Crafting Digital Experiences: Embedding Human-Centred and Participatory Design into Archaeological Practice

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As digital archaeology has grown as a field of practice, so has the number of digital resources developed for specialists and non-specialists alike. However, the creation of such outputs has not always been accompanied and informed by design theory and practices. Design - used in its broadest definition as a process of conceptual making - is an integral, if often implicit, part of archaeological practices and it is through design that we develop and share our work - from data collection and analysis to interpretation and dissemination – and engage with our stakeholders. Engaging with core design practices offers meaningful opportunities for generating new forms of archaeological knowledge production and sharing, as well as creating digitally mediated experiences that are not guided by our own assumptions about our stakeholders' needs and can really affect people's engagement with the past. In this paper, I investigate the benefits of embedding Human-Centred and Participatory Design into the archaeology and heritage sectors to create more critically engaged digital encounters with the past.

CCS CONCEPTS • Arts and Humanities • Collaborative and social computing

Additional Keywords and Phrases: Digital Archaeology and Heritage, Human-Centred Design, Participatory Design

1 Introduction

1.1 Digital Media in Archaeology

Archaeology has always been a visually rich discipline. From archaeological illustrations to photographs, from GIS to 3D models, the field has a long history of using visual representations to document the archaeological process and present interpretations of the past, as well as to encourage direct reflections on archaeological materials [1, 2, 3]. However, despite visual media's critical role in the production of archaeological knowledge, the ways in which their adoption influence such knowledge creation have often been underexamined, limiting their theoretical impact on the discipline [4, 5]. As Smiles and Moser observe "we need to engage with the problematics surrounding the image's mediating function as a bearer of archaeological knowledge, and this is as valid for the analysis of virtual reality (VR) reconstructions as it is for eighteenth-century engravings" [6, 2].

In recent decades digital technologies and media for recording archaeological evidence, visualizing and communicating interpretations of the archaeological record have become ubiquitous within the archaeology and heritage sectors, affecting and reshaping people's engagement with the past. Providing an extensive overview of the vast range of archaeological and heritage digital media developed for public and specialist stakeholders is beyond the scope of this paper, which focuses instead on the critique around how such media are designed and the impact they might have on their intended stakeholders - here broadly referred to as specialists and non-specialists engaging with archaeology and heritage for either professional or personal interest. It has often been argued that digital media rapid uptake has not been accompanied by a sustained body of critical theoretical discussion on their application, and the call for a more theoretically driven approach to digital archaeology has been increasingly debated in the past decade [7, 8, 9, 10, 11, 12, 13, 14].

As pointed out by Perry and Taylor [15], while some so-called new technologies have in fact been adopted for several decades, a more critically engaged approach to their application has yet to be developed. The overwhelming focus on practical use and applications of 3D technologies, combined with their increasing affordability and usability, has very often led to the creation of digital resources motivated mainly by technological availability. Perry and Taylor's critique underlines a tendency within our discipline to design and develop digital resources that are seldom informed by critical reflections on who are our core stakeholders and what needs and expectations they have. Moreover, we as practitioners often do not invite our stakeholders to take part in the design process, thus missing meaningful opportunities to include different voices and perspectives that can help generate new forms of archaeological knowledge production and sharing [16, 17]. However, within the past twenty years, a small but growing body of work has been arguing for a more self-conscious, ethically aware and socially engaged archaeology [18, 19, 20, 21]. As Garstki puts it:

> "all stages of archaeological practice are embedded in socio-political institutions and formal and informal communities. As such, the design and use of digital tools in this practice cannot be conducted without the broader considerations of their impact; how does it help, and hurt, all stakeholders." [22, 6]

This critical self-awareness is also reflected in numerous mission statements of archaeological professional organisations, heritage agencies and university departments [see for example 23, 24. 25]. As archaeology foregrounds its relevance for contemporary society and potential in delivering public (social, economic and environmental) benefits, it needs to demonstrate

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how such benefits are delivered and why public funds should be allocated for it. As such, collaborative practices engendering wider inclusion and active participation are essential to claim archaeology worthiness of public funding [26, 27]. Adopting collaborative practices and extending participation to various stakeholders can be challenging, as it requires shifts in practice and tools to actualize such changes. We might not be aware of the means by which we can effectively integrate them in our design processes. Luckily, there is no need for us to reinvent the wheel, but to look at other disciplines – such as design - for guidance, inspiration and tools for actualizing co-creation in our own workflows.

1.2 Introducing Human-Centred and Participatory Design

The definitions and meanings of design are various and multifaceted: in the broadest sense 'design' refers to the process of envisioning, planning and developing products, systems or resources. Here, I refer to design in its human-centred meaning, as a collaborative process that focuses on people's needs, challenges assumptions, and develops creative solutions that can be prototyped and tested [28].

Based on this notion, my research posits that design is an integral – but sometimes implicit – part of archaeological and heritage practices and it is through design that we, as archaeologists and heritage professionals, develop our research and engage with our communities and stakeholders. However, we have yet to fully exploit the potential of a more design-led practice which offers us a way to engage more explicitly and pervasively with iterative, reflexive, participatory and ethical approaches in our work. To improve our practice, we need to incorporate critical reflections on design into our processes and explicitly embed design theory and practices into our outputs. This is particularly true in relation to digital resources, whose pervasiveness within our sector have not always been accompanied by thorough evaluation of people's experiences and broader consideration of their impact on stakeholders. Using Parry's [29] definition of 'the Postdigital Museum', as the digital has naturalised itself into museums' organisational structures, and digital media is no longer a new practice, it is time for research in digital heritage to focus on a more self-reflective, critical scrutiny of heritage institutions' relationships with digital media.

Design research and practice have increasingly evolved toward a human-centred and participatory approach, putting people at the heart of the design process. Back in 2008, Sanders and Stapper [30] described the changing landscape of design as moving away from a user-centred approach [31], whose focus on products and notion of people as passive consumers were considered inadequate in addressing the challenges of designing not simply products meeting specific requirements, but for people's purposes and societal needs. Van der Bijl-Brouwer and Dorst define Human-Centred Design (HCD) as a group of methods and principles describing "how to gain and apply knowledge about human beings and their interaction with the environment, to design products or services that meet their needs and aspirations" [32, 2]. The underlying concept is that in order to deliver real value to the intended stakeholders, the design process needs to go beyond immediate needs and deeper into what is truly meaningful to people.

