Integrating AI in Museums
A New Phase in the Museum's Transformation
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1. Introduction

Museums have undergone significant changes in recent decades in how they function and the definition of their goals. Formerly dedicated to representing and preserving the values of the past, museums now strive to reflect and react to contemporary reality and acknowledge their duty to convey future challenges. The assimilation of new technologies in museums has connected museums with what can be referred to as *digital being* and *digital thinking*, while becoming part of a digital ecosystem of networks and collaborative platforms, combining the physical with the virtual (Bowen and Giannini 2019, 3).

The latest phase in the museum's digital transformation is the inclusion of artificial intelligence (AI) technologies, which have already changed how we perceive reality and acquire knowledge. Integrating AI in museums is currently in its primary stages and is still directed mainly at specific domains expanding the capacities that digital technologies have provided so far: From knowledge organization through preservation, curatorial, and interpretation practices to interaction with visitors and institution management. Although integrating AI in museums has not generated a paradigmatic shift in the ways museums perform and define their role in society, this article argues that it has the potential to make a more substantial transformation in the future.

To understand the potential impact of AI's integration in museums, this article focuses on the transformation of museums' "knowledge organization systems" resulting from such integration. This text analyzes how three major museums "actors" – workforce, visitors, and provenance – contribute to the transformation and reshaping of these systems. It argues that the advent of AI in museums results in two seemingly contradictory processes: On one hand, AI's capacity to amalgamate diverse knowledge systems and resources from various ontological fields enables a comprehensive and systemic approach to the museum, offering a self-reflexive

perspective. This enables museums to more systematically contextualize their exhibitions and deal with meta-museological issues. On the other hand, the increasing reliance of museums on external stakeholders, such as AI-related and big-data industries, governmental institutions, and global collaborations, has a genuine impact on the growing process of platformization in museums, which challenges museums' autonomy and uniqueness. This article argues that the dynamism of museums relies on the interplay of these two processes, which can uphold the museum as a dynamic institution and redefine its connections with the "outside world."

As most research addresses the potential benefits, limitations, and risks of integrating AI in museums, this paper pays special attention to the infrastructures and mechanisms that enable such integration and explores their impact on the museum performance. It emphasizes the role of the different agents and stakeholders (revealed and concealed) involved in this process and the power structures that they form given that infrastructures often are invisible yet "highly politically and ethically charged" (Bowker and Star 1999, 147). This article follows Bruno Latour's actor-network theory (ANT), which claims that objects, technologies, and different organizations, along with human beings, have their own agency. Therefore, they can "authorize, allow, afford, encourage, permit, suggest, influence, block, render possible, forbid, and so on" (Latour 2004, 226). This approach provides a better understanding of the interrelations between the social and the technical systems, which are not conceived as simple tools used by humans but as part of a larger ecosystem containing the social context of their development, implementation, and use (Park 2021, 239). Based on these assumptions, this article claims that a deeper understanding of the consequences derived from the convergence of AI in museums cannot be achieved without understanding thoroughly what is facilitating this convergence, which is far beyond its algorithms and its generative properties.

2. Knowledge Organization: Digitation and Metadata Agency, and New Infrastructure Agents for Knowledge Organization

Museums are cultural institutions, but they are also institutions of documentation, authority, and control. Traditionally represented as a humanistic world order based on classification and categorization principles, museums made it possible to theorize the unseen, make the invisible visible, and solidify the relationships between the marginalized and powerful (Bennett 2004). Museums' traditional cataloguing systems have been transformed with the advance of new technologies and the exten-

sive digitizing of museums' collections. The transformation from analogue documentation to networked cataloguing systems has made the sociotechnical aspect of museums' knowledge-organization systems more evident. Therefore, museums have functioned not only as sites for ordering systems of historical documents but also as sites of negotiation and performance (Turner 2017, 474-475).

To understand how these intricate processes occur with AI, it is necessary to explore the significance of the evolving nature of digital objects, which are the system's "building blocks". These objects are based on a clear distinction between data and metadata. As data represent the digitized version of the museum's object (or, in the case of original digital objects, the objects' self), metadata can be defined as "data about data" (Baca 2008, 2016) or as "structured data about resources" (Park 2021, 242). The meta-data allow automated and machine-readable processes to be created around the data. The unique mobility of metadata results from their being part of a system that can reflect three different features about objects: content, context, and structure (Ibid).

