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Digital Cultural Heritage Design Practice: A Conceptual Framework

Human-Centred Design approaches in museums give rise to a new, digital cultural heritage design practice by refocusing design from the (digital) technology on to the (digitally-enhanced) visitor experience and requiring involvement in design from both designers and non-designers. This practice is foregrounded as central within a wider landscape of transformative museum design and innovation. The paper calls for a new research agenda that takes design practice as the unit of analysis and recognizes the uniqueness of each cultural heritage organization and its capacity to deploy digital media and technologies successfully in its own unique ways and as a matter of organisational fit. We outline this agenda through a conceptual framework for the analysis of digital cultural heritage design practice along the dimensions of activity, tool mediation, and knowledge production. The framework acknowledges that the design of digitally-enhanced visitor experiences is catalytically mediated by tools and constitutes powerful ways of knowing-in-designing.

Keywords: design as practice; museums; digital cultural heritage

Introduction

Digital cultural heritage design explores how digital technologies and media can be used to enhance the visitor experience. Research effort has concentrated on its outcomes and methods, and the merits of the outcomes in transforming the visitor experience. Meanwhile, the ‘designing’ itself has been forming into a practice to which research has not yet responded and which has not been analysed as a parameter for the effectiveness of the outcomes. This paper brings the importance of practice (understood as ‘doing’ digital cultural heritage design) into focus to propose and defend a new research agenda that is located within a wider landscape of transformative museum design and innovation practices.

It is important that research focuses on design practice urgently, by refocusing the analysis of digital cultural heritage production from outcomes to practice. Design research tells us that design outcomes are the product of intertwined, complex factors of human nature and the dynamics between people, practices, and social processes (Olesen 2015; Roberts 2014, 2015; Roppola 2013); to focus on design practice is to focus on these factors and dynamics in order to understand their role in the production of digital cultural heritage as equally important to the features and potentials of the digital technology. Olesen (2015, 284) remarks that “not much of design research critically considers the organizational processes in which digital museum communication emerges”; this echoes others’ calls for research into cultural heritage design practice, its methodology, institutional embedding and management (Olesen 2016; Roberts 2014, 2015; Roppola 2013).

Responding to this need, this paper presents a conceptual framework that features three perspectives – activity, tool mediation, and knowledge production – through which to analyse digital cultural heritage design practice. It provides a means for analysing this new practice in terms that it has not before been analysed in museums: in terms of an activity system where a disciplinarily diverse team of staff and partners engages in the (co)creation of knowledge about how to design in ways that are specific to and appropriate for the museum and its audiences; in terms of the network of actions and actors that constitute the practice; in terms of the design methods and representations that catalyse the design activity system; and in terms of the design knowledge assets that grow out of and feed back into the system. The framework is informed by design research approaches that advocate design as practice (Crouch and Pearce 2013; Julier 2007, 2013; Kimbell 2011, 2012; Kimbell and Street 2009). It reveals new ways of understanding how disciplinarily diverse museum teams come

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together in digital cultural heritage design practice, and new ways of understanding this practice as deeply situated and reliant on equally situated knowledge. In so doing, it opens a new research agenda for digital cultural heritage design that refocuses attention from what is being designed (outcome) to how it is designed (process).

The paper is structured as follows: Section 2 presents a brief overview of the context in which the new practice emerges, setting the scene for an approach that grounds the study of design in the situated practices and work routines of the individuals who perform it (Kimbell 2011). Section 3 elaborates the informing of the framework by design as practice approaches (Julier 2013; Kaptelinin and Nardi 2012; Kimbell 2011, 2012; Kuijer and De Jong 2011; Kuutti and Bannon 2014; O’Keeffe, Thomson, and Dainty 2015). It also presents background information on the case study that is used to illustrate the conceptual framework in subsequent sections. Sections 4, 5 and 6 present the three perspectives of the conceptual framework that examine digital cultural heritage design as *activity*, as *tool-mediated practice*, and as *knowledge production* respectively. The paper concludes by calling for a new research agenda for digital cultural heritage design that takes practice as the unit of analysis.

