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Implementing Curiosity Hooks and Caring Practices in the Reconstruction of Lost Polychromy. Design Prototypes for Interactive Experiences

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Abstract

Engaging museum audiences with problems such as the conservation of monuments or the fading or lost colours of our Cultural Heritage remains a challenge, as traditional approaches often fail to establish lasting connections. Recent museological debates highlight a "sense of care" as a key perspective in fostering relationships between citizens and Cultural Heritage. The PERCEIVE Horizon project explores "caring prototypes" to enhance engagement with coloured collections. Building on research on curiosity-driven engagement, this study investigates design strategies for digital and hybrid prototypes, specifically tailored to engage visitors with the lost polychromy of ancient statuary. Our qualitative user research in museums and educational contexts reveals that audience feel to be involved most when actively solicited by an investigative process, rather than being treated as passive observer of reconstructions. We propose here a User eXperience (UX), interface (UI) and interaction (IxD) solutions inspired by a "care" theory. The theory is based on three concepts: "care practice", "care as a process" and "effort". The result is a modular interactive UX that guides visitors through the step-by-step reconstruction of lost polychromy, integrating archaeological, literary, and scientific data to foster a deeper connection with these fragile collections.

CCS Concepts

• ***Human-centered computing*** → ***Empirical studies in interaction design;*** • ***Applied computing*** → ***Fine arts;***

1. Introduction

In the last decades, interest in lost polychromy has grown, and museums worldwide have begun exploring how to communicate this theme to the public. Early exhibitions often met with scepticism, as classical statues are still widely perceived as white, and the lack of visible colour traces makes polychromy feel abstract or irrelevant to audiences. Initiatives such as Bunte Götter [Lie23], ChromaAR [The23], and the Athena installation at the MFA Boston [Bla22] sought to reveal the vibrant hues of ancient sculptures, using painted casts, AR projections, or 3D models. Despite these varied media, public responses remained lukewarm, often seeing such reconstructions as speculative or inconsistent with traditional expectations of antiquity [Mar06].

To address these challenges, the Horizon project PERCEIVE [PER23] explores "caring prototypes": interactive experiences designed to strengthen the audience's affective relationship with artworks. A first proof of concept tested this idea on *Bathers by the River* by Matisse (1909–1917, Art Institute of Chicago) [VP24], showing that creative engagement [BEC08] may elicit caring behaviours in visitors. However, that protocol focused on a very different phenomenon, i.e. compositional rearrangements on canvas, where colour change reflected authorial intent. In contrast, the polychromy of Greco-Roman statues was lost due to environmental degradation, with only minor pigment traces recoverable today. Scientific methods rarely yield a single reconstruction but rather multiple plausible hypotheses. Moreover, the Matisse prototype explored only one interaction model, without testing alternative strategies to foster care.

This paper builds on that foundation to propose a new "caring prototype" specifically addressing lost polychromy. Section 2 introduces the conceptual tools of "curiosity" and "care" and outlines their implications for interaction design. The following sections present the prototype, its alignment with this framework, and a critical reflection on its potential and limitations.

2. Curiosity and Care as Design Concepts

2.1. New Insights on Lost Polychromy in Museums

To better understand how museum visitors engage with the theme of lost polychromy, two qualitative user studies were undertaken

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as part of the PERCEIVE Horizon Project: the *Curiosity Probe Kit* and the *MANN Experts Room* [CBB*25]. The *Probe Kits* [BP23] were distributed to a class of university students and consisted of a simple booklet designed to explore how different triggers stimulate curiosity and engagement with cultural heritage. It included diary entries, questionnaires, and multimedia tasks focusing on curiosity and more specifically, on ancient polychromy.

Analysis of the activities, revealed that the most effective triggers of curiosity were consistently identified as novelty, unexpected, and unknown elements found during an experience. They were particularly triggering in prompting participants to seek further information or explore topics more in depth, transforming curiosity into a more sustained interest. When applied specifically to the topic of lost polychromy in ancient sculpture, the *Probe Kit* activities began to show that participants responded with heightened curiosity to tasks involving the scientific reconstruction processes, more than the final re-colouring of the statues. Rather than being directly drawn to the final coloured reconstructions, participants expressed greater curiosity levels and fascination towards the process of how traces of colour were discovered, what tools were used, and the interpretive challenges involved in making hypotheses about reconstructions. This shift in focus, from outcome to methodology, suggests that audiences are more deeply engaged when they are encouraged to step into the shoes of scientists and conservators.

