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Cultural Heritage for All with Virtual Reality: early findings of a Scenario-Based Design approach

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ABSTRACT

This paper describes the findings of the early stage of a research aimed to design a virtual reality (VR) solution as a compensatory tool for improving the accessibility of cultural heritage sites for visitors with mobility impairments. For the research**,** the Scenario-Based Design method (SBD) is applied to identify user requirements of the VR interface, within a User-Centered Design approach. Based on this method, different **personas** and corresponding **scenarios** are designed to represent the needs, motivations and behaviors of the main target groups of users and the applications of compensatory technological solutions. Further, the SBD is used in the prototyping phase as a tool for the co-design activity, which involved users with specific accessibility needs, designers and other stakeholders to identify the requirements of the VR solution. The paper presents the preliminary findings relating to the functional and experiential requirements and discusses the methodological and practical implications to support the use of this approach for the co-design of digital solutions for cultural heritage accessibility.

PAROLE CHIAVE

Cultural Heritage, Accessibility, Virtual Reality, Scenario-Based Design, User Experience, Human-Computer Interaction.

1. BACKGROUND

The design of digital applications to improve physical, intellectual and sensorial access to cultural heritage visitors with different accessibility needs is a growing research area, grounded on the need to guarantee the right to culture as stated by the Universal Declaration of Human Rights [2; 3; 4]. Studies in this area address the design and impact of virtual reality (VR) as a tool to improve accessibility at heritage sites [5;1;17;7;10]. In this direction, User-Centered Design (UCD) [8] is supported as the preferred approach, in line with the principles of Design for All [2] and design for user empowerment [9].

Among the UCD methods, Scenario-Based Design (SBD) [15] has been used for the development of tourism digital experiences [11] and in digital support systems for museums visits and exhibitions [6; 14]. This methodology is useful to engage users, designers and other stakeholders in collaborative design, as an effective bridge between designers and the end users [11]. It provides the possibility of visualizing a case of use in a narrative (i.e. a storyboard) of a typical situation in which the end user interacts with the digital solution. In this way, it facilitates the users to imagine possible difficulties or advantages in using the digital application and the designers to adequately consider the contextual and social factors for its sustainability. In this sense, the scenario becomes the design tool that can be modified, enriched, extended in the co-designing activities in parallel to the technological implementation.

However, there is a lack of research focusing of the use of this specific approach to support the identification of the dimensions of the visitor experience to be enriched with VR and the requirements for an effective interaction with the digital solution in the context of cultural heritage accessibility. This paper aims to provide an initial contribution in this direction, by describing the findings of a study that adopted SBD as a tool to identify user and functional requirements of the VR interface from the concept generation to the prototype design.

2. MATERIALS AND METHODS

This study is conducted within a research project aimed to develop a VR mobile application to improve visitors' experiences at heritage sites where physical barriers cannot be easily eliminated to allow full accessibility [11]. Based on UCD, the research involved users with permanent and temporary mobility impairments, including elderly, in all the stages of the design cycle (Fig. 1), in order to fully take into account their expectations, needs and requirements in relation to the use of VR as a compensative experience of inaccessible cultural heritage. In the explorative stage of research, a multidisciplinary approach at the crossroad of tourism experience design and innovation, human-computer interaction and heritage valorization has been applied to develop the personas and preliminary scenarios as tools to

support the co-design activity in the prototype phase [10]. Personas have been developed on the profile features of the main target groups for the VR solution, in relation to three main features (as exemplified in Fig. 2): 1) accessibility needs [16], 2) engagement with cultural heritage, 3) attitude and use of technologies in tourism/leisure activities, including VR . The four personas represent the protagonists of four corresponding preliminary scenarios. Each scenario was matched with three elements, as detailed in Table 1: a) level of site accessibility; b) users' motivation for visiting the heritage site; and c) expertise or attitude in use of technology.

