A methodology for enhancing the accessibility of scientific museum's collections

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Keywords: Cultural Artifacts, Extended Intelligence, Accessibility, Augmented Interaction, Brendel Models

Abstract

In this paper, we propose Scientific Collections Accessibility Making Process (SCAMP), a methodology to generate meaningful interactions with cultural heritage artifacts leveraging digital technologies with the aim to foster cultural engagement and inclusion. Having the objective of increasing the accessibility within museum paths both for the general public and for blind and visually impaired people, we developed a standardized, yet flexible approach for the reinstatement of tactility within museum paths and objects and a participatory model of fruition for museums' scientific collections.

A general need for renewal within the museum field has been expressed in multiple occasions during the last century: on one hand, applying extended intelligence and new digital technologies (e.g., augmented/virtual reality) to engage the public even beyond the "physical" nature of museums, while on the other proposing to go back to the *sensorium*, meaning "the entire sensory apparatus as an operational complex" (Ong 1991), moving beyond ocularcentrism (Candlin 2008, 2017; Classen 2005; Howes 2014) in order to take things a step further and enable genuine inclusion during museum visits. This need for multisensory experiences within museums' paths is not confined to the scientific community. Indeed, according to Kenderdine "museum visitors today expect learning that stands up as an experience (Macdonald, 2007), and expect a physical experience enlisting all the senses (Hooper-Greenhill, 2006).". The sense of touch plays a central role within this perspective. The rediscovery of haptic exploration is described as crucial in visitors' engagement giving them the "impression of having comprehended [museum objects'] nature" and "experience[d] them intimately" (Classen 2005, 277), moving beyond the merely theoretical comprehension and enriching it with the information that is possible to collect only using the senses. Furthermore, the reintroduction of touch has significant ethical and social implications (Candlin 2017; Muscarà and Sani 2019) allowing *all* visitors, including blind and visually impaired people, to be part of the museum experience. As Black argued, indeed, "touch and object handling should be built into the gallery as a normal element of the display" (Black 2005). In order to achieve this goal, the use of replicas of cultural heritage objects allows to

overcome the oculocentric paradigm, to use digitization to create a product that encourages multisensory experiences with historical objects while preserving the originals (Ballarin et al. 2018). The growth and adoption of rapid prototyping through 3D printing, which makes it possible to obtain physical replicas of digital objects, has created new opportunities and developments in the field of cultural heritage as well (Scopigno et al. 2015), enabling the usage of digital technologies to restore usable material objects in hybrid and non-hybrid (Bannon et al. 2005) settings. Nevertheless, the use of these technologies within museum displays is under-utilised and still under-researched (Wilson et al. 2018).

Our aim is to consider the aforementioned instances to make use of digital technologies, HCI approaches and UX design (see King et al. 2022) to implement a workflow for the creation of 3D-printed replicas of scientific manufacts with a high historical value which, by means of multimedia content and a strong focus on tactility, encourage active processes of knowledge construction by means of direct, guided exploration. This is achieved by means of the "Scientific Collections Accessibility Making Process (SCAMP)" methodology, which exploits these principles and the natural characteristics of objects that can be applied to in order to make them "accessible again" to the general public, and improve their accessibility for blind and visually impaired people.

To demonstrate the feasibility of the SCAMP methodology, we applied it to the Brendel collection of University of Bologna (Maurizzi 2010): these models were created in late 19th/ early 20th century by the Brendel Company for the academic needs of botanical science and agricultural students, and are large-scale exemplars of plants and seeds in various stages of their biological development. They are composed of a variety of materials, ranging from papier-mâché to wood to animal feathers. These exemplars are well suited to our methodology because they embody both artistic and scientific values and were designed for real, physical interactions: as learning objects, they were intended to be manipulated and disassembled by students to better understand plants' anatomy, the different stages of their growth and their diseases. Over time, because of age and intense use, most of these objects were broken or worn out and have consequently been put away. In particular, the Bologna Brendel collection consists of 95 items displaced several years ago in closets and basements and rediscovered only in 2008. The Brendel Company sold the botanical models through catalogs all over the world; as a result, many institutions (such as universities, schools, and botanic gardens) now have Brendel collections. Our methodology can therefore be used with a variety of collections and in a variety of settings. It might also be used with other collections of manipulable scientific objects, like the Dr. Azoux models.

Our approach is meant not only to restore these objects to a reasonable physical state for display purposes, but it intends to also provide a substitute experience for tactile and physical interactions by using expendable 3D printed copies of the original (and precious) items. In order to develop multimodal experiences within museums' paths, our aim is to use the replicas for the development of multimedia interactive installations. The methodology involves an iterative process and several technical and theoretical challenges, and its main steps involve a) the restoration of the original artifacts; b) the digital scanning of the original artifacts, and the realization of a physical replica through 3D prototyping; c) the design of the user experience of the multimedia installation; d) front-end and back-end development of the multimedia installation; e) user

testing involving blind and visually impaired people; f) the design of the entire exhibition. This entire workflow involves several professionals collaborating synergically.
The project is currently under progress, and two different prototypes have been created in order to better understand the theoretical and technical difficulties associated with the presented methodology. First off, a multimedia interactive installation prototype has been developed for the *Phaseolus vulgaris* Linn. Brendel model (which represents the early stages of the germination process of a bean plant), both to demonstrate the feasibility of the proposed process and to evaluate its impact with real users, obtaining very encouraging results (Grillo et al. 2022). After that, the usage of the most advanced 3D scanning and 3D printing technologies has been explored to make the proposed process much more scalable in terms of time, cost and accuracy.
Our aim is to propose a new way to interact with cultural heritage, fostering accessibility, social inclusion and a use of ICT to go beyond a hard distinction between the "material and the virtual" (Witcomb 2007), in order to change our understanding of the physical realm of Cultural Engagement. In particular, blind and visually impaired people are mostly excluded from the possibility to appreciate in first person and, therefore, construct their own knowledge starting from Cultural Heritage collections (Vaz et al. 2018). We want to use digital innovation to reverse this trend within museum paths. Moreover, children could benefit from a participatory approach, relying on their senses to better grasp complex abstract notions. In this way, we want to fill both the gaps mentioned before through a theoretical and practical modeling process focusing on accessibility and inclusion.

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