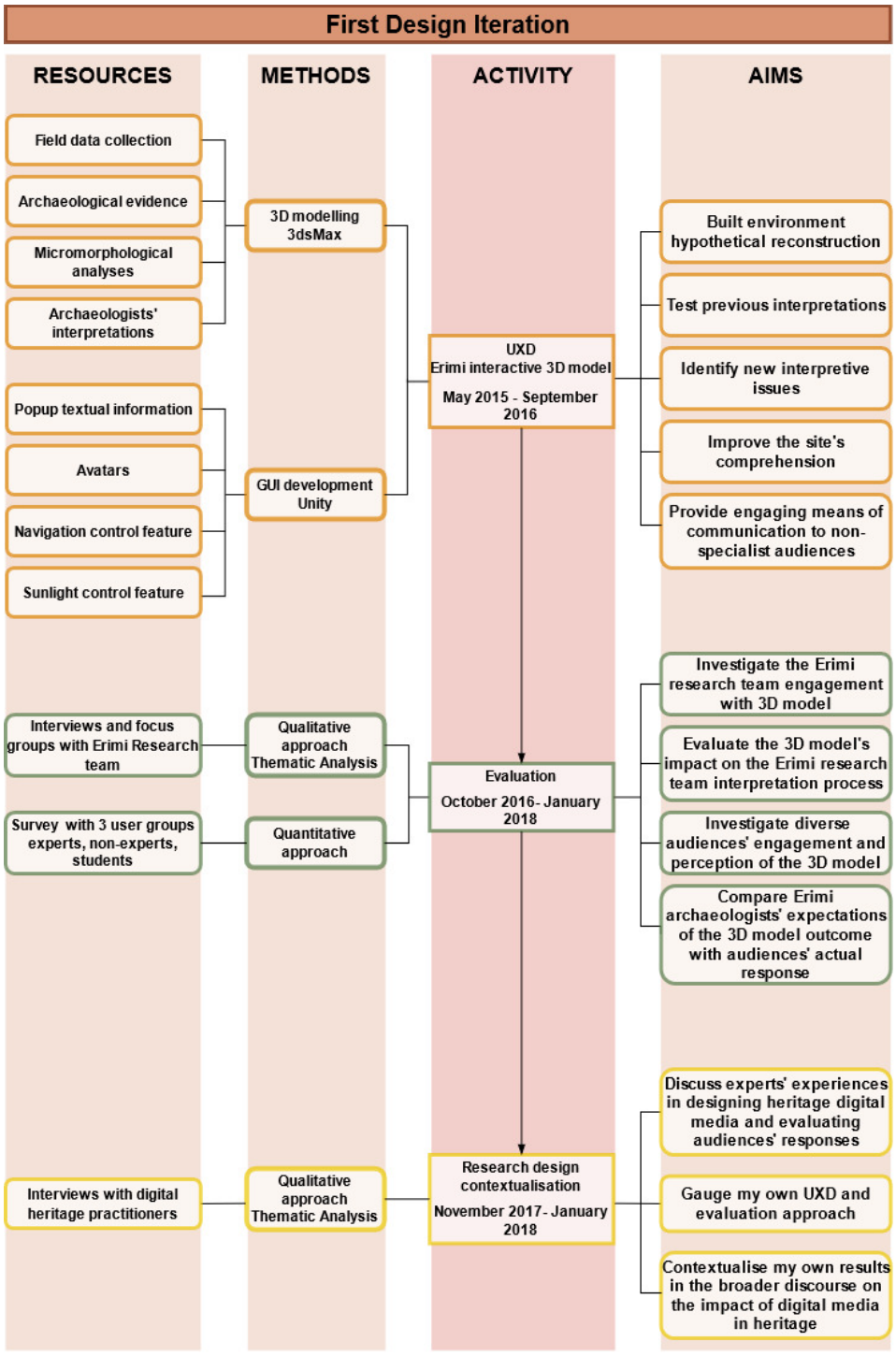
Within the variegated landscape of HCD approaches, my research draws inspiration from Participatory Design (PD) (often referred to also as co-design) developed in Scandinavia during the 1970s to actively involve all stakeholders (e.g., employees, partners, customers, citizens, end users) in the design process. Robertson and Simonsen [33, 2] define PD as a "process of investigating, understanding, reflecting upon, establishing, developing, and supporting mutual learning between multiple participants in collective 'reflection-in-action'". The main aim is to create an equal opportunity design environment where stakeholders are given a more responsible role and treated as peer co-designers. At its heart are both pragmatic and democratic values; pragmatic because the inclusion and engagement of more people leads to more ideas and, eventually, the creation of usable and empathetic design solutions. Democratic in the sense that people whose lives will be affected by the product or service being designed, have a fundamental right to have a say in the process. The core principles of PD are mutual learning and empowerment, through processes of co-creation, prototyping and hands-on experiences: in PD stakeholders and professional designers learn from each other by collaborating toward a shared goal and creating spaces where people are empowered to actively engage in the process of imagining their own work practices, communities, or everyday life [34]. This work is also situated within the design thinking discourse, which recognises that design is no longer the exclusive domain of designer specialists [35]. Among the many conceptualisations of design thinking, I refer hero to its definition as a HCD approach aimed at gaining a deep and empathetic understanding of people with a strong emphasis on collaboration among interdisciplinary group, communities and stakeholders carried out through an iterative process based on different prototyping methods [36].

The application of HCD and PD practices in not new within the archaeology and heritage sectors, as evidenced by the meSch [37] and EMOTIVE [38] projects focused on co-design in cultural heritage, bringing together multidisciplinary groups to co-create digitally meditated heritage experiences; or the work undertaken within the ACCORD project [39] and Italia Terremotata [40] aimed at empowering communities through active participation in the co-design of 3D visualisations and immersive media. Moreover, scholars such as Mason and Vavoula have been investigating the pivotal role played by HCD and design thinking in digital cultural heritage practices, proposing a "new research agenda for digital cultural heritage design that refocuses attention from what is being designed (outcome) to how it is designed (process)" [41, 407]. Similarly, Avram et al. [32, 4], pointed out the need for reflective accounts of how HCD unfolds when applied in practice and what kind of impact it has on archaeological and heritage practices.

By adopting a reflexive iterative design approach, where insights gained through iteration one informed the research focus and methodology of iteration two, my research sought to investigates the impact of embedding HCD into the creation of digital

resources and how archaeologists and heritage professionals can benefit from it terms of both personal and professional gains. Firstly, by examining the impact of such resources, specifically interactive 3D models, on different stakeholders. Then, by assessing the design process behind the development of digital experiences, exploring practical ways for actualising HCD in archaeology and heritage workflows, through hands-on collaborative and multidisciplinary design activities.

In the remainder of this paper, I will examine how archaeological practices can benefit from HCD approaches into the creation of digital resources by discussing the two design iterations carried out for my doctoral research at the University of York (UK) between 2014 and 2020. The first iteration, presented in Section 2, was aimed at evaluating different stakeholders' engagement with archaeological interactive digital media; the second one, discussed in Section 3, was focused on investigating the design process behind the creation of such media through a series of co-design workshops (Figure 1). Lastly, in Section 4 I discuss future research directions and state my final conclusions arguing that the collaborative process enabled by the adoption of HCD collaborative practices promotes meaningful ways of knowledge production and sharing. It also leads to a more critical reflection on what motivates us, as archaeologists and heritage practitioners, to design digital resources and a deeper understanding of our stakeholders, who they are and what they feel and need.