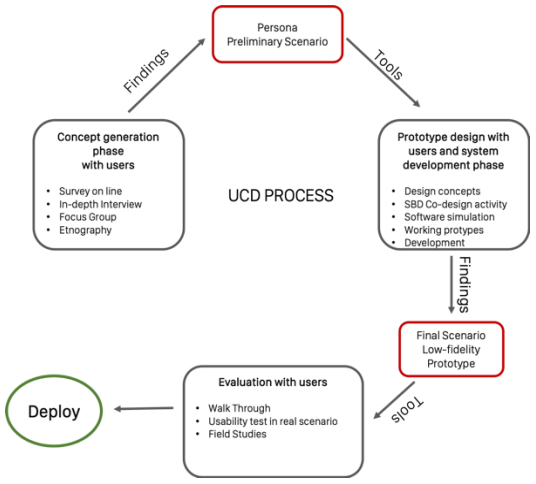

Figure 1: **The UCD Cycle for the research**

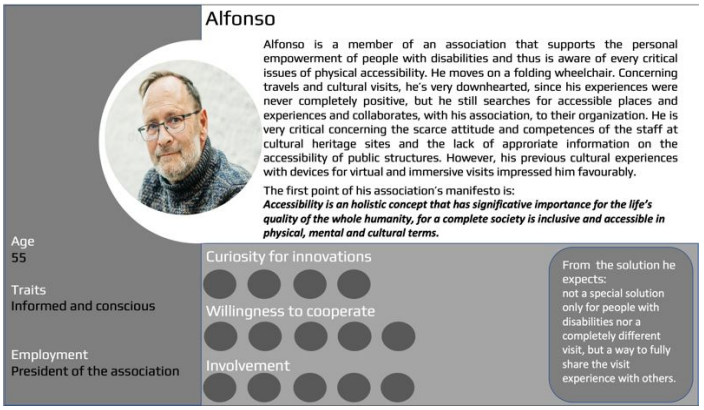

Figure 2: **Description of a *persona***

Accessibility of the site	**Personas' motivation and attitude towards technology**	**Scenarios' Storyboard**
Totally inaccessible	Persona 1: High motivation to visit heritage, high attitude to use technology (included VR)	Persona 1 is a young woman with a permanent mobility impairment would go for a cultural visit and a friend proposes her to visit an amazing church that unfortunately is totally inaccessible… (to be continued).
Partially accessible	Persona 2: Medium motivation, medium attitude to use technology, low experience with VR.	Persona 2 (Fig. 2) is a man with a permanent mobility impairment, member of an association for people with disabilities, and he is looking for a site for the annual journey day. He finds an interesting partially accessible cultural site ... (to be continued).
Partially accessible	Persona 3: Low motivation, high attitude in use of technology, included VR.	Persona 3 is a young boy, with a broken leg, who is visiting a site with his classroom, but he is very bored and the partially accessibility of the heritage site is a barrier for him... (to be continued).
Totally or partially inaccessible	Persona 4: Medium motivation, low attitude in use of technologies, no VR experience.	Persona 4 is an old woman with a great desire of visiting a cultural site with her grandniece, but her mobility is limited, and the site is not totally accessible… (to be continued).

Table 1: **The three design features for preliminary *scenarios*.**

As an example, in the second scenario Alfonso, a man with a permanent mobility impairment, has to define the annual recreative program for his association, in which a cultural visit is planned; the corresponding scenario (Fig.3) described needs, reactions, problems that can arise in this typical situation.

3. THE CO-DESIGN ACTIVITY

The preparatory tools described above were used in the participatory design activities, aimed to obtain the guidelines for the development of the VR solution in terms of experiential and functional users' requirements. In order to carry on the co-design phase, pairs of users with different accessibility needs, designers and stakeholders, have been created to work together in envisioning the use of VR as a medium to visit the inaccessible cultural site, using the preliminary scenarios as a basis to create and visualize a personalized story. The co-design activity involved ten participants -the corresponding users to personas, the designers of VR interface, the designers of experience and a stakeholder- as detailed: president of a disability association, user with permanent mobility impairment/ user with permanent mobility impairment / user with temporary mobility impairment/ old user with mobility impairment/ accessible tourism expert from industry/ hardware developer/ UI Designer/ experience Designer/ UX Designer/ accessible tourism expert from industry. The activity was conducted during a Focus Group organized in a single day at the headquarters of a disabled people association. It was divided into three moments: a) the empathize phase (participants' self-presenting, brainstorming on the accessibility of cultural heritage); b) evaluation of different digital solutions for cultural visits (a test of Oculus RIFT device with a VR

cinematic experience of a cultural site; an app for the virtual guided tour of a museum with smartphone and cardboard; a 3D model desktop base visit of an ancient cathedral) for an in-depth understanding of the requirements of the VR solution; c) co-design of scenarios (combination of pairs users/designers, introduction of preliminary scenarios structured as storyboards, co-design).

