



## Creating Virtual Reality Spaces with Mozilla Hubs: Designers' Expectations and Applications in AudioVisuals Creativity

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# Creating Virtual Reality Spaces with Mozilla Hubs: Designers' Expectations and Potential Applications in AudioVisuals Creativity

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## Abstract

Virtual Reality (VR) spaces have become easily accessible due to the evolution of web VR standards and frameworks. In parallel, VR development tools have become more user-friendly and provide non-experienced designers the ability to design VR applications for the web. Under this light, this work aims to explore the designers' expectations from such tools and their perspective regarding the potential applications in the audiovisuals creativity domain. In this work, in order to accomplish its goal a small group of young designers is employed to be trained in the use of a web VR development platform, i.e., Mozilla Hubs, and to provide their feedback regarding the types of applications they are interested in designing. Their responses are analyzed in order to provide a set of instructions suitable to serve most of their requirements in designing VR applications with the considered platform as well as for providing information on the adoption of VR technologies and applications by the so-called "digital natives" generation.

## Keywords

web VR, VR spaces, audiovisuals creativity, designers' expectations, potential VR applications, VR adoption

## 1 Introduction

Virtual Reality spaces, hereinafter referred to as VR spaces, create environments in which individuals and organizations have continuous worldwide access, having no space limitations (unlike the real world) despite the fact that virtual spaces can provide the required area and social practice to create places akin to a real physical space, while also providing a significant cost limitation (or no cost at all). The above advantages mark VR spaces as an accessible and easily manageable environment for a variety of uses, including virtual tours [1], interactive exhibitions [2], and enlivening settings [3].

Given the increased use of VR spaces for a variety of purposes, this paper is designed to identify the potential uses of VR spaces in the domain of AudioVisual creativity by exploring the ways that audiovisual artists and creators would make use of them as VR space designers. Additionally, as the domain of AudioVisual creativity encompasses many different disciplines there is considerable possibility that audiovisual artists and creators are not experienced in designing VR spaces and the technologies and tools that will be used by them should be relatively easy to use. There are numerous

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studies studying the user expectations for specific categories of VR applications, but according to our knowledge no previous work has been done in studying the expectations of the designers.

A new generation of technologies and tools following the Web Virtual reality (WebVR) paradigm have been developed in order to provide designers the ability to create VR spaces and allow users to access them through their web browsers. WebVR began as an experimental application programming interface that allowed web browser applications to interact with virtual reality hardware, allowing users to experience virtual reality in their browser [4]. The idea is to make it easier for everybody, regardless of technology, to participate in virtual reality experiences. WebVR websites are becoming increasingly popular, with Mozilla Hubs<sup>1</sup> and Showroom<sup>2</sup> by Little Workshop among the most popular. Furthermore, WebVR provides the opportunity to provide consumers with a meaningful experience that ensures a number of benefits for WebVR applications, including increased support, lower costs, and the elimination of the need for app stores or downloading large application files.

Mozilla Hubs is an open source project that explores how communication in mixed reality can come to life. The system provided as an application is an experiment in the WebVR community designed to be accessible for every browser and virtual reality headset. Creators of VR spaces with Mozilla Hubs are able to get servers for streaming media and designate a dedicated server for content. This allows designers to configure their rooms for higher uptime and large concurrent user numbers for large events, as well as a VRChat that allows users to engage with one another as 3D character models. Mozilla Hubs is selected due to ease of use, its open-source nature and the ability to host VR spaces in the infrastructure provided by Mozilla Hubs thus eliminating any operational costs.

The purpose of this paper is twofold. First, it explores the expectations of designers who are interested in designing WebVR spaces for artistic, collaboration, promotional purposes or other potential applications, and second, it provides a set of instructions designed to enable non-experienced in VR space design creators to create VR spaces with Mozilla Hubs according to their purposes.

## 2 Related Work

The use of Virtual Reality, as technology evolves over time, becomes an increasingly widespread means of expression and creation in the field of audiovisual arts. But already in the past, various efforts integrating Augmented Reality and not necessarily utilizing Virtual Reality, highlight the intention to use these technologies in audiovisual art. Such examples are two studies; the first [5] presents an approach for collaborative musical creativity using Virtual Environment technologies and an Augmented Reality system. The second [6] aims to create a system, via the help of an Augmented Reality software, that allows museums to exhibit digitized cultural content in virtual exhibitions either inside or outside of the museum hall.

