and edited equirectangular image (Editing by M. Russo)*

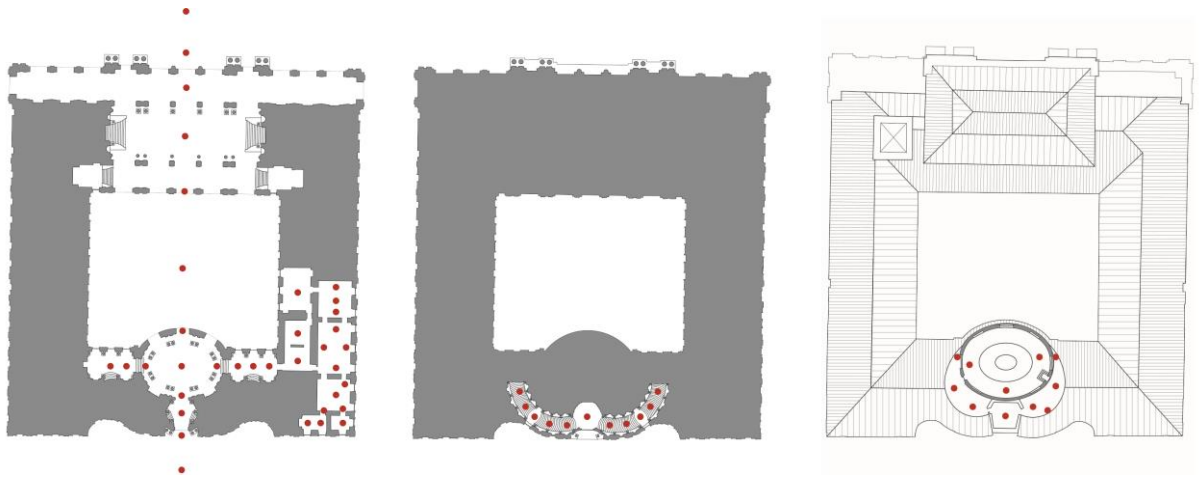

Figure 3: *Plans (ground floor, first floor, top floor) with the distribution of VT viewpoints (Editing by M. Russo)*

Figure 4: *Wireframe of VT interface. (Editing by M. Rinascimento)*

It is optimal for viewing on computers but can also be re-adapted to tablets and smartphones without modifying the original images. In these cases, the UI elements automatically adjust to the screen size, preserving both accessibility and interactivity of the experience. These elements can be further calibrated during the final implementation phase, once the target platform has been identified.

6. VIRTUAL TOUR USER INTERFACE

In order to make the virtual tour output as accessible and easily navigable as possible for the Museum broader target audience, some UX Design methodologies and good practices were followed so as to additionally guarantee the achievement of a User Centred output.

First, simple B/W visual schemes, technically referred to as wireframes, were sketched to represent a draft of the appearance of the digital interface of the virtual tour to-be (Fig. 4).

In this phase, it was crucial to convert the insights collected during the VT's benchmarking analysis, discussed in paragraph 3 of this contribution, in early design choices, namely spotting the elements and components of interest standardised for a virtual tour, like an interactive plan of the explorative area and control buttons for movement, and position them in the VT interface. This methodology helped the research and

design team to imagine the digital interface layout, the displacement of content and ensure that the flux of user interactions with the digital system designed is intuitive and smooth. Coherently, the visual appearance of user experience components isn't relevant at this point, indeed placeholders recalling the shape and space occupied by interactive elements are placed. Following the design of the layout, a set of icons and visual components were designed and positioned in place of the correspondent placeholders (Fig. 5). Ensuring suitable movements dynamics resulted being essential to offer a pleasing and customizable exploration of the VT. Reasonably, the research team decided to design varied modalities to move in the digital space as both a set of movements and exploration icons and an interactive plan of the Museum building. The former was placed at the bottom of the interface in order to support the user to move across spherical images according to directions and zoom in or zoom out; the latter is formalized as a thumbnail of the plan of the building that visually tracks the position of the user in the VT and displays their optical cone, suggesting the user orientation in the map.

Another thought laying in accessibility and usefulness UX dimensions was on the possibility for users to freely explore the VT without being distracted by redundant visual
indicators and components. For this reason, an eye-like icon was added onto the interface allowing users to enable or disable the rest of the icons, thus visually freeing the interface and facilitating a complete exploration of the spherical images. Finally, the definitive VT interfaces took shape (Fig. 6).

At this final stage, numerous tests were carried out to favour continuity along the route and inter-visibility between acquisition points that are placed along the pavement of the explorative area.

Users can in fact interact with both the observation points green-colored in the map and the acquisition points that can be found as users dive deep in the VT route. To furthermore enhance the exploration of the VT, an additional interactive component was added next to the building's plan, as so the icon displaying the mapped and explorable floors allowing users to directly teleport from one level to another just by clicking it.

Figure 5: *Wireframe of VT interface with designed icons and interactive elements put in place (Editing by M. Rinascimento)*

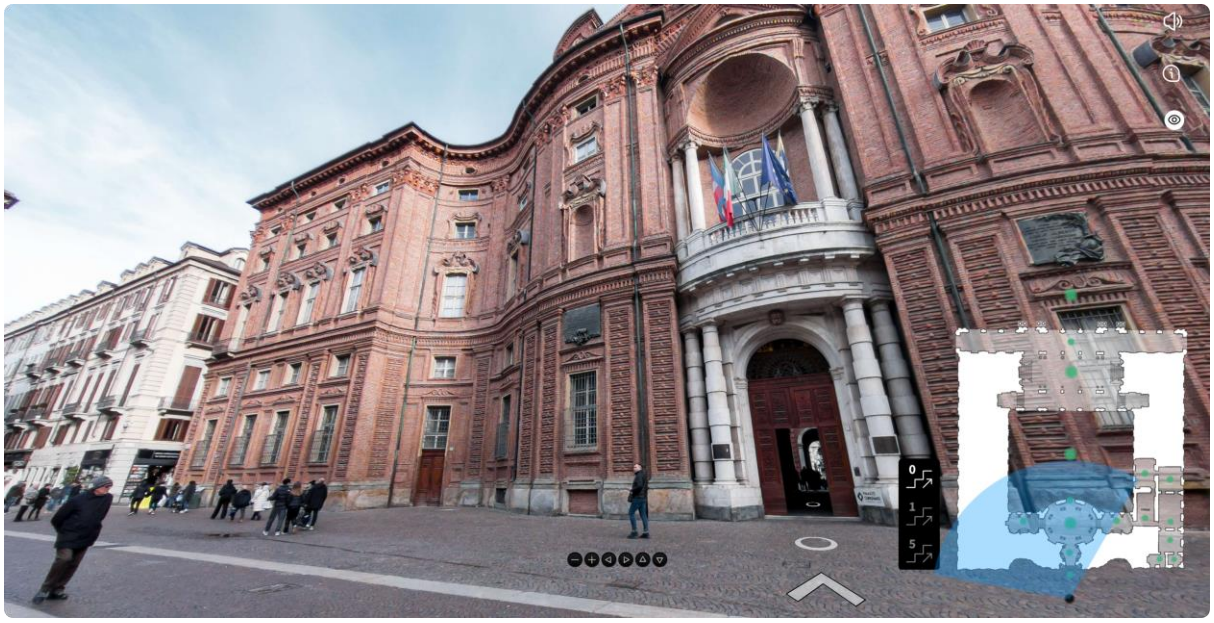

Figure 6: *Definitive VT interface displaying the façade of Palazzo Carignano (Development by M. Russo. UX Research and Design by M. Rinascimento)*

7. IMMERSIVE FRUITION OF EXISTING ARCHITECTURAL HERITAGE

The VT solution was identified as optimal for the Palazzo Carignano Museum. The choice of trade-off between accuracy and quality in cultural heritage documentation avoided the resource expenditure required by detailed geometric and morphological modeling with high-resolution textures, which was misaligned with respect to the necessary communicative output [7] [8]. Alternative approaches, although producing metrically accurate and morphologically detailed models, require articulated workflows for processing, optimization, and integration of heterogeneous datasets, with consequently significantly higher computational and temporal resource requirements [9].

VT based on spherical images, however, constrains public fruition to predetermined station points from the acquisition phase, limiting spatial continuity and the perception of motor freedom. These are essential elements for a robust sense of presence, understood as the product of immersion and coherence [10]. Nevertheless, although this feature correlates with navigation fluidity, user control, and sensory feedback [11], it can be elevated even with interaction limitations, being associated with better cognitive performance and spatial abilities [12].

The immersiveness of the experience can be significantly enhanced through the use of Head-Mounted Displays (HMDs), which substantially improve the sense of presence compared to desktop monitor visualization. HMDs provide a wide field of view, three-degrees-of-freedom (3-DoF) tracking, and sensory isolation from the surrounding environment, thereby favoring perceptual immersion. Comparative studies demonstrate that 360° fruition via HMD produces superior perception of control and immersion compared to desktop screens, despite the limitations of constrained navigation [13] [14].

The 3DVista Virtual Tour PRO software enables the conversion of the VT into an immersive experience for HMDs through the insertion of a VR icon in the UI and the enabling of an export option that optimizes content through foveation techniques and visual quality calibration for different hardware architectures, including Meta Quest, Pico, and HTC Vive. The platform implements two interactive paradigms: gaze-based interaction, which reduces cognitive complexity and mitigates the risk of Visually Induced Motion Sickness (VIMS) [14], and controller-based interactions, which expand interactive possibilities by enabling the activation of embedded multimedia contents.