Digital Cultural Heritage Design: the emergence of a new practice

Digital cultural heritage design is driven by the need to deliver visitor experiences and services that integrate digital and physical interactions. This need raises complex design problems that go beyond issues of interface usability to include the physical, social and cultural positioning of digital elements within the overall visitor experience. In practice, this translates into more museum staff, from more museum departments, engaging with the processes of designing visitor experiences. This in turn gives rise to what we refer to in this paper as *digital cultural heritage design practices*: practices that are driven by

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the production of integrated physical and digital visitor services, and which are fuelled by the digital upskilling of the museum workforce (Royston and Parry 2019).

Digital cultural heritage design practice must be seen alongside the sector-wide institutional refocusing from objects and collections to visitors (Samis and Michaelson 2016) and stories (Nielsen 2017). It is contextualised by two concurrent shifts towards socially-engaged (Janes and Sandell 2019) and community-oriented curatorial practices (Golding and Modest 2013). Digital cultural heritage design is both shaping and shaped by the integration of digital within these emerging audience-focused museum practices and, therefore inevitably, results in and emerges out of the organizational change that ensues.

Often this happens through the introduction of Human-Centred Design (HCD), i.e. the application of methods and tools for understanding human users and their needs and feeding that understanding into the design of socio-technical systems that support our creative explorations of the physical and digital spaces we inhabit (Giacomin 2014; van der Bijl-Brouwer and Dorst 2017). Within the organizational context of the museum, an understanding of visitors' creative explorations and engagements can only be achieved through the confluence of all parts of the organisation to design visitor experiences and services. As this realisation sinks in, we have in recent years seen within museums the emergence of numerous HCD approaches (French 2016; Mitroff Silvers 2017; Mitroff Silvers, Rogers, and Wilson 2013), the implementation of which requires substantial organizational change.

The case of Derby Museums' *Museum of Making* in the UK illustrates clearly this organisational change and its contexts. Derby Museums is an independent charitable trust that manages three museums in Derby, a medium-size city in the East Midlands. The *Museum of Making*, previously known as the Silk Mill, is part of the

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UNESCO Derwent Valley Mills World Heritage Site. Throughout its development, the museum adopted HCD as a way of thinking, exploring, experimenting, creating, and making. The integration of HCD brought new creative design tools and methods that required working routines and practices to change (Fox 2015). Similar examples of HCD adoption in museums can be found across the world,¹ promoting highly collaborative, multidisciplinary working practices (Norris and Tisdale 2016), where museum professionals are called to take an active part in design activities in collaboration with external specialists and partners (Vavoula and Mason 2017; Mason 2015). This results in change: in new types of social interactions, work patterns and structures within the organization that stem from the introduction of new physical and conceptual tools for creativity and collaboration, the re-configuration of workspaces, and more generally the re-alignment of the organisation's working practices. Amidst this change, digital cultural heritage design is forming into a new practice. The following section looks closer at the *practice* nature of digital cultural heritage design, to identify the main dimensions that need to be considered in its analysis.

Digital cultural heritage design: a design-as-social-practice approach

Our analysis of digital cultural heritage design is based on an emergent direction in design research that calls for studies of design as social practice (Dorst 2008). This line of research foregrounds ecologies of design and the need to study interrelated aspects of the

¹ See Dana Mitroff Silvers <https://designthinkingformuseums.net/category/case-studies>; Giuliano Gaia <https://medium.com/@invisiblestudio/how-we-helped-the-egyptian-museum-of-turin-to-re-think-its-audioguide-using-design-thinking-6a27b080b3de>; and Frankly, Green + Webb <http://www.franklygreenwebb.com/2015/11/03/van-gogh-museum-amsterdam/>

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design process (Dorst 2015, 2016; Kimbell 2011, 2012; Kimbell and Street 2009). It draws on previous work on theorising practice in other domains (Schatzki, Knorr-Cetina, and Von Savigny 2001; Nicolini 2012; Reckwitz 2002) to propose design-as-practice as an ontological position that moves away from a focus on methodological or cognitive perspectives of the design process. It views design as “a situated, contingent set of practices carried by professional designers and those who engage with designs ” (Kimbell 2012, 131). It offers a way to conceive of design as a situated collaborative accomplishment, constituted as a nexus of activities, tools and material infrastructures, knowledge sharing and know-how, and the institutional arrangements within which designs are collectively created (Kimbell and Street 2009).

A ‘practice’ is the network of everyday (inter)actions among individuals within an organization. Accordingly, a digital heritage design practice emerges when a set of collaborative design activities, completed during interactions between museum staff, digital developers, designers, and other stakeholders, become part of everyday, routine museum work. Routinisation through repetition transforms everyday activities into practice (Parmigiani and Howard-Grenville 2011; Pentland, Hærem, and Hillison 2010).