Another more recent example is a study about indigenous storytelling using a Virtual Reality system [7]. Although the main focus of this study is not the use of Virtual Reality for audiovisual creativity, it examines the use of VR for indigenous storytelling and gives prominence to the expression of the indigenous artists via advanced technology, such as Virtual Reality. Authors designed their work to be available on major platforms, such as Youtube<sup>3</sup>, Steam<sup>4</sup> and more, while on the technical part, the Unity<sup>5</sup> game engine is used.

Among other interesting examples, there is a study that uses Virtual Reality combining scientific and creative purposes in “Sci-Fi Miners” [8]. Sci-fi Miners is aimed to create a virtual reality artistic performance of the microcosm, a scale which is not accessible by physical human presence. This work not only combines science and technology with art, but more importantly, indicates that Virtual Reality can be used for various creative purposes, in fact, utilizing software, such as OpenFrameworks, OpenCV and Unity3D for the development of the 3D space.

<sup>1</sup> Available at <https://hubs.mozilla.com/> (Accessed: 26/8/2021)

<sup>2</sup> Available at <https://showroom.littleworkshop.fr/> (Accessed: 26/8/2021)

<sup>3</sup> Available at <https://www.youtube.com/> (Accessed: 26/8/2021)

<sup>4</sup> Available at <https://store.steampowered.com/about/> (Accessed: 26/8/2021)

<sup>5</sup> Available at <https://unity.com/> (Accessed: 26/8/2021)

In [9], authors present VIRTUE, a system that gives the ability to the user to build multi-modal, virtual exhibitions in 3D space, in which the visitors can navigate. It also presents two perspectives, the curator's and the visitor's. On the one hand, the curator is able to manage the content, build the space and design the exhibition. On the other hand, the visitor can navigate through the space to observe the exhibits. Also, the VR application in this work is developed for the HTC Vive headset using Unity with the SteamVR Plugin. Last but not least, although the concept of creating a virtual reality exhibition is quite relevant and progressive and the 3D space offers a satisfyingly realistic atmosphere to the visitor, it is essential to reflect on the experience of the observation of the virtual paintings compared to the real, physical ones, which is the issue examined in [10]. Besides substantiating the reasons for creating a virtual reality exhibition, this study proves that virtual paintings are able to give correspondent experience to the visitors. In addition, this work suggests ideas on designing the displays in a way that offers an even more pleasing virtual experience of the artworks.

### **3 Designers' Expectations and Potential Applications for AudioVisual Creativity**

Literature review does not provide sufficient information regarding the designers' expectations and the potential applications in the domain of AudioVisual creativity. Given the numerous disciplines that AV creativity encompasses, this work is focused on students of the Department of Audio and Visual Arts, Ionian University, Corfu, Greece, in which new media, multimedia, immersive and interactive applications are among the studied subjects. In addition, the participants are students participating in a course about VR and AR (Augmented Reality) environments which is taught in the fourth year of their studies and they are interested in designing such (VR/AR) applications.

#### **3.1 Methodology**

The presented study consists of two phases, where in each phase a dedicated questionnaire is used (the questionnaires are provided in Section 6. Appendix). In the first phase and prior to the questionnaire, a presentation of the Mozilla Hubs framework is given and participants are given time to spend in using virtual scenes created and hosted in Mozilla Hubs. The purpose of the first phase and its questionnaire is to explore the potential applications that students are interested in developing and whether they think that Mozilla Hubs could be useful for that purpose. Additional questions regarding their experience with VR applications, equipment and design tools are also included in questionnaire 1. In the second phase, the participants are asked to design a VR space with Spoke, which can be related to the idea proposed during the first phase or not. Additional questions regarding their opinion on the Spoke tool are included. Initially, 18 students showed interest in participating in this study. Finally, a fraction of those participated and provided complete questionnaires in both phases thus resulting in a smaller group of subjects (N=8).