First Design Iteration
RESOURCES
METHODS
ACTIVITY
AIMS
Field data collection
Archaeological evidence
Micromorphological analyses
Archaeologists' interpretations
3D modelling 3dsMax
Popup textual information
Avatars
Navigation control feature
Sunlight control feature
GUI development Unity
UXD
Erimi interactive 3D model
May 2015 - September 2016
Built environment hypothetical reconstruction
Test previous interpretations
Identify new interpretive issues
Improve the site's comprehension
Provide engaging means of communication to non-specialist audiences
Interviews and focus groups with Erimi Research team
Qualitative approach Thematic Analysis
Survey with 3 user groups experts, non-experts, students
Quantitative approach
Evaluation
October 2016- January 2018
Investigate the Erimi research team engagement with 3D model
Evaluate the 3D model's impact on the Erimi research team interpretation process
Investigate diverse audiences' engagement and perception of the 3D model
Compare Erimi archaeologists' expectations of the 3D model outcome with audiences' actual response
Interviews with digital heritage practitioners
Qualitative approach Thematic Analysis
Research design contextualisation
November 2017- January 2018
Discuss experts' experiences in designing heritage digital media and evaluating audiences' responses
Gauge my own UXD and evaluation approach
Contextualise my own results in the broader discourse on the impact of digital media in heritage

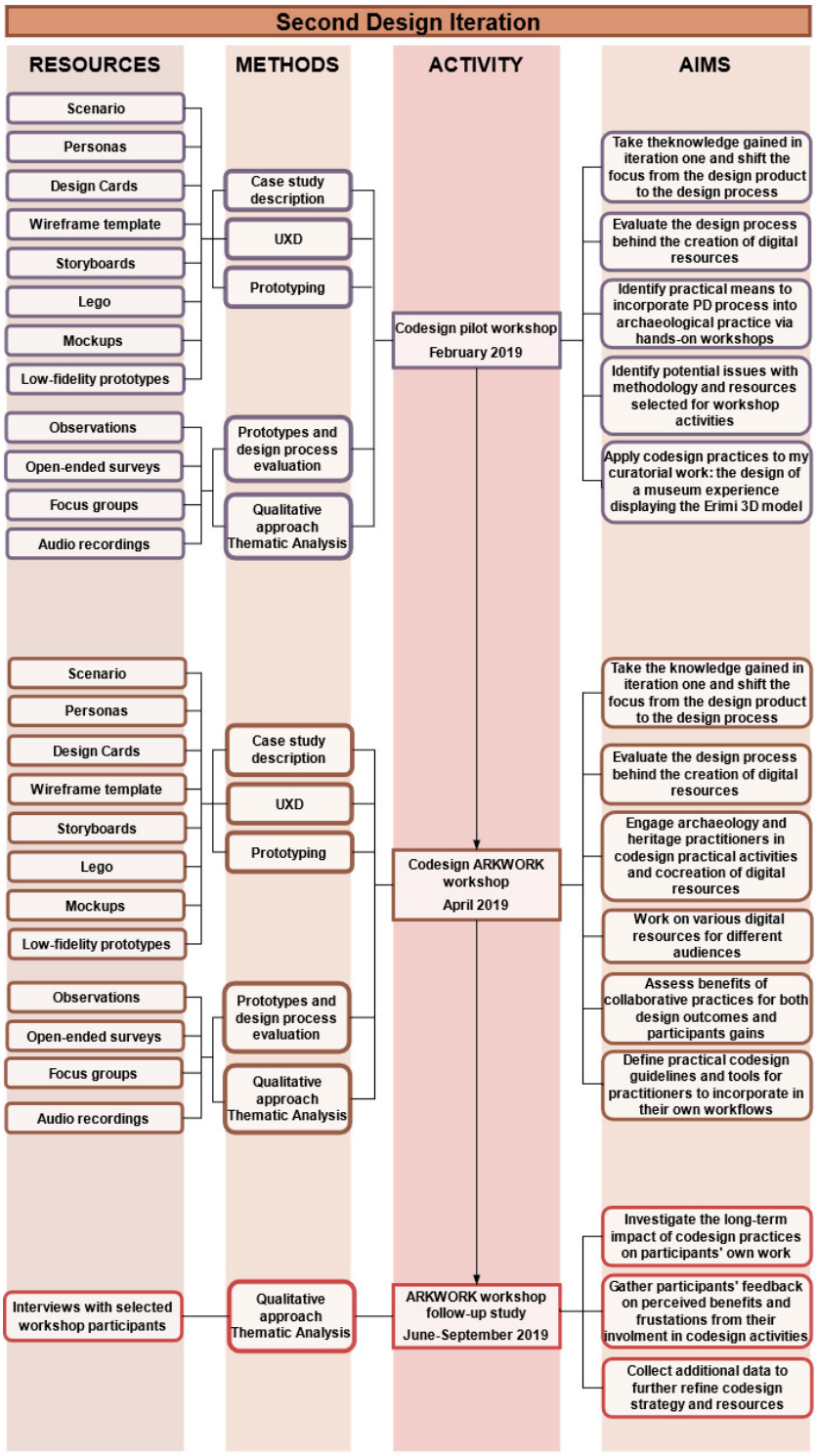


Figure 1: Diagrams illustrating the sequence of activities conducted for each iteration of the research project. From the left each column illustrates: resources used, methods adopted, timeline and specific aims of each activity (credit: author).

2 The Erimi-*Laonin tou Porakou* User Experience

The first iteration of my research focused on examining the efficacy of interactive 3D models as digital resources for archaeological research and academic and public dissemination, as well as the impact of such resources on different stakeholders. For the purpose of this research project, I adopted as a case study the prehistoric settlement at Erimi-*Laonin tou Porakou* - a Middle Bronze Age site located in the southern coast of Cyprus (2000 - 1650 BCE) [42] - to develop an interactive 3D hypothetical reconstruction of the

site. Like many other poorly preserved archaeological sites, Erimi is problematic in terms of achieving a comprehensive interpretation of the site's architecture and, more broadly, of communication to academic and public stakeholders. Its present state is not easily understandable nor relatable by people outside a restricted circle of experts, thus making a 3D visualisation potentially very valuable for public engagement (Figure 2).

Figure 2: The Middle Bronze Age settlement at Erimi-*Laonin tou Porakou*.

This design iteration focused on investigating and evaluating different stakeholders' perceptions and engagements with the Erimi interactive 3D model using mixed methods: questionnaires, interviews and focus groups. It was defined by different stages along the following workflow:

1. Data acquisition and recording: gather all available data about the settlement history through a multidisciplinary approach, including material evidence and micro morphological analyses.
2. 3D modelling: create an interactive 3D model that shows the site in its current state as well as the interpretive visualisation of the settlement.
3. Evaluation: present the 3D visualisation to different groups, composed of specialists and non-specialists, and use both qualitative and quantitative approaches to collect their feedback.
4. Research design contextualisation: conduct a series of interviews with digital heritage practitioners and museum curators, to discuss their research results on stakeholders' reception of interactive digital media and to better contextualise the results of my own research.

The Erimi interactive 3D model was developed using the commercial 3D modelling software Autodesk 3ds Max [43] to model the hypothetical reconstruction of the built environment according to several interpretive hypotheses made over the years by the Erimi research team [44]. It was then imported in Unity [45] to create a user interface (UI) that allows to explore the 3D model, while retrieving information through interactive hotspots, and also provides a first-person navigation via avatars in form of luminous silhouettes (Figure 3).