As will be explored more fully later in this paper, design-as-practice thus transports the locus of design work from the designer’s head to the nexus of workplace interactions, highlighting the systems of *activity* at its ontological core. Meanwhile, the human activities that constitute design practice are mediated by design artifacts and spaces (De Vries and Masclet 2013) which become an integral part of the collaborative design activity they facilitate. Central to the patterns of activity mediated by external representations of design is the knowledge embedded in individuals, design artifacts, and the social interactions between them (Ewenstein and Whyte 2009). This knowledge is mobilised as design activities take their course, and results from the course of design

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activities. It evolves as the team's design practice develops and is an integral part of the team's practice (Orlikowski 2002). Design-as-practice thus views *knowledge* as emerging from practice and existing within practice, highlighting practice-as-knowledge at its epistemological core.

We therefore propose *activities*, *knowledge*, and *mediating objects and tools* as three interrelated perspectives from which to look at digital cultural heritage design practice (see Figure 1). These three core aspects occur recurrently in theoretical accounts of practice, which is portrayed as "a routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz 2002, 243-63). The development of the three perspectives draws on activity theory, studies of external representations in design, and organisational knowledge studies. Miettinen, Paavola, and Pohjola (2012) classify these as 'classical practice theories' and argue that, in contrast to the new social theories of practice, they are better able to analyse how practice changes through the reflective processes that are activated when routines and habits break down. While our analysis is not focusing on breakdowns per se, the routines and habits of digital cultural heritage design practice are under formation and therefore subject to reflective development and change.

Nicolini (2012, 215) urges such adoption of different perspectives from which to understand a practice in all its complexity as a "multifaceted and multidimensional phenomenon [that] can only be empirically approached from [multiple angles]". In digital cultural heritage design, the performative interplay of these three perspectives enacts *designing* (Kimbell 2012). By interrogating theories and concepts across the three dimensions, the following three sections reveal new ways in which research can

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 probe digital cultural heritage design practice to understand the production of digital in the museum.

