The collaborative work of heritage : open challenges for CSCW

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Citation:

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The Collaborative Work of Heritage: Open Challenges for CSCW

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Abstract. This paper discusses seminal contributions by and current open challenges for CSCW in the study of cultural heritage practices. It provides an overview of key issues relating to social and cooperative interactions - particularly around the design and use of technology - at heritage sites that have emerged in CSCW, and pertaining the conduct of visitors, the design and evaluation of interactive installations for guidance and access, and the creation of novel artistic performances. The paper then presents a set of open challenges for future CSCW work, particularly regarding the very re-definition of heritage in light of the social and collaborative practices that have arisen in recent years within the museum and heritage professionals community, and the emergence of new roles and practices for organisations, staff, visitors and related stakeholders. The paper aims at consolidating the range of contributions that CSCW has made to cultural heritage and at outlining key issues and challenges for future research in this domain.

Introduction

Cultural heritage institutions, museums in particular, have long been a domain of study in human-centred computing from a variety of different perspectives: from usability studies of museum technologies, to the design of innovative interactive exhibits, information displays and fully immersive installations. Within this landscape, cultural heritage has been a relevant domain for CSCW as well, with particular regard for how groups and communities approach heritage sites and for how technology can mediate this. The relevance of cultural heritage for CSCW researchers has further increased as the identity of heritage institutions

as information collection and delivery units began to be questioned and challenged, and a new socially inclusive and participative idea of heritage became widespread (Simon, 2010).

Museums, in particular, were seen in the past as didactic institutions allowing for very limited overt interactivity and focusing more on their holdings than on their visitors (Hooper-Greenhill, 1992). The tradition of visitor studies contributed to change this mindset by actually investigating what people did in museums, and how an exhibit was perceived and understood, thus acknowledging the importance of visitors in the life of heritage institutions. CSCW researchers further developed this work by conducting in-depth studies of museums as settings for social interaction, collaboration and co-participation, whereby visitors' practices are illuminated and detailed with regard to their relationship with each other and with what is exhibited (see for example vom Lehn et al., 2001, which we will discuss in greater detail in the following section).

However, museums and exhibitions are only one example of cultural heritage institutions where a CSCW focus can unearth knowledge: if we think of heritage as the domain that collects and preserves what people and communities value as representative of their history, identity and values (Giaccardi, 2011), the range of places of heritage worthy of investigation extends to cities, historic buildings, open-air parks and other sites, that groups and communities visit and frequent for leisure, study or work. Other heritage sites, such as city quarters, landmark buildings and outdoor sites also represent historical, political and social values, therefore practices of sharing and collaborative creation and interpretation occur there. In this light, several examples of CSCW research in these settings are undoubtedly of relevance to the heritage domain.

Whereas CSCW has produced key contributions to understanding and defining cultural heritage, it is not quite continuing to do so at a time when heritage is being redefined in social terms, and when conceptual and practical approaches to curating and communicating heritage have developed a distinct affinity with themes of coordination, awareness and cooperative sense-making that are core to CSCW. In recent years, much CSCW work in and for heritage sites has largely being limited to case-study exercises whereby themes that have previously been unearthed within the discipline, for example the nuances of instances of social interactions in experiencing heritage, are echoed and/or confirmed through new empirical data sets. Other exemplars of work simply utilize heritage sites as a backdrop for the evaluation of multi-user technologies, however without delivering novel contributions to the understanding of heritage and of novel social and collaborative dynamics occurring.

While much of this body of work is well executed and adds knowledge to the existing stream of research, it has not produced significant new insights on heritage itself: how is the notion of heritage changing in light of new

organisational approaches to involving visitors? How is technology playing a different role in this respect?

We do feel that the scope for CSCW for producing novel and seminal work in the heritage domain is greater even than it has been in the past, and that some current themes of research on social and cooperative work in curating, presenting and interpreting heritage being explored in related disciplines should feature also in CSCW and be approached through the field's concepts and sensitivities.

Museum professionals themselves have developed sensitivities for audience-centric work in museums with the goal of increasing participation. As Simon puts it:

"[An audience-centric approach] requires staff members to trust that visitors can and will find the content that is most useful to them. When staff members put their confidence in visitors in this way, it signals that visitors' preconceptions, interests, and choices are good and valid in the world of the museum. And that makes visitors feel like the owners of their experiences" (Simon, 2010).

This perspective on the relationship between heritage institutions, their staff and their visitors opens a wide range of possibilities for the study of how complex ecologies of collaboration are currently redefining our very notion of heritage. Very little work thus far has studied this in depth, and a great many issues are left to be investigated. We believe that this very reconfiguration of heritage offers CSCW open challenges and opportunities for providing in-depth accounts of such practices in ways that have not been adopted by other disciplines.