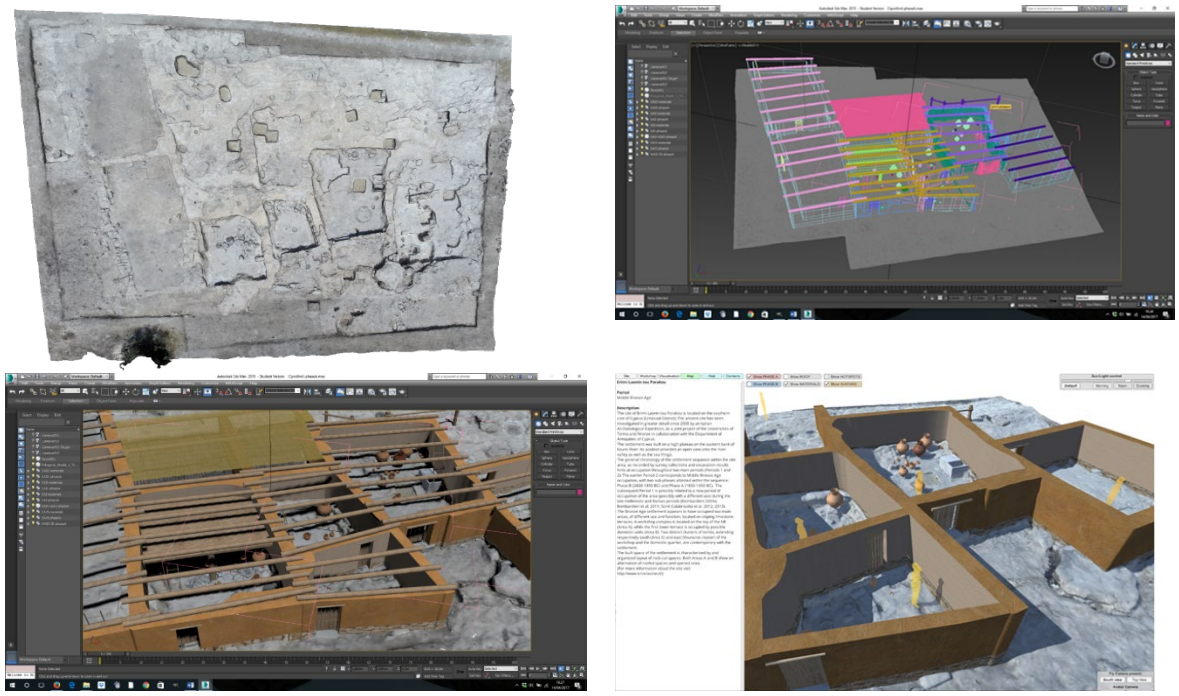


Figure 3: Images of Erimi 3D model and UI (credits: author).

The evaluation process started with seven interviews and a focus group with the Erimi research team, in order to exploit their knowledge of the specific research context to detect issues and topics, such as whether the model is suitable for them and other stakeholders, which could be then thoroughly addressed within the quantitative analysis through focused questions. This first stage was also aimed at investigating whether the interaction with the model had an emotional impact upon these experts (in this instance I kept the definition of 'emotion' broad, defined by the participants themselves) and observing how they used and perceived the 3D model, then comparing their responses to those of other stakeholders unfamiliar with the case study's particular context. Furthermore, a year later I conducted a second focus group with the same participants, to evaluate if and to what extent the interaction with the 3D model had been affecting their perception of the site and interpretation of archaeological evidence.

This was followed by one multi-stage survey with three groups composed of experts, non-experts and students. Participants were asked to interact with the 3D model and complete a questionnaire with twenty-five open and closed-ended questions, aimed at gathering their feedback and evaluating their perception of the model in terms of usability and comprehensibility as well as their level of engagement (54 questionnaires in total). For the purpose of the study, the distinction between experts and non-experts, was based on whether participants were researchers or practitioners knowledgeable in the use of 3D modelling and visualisations in the archaeological and heritage sectors.

Finally, the evaluation process ended with eight interviews with digital heritage scholars and practitioners whose field of expertise is the design, development and evaluation of digitally mediated experiences for different stakeholders. Data collected through these interviews were used to develop a better comprehension of the effect that the dissemination of these forms of (re)presentation of the past have upon people's perceptions, as well as to better contextualise the results of my research.

The qualitative datasets gathered during the first iteration via audio recordings of interviews and focus groups were analysed with the qualitative software NVivo [46], using Thematic analysis (TA) to identify and interpret patterns or themes across data [47]. I decided to adopt TA because of its flexibility and ability to provide a detailed and complex account of data. Themes, in fact, can identify something meaningful in relation to the research questions and patterned responses or meanings within the data set. Engaging with my data set through TA gave me the possibility to combine a deductive approach guided by my interest in investigating the specific topics I outlined above, with an inductive one where the analysis is located within the data content and my identification of themes was strongly linked to the data themselves [48].

Data were first coded and collated, then analysed to see how they may combine to create overarching themes, and finally themes were revised and refined (for the description of each theme see Appendix A). Quantitative data collected through close-ended survey questions were analysed using the web-based survey tool Qualtrics [49] to study their distribution among the different user groups. Quotes and responses obtained from participants were either anonymized or attributed to them according to their consent. When anonymized, I randomly assigned respondents with pseudonyms [50].

Perhaps unsurprisingly, some of the themes developed from interviews and focus groups with members of the Erimi research team - namely access and circulation within buildings and use of spaces - highlighted how the interaction with the 3D model heightened their comprehension of the built space, while also fostering new interpretive issues regarding accessibility and the

different use of spaces as exemplified in the following quote by Marta: "another thing that the model helped me with is a deeper conception of open spaces as community spaces and closed spaces as areas where selected activities were carried out by a selected group of people" [17, 129].

What I believe more interesting is the comparison between the theme of different stakeholders' needs and expectations generated from the interviews and the ones related to usability and comprehensibility developed from the survey. Such comparison suggested a persistent tendency among some practitioners to consider the way we communicate archaeology via digital products universal and valid for everybody, without considering how diverse are the needs of different stakeholders. For example, members of the Erimi research team anticipated a positive response from other archaeologists and practitioners, while in fact the experts who participated in my survey were the most critical and less enthusiastic group - only nine of the 24 participants considered it very engaging and six thought it was very stimulating. Moreover, the experts group pointed out several issues in the survey – such as a feeling of disorientation while interacting with the model or the use of academic jargon - that in their opinion were likely to have a negative effect on the experience of non-expert users. One expert user, for example, indicated that "the model/interface here is very much geared to the academic researcher - there is very little to engage the non-archaeologically-literate", while another expert user wrote:

> "didn't know exactly what would be best to click on next - and the lack of direction was a bit more confusing rather than liberating. I think I would have appreciated the option of a "story" I could navigate as well as the option of free exploration. By "story" I mean a recommended path of exploration, perhaps offered by the tutorial." [17, 140]

However, feedback from non-experts about their engagement with the model did not reflect these concerns, suggesting how we as practitioners are still making assumptions about our stakeholders. In fact, none of the non-expert participants reported having problems interacting with the 3D model and the majority of them gave a general positive response to the overall experience, which was perceived as engaging and stimulating (respectively nine and eight out of 13 participants) (Table 1, Table 2; Table 3).

