Tampere University of Applied Sciences

An investigation on designing sustainable art exhibitions

The “Aerial Roots” hybrid exhibition as a study case

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ABSTRACT

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Since the COVID-19 pandemic started, the interplay between art and technology changed and brought new ways of imagining the future of visual art. This study aimed to find alternative ways of producing art exhibitions, combining art, technology, and different co-creation models.

As practical research, the Aerial Roots hybrid art exhibition was produced by seven students from Tampere University of Applied Sciences. The exhibition took place in February 2022 at Himmelblau Gallery in Tampere, Finland and is available virtually via Matterport online platform until 2023.

This thesis presents the most significant results from the “Aerial Roots” hybrid art production combined with theoretical data on contemporary art, virtual reality, and sustainability, gathered primarily from articles, reports, usability tests, and technology comparisons.

The findings brought new viewpoints on topics such as cultural accessibility, digitization, and sustainability. It was found that alternative production models generated by the use of new audiovisual technologies can offer immersive, accessible, and sustainable solutions that can be beneficial not only to the visual art field but also to freelancers, companies, and organizations in the creative industry sector.

To help society, art and technology evolve harmoniously in the future, further development is required. Simplified technological tools and virtual platforms dedicated to immersive art experiences are needed to bring art closer to society and encourage artists to find new ways of collaboration for a stronger impact in their communities.

Keywords: new media art, art exhibition, interactive, virtual reality, sustainability

CONTENTS

GLOSSARY

Ableton Live	Digital audio workstation
AR	Augmented Reality augments the reality by adding digital elements to a live view, often by using a camera or a smartphone
AI	Artificial Intelligence
Alchemy	Virtual Instrument audio plugin
App	Mobile Application
Captur3D	3D Virtual Tour Software and Management Platform
Creator Studio	A tool inside Captur3D for customizable virtual tours
Digital twin	A virtual clone or representation of an object or space that can be updated in real-time, usually for data collection and decision making
Eventide	External multi-effect unit with an algorithm library
Fluxus	International avant-garde community of artists, composers, designers, and poets that during the 1960s and 1970s has profoundly challenged the nature of art production by combining a diverse range of art forms
Google Cardboard	An affordable solution designed by Google for experiencing virtual reality with the smartphone
IoT	The Internet of Things is the concept that describes the network of physical objects embedded with sensors, software, or other technologies to connect and exchange data with other devices and systems over the internet
Kinect	Motion sensor add-on for Xbox and PC manufactured by Microsoft
Matterport	Technology is destined for virtual tours using a 3D camera that scans the physical space and an online platform to render, edit and present the virtual tour
MR	Mixed-Reality is similar to AR, except that when the user moves specific objects in the real-world, corresponding virtual objects move too

Oculus	VR Headset with an online marketplace of over 250 games and apps
Omnisphere	Virtual Instrument audio plugin with a large library
PIR	Passive Infrared, made of a pyroelectric sensor
Python 3	Newer version of the Python programming language
Sketchfab	3D modelling software platform for VR and AR content
SketchUp	3D modelling computer program
SWOT	SWOT analysis (or SWOT matrix) is a strategic planning and strategic management technique used to help a person or organization identify strengths, weaknesses, opportunities, and threats related to business competition or project planning
Touch Designer	Node-based visual programming software for real-time interactive content
Unity	Cross-platform game engine developed by Unity Technologies, which is primarily used to develop video games and simulations for computers, consoles and mobile devices
VR	Virtual Reality is defined as a completely immersive experience that replaces a real-life environment with a computer-simulated one
XR	Extended Reality
YBA	Young British Artists: Independent group of visual artists who started to exhibit together in 1988 in the United Kingdom

1 INTRODUCTION

Evolution can be considered the core of every living thing on Earth. Similarly, in biology, evolution is the starting point of the understanding of any living being. Typically, humans as species are genuinely understood to use the environment, they live in for evolving and developing their communities. Notably, since the 18th century, the concept of human evolution is discussed in parallel with the alternatives brought by industry. The Industrial Revolutions made significant changes in human civilization. Since the first Industrial Revolution, humanity begins the road of industrial discoveries. With each Industrial Revolution, new energy sources and new technologies are brought for making the working environments more efficient, and the leisure time longer, while the heavy labour is transferred to the machine. Looking at the Fifth Industrial Revolution or Society 5.0, after four industrial revolutions, technology becomes an integrated part of contemporary society, used in almost any aspect of daily life. (Melnyk, L. Kubatko, O. Dehtyarova, I. Matsenko, O. & Rozhko, O. 2019.) As a consequence, the models for delivering art, culture and/or entertainment are changing also, allowing technology to be part of their development.