From this premise, the goal of this paper is twofold: firstly, to highlight and consolidate through a review the significant contributions made thus far by CSCW with regard to cultural heritage and to reflect on the potential of other current work to be developed further, and secondly - and most importantly - to propose a set of future challenges linked to current developments in heritage studies and heritage management practice that can inspire and encourage novel developments within our field.

In the following sections, we present a review of seminal CSCW contributions to cultural heritage, discussing their importance in defining an understanding of the domain. We will then propose a set of current and future heritage themes and, finally, a discussion of the challenges and open questions linked to them.

CSCW and Cultural Heritage: Key Contributions

In this section we provide an overview of key CSCW contributions to the cultural heritage domain, highlighting how this research has helped shed light on crucial issues such as visitor experience and the potential of interactive technology in developing our very understanding of heritage.

We see this work as addressing three major interconnected themes: firstly, visitor activities and social interactions at heritage sites; secondly, the design, deployment and evaluation of heritage technologies in 'companion' roles, such as aiding the interpretation of an exhibit or site and for visitor guidance; thirdly, the creation of interactive artistic installations that are not mediating access to existing museum or exhibition holdings, but that are themselves newly realised heritage artefacts (e.g. interactive art and performance).

These three themes of CSCW research are quite distinct given that they concentrate on different issues, questions and goals, and as to where the main contribution lies (e.g. documentation of practices vs. design guidelines, for example), although they are closely interlinked for they are often connected by conceptual and methodological approaches and together they depict the multi-faceted aspects of experiencing heritage.

Visitor practices

The work conducted on understanding visitor conduct at heritage sites and the social and collaborative aspect of experiencing heritage unearthed the nuances of social interactions, communication and cooperation within groups and between individual visitors (vom Lehn et al., 2001). Visitors were observed in naturalistic situations while exploring exhibits either alone or in groups, and their physical and communicative activities detailed. These studies largely utilised the technique of video-based observations, allowing for the subsequent moment-by-moment analysis of data capturing visitors' activities (vom Lehn, 2010).

One of the key findings in this body of work is that, even if a certain museum or gallery did not explicitly encourage social interaction and participation, these occurred naturally in visitor practices. Museums, exhibitions and other heritage sites are therefore inherently social and a focus on lone actors, without considering the broader physical and social context of their actions, is limited when attempting to truly understand the visitor experience of exhibits.

Not only interpersonal interaction takes place regularly in heritage settings, but others are essential part of how the experience of heritage is configured: "The visual, vocal, and tactile conduct of others provides resources for looking, seeing, and experiencing the various exhibits" (vom Lehn et al., 2001, p. 206).

Moreover, behaviours emerging among groups of visitors aim at both maintaining coherence to the visit as an individual pursuit and at supporting the group experience: work is put in by group members in exploring exhibits in a desired way, but also in keeping group cohesion and in keeping interpersonal interaction at a desirable level while visiting.

Visitors pay attention to exhibits but also to others, and key to a positive experience for them is the possibility to gain access both to exhibits and to others for conversations, and to maintain awareness of the overall environment and of other people.

In other words, visitors 'work' to keep things social and endeavour to make interpretation social through verbal discussions, gestural illustrations, show and tell-like interactions, etc. This happens also with strangers when casual encounters and casual interactions occur both verbally and non-verbally (through hand gestures, positioning of one's body, gaze, etc.).

Another finding is that dwell time in itself is an incomplete indicator of engagement, although it had been utilized as key measure of engagement with exhibits (and often in isolation) in early literature in both HCI and museum studies. Longer dwell time in front of an exhibit does not necessarily equal to positive and prolonged engagement with it; conversely, short dwell time does not equal to lack of engagement. Social and contextual factors need to be considered as well as dwell time for understanding how visitors establish connections with what is on display. Similarly, that of engagement with heritage is a nuanced notion: as length of time is not a univocal measure, engagement can also be more or less active (e.g. certain "passive" visitors approaching exhibits are differently engaged with them), central or peripheral, etc. (Heath et al., 2002).

These insights significantly moved beyond the body of work on visitor studies that was very much focused on single instances of behavior rather than socially situated conduct, such as - for example - Veron and Levasseur's framework of visitor typologies entirely based on spatial movement and on "boxing" visitors into fixed and strictly individual models (Veron and Levasseur, 1983) that has influenced the design of model-based technologies such as certain types of adaptive guides (see for example, Marti, 2001): similar instances feature in a lot of HCI research but were never truly successfully deployed in heritage settings.

A particular aspect of heritage experience is its educational value. Structured and informal earning in museums and other heritage sites have been important topics in the literature, particularly within Computer-Supported Collaborative Learning, with particular attention to understanding how learning occurs and can be facilitated in heritage settings and to how educational activities take place (Marr et al., 2003; Hemmings et al., 1997; see also Hornecker, 2010). From this body of empirical work, implications have been drawn particularly for the design of educational technologies.