### **4 Results**

The participants' responses of the first questionnaire are analyzed in order to reveal the applications that participants would potentially develop. Four of the eight students answered that they are interested in creating a game, one in creating a mental health app, one in creating a virtual planetarium/educational app, one in creating a VR collaboration tool for artistic projects, and one in creating a virtual communication space (Table 1).

**Table 1**

Potential applications

Applications Categories	Count
Game	4
Mental health application	1
Virtual planetarium/educational	1
Artistic collaboration tool	1
Virtual communication space	1
Total	8

All the participants stated that they found the Mozilla Hubs to be useful and that they understand how it works. Five out of eight (5/8) participants stated that Mozilla Hubs has the functionality needed to implement the proposed idea (according to their response in the first question, Table 2 responses).

**Table 2**

Questionnaire and responses.

Questions	Positive response (yes)	Negative response (no)
I find the Mozilla Hubs to be useful	8	0
I do not understand how it works (the Mozilla Hubs)	0	8
Mozilla Hubs has the functionality needed to implement the idea (proposed application in question 1) that I describe	5	3

In the second phase, the participants are asked to implement an application utilizing the Mozilla Hubs framework and to answer the second questionnaire. The implemented solutions and the provided answers are analyzed and classified, resulting that three of the eight (3/8) participants responded with a VR portfolio, two (2/8) with a virtual exhibition, one (1/8) with a virtual art installation, one (1/8) with a game, and one (1/8) with a virtual communication space (Table 3).

**Table 3**

Implemented applications

Applications Categories	Count
Portfolio	3
Virtual Exhibition	2
Virtual art installation	1
Game	1
Virtual communication space	1
Total	8

It is noted that the responses in the second phase regarding the type of application and the implementations are different from those proposed in the first phase (Figure 1). The differences between the proposed ideas and the implemented applications can be attributed to the fact that participants may be optimistic about the functionality and characteristics of the used platform, their capabilities and know-how of using the tools, as well as the amount of time and effort that they could provide for the implementation of their initial ideas. Regarding the functionality and characteristics of the used platform, it is noted that currently Spoke does not provide functionality for creating interaction mechanisms and this is a major limitation for many types of applications that custom interaction mechanisms are required.



**Figure 1a, 1b.** Initially proposed implementation ideas and the final implementations.

The analysis of the majority of provided applications including Portfolios, Virtual Exhibitions and Virtual Art Installations shows that these applications share common characteristics, namely, the designers have integrated content that is created out of the Mozilla Hubs platforms and which is used as items that are exhibited and which users are supposed to observe and interact with. The above characteristics lead us to consider the inclusion of all of the above applications (Portfolios, Virtual Exhibitions and Virtual Art Installations) into the same category (Virtual Exhibitions).

Moreover, a set of questions regarding the perceived usefulness and ease of use of Mozilla Spoke (the tool for designing VR spaces in Mozilla Hubs) are included in the second questionnaire (Table 4) resulting that, all the participants (8/8) found the Spoke tool to be useful and that they understand how to use it. Two out of eight (2/8) state that the Spoke does not have the functionality needed for their purpose. Moreover, five out of eight (5/8) did not watch the presentation of the Spoke tool during the course and did not have used it before. Given the aforementioned, it is considered that instructions aiming towards the creation of Virtual Exhibitions by non-experienced designers with the Mozilla Hubs framework would be of interest for these users.

**Table 4**  
Questionnaire and responses.

Questions	Positive response (yes)	Negative response (no)
I find the Mozilla Spoke to be useful	8	0
I do not understand how it works (the Spoke)	0	8

Spoke has the functionality needed for the designed project	6	2
I watched the presentation of the Spoke tool during the course or I have used it before	3	5

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## 5 Developing Virtual Reality Spaces for Virtual Exhibitions

Given the wide accessibility that the world wide web provides it was a matter of time before VR would make use of it. Web VR frameworks and applications are now used in many cases. One of these efforts has resulted in the Mozilla Hubs framework. Mozilla Hubs is an open source project that enables designers to create VR spaces called rooms. Mozilla Hubs provides the infrastructure to host the developed VR rooms, creating multi user environments, in which users can interact with the space and other users while being able to share media (images, audio video, pdf, etc.) and use VR chatrooms.