The *MANN experiments*, conducted at the National Archaeological Museum of Naples (MANN), served as a crucial extension of the insights initially gathered through the *Curiosity Probe Kit*. Consisting of two complementary experiences —the *Expert Room* and guided itinerary to discover MANN's coloured collections— these experiments placed visitors directly in the environment of ongoing diagnostic and digitisation research on ancient sculpture. While the *Probe Kit* had previously highlighted the mechanisms through which curiosity is triggered, the MANN experiments offered the opportunity to test these triggers in a museum context, with a broader and more diverse audience.

The results confirmed and deepened the initial findings. Participants again reported high levels of curiosity, but in particular the scientific process itself consistently emerged as the most engaging aspect, with its diagnostic techniques, multispectral imaging and complexity of data collection. In both cases, visitors expressed a greater fascination with 'how we know' than simply what we know'. Diagnostic analysis, pigment detection and the careful step-by-step reconstruction of polychromy generated more sustained engagement than static displays or colour renderings alone.

The results of the user studies conducted when the *Curiosity Probe Kit* and the *MANN Experiments* were combined shed light on how the public perceived the discovery of lost polychromy. A high level of curiosity was evident across the different groups of participants, with many visitors expressing surprise at how the research could reveal new colours on ancient sculptures long thought to be white. This response highlighted a fundamental shift in how museum visitors approach the concept of ancient art and polychromy: rather than seeing colour as a reconstruction or interpretation, they began to appreciate it as an integral part of the original artwork, rooted in science and research.

2.2. Caring for Cultural Heritage. A Theoretical Framework

Museums and cultural institutions are acknowledging the importance of care as a perspective to understand the complex relationship between visitors and cultural heritage (see e.g. [Bal24] and [Sta]). Nonetheless, in interaction design domain this concept is unexplored and a framework providing reliable guidelines for the conceptualisation of digital heritage experiences is missing. The research activity of the PERCEIVE project attempted to fill this gap, elaborating a first framework on the topic [VBC*25]. This model draws on existing contributions from philosophy [Tro93] [Gro23], legal studies on Cultural Heritage [Woo23] and curatorship [Gro08].

It stems mainly from the reflection of the moral philosopher by Joan Tronto: even though she does not focus explicitly on Cultural Heritage (CH), she argues that care is a process, a "set of practices" that "includes everything that we do to maintain, continue, and repair our 'world' so that we can live in it, as well as possible. That world includes our bodies, ourselves, and our environment, all of which we seek to interweave in a complex, life-sustaining web" [Tro93]. In this pilot study, we fully adopt her care theory, based on a four-stage model, introducing small adaptations to the CH domain (see [VBC*25] for a more detailed discussion). The result is shown in Fig. 1.

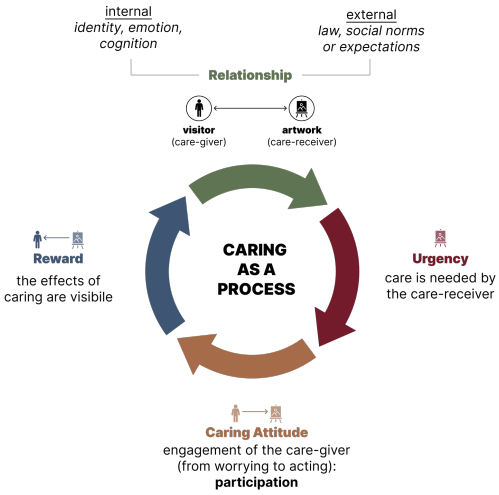

Figure 1: *Caring as a process: framework visualisation*

"PERCEIVE Care Framework" considers caring as cyclical process, organised into four core stages (or components). Owing its circular nature, the elicitation of care does not have fixed beginning nor a definitive end. An essential element of the care theory is the *relationship* between care-giver and care receiver, which may derive either by internal (e.g. emotional engagement, recognition as part of its own identity, cognitive appreciation) or external factors (e.g. legal prescription, social expectations). The essence of the framework is however the perceived *urgency* to act: the care-giver recognises that the care-receiver (in this context, the cultural object or sites) is at risk and acknowledges its own responsibility to meet this need. Traditionally, the risk of loosing the object (i.e. a *sense*

of loss, see e.g. [Har01]) is considered one of the most effective triggers in this phase.

This perceived urgency ignites a variety of responses, defined in literature as *caring behaviours* or *attitudes* and which may considerably differ in terms of purpose, effort, or involvement. In a museological perspective, this coincides with audience engagement and their participation [Sim10]. Lastly, Tronto stresses the importance of the phase of care-receiving, formalised in PERCEIVE Framework as *reward*: here, "the object of care [responds] to the care it receives. For example, the tuned piano sounds good again, the patient feels better [...]. This phase provides the only way to know that caring needs have actually been met" [Tro93]. As suggested by Tronto herself, the results of conservation and restoration activities - which also includes the study and reconstruction of lost polychromy - well embodies this phase.