Table 1: Non-experts' responses to questions 17 "The text descriptions were clear and comprehensive"

Response	Number of Selections
Strongly agree	4
Agree	7
Somewhat agree	1
Neither agree nor disagree	1
Somewhat disagree	0
Disagree	0
Strongly disagree	0
Total	13

Table 2: Non-experts' responses to questions 19 "It was easy to interact with the model"

Response	Number of Selections
Strongly agree	3
Agree	8
Somewhat agree	1
Neither agree nor disagree	1
Somewhat disagree	0
Disagree	0
Strongly disagree	0
Total	13

Table 3: Non-experts' responses to questions 21 "How would you evaluate this experience?"

Statement	Not at all	A little	Mildly	Moderately	Somewhat	Very	Extremely	*Total*
It was engaging	0	0	0	1	3	7	2	*13*
I felt bored	11	1	0	0	1	0	0	*13*
It was stimulating	0	0	0	3	2	6	2	*13*
It was a waste of time	12	1	0	0	0	0	0	*13*
It was useful for learning	0	0	2	1	0	6	4	*13*

These results were further confirmed by data gathered through the interviews that I conducted with digital heritage practitioners and museum curators working on the design and evaluation of interactive digital media for various stakeholders.

Their responses, in fact, not only underlined the lack of proper evaluation of digitally mediated experiences as a persistent issue within the heritage sector, but also pointed out that we still have partial knowledge of the actual impact and effect of such experiences. According to Laia, in relation to the theme of stakeholders' expectations,

> "I would say that [among] experts in cultural heritage what they think audiences expect is not really what audiences expect. They are concerned about different things[...] I think it is because cultural heritage people take for granted that everybody is interested and the way to communicate is universal and valid for anybody and it is not. For example, studies have proved that photorealism can be counterproductive, but we still think that it is all about visualisation and it is not." [17, 153]

Similarly, Alfonsina stated that:

> "[Museums] visitors do not care if the rendering is perfect, the only important thing is that it is something familiar and believable. We have been working for years on rendering, photorealism and characterization and in the end, we realized that that led us nowhere and that simpler things were enough." [17, 153]

Understanding the impact of interactive digital media and adopting HCD practices to design with stakeholders experiences that are more meaningful to them, are amongst the most important challenges for the archaeology and heritage sectors. From the analysis of the interview data, in fact, emerged the value of more human-centred approach to create experiences that are bespoke to stakeholders' needs and expectations, as highlighted by Luigina while discussing best practices:

> "the way I work has always to do with understanding end users, institutions' stakeholders, so it is always designed with a very long process behind. At the beginning, we never start knowing what technology is going to be. There is always a process of design and that process most of the time is participatory, so it is the museums, the heritage professionals, the visitors who have a role in shaping that and we show them options: they have an idea about what the interaction should be like and we show them what they can use to achieve that" [17, 162].

Conducting these interviews with experienced practitioners was very useful as it engendered an even more critical reflection on my own work and on the common challenges we face when it comes to grasping the complexities of the role of digital technology in archaeology and heritage experiences. Rather than just focusing on the implementation of my interactive 3D model, I decided it was even more worthwhile investigating how digitally mediated experiences in our discipline are actually developed and how to improve their design from the outset by adopting collaborative practices.

3 The Co-design Workshops

The second iteration of my research took the knowledge gained in iteration one and focused on the process behind the creation of digital resources, to investigate ways in which archaeologists and heritage professionals can design them more meaningfully and relevantly to their stakeholders through co-design approaches. Drawing upon previous studies using HCD and co-design approaches and tools in archaeology and cultural heritage [50, 51], I organized two workshops at the University of York structured around four activities in which participants worked in groups guided by a facilitator, to test the benefits of co-design practices and find practical ways to incorporate such practices into their own workflows:

1. Case Study Description: during this activity each group is asked to work on a preselected case study, provided by the facilitator.
2. User Experience Design (UXD): participants define how to structure an experience that matches the facilitator's brief. During this activity, participants use some of the most common HCD techniques such as scenarios, user personas and design cards.
3. Prototyping: within this activity, each group creates mock-ups (e.g., interfaces, storyboards or Lego prototypes) of the designed experience to visualize and make it tangible.
4. Evaluation of the design process and outcomes via qualitative methods.

The evaluation framework for both events applied observations, audio recordings of all design activities, open-ended surveys and group discussions, in order to triangulate the collected data and obtain a deeper understanding of the efficacy of the co-design techniques and resources adopted, in terms of participants' professional and personal gains as well as fostering meaningful ways of mutual leaning. Additionally, I conducted follow-up interviews with a few participants in the second workshop to gather their opinions and reflections on whether, what, and how they actually gained in the longer-term by being involved in the co-design activities [37]. As for the iteration one, qualitative data were analysed using NVivo and adopting a TA approach. For this iteration, participants were provided the option of being identified by name and job title, only by job title or to remain completely anonymous. When the option of anonymity was selected, I randomly assigned pseudonyms to identify participants and anonymized their quotes and responses.

The first workshop was a one-day pilot session involving eight participants working in two groups It aimed at testing the overall workshop procedure, in terms of the structure and planning, as well as the co-design techniques and resources that were to be adopted for the following event. Participants were recruited among lecturers, PhD and master's students from the Universities of York and Glasgow with research expertise and interest in co-design approaches applied to digital archaeology and heritage. To provide participants with a case study for the co-design process, I decided to use a project I had been working on alongside my PhD

for the design of a museum visitors' experience within an exhibition on Cypriot history and archaeology. Here, the interactive 3D model I created for the first iteration of my project was going to be displayed via touchscreen alongside 3D replicas of few artefacts from Erimi-*Laonin tou Porakou* associated with interactive tablets as part of the visitors' pathway [52]. I chose this case study as emblematic of a persistent issue in digital heritage and the way digital resources are designed, i.e., the assumption that digital resources do not need to be curated nor their design informed by considerations of different stakeholders' needs. The design of the visitors' experience, in fact, required meaningfully integrating within the exhibition a digital product that was not specifically conceived and developed for a museum setting. Integrating this project into my research allowed me to use feedback gathered through the first iteration to improve the experience with the interactive 3D visualisation of the site. It also offered the possibility to design a more articulate multimedia experience with the benefit of a co-design approach that was not adopted during the first iteration of my research (Figure 4).

To collect participants' feedback on the HCD process, I decided to structure the focus group discussion around their general impressions and opinion of the co-creation approach and methods adopted for the pilot workshop, as well as what they gained both professionally and personally from their participation in the co-design activities.