Philosopher Yuk Hui's analysis of the concept of metadata can be useful in exploring the potential role of AI in museums' digital archives and museum collection management systems (CMSs). Referring to the properties of digital objects, Hui argues that the value of these objects is not limited to the information they contain but rather to their ability to make connections with other objects through metadata. The networks that operate and link the various objects are actualized through parametric definitions and algorithms and through different computer protocols and standards. (Hui 2016, 25). "Data become objects and also the source of relations; this means the objects can join together materially through transmission networks, codes, and so on" (Hui 2012, 393). Therefore, digital objects cannot be perceived only as data, but as the overall system that makes it possible for the object to connect with other objects.

Metadata's agency can become more powerful when AI systems are integrated. As AI algorithms flow through large data sets containing data from different sources, they may attract new actors and expand their network. They can contribute to overcoming museums' conventions, standardized protocols and policies related to collections documentation by discovering new patterns within the datasets. Therefore, they can offer new opportunities for museum curators and visitors (for example, AI Explorer, Harvard Art Museum, 2019 or MosAIC, Rijksmuseum, and the Metropolitan Museum of Art, 2020).

An additional assertion by Hui can help understand this new dynamic

generated in knowledge-organization processes made possible through AI. Following Gilbert Simondon's distinction between the concepts of individualization and individuation (Simondon 2009), Hui argues that the ability to produce connectivity between various objects relies on two parallel processes: Distinguishing one object from another through a process of individualization, signified by an evolutionary progression of form toward a fixed form. On the contrary, the continuously becoming subject enabled by "a transformation in the operation of relations and structures" is signified by the process of individuation (Hui 2016, 109). This process is embedded with the same somatic potential as a person while being concretized continuously (Rozenberg 2021, 7). Applying connectivity through these parallel processes with AI algorithms enables the dynamism of the construction, management, and distribution of knowledge in museums generated by the diverse actors engaged in the museum's performance.

Knowledge Infrastructure

The complexity of AI-based knowledge-organization systems in museums, which allows objects to connect with other objects to generate knowledge, surpasses the pure structure of the algorithms. It encompasses material resources, human labor, and data for their production, distribution, and disposal. The multitude of agents engaged in these processes represents a diverse array of social complexity and political interests. Before delving into the practical aspects of using AI in museums, we will briefly refer to the broader aspects of the infrastructure required for using these technologies.

In a report produced for the European Union (EU) (Magdalena 2023), it is asserted that the EU depends on the United States for its online cultural platforms and on Asia for its equipment. U.S. companies manage 90 percent of the EU's data, and EU platforms represent only 2.7 percent of the global total value of platforms (as of 2021). As a result, European museums strongly rely, as in other parts of the world, on foreign companies to develop their AI-based applications for collection management and for the storage of their databases. These information-technology (IT) companies currently provide diverse AI tools at no cost or for a reasonably low price, ranging from machine-vision tools that assist in creating metadata tags for images (such as Google Cloud Vision API and Microsoft Azure) or a natural-language processing tool used, for example, for analyzing visitor feedback (IBM Watson).

As we know, these corporations are an integral part of the contemporary power landscape and are oriented toward commercial interests. They have supplanted the conventional political power structures associated with

nation-states, which dominated the museums in their earlier forms, shaping the foundations of new knowledge structures. The immense datasets and processing capabilities wielded by these corporations render the creation of viable alternatives nearly impractical without substantial collaboration on a large or even mega-scale, as can be seen in the Europeana project. Therefore, any initiative for alternative infrastructures for knowledge sharing should comprehend the (existing and potential) implications of dependencies on external actors and on the ability to provide reliable data to implement AI effectively. [1]

Initiating alternative frameworks for knowledge management systems using AI raises the inherent conflict imposed by digitation processes in museums. On the one hand, there is a pressing need for the unification and standardization of metadata and the development of controlled vocabulary to enhance the internal efficiency of museums' collections management systems based on professional standards. Achieving these goals should ensure the interoperability of collections data across various cultural institutions (Baca 2008, 2016). On the other hand, allowing distinctive contextualization in each museum is essential in preserving the unique character of individual institutions and the singularity of their collections. Within this frame of reference, the distinction between individualization and individuation processes on the systemic level not only reflects the system's operation process but also becomes a source of political institutional debate. In addition, conflicting agencies from trained datasets can lead to issues with copyrights and licensing.