At the same time, new concepts are constantly introduced. What other roles art can play today in society? How art will be communicated to the next generations? The concept of space travelling is not new, but in recent years received new interpretations. However, the multiple versions of the future portrayed in the Sci-Fi movies and the reality that humanity is currently creating are not far from each other. In the last decade, since the development of VR glasses, the idea of transporting oneself into a different reality is becoming available to the broad public. Terms such as virtual presence, digital avatar, mixed reality (MR) or extended reality (XR), have been recently introduced and they become more frequently used nowadays. At the same time, the current technological developments are activating the most influential companies to make the necessary implementations towards a virtual future. (Sinha 2022.)

Is it possible with the new technological developments to make art exhibitions more inclusive, accessible, and sustainable? Using a new production model that embraces technology and co-creation models, the “Aerial Roots” art exhibition

was designed for artistic experimentation and technological exploration. Focusing on environmental and social sustainability, the starting point of the discussion was the “Aerial Roots” physical exhibition, which took place from the 4th of February to the 25th of February 2022 at Himmelblau Art Gallery in Tampere, Finland. With the intention of bringing a different perspective on how art exhibitions can be transported into the virtual world, the” Aerial Roots” exhibition was brought into the digital realm, providing an interactive virtual tour available until 2023 (https://captur3d.io/view/tamk/aerialroots).

The study aimed to find creative alternatives for art exhibitions that can be interpreted by the artists, cultural producers and institutions, such as art universities, museums or art galleries. Justifying the urgency of learning and understanding the importance of digitalization in art, the discussion opens with the current role of virtual tours in visual art, looking closer at the role of VR in the future. Chapter Two brings social and environmental sustainability into focus, including examples of how VR and digitalization, in general, are currently understood and used by museums and art galleries around the world and what benefits and new possibilities arise from the use of these technologies. Subsequently, the practical case, “Aerial Roots” hybrid exhibition is introduced. Chapter Three delves deeper into the production model chosen for the “Aerial Roots” hybrid exhibition. It offers an overview of the alternative art experience that was intended to be created and the materials, production methods, and AV gear used for designing the physical experience.

Chapter Three is dedicated to the “Aerial Roots” virtual tour and offers a quick practical guide on how to digitalize a physical exhibition using Matterport technology, focusing on the design of the ”participatory journey” in a digital environment. Chapter Four focuses on the challenges encountered while producing the physical exhibition and the virtual tour, examining the technical possibilities the production team found for solving these problems. The last chapter exposes relevant impressions after creating the “Aerial Roots” exhibition and presents the conclusions on the importance of technology in art and society.

Given the above, it can be stated that the digital shift brought by the COVID-19 pandemic marks a new era, where technology becomes an indispensable tool for

contemporary society. The latest industrial developments bring art in front of a blank canvas with infinite possibilities for creating imaginable and unimaginable realities. For opening the door towards innovation, this thesis presents a set of alternative methods for producing and exhibiting art, using new technological tools that can facilitate a more immersive art experience and offer sustainable solutions for the future. From here, new discussions arise on how art projects can be virtually produced on a national and international scale.

2 VIRTUAL TOURS: ANOTHER WAY OF GETTING IN TOUCH WITH ART

Why virtual art tours are needed? The following section gives a general overview of the current use of virtual tours in the visual arts. It demonstrates how VR can be seen as a sustainable option for the future.

2.1 A quick view into the future

On a broader scale, due to the continuous technical improvements in digital production, industrial development reached a new level. Nowadays, new concepts are brought concerning the road taken towards cutting-edge technology and its future implications of it. According to Klaus Schwab, Founder and Executive Chairman of the World Economic Forum (WEF), humanity has just witnessed the fourth industrial revolution (4IR). Industry 4.0 or “The Smart Factory” is a concept that describes the application of multiple modern emerging technologies and the various combinations between them. It encourages the idea of learning-by-doing, leaving the road open for adaptation and optimization during the process. (Lavopa and Delera 2021.)