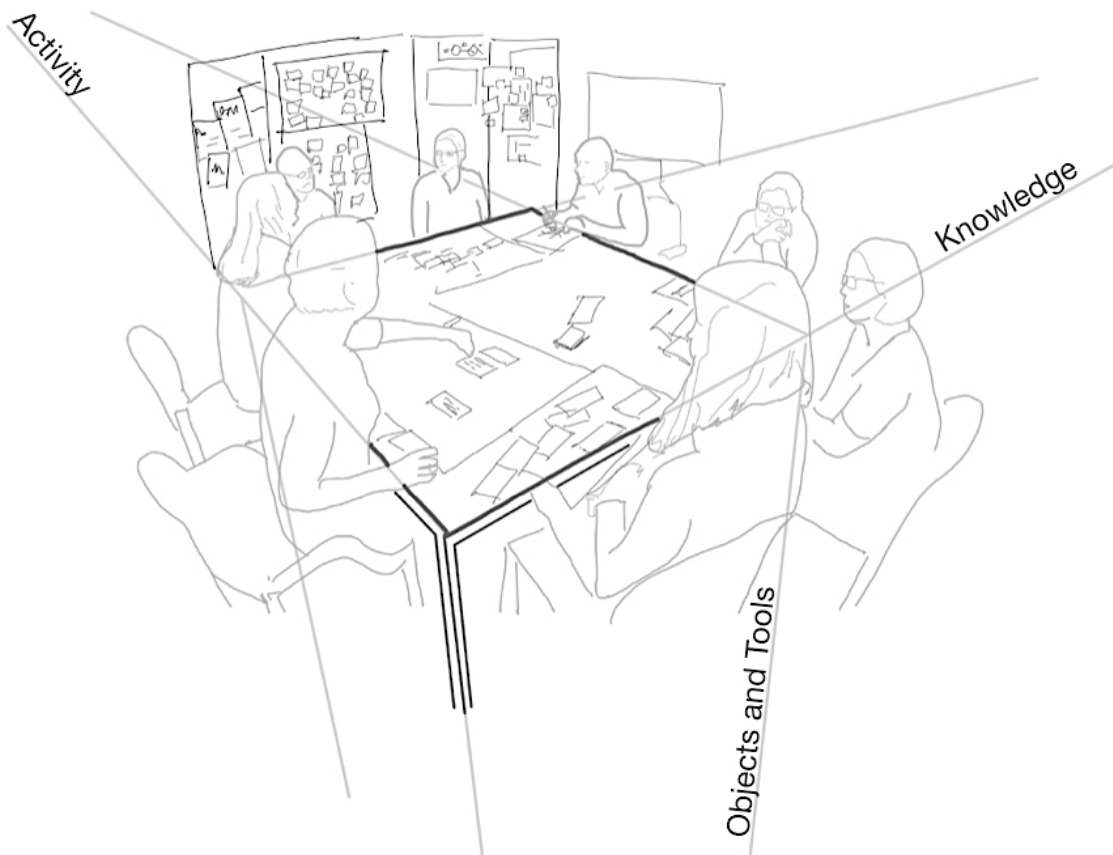


Figure 1. A three-point perspective of digital cultural heritage design practice

The formulation of the conceptual framework resulted from our work on two research projects funded by the EC Marie Skłodowska-Curie Actions between 2012 and 2018. The first project studied American museums engaging in the production of digital technologies and media to enhance the visitor experience. The research involved series of interviews with museum staff and external partners who were involved in the design process, as well as analysis of related project archives and documentation. It focused on how disciplinarily diverse teams negotiate a shared understanding of visitor needs and translate that understanding into new digital media through design. The second project was conceptualised as an experiment in instigating the emergence of a digital cultural

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heritage design practice. It involved the first author working for a period of six months as a Human-Centred Designer-in-residence at the Fitzwilliam Museum in Cambridge, UK, alongside a team of Fitzwilliam educators, curators, digital specialists, visitor services staff and graphic designers, to develop a digital Family Guide service². Our analysis focused on how team members engaged with different HCD methods and tasks.

Looking at the case studies in the two projects, we started to notice a pattern: the introduction of HCD resulted in reconfigurations of the networks of everyday (inter)actions among individuals within the organization. These reconfigurations, which differ between organisations, become a new 'practice' when a set of collaborative design activities, completed during these interactions, become part of everyday, routine museum work. This hypothesis led us to revisit the design, museum and organisational studies literatures that had informed our previous analysis and bring them together under the conceptual framework presented here. Thus, rather than focusing on an empirical case and post-rationalising phenomena we found in the field, we bring important concepts of HCD and design practice theory together in a conceptual framework of digital cultural heritage design practice. Our presentation of the conceptual framework in the following sections therefore retrofits data from the Fitzwilliam case study onto the conceptual framework, as a way both to illustrate and validate it.

Digital Cultural Heritage Design as *Activity System*

Activity systems (Engeström 2000) systematically integrate individuals, tools (physical

² For details about the family guide design see: <https://www.museums.cam.ac.uk/blog/2017/03/15/design-thinking-designing-a-new-family-guide-for-the-fitzwilliam/>

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and conceptual), and forms of sociality into a unified whole, inseparable from each other.

Design activity can be analysed in terms of its constituting elements: the *subjects* involved (e.g. designers, educators, curators and visitors); the *object* of its purpose (e.g. develop engaging visitor experiences); the *tools* (e.g. prototyping software) and situated design *methods* (e.g. prototyping) that mediate action (Engeström, Miettinen, and Punamäki 1999). The use of tools by subjects who are pursuing an object is: governed by formal or informal *rules* that specify how the activity takes place; adopted within a *community* that comprises the social groups to which the subjects belong and which has a stake in the common objective; and is subject to *division of labour* including the hierarchical distribution of power and the horizontal distribution of tasks. Such concerted work upon the object results in specific *outcomes*.

An activity system is enacted through a chain of deliberate, goal-driven *actions* that entail routinised *operations* (Leont'ev 1978). The relationship between activities, actions and operations is not static: something that starts as an activity system (e.g. a group engaging with visitor needs analysis) can become an action (e.g. visitor needs analysis becomes part of user-centred design) and, with time, parts of it are routinised into an operation (e.g. routinely testing prototypes with visitors).