The findings of the CSCW body of research on visitor practices have been influential specifically to the design and deployment of interactive technology for heritage settings. The nuanced understanding of how heritage is experienced provides guidance on what technology design should be mindful and supportive of. Conversely, a detailed understanding of how technology can interplay with a

visitor's interpersonal interactions and relationships with an exhibit is essential for good heritage experiences.

A crucial insight from studies of visitor activities in terms of technology design is how interactions around exhibits are more successful whereby there are opportunities for people to be "drawn in", possibilities of physical accommodation around an exhibit, and an open nature of the exhibition itself in terms of commentary and interpretation. Opportunities for interactions with companions and strangers should be supported and encouraged. Overall, variable and contingent forms of interaction around an exhibit should be facilitated (Heath et al., 2002).

Tightly linked with this work is the stream of research on how technology mediates the visitor experience. Technology (when present) at a heritage site can play an ambiguous role: that of facilitating such interactions, but also that of encumbering them. Therefore, many of the findings and design sensibilities from visitor practices studies are resonated in research regarding the evaluation and/or introduction of heritage technologies.

Heritage technologies in use

Another set of significant CSCW contributions regards the study of technology use in heritage settings, whether an extant technology or a newly designed one. This work is focused on the socio-technical aspects of the use of individual and collaborative technologies (e.g. audioguides, touch screens, etc.) and on the design of intentionally collaborative technologies that encourage and often reward cooperative interaction. In the latter case, the research features a specific effort to *design* collaborative technologies and understanding of their use.

An important difference from the previous theme, although equal attention to visitor practices can be found in this body of work - and indeed there are many connections between the two themes of research in terms of agenda, authorship and approach -, is a greater attention to technological mediation, and also a stronger focus on the potential for visitors to take on not just the role of spectators of heritage sites, but also that of active participants by providing them with a range of opportunities for interaction with the exhibits and with others: for example, the interactive guidebook "Sotto Voce" (Grinter et al., 2002) provided visitors to a historic house with additional content and the opportunity of sharing it with others via a shared audio mechanism. In certain cases, visitors are also allowed to make direct contributions to an exhibit, for example by means of written comments, audio recordings, photos, etc.: in an exhibition at the Hunt Museum (Ireland) called "Re-Tracing the Past" (Ferris et al., 2004), visitors were invited to record interpretations of museum objects that were never conclusively interpreted; in the "Secret Life of Objects" at the Helsinki Design Museum

(Finland), visitors and staff were invited to leave annotations on digital representations of a set of historic Finnish design pieces (Salgado et al., 2009).

Researchers have studied the physical engagement with technology (for example the effectiveness or engagement value of certain interaction styles and modalities vs. others), have developed the know-how on how to augment a heritage site through technology in mindful ways, and also have evaluated how different technologies (e.g. desktop, mobile, tangible, etc.) can be of use in particular settings, from enclosed galleries to historic buildings and outdoor sites. Many examples feature studies of novel technologies that have then become commercially widely available, from touch screens and interactive projections, to - more recently - mobile devices, mixed and augmented reality, and multi-touch tabletops (Grinter at al., 2002; Schnädelbach et al., 2002; Galani, 2003; Hornecker, 2008).

Such studies of collaborative use of novel and existing technologies in-situ have also led to detailed guidelines for the design of in-gallery systems and other public interactive systems and, importantly, have demonstrated through empirical evidence the shortcomings of technology introduced without careful consideration of the social nature, use and physical qualities of a particular heritage environment (Hornecker and Stifter, 2006). Moreover, this work furthered understanding of collaborative interactions around heritage as mediated and not by technology and of the re-configurations around technology use and appropriation (Heath and vom Lehn, 2010; vom Lehn et al., 2007).

A main finding is that physical design of technologies –similarly to that of exhibitions - affects group experience in terms of accommodation and access points and therefore in terms of social interaction. In her study of visitor interactions with the "Jurascopes" at the Berlin Museum of Natural History (periscope-like devices overlaying digital 3D animations over real-life dinosaur skeletons and linked to a related multi-touch screen console), Hornecker observed how the physical accommodation of hands-on interactions by more than one individual is linked significantly to dwell time and to spontaneous social interactions, and there is a balance struck between the occurrence of cooperative interactions vs. lone ones, and trade offs of collaboration versus individual use (Hornecker, 2010). Conversely, in studies of multi-touch tabletop installations (such as Hinrichs and Carpendale's field study of the "Collection Viewer" at Vancouver Aquarium) it has been shown that physical interaction is influenced by the social context, the presence of others and the opportunities for non technologically-mediated interaction (Hinrichs and Carpendale, 2011).