If industry at large entered a new era of development due to the use of technology, this suggests that visual arts are part of the same adaptation process towards technology. According to UK Government’s Department for Culture, Media and Sport (DCMS), the creative industry in the UK includes visibly more industries than in the past. The difference between “digital” and “creative” is evolving continuously and the line between these two terms is getting more and more unclear. Because most creative activities now rely on technology, a new term was created by DCMS: the “Creative and Digital Industries”. (The UK Digital and Creative Sector 2017.)

With these ideas in mind, a virtual art tour can be easily seen as an already available means of adapting to the future. With the help of Virtual Reality (VR) and Augmented Reality (AR), it is possible to bring art into the digital world, this time, in a new form. As a result, art can become easily accessible to a broader audience. For getting in touch with virtual art, the audience is required to use a VR headset, but it can also be accessed only with a laptop, tablet, or even a phone.

This new type of interaction with an artwork or an art exhibition brings innovation in the way how art is translated visually, experienced and understood.

2.2 The virtual art tour: Turning challenges into possibilities by embracing the latest technology

Virtual Reality, in general, is a concept older than one might think. The first phases of development were taking place already in the 1950s. However, the development process was slow. Even though the first VR headset was invented in 1968, it was not developed further until the 1980s when VR technology becomes exclusively used by the US military and the National Aeronautics and Space Administration (NASA) (Appendix 1). A significant shift took place when the game company, Virtuality Inc. founded by Johnathan D. Waldern, started to facilitate the use of VR technology for the broader public. The company was born from the need to improve human-computer interaction. Virtuality no longer exists. (Virtuality Inc n.d.)

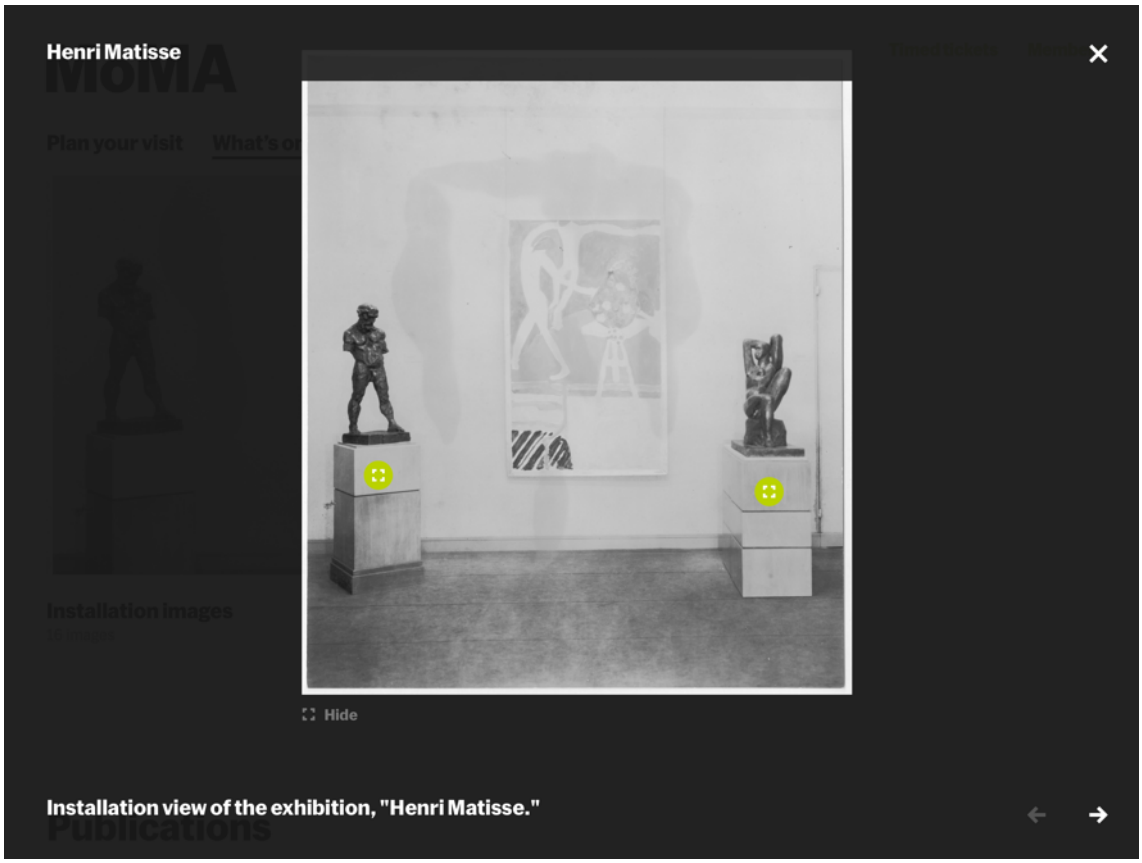
Despite its long history, the VR technology development process was slow (Joshi 2021). Since the release in the 2010s of the tethered headsets Oculus (Rift), HTC (Vive) and Sony (PlayStation VR). Correspondingly, a variety of applications outside the creative industries are already using VR technologies, such as healthcare, automotive, tourism, real estate, education, sports, and event production. (Morris 2022.)