Figure 3: **An excerpt from preliminary *scenarios*.**

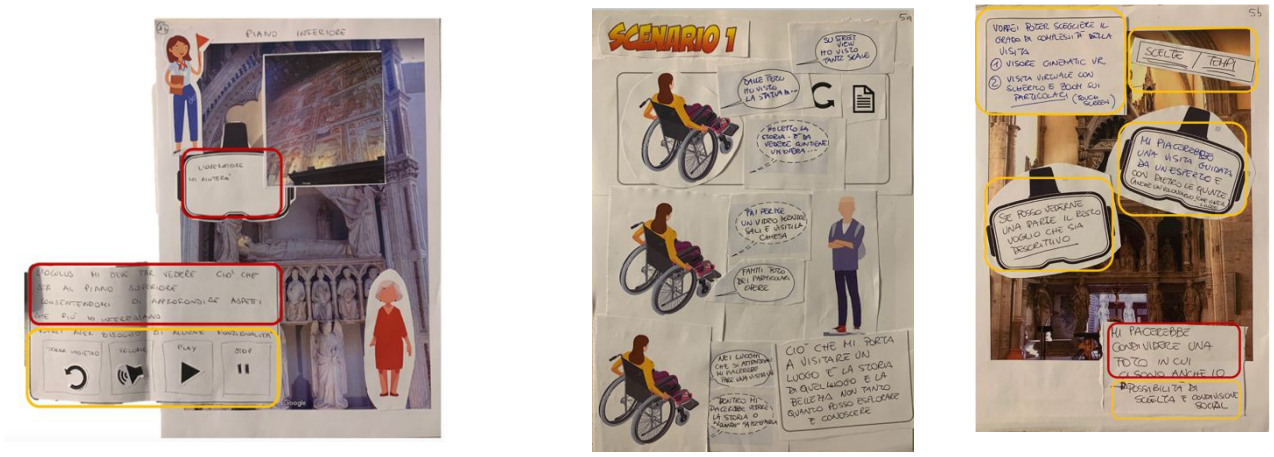

Figure 4: **An excerpt of scenarios envisioned by a user during the co-design activity.**

Each pair chose one of the preliminary scenarios and with the collage technique designed the sequel of the story visualizing the VR experience in relation to both experiential and functional requirements (Fig. 4).

4. FINDINGS

The co-design activity based on SBD allowed to identify the experiential as well as the functional elements for the VR-enabled accessible visit, as detailed as follows.

Experiential requirements

a. Universal solution - The experiential elements should satisfy the requirements of users with different accessibility needs in line with Design for All principles. The VR solution is expected to be implemented as an innovative experience for all the potential visitors onsite rather than as a separated experience provided only to users with mobility impairments. Dedicated solutions for disabled visitors are indeed negatively perceived as marginalizing experiences.

b. Cultural engagement - Curiosity for the cultural experience is the driving force of every imagined scenario, independently from the level of cultural motivation.

c. Connectedness - The possibility to share the experience with users with full access possibility is a fundamental element of the cultural experience, in line with tom Dieck et al. [18] and Marasco e Balbi [10], and it is imagined as the live streaming of contents during the visit.

d. Intellectual stimulation - The virtual experience is a trigger to arouse the interest and motivation of users to learn about the site, as outlined also by Paladini et al. [13]. It is stressed that it should be promoted during the pre-visit phase in order to engage users with different accessibility needs.
e. Storytelling – The narrative modality emerges as an important element; the involvement through an engaging storytelling is requested by users, as previously found by tom Dieck et al. [18], especially in the initial moments of the on-site visit.
f. Autonomy – the smartphone is preferred to head-mounted displays in relation to the possibility to use it more autonomously. For VR devices human assistance is requested by users. If the navigation has an immersive modality, it must include at least an interactive independent part through smartphone or a screen display.