HMDs generate multiple benefits: they enhance cognitive and emotional engagement, improving information retention; facilitate cognitive accessibility by creating controlled environments advantageous for users with neurodiversity; and support wayfinding strategies through intuitive three-dimensional graphic elements. However, the spatial restrictions of constrained navigation and potential discomfort factors, such as visual fatigue and VIMS, persist, intensifying between 10 and 20 minutes of exposure, although some users demonstrate good adaptive

capacity [15]. The immersive experience is therefore optimal for a heterogeneous audience for sessions of approximately 15 minutes and targeted fruitions, while the desktop version remains advisable for extensive explorations and users sensitive to VIMS.
For the case study of the Palazzo Carignano Museum, integration with web-based platforms extends the dissemination potential by enabling remote access through consumer-grade devices, transforming the VT into a communicative tool adaptable to different modalities and contexts of fruition, in alignment with the project's objectives of inclusion and accessibility to cultural heritage.

8. FUTURE EXPERIENCES IMPLEMENTATIONS

At the current stage of development, the Virtual Tour constitutes an explorable spatial database, as described in the previous paragraphs, offering different levels of immersion and a high degree of user freedom. It effectively provides a basis for the implementation of additional content aimed at enriching the user experience through different media:
Audio tracks (music, background noises, voices) that evoke, through movement within the virtually visited places, scenarios of use of the spaces in relation to their intended use in a specific historical period, or that illustrate, through multilingual narration, architectural and spatial characteristics, historical notes, curiosities, or more.
• Multilingual subtitles to ensure maximum inclusion of different types of audiences in support of the audio tracks,
• Videos in Italian Sign Language (LIS) for brief descriptions and illustrations of the contents and highlights of the tour
• Points of Interest (POI), i.e. sensitive points anchored to specific elements of the spherical image, designed as links to specific insights into the architecture visited or objects of particular interest contained therein: these insights may include texts, historical images, archive drawings, documents, three-dimensional models navigable in VR or multimedia content of various kinds.
The design of content related to virtual tours is a particularly delicate matter, requiring the convergence and harmonisation of numerous skills: the content must strictly adhere to a narrative project that intertwines the cultural demands of museum curators, the expertise of communication and User eXperience specialists, and the know-how of those who produce three-dimensional and VR models, audio and video content. The harmonisation of this wide range of content and media must aim to ensure easy, fluid, and enjoyable use, while meeting standards of scientific accuracy. On the one hand, therefore, the content must be presented in an appealing and easy-to-explore way, carefully balancing the different types of content and offering customisable viewing options based on the interests and time available for the virtual visit. On the other hand, in line with the curatorial approach, it must be presented using language that is cognitively inclusive, accessible and understandable to the different segments of the audience for whom the experience is intended.
Based on these assumptions, the research group aims to continue its collaboration with the Palazzo Carignano museum to develop content that complements and supports the virtual visit experience.

9. CONCLUSION

In the field of museum visits, virtual tours have, as we have seen, experienced impressive growth during the pandemic. This has led to their use as a substitute for in-person visits, in which, however, the connection with the architecture has been lost in many cases. A museum as unique as Palazzo Carignano, a building of great artistic value, is not typically used as an exhibition space for the visual arts, but rather as a testament to the historical events that preceded the unification of Italy.
The focus of this work on the use of architectural space, the specific nature of its rooms, and the functions it has assumed over time, as well as its furnishings, characterizes the results of the research, together with the main objective of making spaces available that are not open to visitors or accessible to everyone.

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The authors wrote together pars. 1, 9.

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Virtuality as Knowledge: Reclaiming Unbuilt Architecture through Immersive Archives

Nicola D'Addario

Faculty of Architecture, University of Porto, Portugal, nic.daddario@gmail.com

ABSTRACT: What does it mean to archive architecture that was never built? This paper explores how immersive technologies can transform the historiography of architecture by reclaiming unbuilt or lost projects as epistemic spaces. Traditional archives reduce architectural knowledge to drawings and texts, but digital simulations enable a phenomenological reconstruction of spatial experience—an embodied encounter with the "unrepresentable" dimension of architecture. Building on theories of perception, Gestalt, and architectural phenomenology, this study examines virtual reconstructions as performative interfaces that generate knowledge through experience rather than representation. By addressing the notion of "hypothetical heritage," it argues that virtuality does not merely simulate the past: it reactivates it, converting absence into a critical mode of presence. The paper situates immersive archives within the broader discourse of digital heritage, proposing virtuality as a legitimate domain of architectural understanding in the age of AI and computational creativity.

1. INTRODUCTION

Architecture has always been mediated through representation. Plans, sections, and models are not mere technical devices but epistemic instruments through which space is conceived, transmitted, and remembered. Yet, the conventional architectural archive—composed of drawings, photographs, and documents—inevitably reduces architecture to its visual and textual fragments. As Bruno Zevi famously argued, architecture is not seen in plan or elevation, but in the lived experience of space [1, 2]. This phenomenological claim exposes a critical paradox: how can we know architecture that no longer exists, or that was never built at all?

In the age of digitality and artificial intelligence, this question acquires renewed urgency. While tools like 3D modelling, photogrammetry, and photorealistic rendering are now widely used for architectural representation—though more often for design and analysis than for historical understanding—immersive visualization and interactive simulation enable forms of engagement that transcend static media. These new tools allow users to inhabit digital spaces and to experience architecture as temporal, sequential, and embodied: an encounter closer to Architecture itself. Within this context, unbuilt and destroyed works—long confined to the margins of historiography, despite being substantial to the advancement of the discipline—can be reactivated as experiential archives.

This paper proposes to examine digital virtuality as a form of knowledge: a means to partially reconstruct architectural presence through phenomenological simulation rather than material conservation of analog traces. The term knowledge here does not refer merely to the accumulation of information about architectural form, but to the process through which meaning is constituted in perception. Following Michael Polanyi's notion of tacit knowledge [3], architectural understanding arises from embodied engagement—the "knowing how" that precedes any explicit "knowing that." Likewise, Husserl's *Erfahrung und Urteil* [4] situates experience as the precondition of all conceptual judgment. Within this framework, immersive archives produce not descriptive data but experiential insight: they operationalize knowledge through appearance, orientation, and movement. Virtuality thus reconfigures architectural historiography from a discourse of representation to one of experiential cognition. By situating this approach within the broader debates on digital heritage, post-representational historiography, and computational creativity, the paper argues for an expanded notion of the architectural archive—one that acknowledges virtual reconstructions as critical and epistemic spaces.

2. MAIN ASPECTS

2.1 FROM REPRESENTATION TO SIMULATION

Architectural knowledge has historically been mediated through systems of representation: drawing, perspective, photography, and, more recently, digital modelling. Each of these has produced a specific epistemology of space, defining what can be known, preserved, and transmitted. This problem of translation—from the abstract language of the drawing to the phenomenal reality of the building—was thoroughly explored by Robin Evans [5]. As Zevi and Evans demonstrate, and as phenomenology has long argued, architectural representations dissect, but they do not synthesize the lived experience.
It is critical to clarify that the "virtual" is not synonymous with the "digital." In Deleuze's ontology, the virtual designates that which is real but not yet actual—an intensive field of potentialities structuring the conditions of emergence [6]. This aligns with the classical etymology of the word, which is rooted in potentiality. Pierre Lévy later extended this to the digital domain, describing virtuality as "a mode of being" that demands actualization rather than reproduction [7].
This apparent overlap is not sufficient to consider the terms interchangeable. We should, perhaps, speak of Digital Virtuality: a state where the digital is the medium of application and virtuality is the "mode" of potentiality being actualized. Seen through this lens, virtual reconstructions do not imitate architecture; they activate its latent possibilities. The immersive archive proposed here, therefore, operates as a site of actualization, where the conceptual potential of unbuilt works becomes phenomenally accessible.
This challenges the logic of the modern archive, which, as Foucault suggests, is not a neutral repository but a dispositive that orders knowledge through visibility and classification [8]. In architecture, this logic privileges the image of the building, or its quantifiable data, over its experience.
The emergence of digital and immersive technologies confronts this representational paradigm. While early computer visualization replicated the conventions of drawing, contemporary simulation tools—such as interactive VR environments or HBIM platforms—transform the act of viewing into a performative and temporal process. The archive becomes an interface: not merely a place where information is stored, but a field where spatial knowledge is enacted.
In this sense, virtual reconstruction is not a derivative of the real but a mode of re-presencing: the digital reenactment of spatial conditions, atmospheres, and perceptual rhythms otherwise lost to history. This shift invites a redefinition of the archive itself. As Derrida argued in Mal d'archive, every act of archiving is haunted by the desire both to preserve and to destroy—a tension he calls "archive fever" [9]. Hal Foster later reframed this ambivalence as an "archival impulse," in which contemporary theorists and artists transform archival practice into a generative, performative act [10]. The immersive ar-