Furthermore, group interactions can present very different qualities: for example in the case of families where complex practices of directing, scaffolding and facilitation take place between parents and children in ways that would not occur within groups of a different nature (Hornecker and Nicol, 2012). Encouraging these types of interaction by means of technology can also be part of

broader cultural and social policy relating to heritage, as it happens for example in Japan where family visits to museums are seen as ways to build cultural capital and technology support to them is encouraged (Hope et al., 2009).

Collaborative interactions vary not only depending on the type of visitors and groups, but also on the specific configuration of technology: for example, in mixed reality visiting co-experiences involving both located and co-located visitors, interactions are co-present but also remote, occurring within a digital space representing certain features of the heritage setting as well as in the physical world. The "George Square" system allowed visitors exploring a city to share their location and media annotations to others, both co-located and distant (Brown et al., 2005); the co-visiting system deployed at the Mackintosh Interpretation Centre at the Lighthouse in Glasgow (Brown et al., 2003) allowed physical visitors to interact with "digital" visitors exploring online a VR representation of the exhibit. These examples of literature have thus explored issues of awareness of others, casual interaction with strangers and accommodation of collaborative actions both between co-located and remote visitors.

Another significant body of CSCW work documents the design of and instances of interaction around multiple technological components that are distributed within a heritage environment (Fraser et al., 2003; Hindmarsh et al., 2005; Ciolfi and McLoughlin, 2012). In particular settings, "assemblies" of interlinked interactive artefacts, rather than standalone installations or independent mobile applications, can best sustain how visitors explore, make sense and relate to a heritage site. Besides the challenges of technically realizing an engaging assembly, this work investigates how coherence in the visit is achieved, and sustained engagement and group cohesion can be supported by facilitating the awareness of others across assembly components and by understanding the relationship the visitors establish with the components, with the assembly as a whole and with the site.

Yet another subset of research pays particular attention to technological guides (the study and design of which is a long-standing exercise also in the field of HCI), one of the longest-living types of technology to be used at heritage sites. Findings on the effects of individual guides (particularly audio guides) in disrupting social aspects of the visitor experience and in forcefully shaping the trajectory of the visit have been widely documented in museum studies literature (see for example Gammon and Burch, 2008), and have been addressed within CSCW through designs including social elements to the interaction such as "eavesdropping", e.g. allowing pairs of visitors to hear the audio selected by their companion (Aoki et al., 2002), and tagging and sharing facilities of what the guide provides individual visitors to companions and larger groups (Cosley et al., 2009; O'Hara et al., 2007).

A final subset of contributions worth mentioning focuses on collaborative interactions in online heritage resources, particularly regarding practices of information retrieval and exchange. Digital repositories of heritage content can be seen as "virtual exhibits" that can be visited without a physical presence, with Second Life having been one of the early platforms to experiment with "virtual" displays of collections (Urban et al., 2007), as well as enhanced tools for archiving and recording used by visitors and by heritage staff alike, as adopted by the Spurlock Museum (USA) since the mid 1990's (Marty, 1999). This body of work is significant as heritage institutions are increasingly offering to the public digital exhibitions as well as their physical holdings.

Interactive installations as heritage artefacts

A third and final theme we review here is that of the creation of technologically-enhanced art and performance pieces, whereby the technology is not aimed simply at the interpretation or documentation of what is displayed in an exhibit, a building or a museum room, but it is part of the exhibit itself - for example in the case of interactive art and performance.

In this case, the technology is (part of) the heritage artifact that people come to experience, and this heritage artefact *per se* embodies digital and interactive elements. Here the focus of CSCW research is on the relationship not only between visitors and between visitors and exhibits, but also between the artist/creator and the public: issues referring to the artist's practice are paramount when studying the role of the artist/designer in engendering particular interactions and experiences.

Seminal CSCW research on this theme is represented, for example, by studies of the low-tech artistic pieces created by artist Jason Cleverly that have been exhibited at several galleries worldwide (Hindmarsh et al., 2005). The "Ghost Ship" installation presented the painted scene of an ocean cruise liner with a wooden façade. Video-linked portholes on the ship featured the faces of visitors that were captured on a "deck" situated in another area of the exhibition. In their study of "Ghost Ship" during its exhibition at the SOFA fair in Chicago, Hindmarsh et al. observed how, through its own creative design, the piece facilitated the visitors' own creative practices - such as planned pictures of themselves aboard the Ship to show others – as well as social interactions in the proximity of the exhibit. The artist can design to provide engagement, surprise and humour for individual visitors and groups.