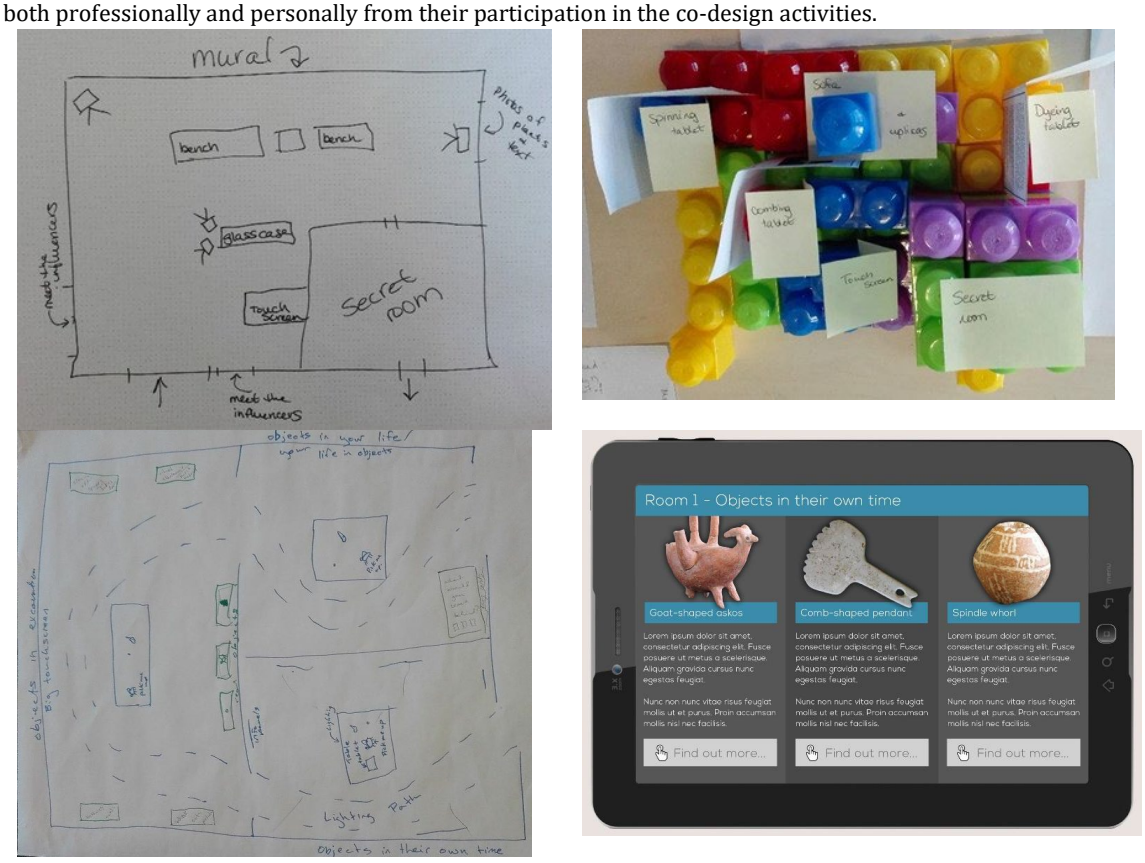


Figure 4: Images from pilot workshop. Visitors experience designs and prototypes (credits: author).

Overall, participants' feedback and observations show a positive reception of the co-design experience. In relation to the theme of perceived benefits, they appreciated that even though the workshop was focused on digital design, there was also a strong mandate to consider the overall user experience and the physical environment in which it was meant to take place, as exemplified in the following quote by Claire:

> "I think it is important to come from the experience point of view, which means everything in the user experiences not just the technology, because sometimes you find that that takes the focus immediately. So, for me this process is about taking that holistic experience" [17, 181].

These reflections were enhanced by the practical task of developing a prototype and the tools provided for such activity, such as the Lego-like building blocks, as highlighted by Harald:

> "when we were sketching stuff out on paper we thought 'oh we have all the space', but then we tried to translate that into blocks, we thought 'Oh, it's going to be really crowded in here!'. So that changed our approach, our core design, automatically and even towards the end thinking about how big is this space compared to the room and thinking about our bodies in the space, that felt useful as well." [17, 182]

Moreover, as perceived benefits, participants appreciated potential applications and transferability of the adopted approach to other projects, as stated by Kristen: "that has definitely changed how I think about museum displays and also, I think I can

incorporate this kind of thinking into the design of my own work" [17, 183]. Interestingly, some participants also mentioned the usefulness of the process for a deeper understanding and appreciation of other people's work and skills, as exemplified in the following quote from Sara:

> "it's about recognising the things that work and don't work with other people and also being able to recognise people's skill set. I think that there is something nice that comes out of that, where they are creative thinkers, or they are good at writing texts or they have wild wacky ideas. I think there is a lot of benefit to that and appreciation of other people's skills" [17, 183].

In terms of my personal reflections on the event, this pilot session allowed me for the first time to observe in action a collective meaning-making process around the archaeological evidence by individuals outside the Erimi research team, providing a new perspective on the construction of knowledge and inspiring me to explicitly convey the ambiguity and subjectivity of the archaeological interpretation process. As such, the museum experience – also informed and refined using participants' feedback collected during the previous iteration - was designed as a journey into the site through the stories and lives of the objects displayed, as shaped by archaeologists' interpretation of the evidence, that also encouraged a broader reflection on the significance of the objects that we leave behind and what they tell us about the cultural identity of their owners [52].

The second workshop was a two-day event attended by eighteen participants from across Europe, recruited among scholars and practitioners with research expertise and interest in designing digital resources for both the archaeological and museums sectors, funded by the EU Cost Action ARKWORK. For this event, participants were divided into four groups - assigned by me based on their expertise, gender and skillset in order to create balanced teams - each one assisted by a facilitator whose purpose was to guide group members throughout the co-design process of a digitally mediated experience. Facilitators were recruited amongst researchers and practitioners with experience in designing digitally-mediated experiences for both archaeological and heritage sectors (e.g., digital archives, video games, interactive experiences, mobile apps, etc.). As for the first workshop, each group was assigned a project provided by the facilitator: a digital archaeogame based on the early Anglo-Saxon period to be used as an educational resource for primary school students; a web-based interface to promote themed events and experiences related to the Neolithic and Bronze Age of Scotland; a heritage experience based on the historic environment of the Castlegate area in York targeting local residents; an online platform based on the Southampton Library Special Collections and Archives encouraging local communities to create and share newly found links between collections. These projects differed from one another in terms of aims, target stakeholders and technologies required, thus representing valuable case studies for better understanding the benefits of co-design approaches for archaeology and heritage practices (Figure 5).

As previously mentioned, the evaluation of the HCD process was carried out iteratively throughout the workshop via a focus group at the end of each day. The first focus group session started with each facilitator presenting their group's work and updating other participants on their progress. Then I opened the discussion to all participants, prompting a collective review and reflection on the first day by asking about their first impressions, gains and their group dynamic and interaction. The second focus group was meant to be a final evaluation of the event, gathering participants' feedback on the methodology and resources adopted, whether they benefited from their involvement and what they learned from each other.

Figure 5: Image from ARKWORK workshop. UXD and prototyping activities for the digital archaeogame (credits: Sara Perry).

As for the previous event, participants in the ARKWORK workshop generally expressed a positive opinion on the methodology adopted for the event. Juan, for example, highlighted its efficacy in avoiding solutionising (i.e., identifying solutions prematurely, without exploring more creative options): "I also think that of having a framework and structure to follow is to prevent what happens a lot in design that people go immediately to prevailed solutions" [17, 203]. Similarly, the tools adopted for both the UXD and prototyping activities proved to be helpful in supporting participants' creative and decision-making processes. Moreover, the choice of using low-fidelity paper prototypes was particularly appreciated as it promoted creativity, while also offering a democratic approach to design since it does not require technical skills, as stated by Judith: "I think overall at the end we were happy to use papers, pens and scissors and we were quite creative in what we were doing." [17, 216]

Tools like personas cards, scenarios and storyboarding were considered particularly valuable for focusing on stakeholders' needs and interests, user interaction, and for embedding the experience within the physical space where the proposed design is supposed to be used. In particular, the development of personas facilitated the transferring and sharing of knowledge, as each participant contributed to the process with their own expertise and experience.