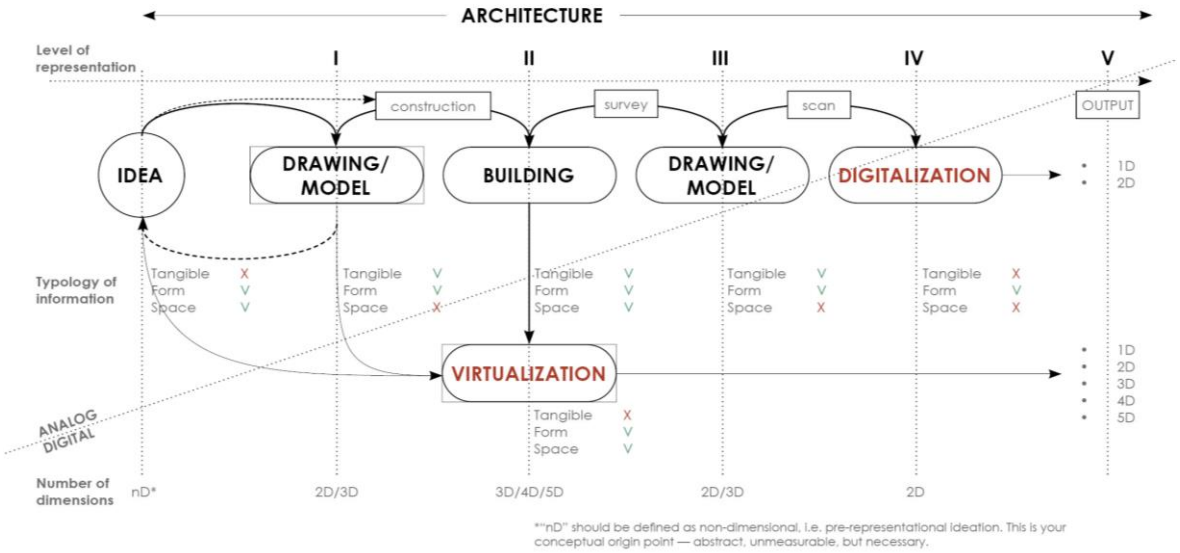

Figure 1: *This framework distinguishes "Digitalization" (IV)—a static 2D output—from "Virtualization." The matrix (left) shows how virtualization is the only mode of representation that, like the physical "Building" (II), can actualize the phenomenological dimension of "Space," which is lost in all other media*

chive continues this trajectory: it no longer safeguards architectural traces, but performs their reactivation. What emerges is a critical form of post-archivality, in which knowledge is produced through the encounter, not merely stored for retrieval.

2.2 THE HYPOTHETICAL HERITAGE

We propose the notion of "hypothetical heritage" based on the recognition that cultural value often exceeds material survival. Architectural history abounds with projects that, though unbuilt, have shaped discourse and imagination: from Piranesi's visions to the utopian projects of Ledoux and Sant'Elia. Traditionally, these works were transmitted as static drawings—"paper architectures" that testified to ideas rather than inhabitable forms, yet still exerted enormous influence.

This concept applies equally to lost architectures that survive only through fragmentary representations. A key example is Paul Letarouilly's monumental survey of the Vatican and Rome's Renaissance buildings, which—acting simultaneously as survey and reconstruction—preserved the spatial logic of structures now long-altered or destroyed. Following the 2003 UNESCO Convention on Intangible Heritage and the 2005 Faro Convention, heritage studies have increasingly acknowledged immaterial practices, memories, and knowledges as integral to cultural identity. Extending this framework to architecture, hypothetical heritage refers to those non-built or lost works whose conceptual potency continues to influence spatial culture. Their preservation, therefore, relies not on material conservation but on the potential to reactivate their experiential dimension through digital means.

Immersive reconstructions, therefore, become instruments of critical remembrance, transforming absence into a productive category of cultural resilience. Yet the reactivation of hypothetical heritage also raises ethical and political questions. As Rodney Harrison reminds us, heritage is never neutral—it is a "mode of cultural governance" that frames how societies relate to their pasts [11]. In the digital realm, issues of authorship, authenticity, and ownership become even more complex: who "owns" the reconstruction of an unbuilt project? What happens when algorithmic processes mediate cultural memory? These questions compel us to treat the immersive archive not simply as a technical achievement but as a site of negotiation, where competing claims to history, authorship, and identity are staged anew.

2.3 PHENOMENOLOGY AS CRITICAL LENS

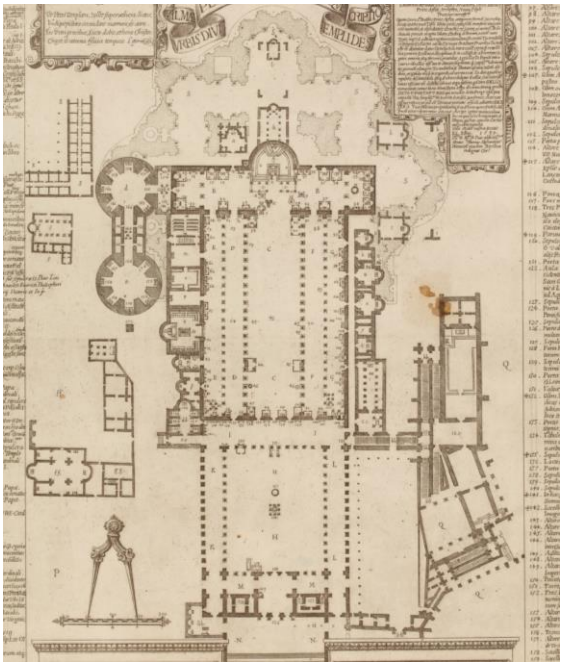

Figure 2: *Paul Letarouilly, plan of St. Peter's Basilica (c. 1840-1860). This plate exemplifies "hypothetical heritage" as it applies to lost architecture. It functions as both a fragmentary record (survey) and a critical interpretation (reconstruction), preserving a spatial logic that has since been altered or destroyed.*

To evaluate the epistemic potential of this newly defined immersive archive, the paper adopts a phenomenological perspective. From Husserl's notion of intentionality to Merleau-Ponty's embodied perception [12], phenomenology has emphasized that knowledge of space arises through experience rather than abstraction. In architectural thought, this lineage informs the work of Norberg-Schulz, Holl, and Pallasmaa, for whom architecture is understood as a lived horizon of orientation, movement, and atmosphere [13].

Immersive simulations invite a re-reading of this tradition in the digital age. They do not replace the body but extend it—creating what Mark Hansen describes as a new corporeal interface [14]. Don Ihde's post-phenomenology provides a useful framework for understanding this extension. In *Bodies in Technology* [15], Ihde describes how technological mediation neither alienates nor disembodies the subject, but multiplies perceptual relations between self and world. Similarly, Böhme's aesthetics of atmosphere [16]—a concept with clear parallels to Gestalt theory—situates perception as a co-

production between the sensing body and its spatial milieu, where the "whole" is perceived before its parts.

The immersive archive exemplifies this relational ontology: it produces atmospheres that are both digitally computed and phenomenally lived, generating what might be called a mediated corporeality—a body expanded by the very technologies that once seemed to distance it from architectural experience. Within virtual environments, spatial phenomena such as light, sound, and materiality can be reconstituted as dynamic perceptual events, allowing users to experience the previously "unrepresentable" qualities of architecture through mediated presence. This constitutes a form of digital phenomenology: not a substitute for the real, but a way of knowing through appearance, engagement, and affective resonance.

2.4 CASE ILLUSTRATION: THE VIRTUAL DANTEUM

To exemplify how immersive reconstruction can function as epistemic practice, this section presents an ongoing project. The virtual reconstruction of Giuseppe Terragni's *Danteum* (1938) serves as a concrete experiment in the epistemic potential of immersive archives. Conceived as a spatial translation of Dante's *Divina Commedia*, the original project remained unbuilt, surviving only through a limited set of drawings and model photographs. Its radical abstraction—geometry as allegory, procession as narrative—has long rendered it an emblem of architecture's speculative dimension. Indeed, its pure rationalist language, lacking familiar references or elements, makes it nearly impossible to grasp scale or perception from the plans alone.

The present immersive reconstruction reanimates this latent architecture through a fully navigable 3D environment built in Unreal Engine 5. The choice of a so-called "game engine" is deliberate: it highlights the proximity between the gaming experience and the pedagogical one we propose. This links the work to the classical concept of ludus (play) as a tool for learning, an idea explored by thinkers from Plato to the Roman orator Quintilian. Rather than adopting the first-person "visitor" perspective (common to both VR and many screen-based games), this third-person configuration positions the user as both observer and participant, producing a doubled mode of perception that mirrors the poem's own dialectic between vision and narration.