In cultural institutions, the caring process greatly benefits of museum mediation: in its broadest definition, it identifies the "sharing of artworks and knowledge [...] to a vast audience" [Mai23] and, in past researches, was even proved to change users' behavioural intentions (e.g. [JBR12]). The activity of curators, museum practitioners and educators can indeed act as a trigger on multiple component of the framework and eventually foster the relationship of care between visitors and objects in art collections.

Museological debate already provided evidence in this regard, associating museums with hospitals as institutions of "care". Also in this context, visitors do not have the possibility to directly on the artwork, but their presence and involvement is essential for the care process. In this regard, Groys observes that "artworks seem to be genuinely sick and helpless – the spectator has to be led to the artwork, as hospital workers might take a visitor to see a bedridden patient" [Gro08]. From the etymology of "curatorship", he deduces that "the process of curating cures the image's powerlessness, its incapacity to present itself. The artwork needs external help, it needs an exhibition and a curator to become visible" [Gro08].

3. The Concept-Based Design of an Interactive Caring Prototype

This theoretical model was used as a guideline for the design of a "caring prototype". In this perspective, we followed a "concept-based interaction design" approach, which extends traditional goal-oriented and user-oriented methodologies by identifying a "theoretical/conceptual point of departure" [SW10].

Also the choice of the case study was drive by these observations on care and curiosity. A set of requirements was defined: the artworks should have (a) traces of colour both visible and invisible; (b) already undergone archaeometric analysis and had been part of a campaign on how to identify lost traces of polychromy, so to include the results in the exhibition; and (c) some kind of hypothesis of reconstruction for comparisons, either contemporary or past ones [NN54]. The *Anadyomene Venus* (inv 6298), originally located in the Iseum Complex in Pompeii and now displayed in the National Archaeological Museum of Naples, answered all the requirements. It was therefore chosen as the main case study of the prototype.

Subsequently, we compared the theoretical caring framework with the qualitative data gathered from the curiosity experiments. In both of them, the dissemination of diagnostic, conservation and restoration activities play a significant role: on the one hand, preservation is the most intuitive form of caring. On the other hand, unveiling the complexity behind these scientific investigations was experimentally proved to stimulate audience curiosity.

The resulting experience guides and actively involves the visitor through the different stages of colour reconstruction, as scientists approach it. The prototype is based on an interactive and modular approach: Tab. 1 aligns the seven modules with the core phases of the user journeys and the components of the PERCEIVE Care Framework.

The first module (M1) consists of an introductory video. It provides a general background on the site and presents to the audience the problem of the original polychromy on ancient statues. The dramatic eruption of the Vesuvius in 79 AD offers a crucial turning point in the script, as it marks the beginning of the deterioration of this statue. This multimedia installation is conceived to elicit visitors' *sense of loss* through ad hoc storytelling, visual and audio effect: this correspond to the *urgency component* and its a preliminary yet fundamental step in catalysing the caring process.

This introduction paves the way to the core section of the experience, which is also visualised in the rendering of Fig. 2. It corresponds to the component of the *caring attitude* and it is organised into different modules, each contributing to a deeper understanding of the reconstruction process. The journey begins with historical sources (M2), where visitors explore ancient texts and iconography to understand how pigments were mixed and how they were applied, and to have a first glimpse into sources that show depictions of coloured statues. The next modules delve deeper into diagnostic analyses, introducing the tools and methods that allow researchers to uncover the invisible traces of colour on ancient statues and in particular showing what was found on the *Anadyomene Venus*.

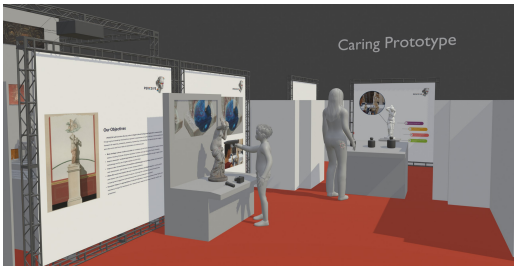

Figure 2: *Caring Prototype, 3D visualisation in Blender*

Through microscopy (M3), visitors see magnification of visible traces of pigments that could otherwise go unnoticed. Then, imaging techniques (M4) like UVL (UltraViolet Luminescence) and VIL (Visible-Induced Luminescence) highlight those hidden pigments and dyes that can be uncovered through the use of special lights, and give more information on those that were already detected. Lastly, spectroscopic analyses (M5) such as XRF (X-ray Fluorescence) and FORS (Fibre Optic Reflectance Spectroscopy) provide deeper insights into the chemical composition of the pigments. Interactive displays let visitors simulate the use of these techniques by selecting points on digital images of statues.