Another significant contribution relating to this theme is Benford et al.'s (2011) framework for orchestrating performance and spectator experience with the creation of artistic technological interventions. By ethnographically examining the practice of the professional artist group Blast Theory in creating and exhibiting interactive installations such as "Day of the Figurines" (a multi-

media experience involving participants in the life of a fictional down over 24 days), the authors argue that the orchestration of positive visitor experiences should be mindful of issues of time around the discovery of a piece and the revelation of aspects of the piece itself, the trajectories of these discoveries, and the transitions among different parts of the exhibits (Benford et al., 2011).

Other studies have been conducted on drawing insights from interactive exhibitions for designing the spectator experience (Reeves, 2011), public leisure indoors and outdoors (Flintham et al., 2011; O'Hara et al., 2007), and immersive experiences in general (Robertson et al., 2006).

These examples feature interactive collaborative technology that constitutes a newly created, purposely designed interactive heritage artifact for public and social use. This links to current discussions on heritage that is "born digital" and open questions on its authorship, status and preservation challenges (Kalay et al., 2008), as well as on heritage that is seen as "natively" created by visitors and participants by means of extensive use of media platforms (Iversen and Smith, 2011).

Through this review of key CSCW contributions to the domain of cultural heritage, we can see how the focus of our field has spanned from describing the finer details of visitor experiences in heritage settings, to introducing design approaches and guidelines, to other issues including artistic performance and digital heritage. These substantial contributions have been produced alongside countless other exemplars of work focused on technology development and deployment and on a small scale case-study format, rather than on high level issues, of which a full review would be beyond the scope of this paper (see, for example, Simarro Cabrera et al., 2005; Fuks et al., 2012).

The work that we have chosen to review in this paper constitutes in our opinion the main body of foundational CSCW knowledge on heritage, for it illuminates fundamental issues that must be understood when studying the domain and the role and potential of technology there. Although some of the examples discussed above are rather situated by their authors within a "leisure" framework, they do however provide key insights on heritage in our opinion, and particularly on informal settings that are less frequently studied than museums and galleries.

Despite the significant contributions outlined above, the stream of seminal research on defining and articulating new heritage practices has recently somewhat "disappeared" from CSCW, or rather it has not maintained the same level of conceptual development that can be seen in previous work, being more focused on small scale case-studies of technology introduction and evaluation. In other words, studies of collaborative uses of heritage technologies are still being conducted, but the furthering of CSCW-relevant themes in heritage has become less substantial. While the number of technology designs to be deployed and

tested in heritage settings (museums, galleries, city spaces, etc.) is constant if not increasing, we see little in this work as yet that is aimed at furthering the understanding and re-definition of collaborative heritage practices beyond the simple recognition of heritage sites as a useful setting for the deployment of collaborative technology.

Nonetheless, if we compare this current work on heritage produced within CSCW to ongoing research in heritage and museum studies, we can see that there is greater potential for the exploration of current issues from a CSCW frame and that this potential should be embraced.

Recently, a notable surge of interest has emerged from the museum management and education community regarding social and collaborative technologies in museums, also due to the low costs and minimal technical training needed to employ social media platforms for blogging, social networking and crowdsourcing that have become widely available and well known by visitors and staff alike. The number of initiatives led by heritage institutions and interest groups involving the public in collaborative activities both offline and online has increased very significantly. Researchers at the boundary between heritage studies and technology design have explored emergent issues of cooperative authorship, shared interpretation and collaborative design that are also important to CSCW (see the essays in Giaccardi, 2012).

In this current scenario, more work is needed in understanding the ecologies of collaborative practices in heritage that have emerged of late by the initiative of both institutions and visitors, and that have led to complex patterns of collaboration and cooperation in interpreting, communicating and creating heritage.

Reviewing existing work and pointing out how CSCW has filled gaps in the knowledge and understanding of heritage practices indicates where further work is needed, moreover an awareness of current work in heritage studies points out new areas where significant contributions can be made.

In the following section we will discuss in greater detail what we identify as the open challenges that CSCW can and should embrace more thoroughly in future research.

Discussing Open Challenges for CSCW

What can CSCW bring to the current lively area of research on the social and collaborative aspects of heritage? To give a better sense of what kind of activities are currently taking place in the heritage domain (and thus to articulate current challenges), we will illustrate one example of the work that a major museum is conducting through collaborative and social technologies.

The Victoria & Albert (V&A) decorative arts Museum in London, one of the world's most important heritage institutions in terms of holdings and number of visitors[1], has developed for many years a dedicated media strategy to regularly involve communities of decorative arts enthusiasts and of passionate museum visitors into their exhibits (V&A, 2010). This has been extended beyond a rich web presence and accessible on-line catalogues (that have been maintained by the museum for over a decade and are used by approximately 25 million visitors a year) by the embracing of approaches such as crowdsourcing through social media to drive some of their flagship exhibitions.