This choice of a third-person perspective, while seemingly at odds with first-person phenomenology, is a deliberate methodological decision. It addresses the "body problem" not through haptic simulation, but through representation of scale and presence. The visible avatar acts as a human proxy or testimone (witness), allowing

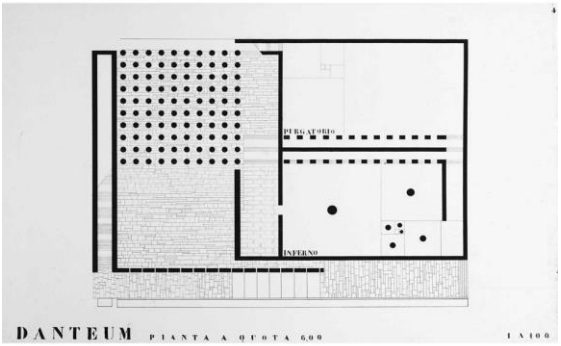

***Figure 3**: Giuseppe Terragni, plan for the Danteum (1938). The primary document of this "paper architecture." Its pure abstraction and lack of familiar references render the project's scale and phenomenological qualities—such as the disorientation of the pillar forest (top left)—"unrepresentable" in two dimensions.*

***Figure 4:** Comparison of historical representation (Inferno) with the immersive archive. Top: Terragni's original perspective rendering. Bottom: The UE reconstruction. The addition of the avatar and the simulation of dynamic light and shadow demonstrate the method's ability to 're-presence' the intended phenomenological script of the space*

Figure 5: *Comparison of historical representation (Purgatorio) with the immersive archive. Top: Terragni's original perspective rendering. Bottom: Corresponding view from the UE reconstruction. The visible avatar, acting as a testimone (witness), transforms the static scene into a performative interface, providing an intuitive grasp of the monumental scale*

the user to observe a body in relation to the architecture. This provides an immediate, intuitive grasp of proportion, scale, and the spatial relationship between the human form and Terragni's monumental voids—a form of "vicarious" embodiment. It also serves a practical function, allowing the experience to be shared and discussed by a group, rather than isolating a single user in a VR environment.

Within this environment, the Danteum unfolds not as a static monument but as a phenomenological script: the progression from the Inferno's darkness to the Paradiso's luminosity becomes a lived, temporal sequence mediated through spatial thresholds, acoustic cues, and material atmospheres. The reconstruction thereby transforms Terragni's unrealized project into an experiential hypothesis—a performative enactment of his architectural poetics rather than a mere visualization. This immersive enactment yields specific epistemic insights unavailable from the static plans. For instance, while the drawings suggest the "Inferno" is dark, the simulation allows one to *experience the phenomenological script* of light's variation during the threshold transition. More critically, the "forest" of pillars at the entrance, often read as a simple formal device, is revealed in the simulation as a powerful instrument of disorientation; the user experiences this loss of direction in real-time, as the original poem suggests and the architect probably intended. This is not the static, "retinal" architecture that phenomenologists rightly critique. Rather, it is a dynamic, sequential engagement of vision—the change in light and exposure during movement—that is fundamental to ancestral embodied cognition. As such, the Virtual Danteum demonstrates how immersive archives can operate as instruments of historical inquiry, enabling researchers to test and interpret the perceptual logic of unbuilt works. What emerges is not a simulation of Terragni's architecture, but a critical re-presencing: an interpretative space where historical imagination and digital phenomenology converge.

3. CONCLUSION

The progressive convergence of digital technology, artificial intelligence, and architectural historiography compels a reconsideration of what it means to preserve, study, and transmit architectural knowledge. This paper has argued that virtual reconstruction should not be understood as a form of illusion or simulation of the real, but as an epistemic practice capable of reactivating the experiential dimension of architecture. By transforming the archive from a static repository into an immersive interface, digital environments enable a performative understanding of architectural heritage—one grounded in perception, temporality, and embodied cognition.

Through the notion of hypothetical heritage, the study repositions unbuilt or lost projects within the field of digital heritage, proposing that absence itself can become a source of knowledge. The virtual archive thus operates as a site of critical reconstruction.

This reconstruction is, fundamentally, a hermeneutic act. Given that the records of hypothetical heritage are often partial or fragmentary, the work is never a neutral technical task but an "interpretation". This task demands a specific, disciplinary *saper fare* (know-how). It is not archaeology, which typically builds upon physical traces, nor is it traditional history, which is often more strictly bound to textual sources. Neither is it the work of a 3D artist, who retains the freedom to invent without disciplinary constraints. This reconstruction is a job for the architect, the architectural historian, and the theo-

rist, as it is akin to developing a "project" (*progetto*)—a critical proposal that synthesizes fragmentary evidence into a coherent, experiential hypothesis.

Phenomenology offers a coherent lens through which to interpret this transformation. The advent of generative AI further complicates this epistemic terrain. Algorithmic reconstruction does not merely automate modeling; it introduces a new form of computational imagination, where the system learns spatial logics and generates plausible but non-existent architectures. As Mario Carpo notes, this constitutes a "third digital turn," in which machines participate in design cognition [17]. The immersive archive thus becomes dialogical: a site where human (interpretive) and machine (generative) intelligences co-produce architectural meaning. The question shifts from what we can reconstruct to how we can collaborate with algorithmic processes in re-enacting architectural memory.

Immersive archives do not replicate reality but stage it anew, revealing how spatial understanding arises from the dynamic interplay between body, perception, and technology. The Virtual Danteum, for instance, underscores the proposition that virtuality, when understood as epistemic reactivation, can transform architectural historiography from an act of recovery into one of creation. By re-staging Terragni's unbuilt vision as a navigable experience, the immersive archive operates not only as a vessel of memory but as a site of thought—an experiment in how architecture continues to think through us, even when it was never built. This points toward a future phenomenology of the digital, one that conceives virtuality not as a surrogate of the physical but as an autonomous and legitimate mode of knowing architecture, where the archive itself becomes a living thought-space.

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Holographic Artifacts for the Enhancement of Academic Heritage: The Curioni Collection at the Polytechnic University of Turin

Maurizio Marco Bocconcino (MMB), Mariapaola Vozzola (MPV), and Emanuele Ricchiello (ER)

Department of Structural, Building and Geotechnical Engineering, Politecnico di Torino, Italia, maurizio.bocconcino@polito.it

ABSTRACT: This paper develops a methodological reflection on strategies for enhancing the wooden models created by professor Giovanni Curioni in the second half of the nineteenth century, aimed at investigating the structural principles underlying architectural and engineering forms. The study examines the academic collection preserved at the Department of Structural, Building, and Geotechnical Engineering of the Politecnico di Torino, which includes over 140 scale models derived from the books L'arte di fabbricare (1867–1885), conceived as didactic instruments for the emerging discipline of construction science, in which Curioni was a pioneer in Italy. Within the framework of the university's Third Mission, the research promotes the creation of a Virtual Museum to disseminate and valorize polytechnic collections through digital platforms and interactive interfaces. The integration of holographic technologies enables the transformation of manuals and models into dynamic, three-dimensional projections, fostering new modes of knowledge transmission. Preliminary applications to selected models from the Curioni Collection highlight the interpretive and narrative potential of holographic representation as a medium for contemporary scientific and cultural communication.

1. INTRODUCTION (MMB)

Research has been carried out on Giovanni Curioni's collection of wooden models, which is preserved at the Politecnico di Torino's Department of Structural, Building and Geotechnical Engineering (DISEG). This research explores the role of Drawing as a cognitive and tactile infrastructure for knowledge. An operational system for the enhancement of academic heritage has been developed through an integrated process of surveying, modelling, digitisation, 3D printing and holographic projection. The project emphasises the importance of striking a balance between digital mediation and physical tangibility, which includes returning the original models to educational settings. Representation is interpreted as a cyclical process in which drawing connects material memory and technological innovation to generate shared, inclusive knowledge.

This contribution offers a methodological reflection on the enhancement of analog models created in the second half of the 19th century. His work aimed to explore the structural essence of architectural and engineering forms. The collection includes over 140 scale models derived from illustrations in Curioni's seminal work L'arte di fabbricare (1867–1885), conceived as a scientific aid for teaching construction science, a field in which Curioni is considered a pioneer in Italy.

The research, aligned with the goals of the university's Third Mission, seeks to promote and disseminate knowledge of polytechnic collections through the creation of a Virtual Museum with the aim of stimulating and encouraging a return to reading physical models and a deeper and more conscious material contact with them. This museum will host information models and digitized documents, accessible through multiple platforms - web repositories, physical and digital interfaces - to reach a broad and diverse audience. The Curioni collection is thus reinterpreted as a contemporary communication tool, where manuals and models are transformed into

"virtual and dynamic projections" through new representational technologies.
Central to this transformation can become the use of holography, a technology based on light diffraction and interference that produces highly realistic three-dimensional images. Holographic devices such as tables, display cases, and projectors enable immersive environments in which images and stories are projected, creating new experiential realities. This new research phase investigates the potential of holographic reproduction, user interaction with holographic artifacts, and how visual representation techniques support this intangible but spatially and materially grounded form of communication. A preliminary application to selected models from the Curioni Collection highlights the narrative and interpretive opportunities enabled by holographic display.

2. ORIGINS, MOTIVATIONS AND KNOWLEDGE PATTERNS FOR THE RESEARCH (MMB)

The research on the Curioni Collection was developed within the domain of Survey and Drawing, which is concerned with the "generation, construction and analysis of drawings, images and models as the results of scalar representations of existing or designed realities" and the "visual translation of concepts, ideas and narratives".
In this epistemic framework, Drawing is conceptualised as a cognitive language and a medium for mediating the relationship between the tangible world and its informational translation.
The collection of wooden models created by Giovanni Curioni in the 19th century as educational aids for construction constitutes a technical and educational heritage that is unique in terms of quality and completeness (Figure 1).
The objective of the research was to restore the models to their original function as tools of knowledge. This was achieved by reinterpreting them in the contemporary digital context and placing them at the centre of a process of representation that combines documentation, communication and, ultimately, teaching.
The activity forms part of a multi-year process of enhancing the technical and scientific heritage of DISEG, which commenced with the Mosca Library [1] and continued with the Porcheddu Archive [2]. These experiences have facilitated the experimental development of methodologies for the surveying and digitisation of historical technical documents, thereby establishing the theoretical and operational foundations for the more complex digitisation of the Curioni Collection.
The most recent phase of the process was represented by the experimentation conducted on the Betta-Bardelli Archive [3], which saw the consolidation of the methodology and its expansion to the field of the representation of constructive memory.