Urgency	M1. Introductory Video	A “sense of loss" is triggered in the visitor
Caring Attitude	M2. Historical Sources M3. Microscope M4. Imaging Techniques M5. Spectroscopy M6. Mockups & AI	The visitor gets familiar with the different methods and tools involved in the color reconstruction process (exploratory behaviour)
Reward	M7. Interactive Projection on the Statue	By interacting with the installation (caring attitude componente), full reconstructive hypotheses are shown: the “image is healed" (reward component)

Table 1: *Alignment of PERCEIVE care components (see Fig. 1) and the modules of the caring prototype*

Building on these analyses, the next module introduces mockups (M6): physical reconstructions on marble that test hypotheses about colour application. AI and computer vision are also employed to reconstruct the statues’ original appearance, synthesizing the findings into plausible visualizations.

The final module (M7) presents a digital reconstruction of the *Anadyomene Venus*, synthesizing all the data into a dynamic visual experience. The set up of this last module consists of a table with a tangible user interface (TUI), in front of a replica of the statue. Through an interactive projection mapping on the statue, visitors can explore different stages of the colourization process: from rough, speculative reconstructions to refined, evidence-based renderings. The change among these different projections is ruled by visitor’s interaction: the table has indeed physical objects which triggers the different phases of the projection.

The props at the core of the TUI are designed to evoke a simple but meaningful metaphor. This approach was shown to “support learning in abstract domains" [BAVDH12]. As depicted in Fig. 2, a first hypothesis being tested is a set of weighs, different in terms of size and weight: in the prototype, this concept is associated with “effort", as physical effort is required to lift them, and is considered also a synonym of “importance". The design of this module adopts the principles of embodiment [Ken15] to catalyse visitors cognition: through the interaction, the user can touch with hand the relevance of the activity of conservators and heritage scientists, as well as understand the labour requested to reconstruct lost polychromy.

Therefore, this phase correspond to the “reward" component: the engagement of the visitors with the exhibition can help - as in Groys’ words - the “sick image heal" [Gro08]: if, at the beginning of the prototype, the polychromy of the *Venus* is presented as lost (*urgency* component), after the interaction with this final module the visitor can access possible reconstructions of the original appearance of the artwork. Following the theoretical framework of Fig. 1, the final result of this exhibition is the establishment of a *relationship* of care between the audience and coloured collections.

4. Main Results and Future Work

This study presents the early design of a “caring prototype" UX, an interactive experience that fosters visitors’ care toward the lost polychromy of classical statues. To achieve this goal, we have described here the concept-based design of this application, starting from a qualitative survey on curiosity in archaeological museum and a theoretical framework on care. The different modules will be implemented following our design, and showcased for an upcoming hybrid exhibition, presented as a result of the PERCEIVE project.

Following this first design, our prototype transforms the act of colour reconstruction into a participatory and investigative process, blending science, history, and creativity. By engaging with the layered nature of historical evidence and the tools used to uncover hidden traces of ancient polychromy, visitors gain a deep understanding of the complexities involved in preserving and interpreting cultural heritage. Rather than presenting a single, unchangeable answer, the room invites visitors to experience the reconstruction as an ongoing, thoughtful, and dynamic act of care: this conveys one of the key message of the installation, i. e the *uncertainty* inherent in the scientific process.

Consequently, curatorial choices should be made to find a balance between the need to visualise coloured statues in a way that is accessible and evocative for the public and, at the same time, to remain grounded in scientific integrity. In visual storytelling, in co-creating a “sense of care”, it is crucial to communicate the *limits* of our knowledge not as scientific weakness, but as a reflection of the object’s historical fragility and the humility of research. In the case of the *Anadyomene Venus*, colours are not imposed as a final rendering, but instead gradually emerge, suggesting multiple hypotheses rather than a single solution. It becomes a metaphor for a truth that remains elusive yet intuitively pursued, a glimpse into a lost reality we commit to care for, to recover, and to share.

This paper shows how “the creation of prototypes serve as input to the development of interaction theories" [SW10]: the theoretical investigation of the sense of care in the cultural domain and the initial analysis of its implication for UX design is our major results. Nonetheless, this prototypal nature constitutes the most significant limitation of this product. More specifically, the effectiveness of this installation is to be considered hypothetical. In the future, an exhaustive testing of this application should be carried out. The PERCEIVE Project consortium already validated a first scale to use as pre-test, aimed assessing visitors’ caring attitude as latent ability [VvGP*25]. Other evaluation techniques are instead currently being devised, in order to elaborate a full evaluation protocol. To reach this goal, the interdisciplinary collaboration among interaction design, cognitive psychology and visitor studies is therefore of paramount importance.

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