Figure 1 depicts an instance of a digital cultural heritage design activity system: a group of individuals (subjects) work together to understand and define a museum's family audience's needs (objective) in order to develop a mobile museum guide for family visitors (intended outcome). The group comprises two educators, a curator, a digital content developer, a graphic designer and a design facilitator/researcher, representing different museum departments/divisions and external partners. Members bring 'to the table' their different disciplinary perspectives, knowledge and understandings. Each comes from a disciplinary community (museum education,

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 curation, design etc.) with vested interests in the museum's family offer; together they

form a small, disciplinarily diverse community that works together, sometimes with constructive tensions, while following social norms and rules related to the specific design tasks in which they engage. Here they are developing family personas (Pruitt and Grudin 2003), but the group have also observed family visitors in the galleries, analysed the technical infrastructure of the museum, and undertaken other actions that contribute to the design of the family guide. Throughout the project, material and conceptual tools mediated their acting upon the objective while rules and regulations mediated their performance as a group and an agreed division of labour mediated the group's engagement with the objective. Figure 2 gives a schematic representation of this activity system.

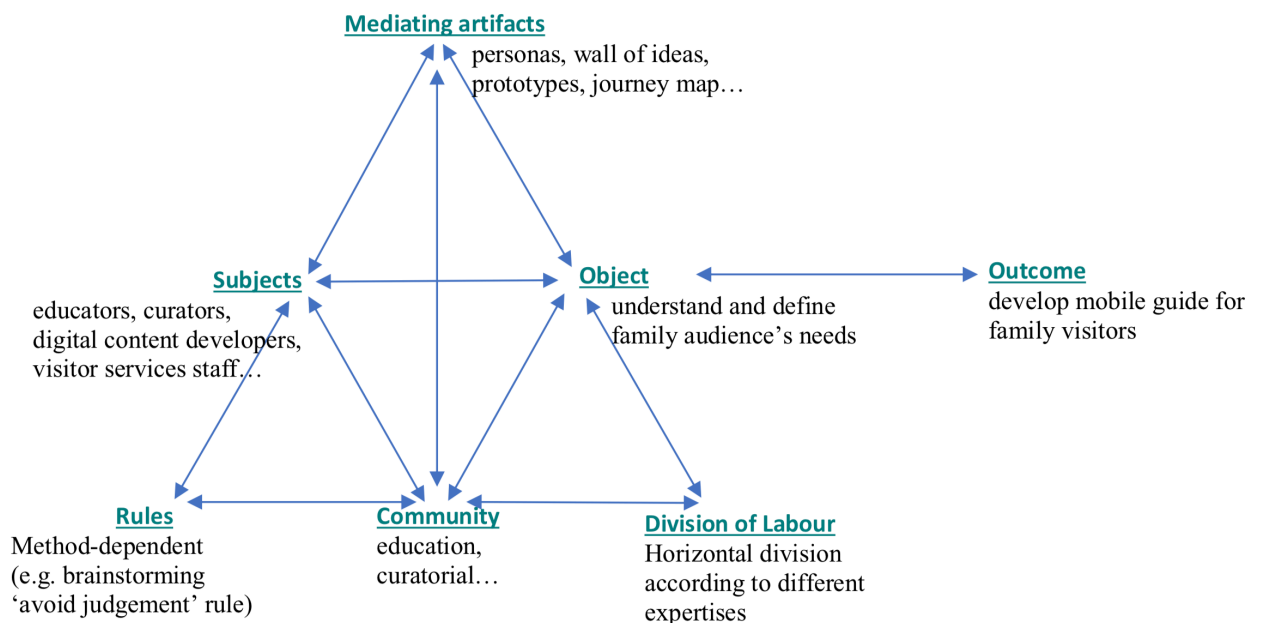


Figure 2. A schematic representation of a digital cultural heritage design activity system, based on Engeström, Miettinen, and Punamäki (1999)

foregrounds the implications of organizational approaches and decisions for the design of digital cultural heritage. In our example, the personas technique was a new tool, the use of which required a revised division of labour than the museum normally adopted for digital projects. For example, the adoption of ethnographic methods to observe visitors required that part of the observation task was assigned to an educator who usually would not undertake this kind of work. It also brought into the design practice new patterns of participation and thereby new expertise, by including visitor services staff in the persona development process (visitor services would not normally participate in a digital project in this museum). A focus on the activity system means that we remain alert to the tensions and opportunities that arise with such changes – the inclusion of new members, the introduction of new tools, the adoption of new methods and operations etc.