Functional requirements

a. Multimodal interaction. Narrative modalities of contents are strictly linked with the devices' functional requirements: for a more immersive visit with the possibility to explore many details, mixed reality and the use of different device is preferred;
b. Minimal action/Minimalist design. The immersive modality is requested in the first moment of the visit, but, aim to autonomous use, the users need an interface menu useful to navigate in all directions and zoom on details of site through basic controls;
c. Capacity of immersion/ user participation/use of diegetic and extradiegetic sound. In relation to the point of view, generally it is described as very close to artifacts, even "inside" them, i.e. the visitor wants to be immersed into the scenes of a painting. In addition, sharing the point of view of those who are not in the same part of the site via streaming. For improved accessibility, the functional requirement should provide for details of the site, such as the presence of inaccessible areas as well as details regarding impediments and difficulties (floors, ceilings) in the areas that the user can visit. A voice over of an expert is requested to fulfill intellectual needs;
d. Application access. For increased autonomy, no profiling is preferred, but just automatic link when the visitor is onsite through personal devices;
e. Ease of use. Headsets/headphones are not preferred as they could not be handled independently;
f. Co-located collaboration/ Remote collaboration. The designed scenario includes the sharing of the experience through various modalities: the posting of photographs after the visit through the application, during the visit via chat (i.e. in the form of call out), through a form of interaction like multiplayer. The requirements obtained with SBD method can be integrated in a design framework that establishes a correspondence between experiential and functional requirements (Fig. 5), summarized in the final scenario (Fig. 6), which supports the development of the low-fi prototype of the VR solution.

5. CONCLUSION AND FUTURE STEPS

Notwithstanding the increased emphasis on user engagement to address the challenge of accessibility from a design for all perspective, research on the tools and methods for the co-creation and co-design of digital solutions for user empowerment is still in its infancy. This study aims to contribute knowledge in this direction, by providing insights into the process, tools and outcomes of user experience design based on SBD. In particular, this study illustrates how Scenario-Based Design can be used to support the design of a VR solution as a compensatory experience for heritage accessibility [1] through the identification of the requirements of users with disabilities, with specific regard to mobility impairments. As the main advantage for the design process, it provides the possibility to visualize the specific context of use and the visitor interaction therein. The early findings allowed to envision the possibilities of interaction with the VR solution on site in three different cultural heritage sites characterized by different level of accessibility. This method provided VR designers with useful knowledge about who are the possible users to design for as well as the socio-cultural contexts of their lives that frame the VR-enabled experiences. From a *design for all* perspective, the value of this method was supported in enabling and empowering users to actively co-create the VR solution in relation to their needs and expectations. As a potential drawback, it needs to be integrated with an early prototyping process in order evaluate the solutions during the all iterative cycle of design. In this sense, the SBD approach can be usefully leveraged to refine the interfaces that will be evaluated imagining their use in a specific context. Based on the early findings, the co-design activity provided development guidelines for the VR solution that have been mostly implemented within the research project, in relation to choice of the device, content development, user interaction and interfaces. A further step of the project will focus on a unified test of usability, accessibility and impact of the VR solution on-site in the real scenario with end users. In particular, the effectiveness of the solution needs to be assessed in relation to different dimensions of users' experience at cultural heritage sites, including engagement with cultural heritage, intellectual stimulation,

connectedness, authenticity, also in consideration of the experiential requirements emerged in the co-design research. Further, the accessibility of the solution deserves more attention also in relation to the possibility of improving personalization features for wider users' access needs in line with recent research [12].