Figure 1: *Classification of models in the Curioni collection.*

In this continuum, the Curioni Collection constitutes the central axis of a research project that has confirmed drawing into a cognitive and disciplinary infrastructure, capable of connecting the history of technical knowledge to its contemporary digital reinterpretation. The objective was twofold: firstly, to document, and secondly, to reactivate the models as formative and perceptive devices. In doing so, drawing, in the broadest sense of the term and in its original form, was placed at the centre of the process of knowledge.

2.1 METHODS AND OPERATIONAL TOOLS (MMB)

The operational process involved three primary methods of surveying and modelling, which were executed concurrently [4].

The acquisition of the subject was undertaken with the employment of a precision laser scanner, with the objective of producing high-density three-dimensional point models for the purpose of conservation documentation.
The utilisation of smartphones equipped with LiDAR cameras facilitates low-cost surveying, a technique that is conducive to the expeditious and replicable acquisition of data for educational and informational objectives.
The reconstruction of the artefacts was simultaneously informed by Curioni's original drawings, which are contained in the volumes entitled L'arte di fabbricare (The Art of Manufacturing). The geometric reconstruction was based on historical sources.
These methods were complemented by traditional direct surveying techniques, utilising instruments such as squares, calipers, and metres, which served as a training aid to instruct students in the requisite knowledge for accurate measurement and representation. The educational approach commenced with a reduced scale model of the artefacts, fostering a foundation for students to develop proficiency in measurement and representation at a smaller representation scales.
The plurality of approaches adopted has enabled the consolidation of the concept of drawing as a comparative process, which integrates tools, scales and languages to facilitate an integrated understanding of the object (Figure 2).
Operationally (see. Cap. 3), the processing was carried out using Polycam Pro, Rhinoceros 3D, Blender and Revit for geometric and informational modelling, while the publication of the models on Sketchfab allowed them to be disseminated on the web with metadata and descriptive sheets.
The 3D printing of the digitised models represented the phase of returning to the material: a cognitive and educational act rather than a reproductive one. This made it possible to verify the geometric consistency and restore the physical perception of the form.
Concurrently, the reintroduction of the original wooden models to the students' desks in the courses taught by professors Ursula Zich and Martino Pavignano (third year of the Architecture degree programme) served to reinforce the connection between tactile experience, observation and representation, thereby restoring drawing to its original function as a sensory cognitive practice.

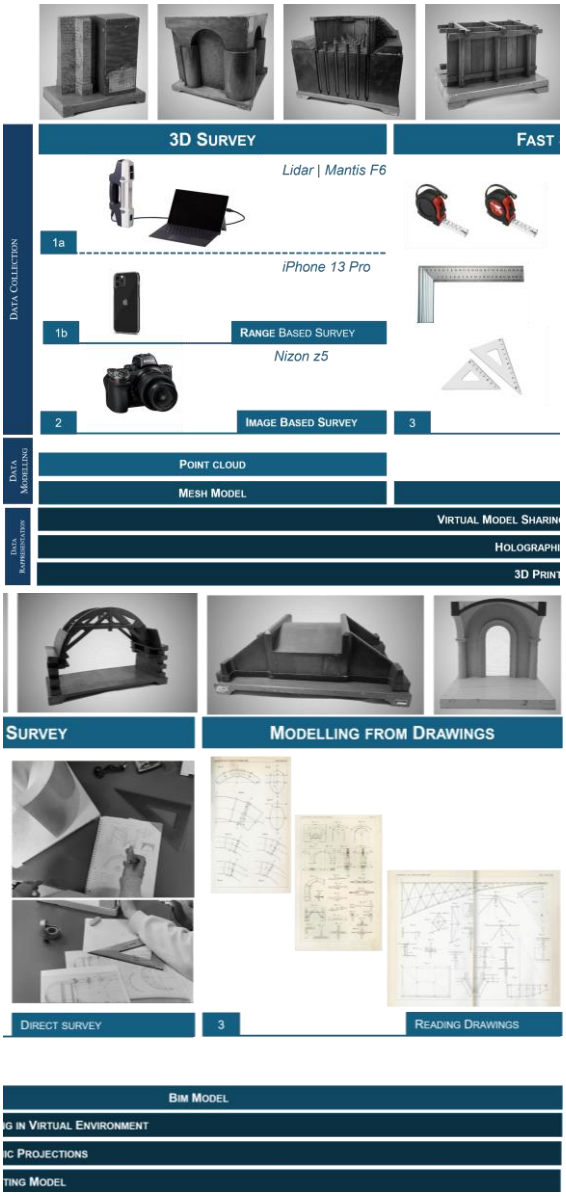

Figure 2: *Survey processes: a matter of integrative techniques in a knowledge system.*

As a preliminary conclusion to the research process, commercial low cost disseminastion of holographic projection technology has paved the way for a novel form of immersive and synaesthetic representation, characterised by the utilisation of digital models. Despite the absence of weight, the hologram restores the three-dimensionality of the form in real space and strengthens the perceptual relationship with the physical object, posing significant problems of scale representation and graphic codes for perception and interaction with projected models, through appropriate interfaces. This phase thus brings the methodological cycle of the research to a conclusion, confirming that digital mediation does not negate matter, but rather serves to amplify its understanding and cognitive value [5].

2.2 EXPERIMENTATION WITH HOLOGRAPHIC IMAGES (MMB)

The most recent updated outcome of the research process was experimentation with holographic images, which served as a phase of reflection on the very nature of representation.
The hologram, understood as a three-dimensional image generated by light and perceived in real space, takes the form of a complex projection, in which the visible form does not exist in itself, but is reconstructed by the observer through an active perceptual process.
It is evident that two primary classifications of holography exist, which differ in terms of their fundamental nature, underlying principles, and methodological value.
The first, more widespread, is that based on retinal memory: the persistence of the image on the retina allows visual perception to reconstruct the continuity of a figure that does not actually exist materially.
This phenomenon is exemplified by rotating LED devices (3D Hologram Fan), which project a sequence of two-dimensional images in rapid succession into space.
The visual system, incapable of perceiving temporal discontinuity, integrates successive projections into a stable figure that appears suspended and three-dimensional.
The holographic image thus arises as a perceptual event, rather than a physical object, and its three-dimensionality is the result of a mental construction based on visual memory.
From a disciplinary perspective, this form of holography is considered to be part of the tradition of drawing, referred to as a "synthetic vision". This is defined as an act of image recomposition through the perception of time and movement.
The perceptual hologram is not a geometric projection; rather, it is a cognitive reconstruction that renders visible the ability of drawing to translate the dynamics of form into visual experience.
The second mode is of a geometric-constructive nature and is distinct in that three dimensionality is not attributed to retinal persistence, but rather to the spatial recomposition of multiple simultaneous projections.
In this instance, holographic reconstruction is based on a principle analogous to that of descriptive projections: a three-dimensional object is represented by four images, placed at the vertices of an optical tetrahedron.
The arrangement of the four views, set at 90° and reflected on semi-transparent surfaces, combines visually at a point of intersection, thereby rendering an actual spatial configuration.
In this case, the hologram is not perceived as an imagined figure, but as a real geometric figure in space, generated by the convergence of orthogonal or perspective projections.
The methodological shift is of pivotal significance: we transition from the act of projection to that of object, from the drawing that serves as a representation of form to the image that meticulously reconstructs it.
From a disciplinary perspective, this signifies that holography transcends its traditional role as a mere advanced form of representation, instead emerging as a three-dimensional synthesis of projections. This assertion positions it as a significant model within the broader history of theories of vision and the construction of space.
The distinction between perceptual and constructive holography provides a methodological framework for interpreting drawing as a medium that transcends conventional boundaries, thereby facilitating the transition from surface to light, from two-dimensional plane to three-dimensional volume, and from the act of drawing to its representation as an image.
In the initial case, representation is considered to be a perceptual act, whereby form manifests itself in the retinal continuity of movement.
In the second, it is a geometric act: form is generated by the convergence of projections, as in descriptive construction or informative modelling.
The two modes articulate the interdisciplinary and cognitive essence of drawing.
The perceptual hologram is the consequence of the synesthetic and temporal dimension of representation, whereby the image is the result of active vision and a bodily experience of space.
Conversely, the constructive hologram serves to reinvigorate the tenets of descriptive geometry, translating the theory of projections into a dynamic three-dimensional system, wherein sections and shadows metamorphose into planes of light interference.
From this standpoint, holographic representation can be regarded as a novel form of projection and section: light substitutes the line, transparency becomes the plane of intersection, and space itself becomes the support of representation.
The section is no longer a static cut, but rather a field of light crossing; the projection is no longer the reduction of form on the plane, but its expansion in real space.