One such recent initiative is "V&A Weddings"[2], whereby the V&A's existing collection of wedding dresses, ornaments and wedding-related objects currently scattered across different departments of the museum (fashion, jewellery, etc.) got to be exhibited from 2009 in a "themed" way online (e.g. before any such physical exhibition yet existed). As well as having curated and created the online exhibition, the V&A has made "Weddings" open to contributors by means of public social media platforms, such as for example the photo sharing service Flickr, where people have been submitting their wedding images to the V&A "Weddings" pool for years. The museum had been recruiting participants in this initiative throughout the web, on both personal websites/blogs and mainstream media[3]. The material submitted by the public is curated online by museum staff, but also open to commentary by visitors[4], and made available for fair re-use by other not for profit initiatives.

The most interesting contributions provided by online visitors were, after negotiation, acquired by the museum for their online collection catalogue (Fig. 1). Finally, "Weddings" has become an actual physical exhibition, titled "Unveiled", that has travelled in Australia, New Zealand and Singapore during 2012 with plans for the exhibition final homecoming in London in the near future. "Weddings" is now a permanent microsite on the V&A main website, together with other similar projects that the museum has spearheaded over the years.

This simple example shows how a strategy for collaboratively accessing, exhibiting and opening up heritage holdings and collections to visitors and contributors online and offline has been deployed by the V&A as part of a larger vision for public engagement and collaboration with stakeholders, that includes

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[1] http://www.vam.ac.uk/

[2] http://www.vam.ac.uk/page/w/weddings/

[3] See for example: http://www.wornthrough.com/2009/04/17/va-wedding-photos-site-needs-you/
And: http://www.dailymail.co.uk/home/you/article-1285624/The-V-A-launched-database-wedding-fashion.html

[4] http://www.flickr.com/groups/va_museum/

online communication and other resources (such as, for example, open source labels[5]) for certain parts of their collection.
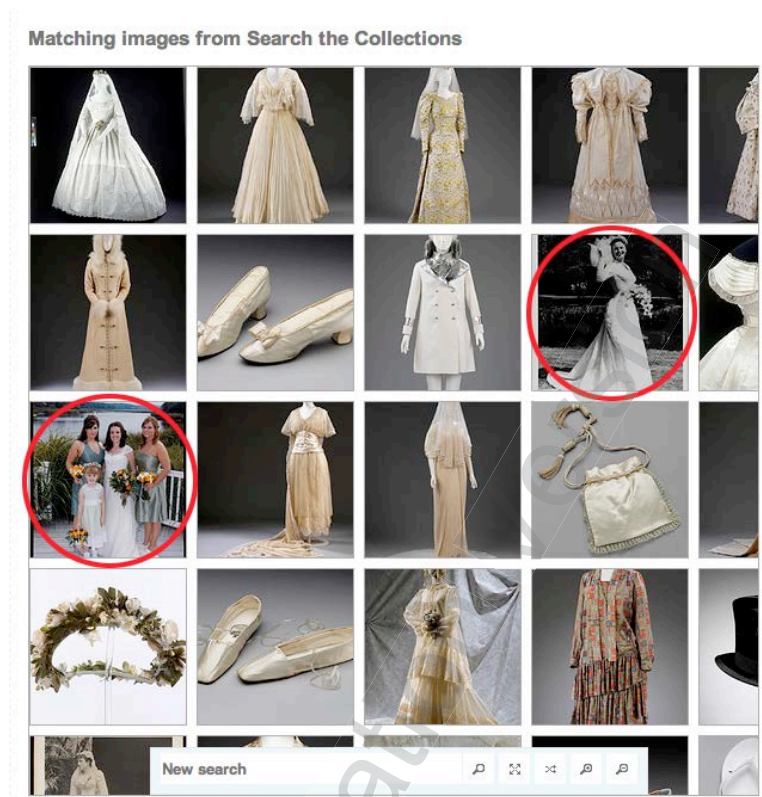

Figure 1. Contributions by online visitors (circled) now feature in the "V&A Weddings" photo gallery, besides V&A holdings (source: http://www.vam.ac.uk/page/w/weddings/).

This initiative is not an exception: many other heritage institutions (museums, historical sites, industrial heritage institutions, city and town centres, etc.) have adopted similar ways of cooperatively building and documenting their holdings. Other examples include the Brooklyn Museum's "Split Second – Indian Paintings" exhibition[6], whereby visitors were invited to explore the museum's collection of Indian paintings online and were asked to express their reaction to what they saw by commenting on a painting in their own words, rating its appeal and choosing one over another. This open-access activity online was followed by a physical exhibition at the museum of the set of paintings that generated the most dynamic responses together with a visualization of the accompanying data. Thus, the online visitors' reactions became part of the exhibition as well.