At a micro level, analysing activity systems helps us deconstruct digital cultural heritage design practice into its constituent actions, to understand their interdependencies and individual contributions, and how they progressively transform into routines and everyday practice. Building *personas* was described above as one action in a network of design tasks undertaken to identify family audience needs. The action itself mobilises knowledge that comes from other actions (observing and interviewing families in galleries, studying academic literature on family museum visits) to transform it into a knowledge representation (persona) that can then mediate further design actions as a tool. Understanding the dependencies and connections in this web of organization-specific activity, can highlight what works and why, what needs to change and how, before morphing into the routinised work that constitutes practice.

At a macro level, analysing activity systems highlights the interconnections with other kinds and forms of organizational practice and, importantly, forms of organizational change that unfold alongside the development of a digital cultural heritage design practice. Activity systems are intrinsically dynamic and mediating relationships develop and change over time (Engeström 2009; Gay and Hembrooke 2004). As a result, practices depend as much on their historical as on their evolving contemporary contexts. Analysing activity systems of design practice can reveal its historical evolution *as it happens*, within its also evolving organizational context, for example the adoption of new tools or the modification of workspaces, or the inclusion of community members into working teams.

At a time when museums are transforming their working practices to embed new design approaches alongside transformations in how they work, this kind of analysis can highlight both synergies and tensions between digital cultural heritage design and the parallel activity systems of, for example, socially-engaged practice or community-oriented participatory practice. Each of these activity systems interact with the others on many levels and through various combinations of their elements (Nicolini 2012), each provoking organizational change and each being impacted by it. Thus, digital cultural heritage design can lead to transformative organisational inquiries (Junginger 2005, 2007).

Digital Cultural Heritage Design as work mediated by design objects

Design work makes considerable use of objects and tools within purposefully constructed spaces (like design studios) that cultivate creativity. Design objects are artifacts that facilitate design activities (sketch pads, prototyping material, spatial configurations) but also artifacts that are the outcome of design activities (blueprints, sketches, prototypes). We also allow the term to encompass non-material constructs that encode

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conceptualizations of the design situation – digital entities like vector-based graphics or acts of performance like role-play. While the activity analysis presented in the previous section acknowledges the mediating role of design objects as ‘tools’, it does not expose the mechanisms through which they mediate design actions. These mechanisms are important because they propel design work and shape design practice and are more discernible when viewed through the analytical lens of *external design representations*.

External representations are ‘configurations of inscriptions’ (De Vries and Masclet 2013) that present aspects of knowledge, structure, rules, constraints and relations of physical or social phenomena and contexts (Zhang 1997). For example, a velocity graph represents a physical quantity related to the phenomenon of motion, a census chart represents aspects of the makeup of social life. As a conceptual construct, external representations originate in cognitive science (Zhang 1997; Zhang and Norman 1994) and are, in a sense, counterpart to our internal representations of phenomena – the mental models, conceptual schemata and thought structures that we develop and use internally to make sense of the world. Subsequent theoretic development of the concept focused on issues of collaboration, including in design (Blomkvist and Segelström 2014; Kirsh 2010) where external representations are seen as mediators of communication and catalysts of creativity.

External design representations present knowledge about the design context that would otherwise be scattered around reports, situations and minds. For example, a persona of a typical nuclear family visiting a museum encapsulates knowledge that may come from front-of-house staff reflecting on their day-to-day interactions with families, academic and professional literature on family learning in museums, and reports of findings from visitor services’ family surveys. The creation of the persona brings together and solidifies these diverse pots of knowledges and in so doing offers the

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design team a new tool to reflect with (Blomkvist and Segelström 2014; Zhang 1997).

Thereby, the persona becomes more than a representation of any one designer's internal understanding of family visitors. It becomes a knowledge artifact that encompasses individual understandings but also affords interactions and integration in other design activities that enable the team to further develop and deepen their knowledge of the design situation – for example, when team members subsequently 'interact' with personas in the process of developing scenarios of use or prototypes.