The configuration of the holographic image as an act of three-dimensional drawing is therefore achieved, resulting in a visual construction that facilitates the establishment of a unified perceptual space for both the observer and the object.

3. DEMATERIALISATION OF CURIONI MODELS (MPV&ER)

The process of surveying and digitising wooden models is part of a research project dedicated to the enhancement and digital preservation of the Curioni Collection. The aim of this project is to define a method for managing and archiving three-dimensional models based on the FAIR principles (Findable, Accessible, Interoperable, Reusable), with a view to ensuring the interoperability, traceability and long-term preservation of digital data [6]. The activity was therefore focused on the documentation and conservation of the artefacts, allowing them to be consulted by the public and enjoyed online, with the aim of creating a virtual museum and transforming them into tools for widespread and participatory knowledge. Digital technologies generate new ways of accessing and relating to cultural heritage, fostering a broader dialogue between people and objects and redefining the way the public engages with collections [7].

The first phase involved three-dimensional scanning of the models using the Polycam Pro application, based on a photogrammetric process that combines high geometric accuracy with an efficient and replicable procedure. The acquisition was carried out through automatic video recording, from which the software extracted sequences of images at regular intervals, processed to generate the point cloud and three-dimensional mesh.

The use of mobile devices and photogrammetry and videogrammetry techniques allows three-dimensional models of good accuracy to be obtained with rapid and automated procedures (Figure 3), thanks to the photogrammetric processing of video frames without the need for complex interventions by the operator [8].

Figure 3: *Visualization of the digital model in a mobile environment.*

For each survey, the maximum detail parameters were set, enabling the "use object masking" option to isolate the model from the support surface and surrounding elements. Uniform lighting and a constant shooting distance ensured the photometric homogeneity necessary for the correct texturing of the model. Once the mesh generation was complete, cleaning and finishing were performed directly within Polycam, using the 'Crop Box' command to remove background residue or unwanted portions and obtain a clean, centred geometry (Figure 4).

This preliminary optimisation phase allowed the digital model to be refined and prepared for the modelling and publication phase. Following cleaning, the files were exported in '.obj' and '.fbx' formats and stored in a dedicated folder structure, which also contained the photographs taken during the survey and the cropped versions. Each model was accompanied by a direct link to the relevant Historical Collection of the Polytechnic University of Turin, so as to create a correspondence between the physical object, its digital replica and the archival documentation.

The subsequent operations were carried out in Rhinoceros 3D, where the meshes were imported to create the support base using the surface extrusion command (Figure 5). The base has a dual function: on the one hand, it closes the lower face, which was not photographed and therefore not reconstructed by the mesh, and on the other hand, it provides a unified dimensional reference for all reproductions.

At this stage, a transparent virtual display case was also added, with a protective and museum enhancement function, as well as a graphic scale indicating the main measurements, useful for restoring the actual proportions of the artefact.

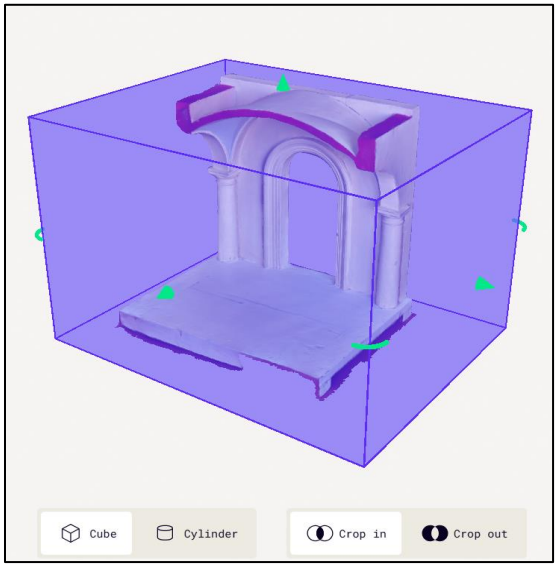

Figure 4: *Visualization of the digital model in Polycam – the "Crop Box".*

Once the complete group, consisting of the wooden model, the base and the display case with measurements, had been defined, it was exported in '.fbx' format, suitable for online publication. The platform chosen for dissemination was Sketchfab, which allows interactive three-dimensional models to be viewed directly from a browser, while maintaining textures and geometric information (Figure 6).

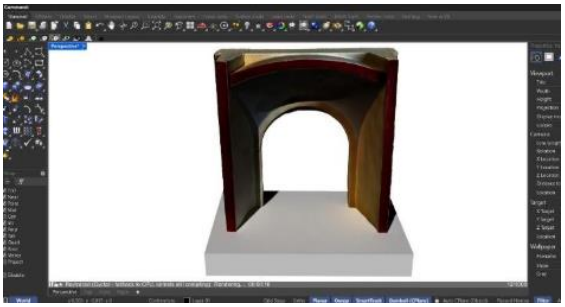

Figure 5: *Visualization of the digital model in Rhinoceros 3D.*

After uploading, the models underwent a visual optimisation process, which included adjusting the lighting, colouring the base and creating descriptive annotations using interactive labels containing technical information, high-resolution photographs and direct links to the Politecnico's Historical Collections website. The integrated annotations make the model not only a three-dimensional object, but also a real information support, through which it is possible to combine spatial representation with the consultation of detailed data and images.

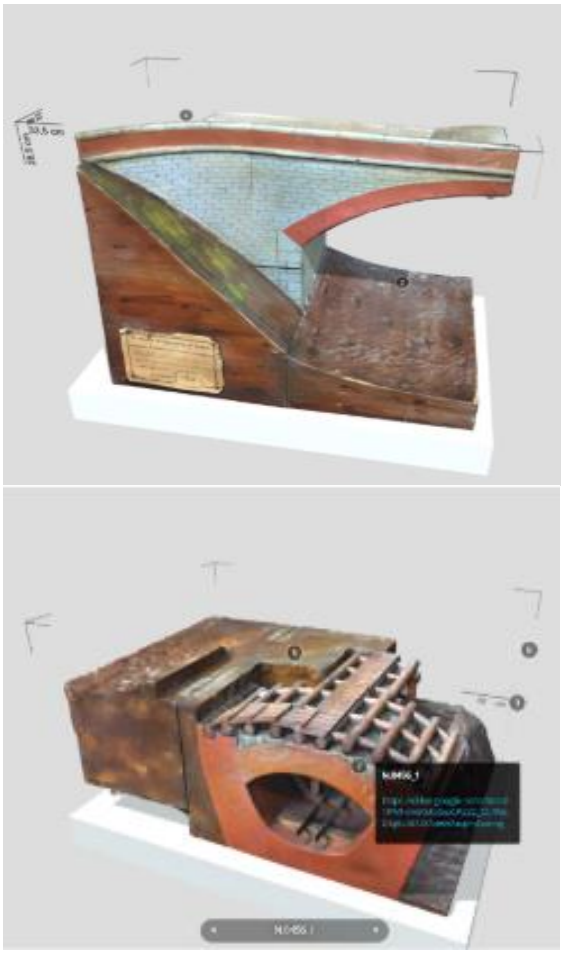

Figure 6: *Visualization of the digital model in Sketchfab.*

The publication of Curioni's models on open platforms such as Sketchfab can be interpreted as a form of distributed digital archive, in which visual documentation, descriptive metadata and provenance information help to ensure the authenticity, traceability and scientific accessibility of the digitised heritage, prolonging its usability and cognitive function over time [9].

Following online publication, the digitisation project was extended to include three-dimensional holographic visualisation using a 3DHologramFan, a device based on high-speed rotating LEDs capable of generating images suspended in space with a depth effect. After modelling and publication, an orbital video was created with the model rotating around its own axis, useful for representing the object in 360 degrees. This video was imported into the SpinDisplay application, software dedicated to managing the contents of the holographic fan, which allows for its synchronisation and projection in real space. In this way, the collection has become not only a digital archive, but also accessible to the public through a visual and interactive installation capable of rendering

the three-dimensional perception of the model and projecting it in holographic form.

4. OUTCOMES, IMPACT AND PROSPECTS (MMB)

The project's methodological elements are characterised by a diversity of skills, ranging from digital representation to diagnostics, documentation to geometric surveying, and information modelling, construction engineering to visual communication [10]. This diversity aligns with the interdisciplinary approach characteristic of the Drawing disciplinar sector, where graphic representation is conceptualised as a scientific, cognitive and communicative language, adept at integrating diverse forms of knowledge into a unified cognitive and representational process. The research has yielded substantial results across multiple domains, establishing a robust and replicable methodological framework for the documentation and enhancement of academic assets [11].

From a scientific perspective, the triangulation between laser scanners, LiDAR and modelling from historical drawings has enabled the comparison of accuracy and survey times, thus establishing a validated protocol that can be transferred to other archives and collections. The incorporation of thermographic investigations has led to the establishment of a novel diagnostic level, thereby demonstrating the potential for drawing to extend to the domain of material and structural knowledge.

From a disciplinary standpoint, the research reinforces the notion of drawing as a dynamic instrument for the acquisition of knowledge and the interpretation of ideas. The dialectic between the digital and the tangible, as evidenced by the transition from modelling to 3D printing, and the reintroduction of wooden models in lessons, demonstrates that representation does not merely substitute for matter; rather, it serves to revitalise its perceptual and cognitive significance. The act of drawing, therefore, becomes a cyclical process: from the real to the digital and back again, in a continuous dialogue between observation and reconstruction.