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[5] http://www.vam.ac.uk/b/blog/digital-media-va/open-sourcing-digital-labels

[6] https://www.brooklynmuseum.org/opencollection/labs/splitsecond/

A final example we bring to bear is "It's Elemental"[7], an online community heritage initiative promoted by the Chemical Heritage Foundation, a small museum in Philadelphia (USA), where students were invited to submit short videos linked to each element of the periodic table. Almost 700 videos are now stored in an online archive that is open to comments. In this case, the collection and the discussion are housed completely online and not on the physical premises of the museum, although this resource is being used for educational activities that the Chemical Heritage Foundation conducts in schools and community centres.

The strategies put in place by many institutions and community groups to foster the social aspect of heritage access and interpretation lead in our opinion to several important open challenges for CSCW research. First of all, we must refer back to the notion of "work", and to the detailed articulation of what happens in the interaction within socio technical systems that is core to CSCW: the work performed by heritage professionals in coordinating, mediating and facilitating online and offline interactions, such as those occurring in the example of "Weddings", requires detailed study and a focus on unearthing situated practices in a changing organizational, physical and cultural context. While much work has been done on understanding visitors, there is a need to focus also on staff and to study their practices in depth. Curating an exhibition, presenting opportunities for visitor engagement, creating educational activities in heritage institutions have acquired different connotations with a view of heritage that is open and participative: the dialogue and interaction between museum professionals and visitors needs investigation and CSCW is ideally placed to gain a deep understanding of such work in the new reality of participative heritage.

Some work within the broader human-centred computing field has begun to explore the role of visitor contributions, albeit a limited way, through the use of interactive technology. While Cosley et al. (2009) see such forms of visitor participation akin to guestbook entries, in our opinion they can be seen as attempts to build on the re-conceptualisation of heritage as being cooperatively created as observed by, among others, Giaccardi and Palen (2008) and Oomen and Arovo (2011). Crucially, this view of heritage is not only open to visitors' dialogical interaction with heritage, but to co-creation. Further work should be conducted with attention to the reconfiguration of roles and organisations in this context. As the possibilities for visitor interactions with heritage have broadened, there is also a need to extend CSCW's nuanced understanding of visitors to include practices of study, work, apprenticeship, voluntary participation, etc., and not simply leisure or informal learning.

Furthermore, it is important to pay attention to the formal and informal communities that are created around heritage, to how they come together

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[7] http://www.chemheritage.org/discover/online-resources/its-elemental/index.aspx

(whether, for example, following local initiatives in support of a heritage site, or bottom-up through online participation) and to how they take advantage of, share and create heritage. Studying how the material that comes to document a collection or an exhibit is collaboratively generated by a community, with different perceptions of ownership, interpretation and meaning, is key in this respect. Related issues beginning to be recognized are how authority and expertise are perceived and sometimes challenged (Thom-Santelli et al., 2010), how value is attributed to newly-created heritage and embraced by a community (Giaccardi, 2011), and how informal communities can generate alternative shared narratives around heritage holdings through the use of their own mobile phones and mainstream media platforms (see Weilenmann et al., 2013). All these issues have been touched upon by recent work, but they need to be substantially expanded and systematically investigated.

In this scenario of change in the heritage domain, we can see that a range of issues is open to investigation for CSCW researchers, studying the use of online and offline technological mediums, and also how communication unfolds between different groups and communities. Other strands of work that CSCW has produced on understanding ecologies of online and on-site collaboration can also be extended to the heritage domain, for example when investigating the transition from web platforms to a physical exhibition and vice versa. Existing studies of organisations at work can also be extended by looking at collaboration not just between visitors, but also between visitors, staff and other stakeholders.

We summarise the range of current open challenges for CSCW in studying cultural heritage alongside three interlinked strands:

- The work of visitors: the practice of visiting heritage sites has evolved, including also the presence of new technological tools for sensemaking and participation. Moreover, we see new forms of social visiting experiences. There is already a substantial body of knowledge on this in CSCW that, however, needs to be extended and expanded to investigate the new forms of interactions for visitors that the heritage domain is embracing. Visitors are also increasingly proactive contributors to heritage, and their new role needs understanding. Visitors are also not necessarily leisure-driven, as the range of activities made available to them is expanding, so our understanding of the visit needs greater specificity.

  - The work of curators and facilitators: existing work does not offer much on this, it is thus a gap to be filled and particularly so as heritage professionals are becoming key in mediating communication and participation among different stakeholders. Their role has changed from that of providers of authoritative content, or simply that of guides, to that of conversation partners in the

interpretation process. Curating is also becoming a collaborative practice online and offline, as we saw in "Weddings" and the other examples described earlier.