On one hand, the challenge created by the pandemic restrictions revealed new perspectives on how society is currently living and working. Looking for alternatives, companies, institutions, and organizations decided to adapt to the technological tools available and use them for continuing their activity. When it comes to visual art, museum and galleries were among the most affected industries. With all doors closed, many of them found new ways of delivering art to the public by being more present in the digital world and connecting more with their audience (UNESCO 2020, 12-14). Among the alternatives, creating virtual tours became a practice that some museums and galleries adopted. Unfortunately, when searching for virtual tours on the Google searching engine, the vast majority of “virtual tours” are only carrying the name, but what they usually imply is usually

2D videos of the specific place or a set of 2D images accompanied by text describing the concept of the artworks.

On the other hand, a valuable example of 2D digital art tours can be seen in MoMa (Museum of Modern Art, New York). Since long before the pandemic, MoMa is continuously updating its digital archive. Art lovers have the possibility to browse through the installation views of more than 5000 exhibitions, dating from 1989, since the museum was founded, to the present day. Despite its 2D implementation, the virtual tours of MoMA include light interactions. The pictures presenting the artworks include buttons that open new windows inside of the pictures or send the user to new pages where one can learn more and have a closer look at the history behind each artwork. (MoMA 2022.)

MoMa digital exhibition archive can be seen as a smart way of using digital tools for keeping a homogenous record of art exhibitions for the museum while offering a different learning experience for the public or even providing a relevant research tool for individuals working in the art field. In this case, with the help of digitalization, art history is being both recorded and showcased to the public.