3. Workforce, Visitors, and Provenance: Agency in Museum Transformation

The integration of AI in museums has introduced new actors into museums and transformed the roles of traditional ones. In this section, we explore the transformation of three key traditional actors that play significant roles in shaping knowledge within museums: manpower, visitors, and provenance records.

Museums' Workforce

Digital transformation has brought new experts in diverse fields to the museum to fulfil the new mission of contemporary museums. Among them

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[1] The need for using alternative datasets derives, among others, from the urge to minimize biases and misinterpretations, extensively examined in many research studies (see, for instance, Ciecko 2020; Craig 2021; Murphy 2023; Zhitomirsky-Geffet 2023).

are experts who specialize in user experience (UX) and search-engine optimization (SEO), innovation, content strategy, community management, storytelling, evaluation, open data, big data, and data analysis (Rodà 2022). These professionals, as well as Deep Learning, machine learning (ML), and natural-language processing (NLP) experts, have been instrumental in bringing about a paradigm shift in knowledge management within museums. However, according to the *Digital Culture Report 2019*, referring to the situation in the United Kingdom, 46 percent of museums face difficulties in executing digital projects due to a lack of skills and knowledge among their employees.

In this state of affairs, IT personnel are gaining increased responsibilities for providing the infrastructure for collecting, recording, and disseminating knowledge in the museum. This can be seen, for example, in the handling of the museum's CMS. Although curators and registrars are the ones who are authorized to produce knowledge about their collection's items, their impact becomes limited. When a curator or a registrar adds metadata to the system, the system informs them what should be recorded and documented and in what ways (Park 2021, 241). In practice, IT personnel can exert a considerable influence on the museum's information policy, content, and functionality, extending beyond the mere functionalities of IT applications (Duff et al. 2009).

Integrating AI into information management systems in museums introduces additional challenges for museum professionals. As the primary custodians of knowledge regarding the museum collection, curators and registers hold exclusive authority in shaping the metadata for the registered objects. However, many experiments have been conducted to take advantage of significant improvements in AI system accuracy for automatic tagging. Examples can be seen in projects such as the SMK Online collection project for image tagging using Microsoft's Vision Services (2019), and the Training the Archive project (2020-2023) at the Ludwig Forum Aachen (Germany), which utilizes machine learning technologies to embed contextual collection data as a means to influence new approaches to curatorial thinking and practices (Arns et al. 2024) According to research conducted by the Electronic Frontier Foundation, which measures the progress of artificial intelligence, the error rate has decreased from around 30 percent in 2010 to approximately 4 percent in 2016, making the error rate comparable to that of humans (Baca 2008, 2016). The advent of AI in computer vision and other domains has led to a gradual shift in metadata creation, with computerized systems facilitating collaboration between

humans and machines or increasingly taking on this role, often rendering human professionals redundant.

However, using AI requires trained data. The precision and interpretive capacities of these automated systems are intricately tied to the quality of databases and algorithms used to formulate the data. As trained data are mainly facilitated by cheap workers in the gig economy,[2] cultural gaps can play a role in the way metadata are defined. In addition, the question of who has the knowledge and who owns it gains heightened importance, given that, with emerging knowledge structures and production mechanisms, dependence extends extensively to external agents beyond the confines of the museum.

Visitors

Museums' digitization process has improved the accessibility of their collections and changed the nature of visitor interactions across both physical and digital realms. Nevertheless, it has also shaped the design of museum knowledge platforms, leading to the prioritization of certain subjects over others in direct reference to visitors' interests. Projects using AI technologies have intensified this process. Natural language processing, cognitive computing, and machine learning allow museums to dynamically tailor knowledge to a diverse audience without being confined to predefined templates while generating new connections. Projects such as Dot, the Tour Guide, from the Akron Art Museum and the Smartify application used at the Smithsonian's American Art Museum and National Portrait Gallery (and being applied in many other museums worldwide) exemplify this kind of experimentation. However, tailoring knowledge to individual visitors based on their engagement preferences mirrors the self-customization practices observed in the commercial sphere. The assimilation of such practices from the business sector into museums is part of a broader transformation in perceiving the museums' evolving mission in contemporary society.