- The work of communities: communities of interest around heritage (with different degrees of formality and training) are increasingly defining and taking ownership of what is of value for them, thus defining and reconfiguring heritage. From cases where an established institution and a community of enthusiasts work together to consolidate and communicate heritage to a wider public – for example the successful "Saving Bletchley Park" campaign in the UK[8] where the work of the British codebreakers during the Second World War has been brought to public attention and recognition–, to examples where ordinary citizens create an informal group for the preservation of what they consider to be of value, no matter how local or small – such as the Cassiar community initiative in Canada[9] for the preservation of the history of a now abandoned asbestos mining town and its people -, we see that community work in heritage creates rich relationships between members and with other stakeholders. Conversely, established heritage institutions are increasingly open to community outreach, and may on occasion leave their physical premises to occupy other spaces where visiting and interpretation dynamics can be quite different from those occurring in traditional exhibit-based museums[10]. The CSCW body of knowledge on community dynamics and on organizational memory and practices constitutes a solid foundation for further studies.

Open questions across these three strands include: how are these new understandings of and practices around heritage negotiated? How are multiple forms of participation mediated? How do visitors, staff and other stakeholders coordinate understandings and meanings? How are their perceptions of theirs and others' contributions, of their roles or of their involvement emerging? What artefacts (technological and not) are central to mediate and assist in coordinating these practices?

In heritage studies, there is currently a widespread use of established social media platforms (e.g. Facebook, Twitter, Instagram, Flickr, etc.), however the exploration of a broader range of possibilities in technology design can be enriched by CSCW sensibilities and understanding. We have seen in previous sections how established heritage technologies - such as mobile guides and interactive displays - have been studied and evaluated in detail, and often re-designed with insights from the study of visitors in situ. Therefore, in the spirit of CSCW that sees technology as a medium and a facilitator, there is room to contribute to the design and development of novel technologies that are currently

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[8] http://savingbletchleypark.org/

[9] http://www.cassiar.ca/

[10] For example, the Walters Art Museum (USA) has held exhibitions of part of its collection and of reproductions outside of the museum and around the city of Baltimore.

emerging as useful platforms in this new scenario of collaborative heritage: for example, DYI electronics, tangibles, lightweight and mobile AR, among others.

Conclusions

In their 2005 paper published in the CSCW Journal, Hindmarsh et al. thus outlined some open challenges for CSCW and cultural heritage:

"The challenge is to consider how to adopt approaches common in CSCW to re-think museum technologies and provide museum designers, and indeed artists, with the tools and technologies to organise innovative collaborative experiences. Indeed, with its concern with understanding and designing for collaboration, CSCW would seem well placed to inform the development of exhibits and exhibitions which aim to enhance interaction and co-participation (…) One additional interest for CSCW in museums and galleries relates to the formidable problems of deploying prototype technologies in workplaces." (Hindmarsh et al., 2005, p. 3)

The authors advocated for CSCW to further its understanding of how heritage institutions foster collaboration and participation. They also recognized that the work of museum staff and also of artists could benefit from CSCW concerns.

In the first part of this paper, we have seen how CSCW has indeed made substantial contributions, and well beyond understanding visitor practices, by also focusing on the design of collaborative experiences and on the orchestration of inclusive artistic performances. The examples of work we have reviewed in this paper have tackled foundational issues in the understanding of heritage: the actual in-situ practices of visitors, the social and collaborative nature of exhibits, the opportunities and risks offered by technology and the concerns in creating partially-digital heritage artefacts for public display.

In the second part of the paper, we have argued that, although we see a proliferation of case studies where technology is designed and then deployed in a heritage setting, it is crucial for CSCW to take on more substantial challenges in furthering research in the cultural heritage domain. This is strictly linked to current developments in heritage studies and heritage management practice, whereby we see an increasing interest for and adoption of participative and collaborative approaches to engaging visitors and other stakeholders. This interest is not only academic, it is in fact embodied by actual practical strategies for engagement put in place by heritage institutions around the world. We have argued that, firstly, CSCW can contribute meaningfully to current discourse surrounding heritage by extending its body of foundational research and insights on work settings, collaboration and co-participation in organisations, and on online and offline communication, to the heritage domain. Secondly, that new areas of investigation, such as the social co-creation of heritage, can be explored and understood by means of a CSCW approach to in-depth studies of situated

practices and of related technologies and meditational tools. More specifically about heritage technologies, CSCW work has influenced their design to respond to crucial social concerns such as the support of more than one user and the support of interpersonal communication during the visit. It can undoubtedly extend this contribution to novel technologies that mediate the social production of heritage. In conclusion, the "work" of visitors, of museum professionals and of the communities that surround cultural heritage institutions are strands whereupon a CSCW focus could be enlightening, if not groundbreaking, if these open challenges are tackled in a timely way.

Acknowledgments

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