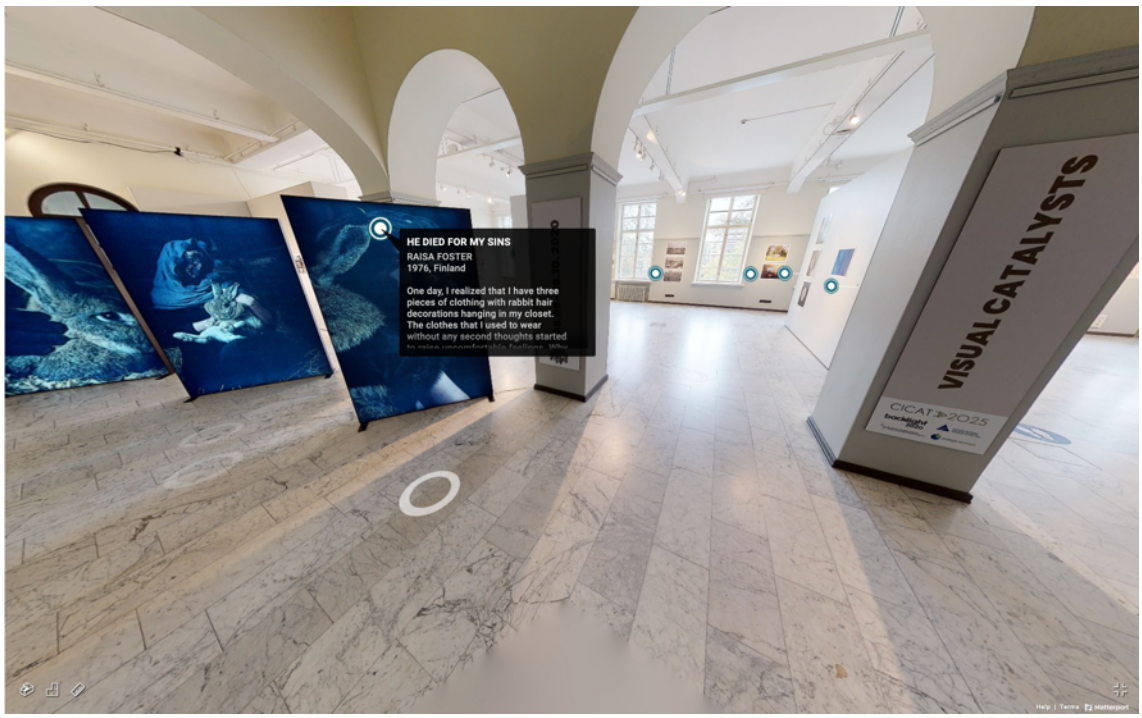


PICTURE 1. Extract from Virtual Exhibition Archive, Henri Matisse's exhibition, by Museum of Modern Art, 1931, New York

The digital archive mentioned above can be seen as an interactive way of visiting art exhibitions from the past and getting more insights into the history of art. However, the practice of 2D virtual tours is perceived more as a traditional way of presenting an art exhibition online. Nowadays, with the use of VR tools, it is possible to bring a new layer of immersion inside art exhibitions.

For instance, a different perspective was brought by the “Visual Catalysts” art exhibition. The exhibition, produced in 2021, during the pandemic, is a hybrid art exhibition that took place in Culture House Laikku, in Tampere, Finland. ”Visual Catalysts” exhibition focuses on art and circular economy and compiles artworks from 38 artists with international backgrounds. The concept of the Visual Catalysts exhibition was created by Doctor of Arts Juha Suonpää, who is one of the researchers of the CICAT2025 project that aims to facilitate the transition from linear to circular economy. (Tampere University of Applied Sciences 2021.) Jose Ignacio, an Interactive Media student, and Luiza Preda, a Fine Art student, both from Tampere University of Applied Sciences, implemented the virtual tour for the “Visual Catalysts” exhibition. In the virtual tour, users can move through the gallery space, learn more about each project, watch videos and listen to the artists talking about their work.

The need for turning the exhibition into a hybrid event came due to the pandemic restrictions from 2021. Surprisingly, the digital implementation shaped perfectly the main theme of the exhibition: sustainability. The virtual tour has been positively received by the international artists involved in the project, who, at that time, were not able to travel for installing and seeing their works exhibited in the gallery space. Furthermore, after one year of its completion, the exhibition is still available for the public online. Each of the 38 projects included in the exhibition includes relevant information and interesting facts on the topic of circular economy and sustainability. The online implementation allowed a much bigger number of individuals to access the information behind each artwork and learn creatively new ways of thinking sustainably while enjoying a digital art experience.



PICTURE 2. View from the virtual tour of the “Visual Catalysts” art exhibition, 2020

When facing physical restrictions, Matterport comes as a quick and feasible solution for delivering art to the public. Matterport is a relatively new service that offers its users the possibility to create, in a relatively straightforward way, a 3D virtual space from any physical space. The virtual tour can be accessed afterwards through the Matterport web-based platform. Any virtual tour can be easily accessed with a regular link, which can be embedded also in other web sources. For both cases, “Aerial Roots” and “Visual Catalysts”, in order to scan the exhibition space, Matterport Pro 2 camera was used together with an iOS-based application powered by Matterport. It is important to mention already at this point one significant feature that Matterport provided lately, is the VR option that can be easily activated inside the virtual tour. The VR option requires VR glasses and is best optimized for Oculus Quest. This additional feature of seeing a digital exhibition in a virtual set ignited the discussion for the production team of ”Aerial Roots” on how to make art more accessible.