The experience has resulted in the establishment of an integrated teaching model at educational and cultural levels. This model combines technical knowledge with direct experience of the artefact, thereby facilitating a holistic learning approach. The integration of conventional surveying techniques, digital modelling methodologies and holographic visualisation has been instrumental in cultivating an understanding among students of representation as a critical, measured and interpretative act.

The research on the Curioni Collection, in conjunction with earlier studies of the Mosca Library and the Porcheddu Archive, and ongoing research in the Betta-Bardelli Archive, establishes a cohesive trajectory. In this trajectory, the act of drawing is recognised as a medium for the transmission of knowledge and as an integral component of the disciplinary infrastructure that underpins technical and scientific heritage. Representation, in its complete cycle from the real to the virtual and back again, becomes the locus where science, culture and memory meet, thus restoring drawing to its original function as a tool for understanding and transmitting knowledge. It is evident that, through these experiments, design reaffirms its ability to adapt to contemporary languages of representation, while maintaining its epistemic nature. Drawing, as a discipline, is one that, while transforming its tools, continues to deal with the relationship between space, vision and knowledge.

Holography, in its various forms, thus becomes the contemporary heir to projection and section, not as a substitute for descriptive geometry, but as its luminous and perceptive evolution, capable of translating the theory of drawing into the logic of light and vision.

The digitisation of the Curioni Collection has enabled the development of a methodological model that integrates the precision of surveying, the geometric consistency of modelling, and the communicative power of digital representation. The transition from documentation to interaction — from 3D surveying to holographic projection — marks an evolution of drawing as a cognitive language capable of extending from the represented space to the perceived space (Figure 7).

Representation is no longer regarded as a closed product (as it seems in archives and collections), but rather as a shared process, in which the digital model becomes a node in an information network that can be consulted, commented on and reproduced.

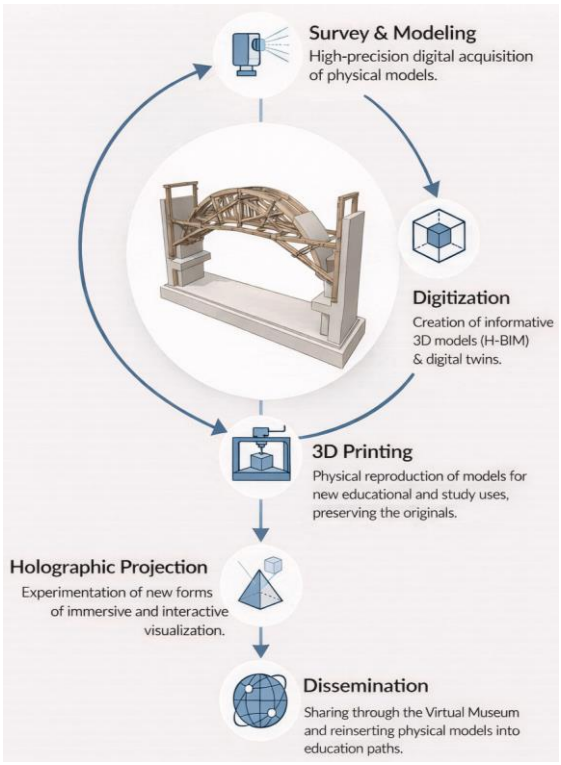

***Figure 7**: An operating system for heritage valorization has been developed to manage analog models into modern communications tools. This cyclical process connects tangible memory with digital innovation.*

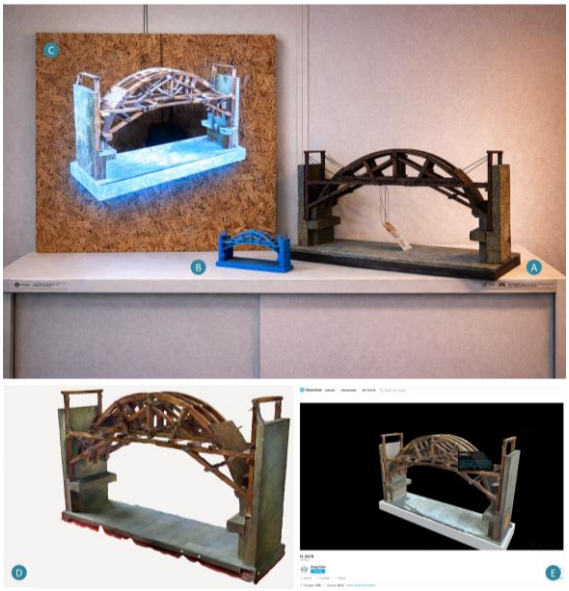

***Figure 8:** Example of a model of a complete suit of armour, known as suspended armour, with wooden fittings (Modello di una armatura completa, detta sospesa con ferramenta in legno), 40x76x20 cm, Inv. 47 (1865-1887, DISEG); A –original wooden model; B - 3D printed model; C – holographic model; D – polycam model; E – sketchfab model).*

The utilisation of cost-effective technologies and open platforms, such as Sketchfab, has rendered models accessible and interoperable, thereby translating the FAIR principles into an operational paradigm of openness and traceability (Figure 8).

This finding serves to substantiate the assertion that drawing functions as a conceptual instrument, serving both as a conduit for comprehending form and, concomitantly, as a medium for the edification of knowledge surrounding it. Experimentation with holographic projection has engendered a novel paradigm in the realm of disciplinary reflection in this applied research.

This experimentation serves to restore the original function of drawing as an instrument of integral knowledge, capable of mediating between sensory experience and theoretical construction.

In terms of future prospects, the project offers a replicable model for the construction of dynamic digital archives and interactive virtual museums. In such a scenario, three-dimensional and holographic representation would become a common language of access, study and dissemination.

The Curioni Collection provides a compelling illustration of how the digitisation process, guided by the meticulous delineation of drawings, can not only accurately restore the physical form of models but also their original function as instruments for thought, comprehension and the dissemination of knowledge, in this case pertaining art of construction.

5. ACKNOWLEDGMENT

The working group involved in the project to enhance and digitise the Curioni Collection is composed of a diverse set of skills and disciplinary profiles from different areas of academic research. It brings together figures from the sciences of representation, surveying and construction, creating a cross-sector collaboration that has made it possible to integrate different methods, tools and objectives into a unified research framework:

Scientific responsibility and coordination: Maurizio Marco Bocconcino; coordination (surveying and modelling): Mariapaola Vozzola; coordination (historical research and educational applications): Martino Pavignano; Ursula Zich, for educational aspects; Marco Piras and Paolo Dabove, for geomatics and measurement skills; Professor Mauro Borri Brunetto, for construction sciences; architect Margherita Bongiovanni and Dr Francesca Gervasio, for activities related to the University's cultural and scientific heritage; engineer Nives Grasso and DISEG technician

Pierluigi Guarrera, for support with acquisitions and metric processing; engineers Luca Gioberti, Federica Bonino, Larisa Semis, Tommaso Verdier, Muhammad Daud, José Luis Reyes Mesias, for assistance with surveying and modelling; junior engineers Emanuele Ricchiello, Roberto Cagliero and architect Salvatore Tartaglia, involved in acquisition, information retrieval and experimentation with three-dimensional and holographic models. The group is also collaborating with the thermographic analysis team coordinated by Monica Volinia, in recent cooperation with the CNR in Padua, for non-invasive diagnostic investigations on wooden models.

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SESSION III

“What´s on in Berlin”

Moderation: Dr. Marinos Ioannides
(Digital Cultural Heritage Research Centre MNEMOSYNE, University of Technology, Cyprus)

Progam EVA Berlin 2026

Conference Day I

"Digital Humanities and AI"

Wednesday, March 18: 08:45 am – 04:30 pm

Conference Dinner

08:45 am – 09:00 am	Reception
09:00 am – 09:45 am	Morning Refreshment
09:45 am – 10:00 am	Conference Opening

10:00 am – 10:30 am
Keynote Speach
Nathalie Keurmeur: "Becoming Digital - Developing a Hybrid Practice"

10:30 am – 12:00 am
Session 1: "Digital Humanities: A Broader Spectrum"

Thomas Weibel
(formerly University of Applied Sciences of the Grisons, Switzerland):
Letterjongg! Featuring Historical Fonts Using Casual Games

Danai Papathanasiou, Stefano Russo, Izabela Derda and Erik Hitters
(Erasmus University, Netherlands):
First They Came for the Schedulers and I Said Nothing:
The Role of Cultural Intermediaries in the Live Music

Jacek Mikucki and Alicja Waszkiewicz-Raviv
(University of Warsaw, Poland):
Intergenerational Shifts in Interactive Approaches to Film Art Consumption:
Generation Z's Preferences and Tastes in the Creation, Distribution and Exhibition of Films

Rodolfo Ward and Suzete Venturelli
(University of Brasilia; University Anhembi Morumbi, Brazil):
Protocols of Appearance: Remaking the Platformized Partition of the Sensible

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12:00 am – 01:30 pm
Lunch Break and Guided Tour Fraunhofer HHI

01:30 pm – 02:45 pm
Session 2: "Reflecting on Digital Tools"

Christos Panagiotou
(Cyprus University of Technology, Cyprus):
A Presentation of the Irregular Archives Project.