External representations capture the design team's evolving knowledge and understanding of the design situation and, thus, become collaborative tools through which the team can think and reflect in-action (Schön 1983), together (Valkenburg and Dorst 1998). They are "part of the determining features of the mind", triggering reflection processes in the same way as the production of a piece of writing triggers reflective thinking (Zhang 1997, 183). Blomkvist and Segelström (2014) similarly argue that external representations 'help designers think', whether they make use of formal notations and conventions to describe the design product (blueprints, design scenarios, storyboards) or are more ephemeral, informally produced representations (role play, walkthroughs). The specific knowledge content that they encapsulate and the kinds of thinking they facilitate, depend on the type of representation chosen and the socio-physical context within which they are produced. For example, the choice to produce personas instead of another representation, impacts the kinds of knowledge of the design situation that are captured and, by extension, their subsequent uses. Similarly, the availability and arrangement of tools and people within the design space impacts how the design team interacts during the production of external representations and, in turn, this impacts their shape and form. How these choices are made and by whom is negotiated in the production of the activity system.

objects (Lee 2007; Star and Griesemer 1989). The typical nuclear family persona from the design team in Figure 1 is, for example, a *boundary object* (Star 2010): it was created collectively to capture the whole team’s knowledges and perspectives, and it subsequently orchestrates group interactions towards ‘thinking together’ about how such families could engage with exhibits while maintaining their individual perspectives. These processes, which involve negotiation and consent building, propel the development of design ideas, and are captured in and subsequently rekindled by external design representations such as rough sketches, persona templates and scenarios of use (Vavoula and Mason 2017).

Digital Cultural Heritage Design as *knowledge-in-practice*

Activity analysis enables us to consider how diverse teams of staff from multiple departments with the shared objective to use digital to improve the visitor experience work together. External representations enable us to understand how such ‘working together’ is mediated by objects and tools. There remain however questions regarding the kinds of design knowledge that are at play, how it develops and how it is maintained and passed on from project to project. We draw on theories and models of organisational knowledge to explore these questions.

The SECI model (Nonaka and Takeuchi 1995) captures how tacit knowledge (i.e. all the things that we know and can perform but cannot readily articulate) relates to explicit (i.e. codified, articulable) knowledge. It thus explains organizations as entities that generate, manage and advance knowledge through four interactional combinations of tacit and explicit knowledge. We share tacit knowledge through shared experiences and social interaction with other staff within and outside our departments, as well as with visitors and communities in the course of everyday service provision and

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collaboration; we make our tacit understandings of the design situation explicit by externalising them through the use of metaphor, analogy and models (Mason 2015) to produce design concepts and models (external representations); we synthesise our explicit knowledges into new explicit knowledge when we synthesise departmental reports into digital strategies or departmental visitor data into personas; and we internalise explicit knowledge as tacit when e.g. our empathetic engagement with visitor personas leads us to develop new, personal ways of interacting with visitors.

Closely related to these SECI processes is the concept of *ba* (Nonaka, Toyama, and Konno 2000), which describes the social, cultural and historical context in which organizational knowledge develops. *Ba* is a Japanese word that encompasses the notions of space and time together. It is formed dynamically by the individuals that engage in knowledge creation through SECI processes. *Ba* is therefore situation-specific, ever-changing and dependent on what digital cultural heritage project is undertaken, by whom, in which cultural heritage organization, and when. Together, SECI and *ba* depict knowledge creation as an organic process, central to and dependent on digital cultural heritage design environments.

Out of SECI processes emerge different types of knowledge assets (Nonaka, Toyama, and Konno 2000): experiential (e.g. our design team's tacit understanding of the design situation); conceptual (e.g. our design team's 'family guide' design concept or the 'family personas' they produced); systemic (e.g. visitor studies and evaluation reports); and routine (e.g. our team's authentic understanding of the Fitzwilliam's organizational context). Knowledge assets themselves become part of *ba* and the knowledge creation process.

Earlier we argued that often digital cultural heritage design knowledge is created through work that takes place at the boundaries between disciplinary socio-cultural

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contexts. The amount and kind of effort required depends on the length of knowledge distance between the disciplines and partners involved (Carlile 2004). This distance is shortest at syntactic boundaries, where an existing shared lexicon helps to transfer knowledge (e.g. future upgrades of the family guide in our example will build on the common lexicon of family personas, scenarios of use, design concepts, etc.) The distance is mid-range at semantic boundaries where knowledge translation addresses interpretive differences (e.g. to address how visitor interactivity impacts the presentation of curatorial content, our team had to translate personas into storyboards). The distance is longest at pragmatic boundaries where knowledge transformation is needed to balance the 'stakes' across domains (e.g. the storyboard had to balance the interests of the curator, the digital specialist and the educator, and what each perceived to be 'at stake' – the chance for collections to shine, for digital interactions to engage, for learning to be facilitated).