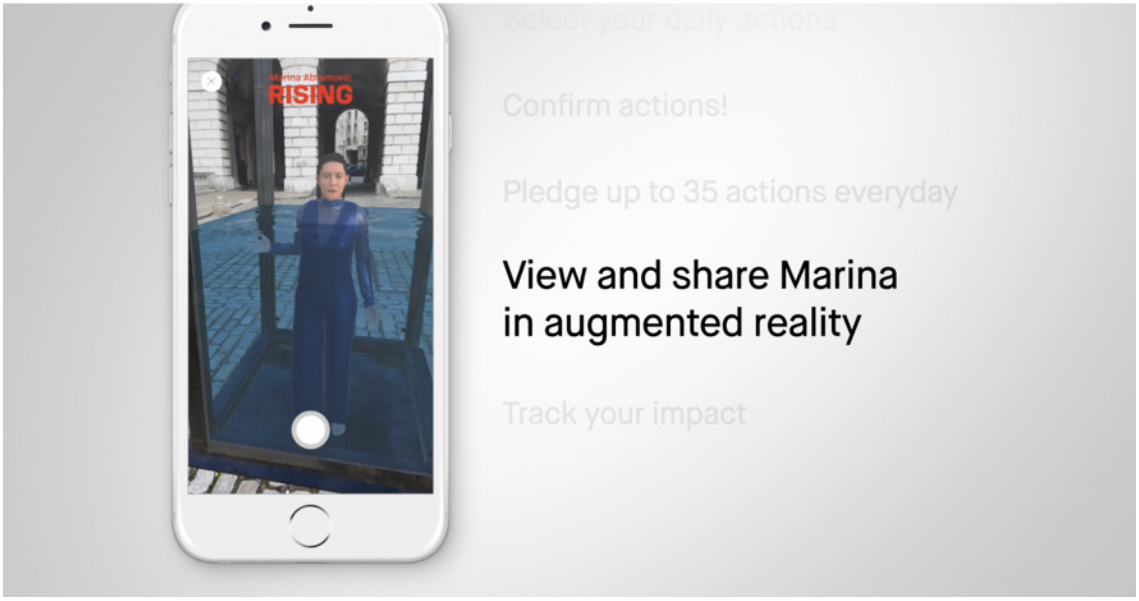
Given the information above, it can be stated that there are already accessible solutions to put into practice for the urgent challenges the world is facing, by the art institutions. VR is an available technology that can be used as an alternative solution that can offer a more sustainable way of exhibiting and consuming art.

Moreover, digitalizing art exhibitions can offer a more effective way of archiving art exhibitions in time.

2.3 Alternatives for a sustainable future

In the year 1987, the term “sustainable” received a powerful meaning. In the Report “Our Common Future” made by the World Commission on Environment and Development in Geneva, the concept “sustainable development” is introduced, next to a plan incorporating more than one hundred ways on how it can be achieved. Since the year 1987, emerging technologies was a topic included in the discussion. Although seen with scepticism by some, when addressing sustainability, technological developments are undoubtedly included in the discussion. “The process for a sustainable future is not expected to be easy or straightforward and painful choices have to be made.” (Brundtland 1987).

It must be acknowledged that entering a new era of development supported by technological tools will certainly encourage another way of thinking about our everyday lives. Real changes towards a sustainable future imply changes in the habits of every individual, company, organization, etc. Even if it might feel painful at first, the uncomfortable situation that humanity is currently facing must be drastically changed. Urgent actions that encourage sustainable thinking must be taken into consideration, explored further and tested, in order to find the alternative solutions needed for the big step into the future.



PICTURE 3. Marina Abramovic. 2018. Rising. VR and AR application

Marina Abramovic (born in 1946) is one of the examples of the contemporary artists who are already exploring the new world offered by the latest technologies. In one interview where she is discussing the process behind her last work, an AR game, named “Rising”, the artist is explaining her almost non-existent relationship between her artistic practice and technology. However, her interest in technology changed drastically in the last few years. Since VR became available for the general public, Abramovic started exploring, as she explains, like a child, the unlimited means of creation inside of the virtual world. (Abramovic 2018.)