Because Mozilla Hubs is a platform that allows designers and users to engage with their environment, it's critical that both the creator and the users will be satisfied with the results. Given that Virtual Exhibitions are the most common type of application in this study, the most critical requirements for both designers and users that the VR spaces must meet are compiled. Regarding the designers, and particularly for inexperienced designers, it is important for them to be able to create the desired VR environments for the experience and place specific features and audiovisual artworks. On the other hand, it is critical for users to be able to enter one or more virtual rooms that are easy to navigate, as well as interact with other guests and scene objects.

### 5.1 Guidelines and Requirements

Virtual events are becoming an increasingly important component of business. Event planners are increasingly exploring new ways to integrate more aspects of real events to the virtual world. Virtual exhibitions are interesting tools for giving viewers content and information. Usage of live chat or a virtual appointment can be available to network in order to interact with exhibitors and other users. Outlining the objectives and establishing the aims of a virtual exhibition in the same way that can be done for a live event premises that creators have a clear idea of what they want to accomplish with their Virtual Exhibition.

The attendees must be able to easily access the content so the designer has to make the information access simple for viewers. The points of interactivity should be well-defined and labeled. Visitors should be able to access linked content via a website or other external resources, as well as to download and review the exhibition.

VR spaces should be interactive. Interactivity has many faces in the Virtual Exhibitions. It could be in the form of a pop-up video player that allows the user to see and play video content as needed or of a tour where the visitors can explore a custom exhibition hall, with individual stand locations represented by the stand's footprint. Attendees should easily explore all of the exhibits and decide where they want to spend their time by navigating in it.

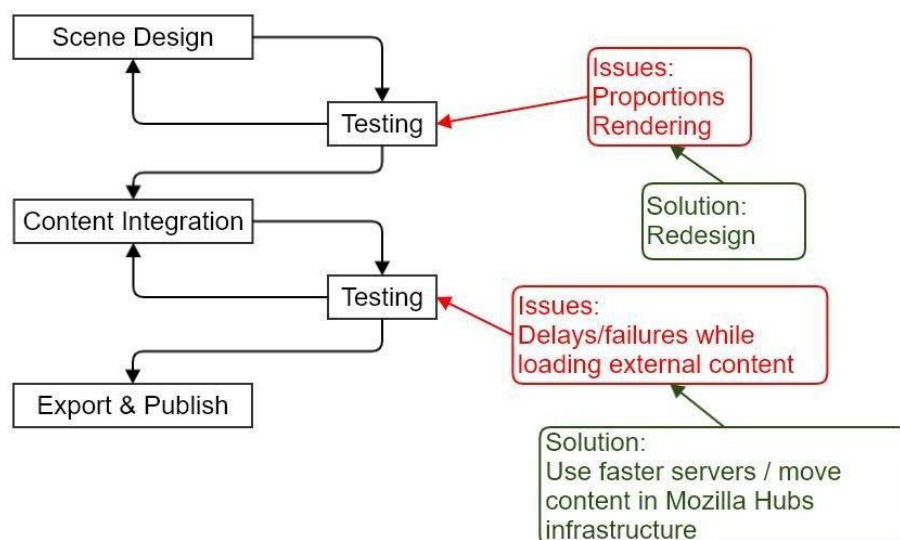
The Virtual Exhibition advantages, when it comes to getting crucial messages across to the designers target audience, is that virtual exhibitions are more cost-effective than traditional exhibitions. A more eco-friendly online version can be developed without the costs of what a proper exhibition would demand.

## 5.2. Development Process

The considered virtual exhibitions are developed using the Mozilla Hubs Spoke tool. The development process consists of three main phases, namely: i) the scene design; ii) the content integration; and iii) the final export and availability for users (Figure 2). Between every phase, a set of tests is conducted in order to diagnose any issues that would affect the quality of the implementation.