With time, as design practice matures within the organization, the design team's repertoire of boundary work expands and so does their ability to deal with novelty and knowledge distance. At this point, the practice is fully developed and the team exhibits the characteristics of a Community of Practice (Wenger 1999) where new members start at the periphery and, through engagement and reflection, reach its core (Lave and Wenger 1991). Engagement is crucial in both sustaining and learning about the practice, and is the means through which knowledge is created and shared (Lave and Wenger 1991). In our example, the design team had not yet formed into a Community of Practice. It is entirely possible however, that with time and continuous engagement in digital cultural heritage projects, they will develop a set of design knowledge assets, experiences and interpersonal relationships that allow members to identify as the organization's digital cultural heritage design team. In so doing, they will also

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inadvertently create frameworks for active participation that scaffold new members' movement from the periphery to the centre of the practice.

Implicit in our discussion is the fact that digital cultural heritage design involves two kinds of knowledge: a deep understanding of the design context (i.e. knowledge about visitors and their needs, the museum and its collections and services, and the availability of digital technologies and infrastructures), and applied design knowledge (i.e. knowledge about appropriate design methods and tools). Those in the team who lack formal training in design will rely on developing related knowledge and skills on-the-job, through hands-on involvement in design projects. Similarly, team members will rely on involvement with others to develop a more rounded understanding of the different aspects of the design context. The two types of design knowledge are inextricably linked in-practice. Thus, the creation of a *visitor journey map* requires both knowledge about how visitors move and interact within the exhibition space and knowledge of using journey maps effectively to design visitor flows and interactions. It is this dual knowledge requirement that brought the team of diverse expertise together in the first place.

What we have demonstrated here is that, in fact, hands-on involvement and social interaction in-practice are central to the creation and sharing of design knowledge that is specific to the context of the cultural heritage organization and to the design problem. In so doing, we have opened up new ways of understanding digital cultural heritage design as a deeply situated practice that relies on equally situated knowledge and encourages us to focus our research not only on the features of successful digital cultural heritage applications, but on the successful configurations of knowledge processes, contexts and assets that facilitate boundary work and the maturing of digital cultural heritage design into a Community of Practice.

Conclusion

We presented a conceptual framework for the analysis of digital cultural heritage design practice that advocates the study of the complex and interrelated aspects of design-as-practice and the close inspection of the organizational contexts that enable this practice to emerge and flourish within organizations. The framework opens up a new research agenda that refocuses attention from design outcomes to design processes by asking questions about how the makeup of the practice and its network of actions and actors impact its outputs. Specifically, it foregrounds questions about how design methods facilitate ways of knowing-in-action that foster collaborative conversations and lead to shared understandings of visitors (the family personas are a social accomplishment resulting from collaborative work that synthesizes members' understandings of families that visit the museum). It foregrounds questions about physical and social design spaces and the arrangements of people and objects within them, which can help us understand how creativity and power/authority dynamics within design teams are balanced by the form and shape of design representations and therefore of design (the 'wall of ideas' in Figure 1 gave all group members, irrespective of rank, hierarchy or discipline, equal access to the creative activity). It foregrounds questions about the lifecycles of design representations beyond the specific projects in which they are created, and the sharing and reuse processes through which they become design knowledge assets (the family personas can be reused in other design projects that target families). It foregrounds questions about the successful alignment of design knowledge creation processes, context and assets that facilitate boundary work and the maturing of digital cultural heritage design into a Community of Practice. Finally, it foregrounds questions about the many ways in which digital cultural heritage design practice meets other systems of organizational activity, in (tentative) synergy or (productive) conflict.

participatory design projects (e.g. Avram et al. 2019; Butler, Fox, and Suzanne MacLeod 2018). Further research is needed to extend the framework in this direction and to understand how co-design with visitors and communities impacts digital cultural heritage design practice and its neo-institutionalisation (Powell and Bromley 2013).

To take digital cultural heritage design practice as the unit of analysis is to recognize that each cultural heritage organization is unique and has the capacity to develop its own bespoke design practice that leads to deploying digital media and technologies successfully for the engagement of its visitors and audiences in its own unique ways. It is also to acknowledge that these ways depend as much on the technologies involved as on the creative involvement of staff and partners in understanding the visitor experience and what visitors want from this organization, at this point in time. These acknowledgements are intrinsic to the research agenda we outlined above, which therefore can generate significant new insights into how design practice not merely produces, but also shapes design outcomes.

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