Abramovic wanted to bring awareness of climate change to the children regarding the risks created by the rising sea levels. She has always found it more challenging to target children who have been born around technology, as they are not so easy to reach with the conventional art practices. For delivering the message to the youngsters, the contemporary artist changed her tactic to fit the needs of her target audience. She created a virtual clone of herself and add it to an AR app. “Rising” is an AR game, addressing the urgency of action in front of climate change. Children can download it on their phones, and they are invited to take daily actions towards the raising of the sea level rise. If they do not make the daily actions, the digital avatar, Marina Abramovic, will slowly die, drowned in water and the Earth will be destroyed. When it comes to the usability of the app, it was not possible to be tested as the app is not currently available in Finland.

Undoubtedly, when addressing the future of visual arts, it is important to understand visual art’s powerful role inside society as a place to raise discussions on the new changes. One recurring explanation for the importance of art in humans’ life comes from the individual’s need to reflect on his surroundings (Dissanayake E. 2015, 64). Any significant change inside the society is usually reflected in an instant in visual arts. For this reason, art institutions, museums and galleries must meet the needs of the artists chosen to exhibit. If artists respond positively to the technological developments from their surroundings, the art institutions will also need to provide, support, and facilitate the new equipment of the new art forms in contemporary society.

Another notable example is the eight-minute VR experience offered by Louvre Museum. In the year 2020 after years of research, the curators Louis Frank and Vincent Delieuvin prepared a landmark exhibition, “Leonardo da Vinci”, which introduced an element of surprise: the VR Mona Lisa. (Louvre Museum 2021). The project came as a solution to the problem that the museum was facing: the constantly big number of visitors for one of the most famous artworks in art history, “Mona Lisa” (HTC 2019.)

PICTURE 4. Mona Lisa VR application (Louvre Museum 2021)

Using the VR technology, the museum found not only one but two sustainable alternatives for solving the challenge created by the vast number of visitors. Emmanuel Gorinstein, art director at Emissive, one of the pioneer companies in virtual reality, was part of the collaboration with the Louvre Museum. According to a video posted by HTC VIVE ARTS on YouTube Mona Lisa: Beyond the glass, Gorinstein explains the museum’s need for an alternative solution, mentioning that the average time for experiencing The Mona Lisa painting was reported to be 30 seconds, due to the continuous mass of people circulating in front of it (HTC 2019.) However, in the virtual world, not only that the audience can take all the time needed, almost wherever and whenever, every user becomes an active participant who can interact in the virtual reality with the new version of the artwork in an immersed and intimate environment.

With the current 3D tools, it was possible to bring new visual information to the viewer. For example, the ‘sfumato’ painting technique used by Leonardo da Vinci

cannot be easily understood by the majority of art visitors who experience the artwork in real-life. As a solution for this, the virtual environment mimicked the traditional painting technique for creating the real environment in which Lisa Gherardini (the name of the real person behind “Mona Lisa”) is known to have lived, at the moment when the painting was done. A strong accent was also put on creating a more realistic Gioconda, by creating a full-body statue sitting on a chair. With the VR glasses, the user can move around the virtual Mona Lisa and get as close as seeing the textures of her cloth. The virtual Mona Lisa can be experienced with a pair of goggles in Salle des États, on the museum’s premises or it can be accessed by downloading an app, in the comfort of home.

It can be concluded that artists and art institutions who are embracing the latest technological innovations are bringing new perspectives on what society can learn from art. Art gains new powers. Through interaction and gamification, the young generation is brought closer to experiencing and understanding art. Using the new technological tools creates a positive chain reaction, where artists, who are exploring these tools, activate the art institutions to take a more active part in delivering them. At the same time, art institutions encourage society to take visible actions towards a more sustainable future.

2.4 Smart Digitalization next to Sustainable Thinking

Using VR and AR technologies for consuming and creating art seems like a feasible method that addresses new sustainable viewpoints. The latest technologies can encourage more people to get in touch with art, while the need for travelling is reduced. Like many aspects of the modern every-day life, visual art is also pointing to digitalization. The power of creation in the digital realm is not to be underestimated, as it offers infinite possibilities, many of these impossible in the physical world. If art exhibitions enter the virtual realm, new professions will be also needed for the digital implementation of the art shows. Moreover, while the pandemic continues the acceleration of technological developments, Industry 4.0, implemented in 2011, is already seen as a past alternative. In its place, Industry 5.0, named also, Society 5.0, introduces a significant transformation in the way technology and well-being are understood.