In relation to the theme of professional and personal gains, some participants appreciated the flexibility of the co-design process and the possible transferability of some elements into their day-to-day work. They also highlighted how the co-design work carried out during the event gave them a new outlook on their own practice, challenged their preconception and promoted reflexivity, as stated by Claire:

> "I think professionally I'm quite familiar with using techniques of co-design, but what really comes home for me is every project, every workshop is different. They're completely different, and that keeps it fresh but it's also surprising and it makes you think. It turns whatever preconceived ideas you came in with, it challenges them, it turns them upside down" [17, 203].

Thus, some participants advocated for a more frequent adoption of this process. Jennifer, for example, said that the workshop had been

> "an incredibly valuable experience taking part in a co-design activity in a topic that I know nothing about, because I've been thrown into the role of a very unconfident user and that's enabled me to reflect very strongly on my practice as a facilitator and about if I was facilitating my experience over the last few days how would I have anticipated some of those challenges that I faced. I guess I would really strongly recommend trying to go to an event like this, that it's completely outside your realm of experience. I think for me that's been very valuable" [17, 203].

As for mutual learning, some participants felt they acquired new knowledge and deeper appreciation of how other professionals think and work, as indicated in the following quotes by Gavin and Costis:

> "I think for me the process of co-design and listening to people – I hope I did – and actually coming to a slightly different solution, a slightly different understanding, has been really powerful for me. I think for me that culture of coproduction beyond just the technical process is an interesting dimension as well, particularly if we were working with those not in the sector." [17, 595]
>
> "it always takes some time to get familiar with each other, so maybe we spent an hour getting to know each other and it was very natural and reasonable within the process and maybe this is part of the learning, for people to be creative together they need to overcome issues of social capital and recognition of professional expertise. That was very fluid for us, there were interesting ideas on the table." [17, 215]

Finally, participants' feedback gave me a better understanding of the ways in which the activities, the role played by facilitators, and the composition of the groups shaped and influenced these processes. As for my personal observations during the workshop, facilitators proved to be fundamental in guiding the group, helping reach consensus in the decision-making process and ensuring that every participant, in particular the ones less familiar with co-design practices, had a say in the design process. They also adopted different approaches: some facilitators acted more as an additional party, moderating the discussion if and when needed or bringing the group back on track when it was digressing and losing focus on the task at hand; while others decided to adopt a more structured approach and lead the group throughout all the activities.

The themes of the role of facilitators and frustrations developed from the follow-up interviews seemed to suggest that when highly structured and facilitator-driven, the decision-making process caused frustrations in participants who felt they had a more passive role and eventually resulted in impediments to their professional and personal gains as pointed out by Ian:

> "we didn't kind of follow the approach we were supposed to be following, so I'm not quite sure, we didn't really work with the approach and tools you provided us as it was described. I didn't much learn about the participatory approach." [17, 218]

On the other end, the more open and participatory approach adopted by other facilitators seemed to have engendered a more effective learning by doing and ultimately led to more defined and significant gains for participants, as indicated by Andriana:

> "after I came back, I developed a low fidelity prototype and tested it with some of my colleagues and I also created personas about potential users of the virtual library and applied some evaluations methods like focus groups and interviews [...] I am so happy that we are slowly integrating these approaches in my work because now people can see how important it is to avoid future mistakes." [17, 220].

These results show how beneficial it is to integrate HCD practices in our workflows. The highly collaborative and multidisciplinary nature of such practices can help generating new and meaningful forms of knowledge production and sharing, as well as mutual learning, while also promoting collective and critical consideration of stakeholders' needs and aspirations. By embracing HCD principles, practitioners can actively involve stakeholders, create inclusive environments, and develop digital solutions that align with the needs and aspirations of the communities they serve.

Drawing upon the practical experience and insights gained through the iterative evaluation process adopted for my research project, the diagram in Figure 6 presents some concrete examples for archaeologists and heritage professionals on how to embrace a HCD practice either through dedicated events or by integrating single activities into their own workflows. Embedding HCD principles and methods into the normative methodologies of the archaeology and heritage sectors requires them to become part of everyday work and networks of interactions [36]. As such, a conceptual framework and practical means are needed to integrate HCD sustainably and effectively into organisational practices via constant use, sharing and routinisation.

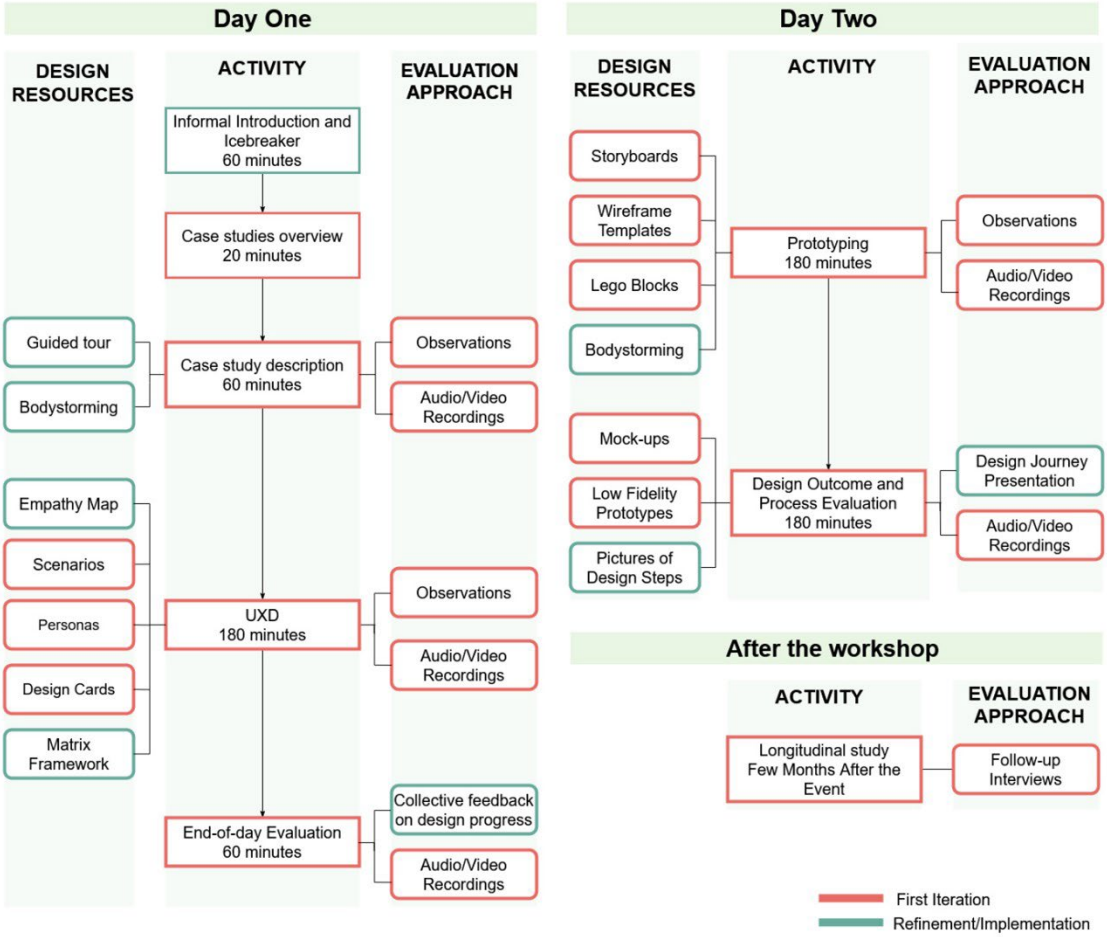


Figure 6: Diagram illustrating workflows, design techniques and resources, and evaluation approaches for co-design workshops.