Additionally, the visitor's role in shaping the museum's transformation has gained prominence in recent decades, partly because they have become subjects of datafication, inspection, and analysis. ENEA system used in Bologna municipal museums (Charr 2021), AI Visitor Behavior Analysis (at the Tate Britain), and Machine Learning Model Project to predict how

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[2] See, for example, the project developed by Auckland Museum to assist with cataloguing the museum's collection using the "gig economy" for image tagging (Moriarty 2019).

long visitors engage with specific works of art (Rohe et al. 2020) are among many projects based on visitors' reactions. The integration of AI into this framework serves to markedly augment visitors' agency, allowing comprehensive analysis and prediction of their preferences (Kuflik et al. 2012). The compilation of data pertaining to visitors' emotional states and preferences, alongside diverse information such as changes in weather conditions or external events that may impact visitor reactions, enabled the dynamism of knowledge organization to become subject to new parameters embedded within/in-between museums' CMSs and management systems.

For these reasons, when the interaction of structured data provided by the museum and the logic of an algorithmic media system becomes affected by the visitor's presence, the visitor becomes part of the intricate interplay between curated content and algorithmic decision making. Further, AI can provide a contextual reading of a changing reality that can be sensed and monitored at any given moment. Because AI relies on statistical and probability calculations and predictions based on past precedents, it reflects techno-societal phenomena generating feedback-loop cycles that can also result in social and cultural stagnation.

AI's impact on the visitor's agency in museums can also be analyzed from an entirely different perspective. IT companies use museum visitors as a resource for manpower for their own interest. These companies take advantage of the museum's infrastructure while employing crowdsourcing practices to refine AI outcomes. They exploit users' time and effort in a way which reminds of Amazon's Mechanical Turk, where users undertake tasks for minimal compensation. A critical examination of the impact of AI applications is illustrated by Tim Schneider (2019), who references the collaboration between the Metropolitan Museum of Art (the Met), Microsoft, and MIT. Despite the collaboration ostensibly commencing to enhance insights into the museum's collection, Schneider contends that it was ultimately steered by the interests of the participating entities. This collaboration, he argues, raises concerns regarding how IT companies might actively assert their commercial interests within the museum, potentially exploiting users through the mandatory exchange of personal data or labor (Ibid.). In this respect, the visitors can be considered as "proxy agents" that enable other agents (AI companies) to use the museum's infrastructures for commercial purposes.

Provenance Records and the Museum's Archives

When museums digitize their collections, they also provide provenance records. These records are essential to establish the history and owner-

ship of artworks and artifacts. Provenance refers to the complete chain of ownership, custody, and location of a work of art or cultural property from when it was created to its present-day location. It is a crucial aspect of preserving and understanding cultural heritage. Although museum provenance records formerly were inconsistent, leading to biases and varying levels of detail (Rother et al. 2022), making these records accessible allows museums to fulfil their social responsibilities by embodying principles of transparency, accountability, and inclusivity, particularly within the current context of endeavors toward restitution and decolonization (Ibid.). In navigating this process, provenance records can illuminate the intricate connections between museums and the repercussions of historical injustices, offering insights that might be absent from standard museum data.

AI algorithms can assist in authenticating museums' objects by analyzing provenance records.[3] Furthermore, they can contribute to achieving higher contextuality of the documented records, providing a museum object with a multiplicity of connections and, therefore, enhancing their transparency. The ability to contextualize data provided by museums through additional resources paves the way for new interpretations and alternative histories.

Using AI can also reveal the complexity entailed in such records by connecting the different circumstances in which the objects became part of the museum's collection, or were registered, stored, or selected for exhibitions. It allows one to find such data as connections to the events that precipitated a specific exhibition or the person who created the record or was involved in it (Laurenson et al. 2017). With robust analytics tools, it becomes possible to discover the potential effects of changing priorities and trends in the art world, history, scientific research, and education (Bayley 2019) and offer an extensive contextualized analysis of the museum's activities.

Furthermore, integrating all data related to both the objects in the museum's collection and the museum's overall performance offers opportunities for self-reflection on the museum's functioning as a cultural institution. Although not much research has been conducted on this aspect of using AI in the context of provenance records, it has a significant potential to expand beyond topics such as colonialism, looted art, and authenticity, which are currently at the heart of provenance research. It can turn object-related data into knowledge about the museum as an institution.

[3] See, for example, ReMasterpiece Project, which aims at re-creating paintings stolen, lost, or destroyed by the Nazis during World War II.