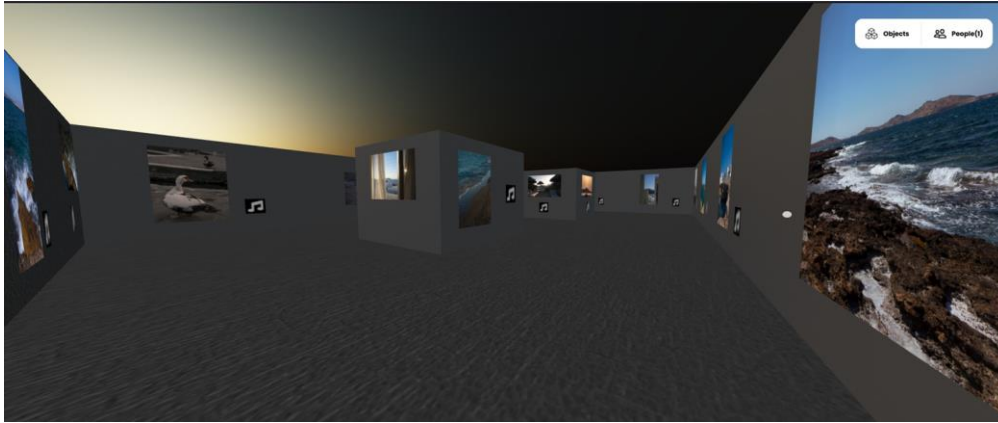
Regarding the design of the scene, the scene is the virtual space of the exhibition where the visitors enter, navigate and interact with the exhibits. For the creation of the virtual spaces, the virtual structural elements that are provided by Spoke's "Assets" menu are used. In particular, to build the exhibition room, the wall and floor elements, as well as the floor block from the "Architecture Kit" were used to have a main space to place the images, videos, audio and 3d models. Concerning the lighting, different types of lights were chosen from the standard "Elements". In this first phase of the development, the designers came up against some issues with the proportions and the rendering, which had to be transformed a couple of times until they got the desired result. The solution provided to this issue is to redesign the architectural elements so that the resulting space looks realistic and its dimensions are suitable for navigation.

Once the design of the scene is completed, the team proceeds to the content integration phase. To import the content, the team first uploaded the images and audio clips to a server and integrated them in the scene by using the URL of the content item. It is important to deal with the resolution of the images so that there is a satisfactory degree of realism and depiction of details on the artworks while avoiding large file sizes of the images as they should load relatively quickly. During the performed tests of this phase it was observed that in each test there are images that failed to load. The iteration of the tests showed that this issue could affect any image and it was a result of page load timeout event. The fact was attributed to the bandwidth of the content server and an alternative is tested. The used the ability to upload content in the Mozilla Hubs infrastructure. Attaining that required the reduction of the size of each file even further, while taking into consideration the sharpness and the overall resolution of the images. An alternative option would be to use another server that would provide better loading times. Once this phase is completed successfully the scene is exported and published (Figure 3).



**Figure 2:** Development Process





**Figure 3:** Screenshot from a virtual exhibition using Spoke

## 6 Discussion

The demand for engaging experiences have led to the rise of VR applications and the tools needed in order to design and implement them. The domain of AudioVisual creativity can benefit from VR applications which are an appealing solution for content communication and audience attraction but a considerable part of the designers are non experienced in developing such applications. Easy to use tools and hosting infrastructures are crucial for the penetration of VR applications in the domain. Mozilla Hubs is considered in this work to be a valid candidate for this purpose and is proposed for time and cost effective development of VR experiences for non experienced designers. While Mozilla Hubs is a relatively easy to use platform it has an important drawback as it lacks the functionality that would allow designers to implement custom interactions. Moreover, this study provides interesting information regarding the adoption of VR technologies and applications and the familiarization of the participants with these technologies which are discussed in the following paragraph.

### 6.1 Adoption of VR Technologies and Applications and Familiarization

The responses provided additional findings regarding the adoption of the VR technologies and applications. According to the answers of the participants (Table 5), six out of eight (6/8) have not used VR applications and five out of eight (5/8) have not used any kind of VR equipment. It is also notable that only a relatively small number of participants (2/8) have any experience in designing Virtual Spaces. Surprisingly, five out of eight (5/8) participants stated that they have participated in, at least, one relevant course.

**Table 5**

Questionnaire and responses.

Questions	Positive response (yes)	Negative response (no)
I have used VR application before	2	6
I have implemented a Virtual Space (with Unity or other similar tool)	2	6
I have used VR equipment before (Headset or other)	3	5

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The results showing the limited adoption of the participants with the considered technologies may not be expected as someone would expect that the participants who belong to the so-called “Digital Natives” generation would be more familiar with these. Nevertheless, literature review provides us with numerous works [11,12] questioning the existence of such a homogenous group with advanced technological skills.