Tatjana Menise and Anna Pecerska
(Riga Technical University, Latvia):
Transmedia Storytelling and the Voices of Underrepresented Communities:
The Case of Latgale

Mingzhu Zhang
(University of Galway , Ireland):
Algorithmic Bias and Cultural Diversity: Risk and Regulation in Digital Creative Ecosystems

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02:45 pm – 03:00 pm
Coffee Break

03:00 pm – 04:30 pm
Session 3: "New Frontiers for Art and Digitality"

Mar Morosse
(Baruch College, United States of America):
Visual-Digital Pedagogies: Rethinking Art Education

Iván-Manuel Tapia Bruno
(Mozarteum (incoming student), Chile):
Disrupting the Sensible: Multimediality and Posthuman Politics in Contemporary Art

Clarissa Alessandra Gambuzza and Matevž Domajnko
(Louisiana State University, Croatia | Verus Digital Gmbh, Germany):
Digitizing the Art Market: Mapping Stakeholder Value in 3D Technology Adoption

Kiersten Thamm
(HPF Innovations gGmbH (Navigating.art), Germany):
When AI Falls Short, We Recalibrate the Social and Technical:
A Case Study in Context-Aware Innovation for Art Historical Research

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07:00 pm
Conference Dinner

Conference Day II
"Museology, AI and Heritage"
Thursday, March 19: 09:00 am – 05:30 pm
Social Event at Palais Populaire

09:00 am – 09:30 am Morning Refreshment

09:30 am – 10:45 am
Session 1: "Curatorial Practice and Innovation"

Clio Flego
(Universitat Oberta de Catalunya, Spain):
Co-Curating with the Machine – Rethinking Audience Engagement through AI Mediation

Valentina Salcedo Paparoni
(Staatliche Museen zu Berlin, Germany):
Accessing the Hidden Core:
Connecting Museum Collection Records through the Heidelberg Accession Index (HAI)

Sylwia Szykowna and Dagmara Domagała
(Adam Mickiewicz University, Poland):
Remediations of Memory in Media Art. From the Archives of the WRO Art Center

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10:45 am – 11:15 am
Coffee Break

11:15 am – 0:30 pm
Session 2: "Digitality and Museology"

Manuel Scortichini
(University of Camerino, Italy):
From Data to Dialogue: Rethinking Visitor Participation through Interactive Installations and Citizen Science in the Museum

Federica Maietti, Ursula Thun Hohenstein, Loreno Arboritanza and Chiara Parisi
(University of Ferrara, Department of Architecture | Department of Humanities, University of Ferrara, Museum of Paleontology and Prehistory, Ferrara, Italy):
Enhancement of Museum Collections and Visitor Engagement through Digital Tools and Immersive Experiences. The CHAMELEON Project

Charlotte Triebus and Chris Geiger
(University of Applied Sciences Düsseldorf, Germany):
Languages of Artistic Research –
On Performative Documentation of Research in New Media Art

12:30 pm – 02:00 pm
Lunch Break and Guided Tour Fraunhofer HHI

02:00 pm – 03:15 pm
Session 3: "Spaces and Museums"

Carlijn Juste
(Centre d'Étude des Arts Contemporains, Lille University, France):
Exhibition in Flux: Spatial Concepts for the Exhibition of Digital Media Art

Pedro Vaz and Bárbara Massapina
(General secretary of the Presidency of the Republic | School of Architecture, University of Lisbon, France):
New Orders and Decorations Museum

Jack Ludden
(Balboa Park Online Collaborative, United States of America):
The Impact of Journey Mapping on Strategic Planning and Digital Transformation

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03:15 pm – 03:30 pm
Coffee Break

03:30 pm – 04:45 pm
Session 4: "Heritage and the Virtual Realm"

Marcello Balzani, Fabiana Raco and Martina Suppa
(Università degli Studi di Ferrara, Italy):
Tradition and Digital Transition in Cultural Heritage: The Contribution of the Colosseum HBIM Project. The Digital Infrastructure and Intelligent Analysis for the Interpretation and Management of Architectural Heritage

Drew Baker, Marinos Ioannides, Anthony Cassar and Petros Siegkas
(Cyprus University of Technology, Cyprus | Technology and Development Unit, Heritage Malta, Malta):
The Multidisciplinary Cultural Heritage Community: Towards a Definition of Roles

Anthony Cassar, Marinos Ioannides and Drew Baker
(UNESCO Chair for Digitial Cultural Heritage Cyprus University of Technology, Cyprus | Technology and Development Unit, Heritage Malta, Malta):
Methodology Over Machinery:
Evaluating Low-Cost 3D Acquisition for Cultural Heritage Digitisation

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07:30
Social Event at Palais Populaire

Conference Day III

"AI, Visualisation and Digitality"

Friday, March 20: 09:00 am – 04:00 pm

Social Event at Deutsche Kinemathek │ Informal get together - Dinner

09:00 am – 09:30 am Morning Refreshment

09:30 am – 11:00 am

Session 1: "Artificial Intelligence and Visualisation"

Irene Ruiz Bazán and Gianluca Vita
(Politecnico di Torino | Accademia di Belle Arti di Urbino/ Politecnico di Milano, Italy):
Drawing the Absent: AI, Restoration, and the Hypothetical Image

Enrico Pupi and Piergiuseppe Rechichi
(Politecnico di Torino - Department of Architecture and Design | University of Pisa - Department of Energy, Systems, Territory and Buildings Engineering, Italy):
Architectural Representation Conditioning Stack (ARCS):
Generative Process Multimodal Control

Giulio Lucio Sergio Sacco and Carlo Battini
(University of Genoa, Italy):
From Early Design Geometry to Architectural Vision:
Open-Source Generative Workflows for Speculative Design

Hannes Rall, Alice Osinska and Aaron Zhi Qiang Lim
(Nanyang Technological University, Singapore):
AI Shakespeare: Mitigating hallucinations in Co-Creative Animation

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11:00 am – 11:30 am
Coffee Break

11:30 am – 00:45 pm

Session 2: "Immersive Virtuality"

Roberta Spallone, Michele Russo, Marco Vitali, Fabrizio Natta, Enrico Pupi, Martina Casciola and Martina Rinascimento
(Department of Architecture and Design - Politecnico di Torino | Department of History, Representation and Restoration of Architecture - Sapienza Università di Roma, Italy):
Virtual Tour for Heritage Accessibility: The case of Palazzo Carignano Museum

Nicola D'Addario
(Faculdade de Arquitectura da Universidade do Porto, Portugal):
Virtuality as Knowledge: Reclaiming Unbuilt Architecture through Immersive Archives

Mariapaola Vozzola and Maurizio Marco Bocconcino
(Politecnico di Torino, DISEG Department of Structural, Geotechnical and Building Engineering, Italy):
Holographic Artifacts for the Enhancement of Academic Heritage:
The Curioni Collection at the Polytechnic University of Turin

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00:45 pm – 02:15 pm
Lunch Break and Guided Tour Fraunhofer HHI

02:15 pm – 02:30 pm
Session 3: “International Cooperation”

UID – Unione Italiana Disegno

02:30 pm – 03:45 pm
Session 4: “What´s on in Berlin”

Andreas Bienert
(University of Applied Sciences Potsdam)

Oliver Schreer
(Fraunhofer Heinrich-Hertz-Institut (HHI), Berlin)

Jacopo Spinelli | Dominik Lengyel | Lyubov Dimova
(Brandenburg University of Technology Cottbus-Senftenberg)

03:45 pm – 04:00 pm
Conference Closing Remarks

06:00 pm
Social Event at Deutsche Kinemathek

07:30 pm
Informal get together Dinner

PROGRAMME ORGANISATION

Chairs

Univ.-Prof. Dipl.-Ing. Dominik Lengyel
(Brandenburg University of Technology Cottbus-Senftenberg,
Chair of Architecture and Visualisation)

Prof. Dr. Andreas Bienert
(form. Staatliche Museen zu Berlin – Preußischer Kulturbesitz)

Eva Emenlauer-Blömers
(form. Senate of Berlin, Department for Economics, Technology and Research, Project Future)

in collaboration with

Dr. Joachim Giesekus
(Gesellschaft von Freunden des Heinrich-Hertz-Instituts e.V.)

Dr.-Ing. Ralf Schäfer
(Fraunhofer Heinrich-Hertz-Institut, Berlin)

Dr.-Ing. Oliver Schreer
(Fraunhofer Heinrich-Hertz-Institut (HHI), Berlin)

Dr. James R. Hemsley
(EVA Conferences International, UK)

Prof. Dr. Anja Ballis
(LMU Munich, Institute of German Philology)

Pedro Santos
(Fraunhofer Institute for Computer Graphics Research (IGD), Darmstadt)

Venue

CINIQ @ Fraunhofer Heinrich-Hertz-Institut
Salzufer 6, 10587 Berlin
Entrance Otto-Dibelius-Straße, 4th floor

https://www.hhi.fraunhofer.de/

Contact

Univ.-Prof. Dipl.-Ing. Dominik Lengyel
B-TU Cottbus-Senftenberg
Konrad-Wachsmann-Allee 4
03046 Cottbus / Deutschland (Germany)
T +49(0)355 69 2449
lengyel@b-tu.de
info@eva-berlin-conference.de

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