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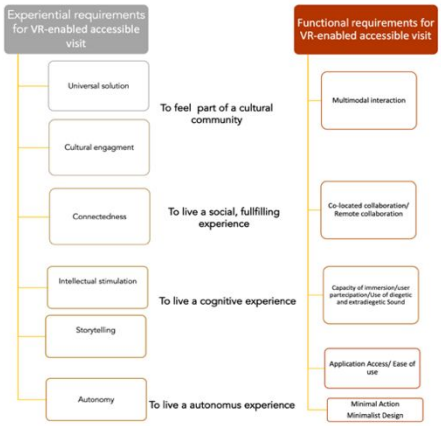

Fig.5 A framework integrating experiential and functional requirements of VR for accessible cultural heritage

Figure 6: Extract from the final scenario to be used for low-fi prototyping

BIBLIOGRAFIA

[1] Agostiano, M. (2016). Enjoyment of Cultural Heritage and "Compensatory Solutions" for an Alternative Accessibility. In: Arenghi, A., Garofalo, I., Sormoen, O. (Eds.), Accessibility as a key enabling knowledge for enhancement of cultural heritage (pp. 131-147), Franco Angeli, Milano.

[2] Arenghi, Alberto; Agostiano, Maria. Cultural Heritage and Disability: Can ICT Be the 'Missing Piece'to Face Cultural Heritage Accessibility Problems?. In: International Conference on Smart Objects and Technologies for Social Good. Springer, Cham, 2016. p. 70-77.

[3] Fogli, Daniela, et al. Advanced interaction technologies for accessible and engaging cultural heritage. In: International Conference on Smart Objects and Technologies for Social Good. Springer, Cham, 2017. p. 364-373.

[4] Fogli, Daniela; Arenghi, Alberto. 'Design for All'versus' One-Size-Fits-All': The Case of Cultural Heritage. In: CoPDA@ AVI. 2018. p. 89-96.

[5] Guttentag, Daniel A. Virtual reality: Applications and implications for tourism. Tourism management, 2010.

[6] Hall, T.; Bannon, L. Co-operative design of children'sinteraction in museums: a case studyin the Hunt Museum. CoDesign, 2005, 1.3: 187-218.

[7] Han, Dai-In Danny, et al. Virtual and augmented reality technologies to enhance the visitor experience in cultural tourism. In: Augmented reality and virtual reality. Springer, Cham, 2019. p. 113-128.

[8] ISO (2010). 9241-210: 2010. Ergonomics of human system interaction-Part 210: Human-centred design for interactive systems. International Standardization Organization (ISO). Switzerland.

[9] Ladner, Richard E. Design for user empowerment. interactions, 2015, 22.2: 24-29.

[10] Marasco, Alessandra; Balbi, Barbara. Designing Accessible Experiences for Heritage Visitors Through Virtual Reality. e-Review of Tourism Research, 17.3.

[11] Mccabe, Scott; Sharples, Mike; Foster, Clare. Stakeholder engagement in the design of scenarios of technology-enhanced tourism services. Tourism Management Perspectives, 2012, 4: 36-44Hall, T., & Bannon, L. (2005). Co-operative design of children'sinteraction in museums: a case studyin the Hunt Museum. CoDesign, 1(3), 187-218.

[12] Montagud, M., Orero, P., & Matamala, A. (2020). Culture 4 all: accessibility-enabled cultural experiences through immersive VR360 content. Personal and Ubiquitous Computing, 1-19.

[13] Paladini, Alice, et al. Impact of virtual reality experience on accessibility of cultural heritage. The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2019, 42: 929-936.

[14] Radder, Laetitia; Han, Xiliang. An examination of the museum experience based on Pine and Gilmore's experience economy realms. Journal of Applied Business Research (JABR), 2015, 31.2: 455-470.

[15] Rosson, Mary Beth; Carroll, John M. Scenario based design. Human‐computer interaction. boca raton, FL, 2009,

[16] Schulz, Trenton; Fuglerud, Kristin Skeide. Creating personas with disabilities. In: International Conference on Computers for Handicapped Persons. Springer, Berlin, Heidelberg, 2012. p. 145-152.
[17] Southall, Helen; Marmion, Maeve; Davies, Andrew. Adapting Jake Knapp's design sprint approach for AR/VR applications in digital heritage. In: Augmented reality and virtual reality. Springer, Cham, 2019. p. 59-70.
[18] Tom Dieck, M. Claudia; Jung, Timothy; Michopoulou, Eleni. Experiencing virtual reality in heritage attractions: Perceptions of elderly users. In: Augmented reality and virtual reality. Springer, Cham, 2019. p. 89-98.