Given the above, the provided answers create new questions to be answered regarding the types of technologies they are familiar with, their experience in using such tools for creating VR applications, as well as their familiarization with new technologies in general, and also draw guidelines for further investigation including more participants and having more diversified groups.

## 7 Conclusion

The objective of this paper was to study the expectations regarding the creation of VR applications by designers of the audiovisual creativity domain and provide instructions serving their creative purposes. In order to explore the potential applications that designers are interested to develop, a small group of students is recruited to participate in the study by answering the given questionnaires and developing a demo VR application. Given that not all of the considered designers are experienced in designing VR applications, an easy-to-use platform, namely Mozilla Hubs, is used.

The results show that the provided demos do not always meet the designers’ expectations but, even in that case, they came up with interesting solutions. The reason that the provided solutions are different than those initially proposed can be attributed to the fact participants may be optimistic about the functionality and characteristics of the used platform, their capabilities and know-how of using the tools, as well as the amount of time and effort that they could provide for the implementation of their initial ideas. The majority of the provided solutions fit into one main category of applications, the Virtual Exhibition.

Additionally, given the interest of the participants for the Virtual Exhibitions, a set of instructions designed to facilitate the creation of Virtual Exhibitions by non-experienced designers is given. Furthermore, this study showed that the “myth of the digital natives” may apply to the relation of the “net generation” with the VR technologies and applications also, thus motivating further future work on this subject.

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## Appendix

### Questionnaire 1.

- 1 Provide a brief description (1 paragraph) of an application that you would like to develop in VR.
- 2 I find the Mozilla Hubs to be useful: Yes/No
- 3 I do not understand how it works (the Mozilla Hubs): Yes/No

- 4 Mozilla Hubs has the functionality needed to implement the idea (proposed application in question 1) that I describe: Yes/No
- 5 I have used VR application before: Yes/No
- 6 I have implemented a Virtual Space (with Unity or other similar tool): Yes/No
- 7 I have used VR equipment before (Headset or other): Yes/No (If yes provide the used system)
- 8 I watched the presentation of Mozilla Hubs during the course or I have used it before: Yes/No
- 9 I participated in the course during a previous academic year (having participated in more than 50% of the course activities): Yes/No
- 10 I have participated in other course relevant with VR/AR systems, environments and applications: Yes/No (If yes provide details, e.g., Erasmus, University, Course title, etc.)

#### Questionnaire 2.

- 1 Create a Virtual space with Spoke and provide a brief description of it.
- 2 I find the tool Spoke to be useful: Yes/No
- 3 I do not understand how it works (the Spoke): Yes/No
- 4 Spoke has the functionality needed to implement the idea (designed application in question 1) that I describe: Yes/No
- 5 I watched the presentation of the Spoke tool during the course or I have used it before: Yes/No

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Fani Tsiamalou is in her 5th year of studies in the Department of Audio and Visual Arts at the Ionian University. In her studies to date, she has emphasized the study of courses on virtual augmented reality, interactive applications and the processing of 2D and 3D graphics. In addition, it participates in research activities related to Virtual/Augmented Reality and the creation of virtual exhibitions where the relevant results lead to scientific publications. At the same time she is professionally employed in television productions taking action in the process of recording and processing.

Despina Sigourtzidou is an undergraduate student since 2019 at Dept. of Audio and Visual Arts, Ionian University, Greece. During her studies, she developed interest in Digital Visual Arts and Multimedia Implementations. So far, she has work experience in the field of photography, while recently she participated in the editing of a video presented in the Department's annual festival.

Vasileios Komianos is a faculty member at Dept. of Audio and Visual Arts, Ionian University, Greece, teaching courses related to Virtual/Augmented/Mixed Reality, video games and interactive multimedia. His research interests are mostly focused on Mixed Reality (MR) systems, on user interaction and user interfaces in MR systems and applications as well as on approaches for artistic expression and cultural communication. He has work experience on designing audiovisual content and installations in the cultural heritage sector, and his works are hosted or have been hosted in permanent and temporary exhibitions as well as in art festivals.