4. The Platformization of the Museum

In the post-digital era, the term *platform* has become the central model around which the internet, organizations, and social interactions are structured. The numerous digital platforms that have emerged since the 2000s have facilitated our daily activities and introduced new cultural practices and social norms that enhance and engineer human relationships (Van Dijck 2013, 9-14). However, although the platformization process is conceptually derived from the digital, it is evident in both digital and physical realms, reconfiguring a broad spectrum of practices and products. Such processes have infiltrated museums, both structurally and metaphorically.

Indeed, while eighteenth-century museums were dedicated to collecting and exhibiting material objects, contemporary museums have transformed into dynamic platforms that facilitate access, sharing, and co-production of heritage in an ever-expanding array of modalities (Lacedelli 2018, 31). They function as platforms for cultural and civic exchange, as well as for intercultural negotiations and the creation of historical and civic values (Schaeffer et al. 2022). Museums' platformization process signifies a multifaceted approach, encompassing a shift in how museums engage practically with their visitors and how cultural values evolve. It is achieved by generating "a microsystem of relationships that interact with other microsystems at both local – the territorial network of stakeholders – and global level – the online ecosystem." (Ibid., 33.)

Contemporary AI-based platform models developed by the IT giants replace the traditional linear-value models generated by creating and selling goods and services. These new value modes derive first and foremost from the connections the platforms facilitates, not from the objects they inhabit (Parker et al. 2016, 6). As we have seen before, this logic also applies to digital objects, redefined by their ability to connect with other objects. When museums integrate their activities into the virtual space, they engage with giant digital platforms like Google, Facebook, Instagram, YouTube, and X, which impact how knowledge is generated, disseminated, and interpreted. During this process, they open museums to a new logic while blurring the rationalities of cultural institutions' logic, manifested in their collections, with algorithmic media (Wilson-Barnao 2018, 95).

As the effect of digital platforms on culture is gradually brought deeper into online environments, culture has become increasingly intertwined with the goals of digital platforms that seek to monetize the vast amounts of user information they gather. These platforms are characterized by the entangling of participatory ideologies, practices, and tools that can be

implemented with social on-demand media platforms and the incumbent surveillance economy generated by AI, characterizing also contemporary museums (Ibid., 96-98). The platformization of museums allows, on the one hand, enhancing the overturning of the traditional model of participation offered by cultural institutions and thus presenting a more dynamic, democratic, co-creative, and audience-centered approach (Bourriaud 2002; Paul 2008; Simon 2010; Gillespie 2010). On the other hand, it ties museums into the confines of the practices embedded within these platforms based on flows of networked data generated by their algorithms and datasets and oriented toward real-time reactions and optimization.

5. Concluding Words

Integrating AI tools in museums amplifies the ongoing transformation of these institutions, shifting from reliance on internal professional competencies and resources to a more platformized model mainly linked with commercial entities. As the influence of tech corporations and global digital platforms becomes increasingly prominent in the current "post-truth" era, ethical concerns, once mainly focused on the origins of assets and represented values, are now evolving to encompass a broader array of implications arising from affiliations with external stakeholders. These include nuanced considerations of the diverse values represented by the external entities, highlighting the need for an ethical framework that addresses the complexities of contemporary socio-economic landscapes. In evaluating this dynamic shift in value priorities, assessing its alignment with the museum's mission becomes crucial. As visitors are depicted as "prosumers" or "producers" empowered to actively "talk back" to the museum, the issue of the museum's authority takes on heightened significance. (Bruns 2006.)

Additionally, a thorough consideration of potential unintended consequences stemming from these partnerships is imperative. These consequences touch upon issues such as trust, privacy, ownership, and security that museums are expected to commit to. The manifold entanglement of different partakers requires a nuanced understanding of how museums can navigate complex societal issues through their new evolving formations.

This article endeavors to show that the profound impact of AI on the platformization process within museums can be regarded as a stimulator for museum's heightened focus on self-reflexivity. The capability of AI systems to link data concerning museum artifacts, exhibits, their performative features and their connections to various entities (such as objects, people, organizations, and technologies) can produce comprehensive

data analytics related to the overall operation of the museum. Thus, it enables a self-reflexive view of the museum's performance while serving as a dynamic platform entangled within other global and local platforms of different characters. In a fragmented reality where authority and trust in their traditional form are being challenged, the museum's self-reflexive engagement with its internal mechanisms becomes a potential anchor for addressing issues related to the museum's transforming goals and values.

This way, with AI's ability to provide a more comprehensive reflection on the museum's performance, museums can intervene with the entire ecosystem in which they act and interact and expand their individualization and individuation capabilities.

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