4 Conclusions

The work presented here has examined the problematic application of interactive digital media for both specialist and non-specialist stakeholders which is most obvious in terms of the lack of consideration that is typically given to the design of the overall experience and to how diverse are the needs of such stakeholders. For example, the creation and evaluation of the 3D interactive visualisation of Erimi-Laonin tou Porakou, originally conceived as a tool for research purposes, challenged some of the persisting preconceptions around the universal efficacy of digital resources in conveying archaeological interpretation to diverse stakeholders and highlighted the tensions between perceived outcomes and actual stakeholders' responses. Furthermore, the practical experience and insights gained through the co-design workshops showed me the value of adopting collaborative practices for the design of digital resources in both archaeological and heritage sectors. It also promoted critical reflection on the possible implications of not integrating such processes within archaeological and heritage practices, in terms of meaningful forms of knowledge production and exchange, as well as engagement with stakeholders.

Incorporating HCD approaches and principles into archaeological practice enables us to reflect on why, what and for whom we are designing. It can also make us be more aware of the role we play in the development of digital resources for the discipline, while identifying what conscious and unconscious values and assumptions drive and shape our decision-making process. Moreover, these approaches can highlight ways to design experiences that better reflect the fluidity, multivocality and sometimes messiness of the interpretive process and engage stakeholders more meaningfully with the archaeological record. However, adopting a more critical and HCD approach is challenging, as it requires commitment, good facilitators to guide the process and a nurturing work environment. Oliver et al. [53] have pointed out that one of the risks of co-design is that this kind of research is often carried out by (mostly female) junior researchers, without proper support and resources from institutional management and senior academics. Nevertheless, especially when supported by design resources, such human-centred and participatory approach to the design of digitally mediated archaeological and heritage experiences is worth the cost as it offers a means to create resources that are truly socially engaged [see for example 40, 54].

For this reason, as for future research directions, I will continue working on the refinement and testing of co-design strategies and resources that prioritise values and ethical considerations in the design process for the wider professional community, promoting human-centred and values-led design as conceptual models. In particular I will focus my work on the application of the Values-Led Design Toolkit, co-designed by myself and colleagues Claire Boardman, Rachel Opitz, and Sara Perry, which tailors values-led and HCD methods to meet the specific needs of archaeologists and heritage practitioners [16]. The aim of such work would be then to offer theoretical and practical grounding for the discipline on flexible HCD methodologies for archaeology and heritage practitioners, to actualize change in the discipline and translate ethical and participatory design approaches into concrete terms.

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APPENDIX A

A.1 Themes from Interviews and First Focus Group with Erimi Research Team

- 3D MODEL EFFICACY FOR ARCHAEOLOGICAL RESEARCH: Participants' opinion on whether and how the interaction with the 3D model was helpful in deepening their understanding of the site and the interpretation process.
- AVATARS: EFFICACY AND UNREALISM: Participants' opinion about the choice of avatars as silhouettes, the issue of unrealism and whether they are improving the 3D model's comprehensibility.
- EMOTIONAL ATTACHMENT: Participants' discussion around their personal involvement with the research project and their relationship with the site itself.
- DIFFERENT STAKEHOLDERS' NEEDS AND EXPECTATIONS: Participants' opinion on the 3D model efficacy for non-specialist, comprehensibility of text description, intended stakeholders and the use of storytelling.

A.2 Themes from Second Focus Group with Erimi Research Team

1. ACCESS AND CIRCULATION WITHIN BUILDINGS: Discussion around how the interaction with the 3D model improved participants' understanding of access control and people's movements within the workshop complex.
- USE OF SPACES: Discussion around how the interaction with the 3D model improved participants' understanding of the different use of open and closed spaces within the workshop complex.
- EMBODIMENT: The process in which the body, and its spatial and material relation with the environment, influences mind, thinking and cognitive processes.

A.3 Themes from Survey

1. COMPREHENSIBILITY: Participants' opinion on the clarity and comprehensiveness of text description and level of information provided.
- USABILITY: Participants' opinion on UI's features and usability.
- IMMERSIVITY: Participants' opinion on navigation, interaction modalities, avatars and first-person perspective.
- ENGAGEMENT: Participants' comments on their personal experience interacting with the UI, what they liked, disliked, learned or remembered.

A.4 Themes from Interviews with Digital Heritage Professionals

1. INTERACTIVE DIGITAL MEDIA: WHY, WHAT, HOW AND FOR WHOM: Interviewees' comments of their work: what kind of digital heritage resources they have designed and/or evaluated, intended stakeholders and main aims.
- STAKEHOLDERS' EXPECTATIONS: Interviewees' discussion on what they have learned through their work and research about what stakeholders expect from their experiences with interactive digital media in heritage settings.
- EVALUATION: AIMS, APPROACHES AND EFFICACY: Interviewees' comments on strengths and limitations of the different evaluation approaches they adopted.
- STAKEHOLDERS' RESPONSE: Interviewees' discussion on how various stakeholders perceived and responded to the interactive digital media they designed and/or evaluated.
- BEST PRACTICE, PARTICIPATORY DESIGN AND STORYTELLING: Discussion around interviewees' experiences and lessons learned, the role played by storytelling and the importance of adopting collaborative participatory approaches when designing digital heritage experiences.

A.5 Themes from First Co-design Workshop

1. STRENGTHS: Participants' comments on the efficacy of PD process and design resources
- ISSUES: Participants' comments on issues around the workshop's structure.
- PERCEIVED BENEFITS: Participants' comments on what they felt to have gained professionally and personally form their participation.

A.6 Themes from Secon Co-design Workshop and Follow-up Interviews

1. EFFICACY OF PD PROCESS: Participants' comments on what they perceived to be the strength of a participatory approach to UX.
- EFFICACY OF DESIGN RESOURCES: Participants' comments on the design resources effectiveness in supporting the UX design process.
- FRUSTRATIONS: Participants' comments on perceived issues within the workshop's structure, design approach and resources.
- GAINS: Participants' comments on perceived benefits, both professional and personal, form participation.
- MUTUAL LEARNING: Participants' comments on what they felt to have learned from each other during the design process.
- ROLE OF FACILITATORS: Participants' comments on how the approach adopted by the facilitator of their group shaped the design process and ultimately affected their perceived benefits.