The latest technological advancements of the last decade changed the way how companies and investors think about the future. The attention of the organizations, institutions, and companies is re-directed into understanding society as a whole. The integration of the latest technologies in all parts of society continues as in Industry 4.0. However, the focus this time is not on the use of technology for only a sustainable future, but also on how technology can take a positive part in the work-life and well-being of the individual.

A “Smart Society” is understood as living in an environment where leaders and citizens make data-based decisions that enable improvements in economic prosperity, social well-being, environmental sustainability, and good governance. At its core, any smart city incorporates similar assets: ITC (Information and Communication Technologies), IoT (The Internet of Things), sensors, deep-learning algorithms, and artificial intelligence. It is stated that a smart city should not be seen as just a policy idea or strategy, but seen in its entirety, as a new social organism that enables collaboration between various parts of society, encourages innovation and supports the new generation of entrepreneurship. (Duygan , Fischer, Pärli & Ingold 2022.) If in industry 4.0 the focus is more on the use of machines and integrating advanced technologies on a broader scale, in Industry 5.0 the focus is directed towards a humanistic point of view, where full customization and user interaction are essential for the quality of the customer experience. (Akundi, Euresti, Luna, Ankobiah, Lopes & Edinbarough 2022.)

Undoubtedly, Virtual Reality can help people access art quickly, fast, and more comfortable manner. VR technology brings a new paradox to the contemporary art sphere: accessibility. On the other hand, as promising as it can be seen by the individuals already familiar with it, VR technology is still seen with scepticism by the general public, who have not tried it yet or are not fully accustomed to the new technology. The implementation of new technologies requires time until their imprint is visible in society.

To summarize, exploring the current technologies for smarter ways of living is seen as necessary for a sustainable future. Looking for ways how to improve art in the digital realm becomes important. The world is already embracing technology as an essential part of humans’ lives and new ways of delivering art to the

public must be found. With any new technology, time is required for testing and prototyping. Therefore, it is essential to start already looking at both current and potential issues that the art world is facing. By using the new technologies creatively, alternative ways of solving them arise.

3 “AERIAL ROOTS” HYBRID ART EXHIBITION

This chapter provides a comprehensive view of the concept behind the “Aerial Roots” exhibition, demonstrating with theoretical and practical examples the main elements used for creating a hybrid art exhibition.

3.1 An alternative look into artmaking

In the 1960s, the concept of “happening” was coined as an art term. A “happening” was usually created in an environment or installation that takes place in an art space. It included elements of sound, light and screen projections borrowed from multiple creative fields, such as theatre, dance, poetry and music. The term was invented by Allan Kaprow, an American Fluxus artist whose concept, at that time, was exactly the opposite of what it soon became. In one of the recordings of him explaining his idea of what is a happening, Kaprow is emphasizing that “the point of this is to make something new, something that cannot even remotely remind you of culture.”(Kaprow 1966). The artist chose this term to avoid art labels and create an untitled event that will not fit any specific category, combining various ways of art creation. Multiple artists in the world started to create happenings at the same time with Kaprow. Although the term is still considered revolutionary in the recent history of art, it has slowly vanished after Allan Kaprow stopped his happenings series. Kaprow is now considered the pioneer of performance art, as the happenings were the first steps towards this new kind of art. Luckily, this type of event had a lasting impact on the artists that came afterwards and encouraged some to reimagine the role of artmaking and consider the audience as part of the artwork. (Abigail Cain 2016.)

For instance, looking in the recent art history, the born of YBA (Young British Artists) was seen as a valuable turn in the British art scene and managed to spread widely inside the western modern art scene. In the 1980s, among the most influential YBA artists, Tracey Amin, Damien Hirst and Sarah Lucas brought a strong new vision of what art can be, while breaking a lot of rigid concepts and limiting constructs that were governing the modern art world at that time. (Young British Artists (YBAS) n.d.). Still students at that time, YBA came with a different

approach towards the artistic process, discussing how art is created and exhibited. Conventional spaces such as old factories or old concert halls were seen as potential art spaces and exhibitions were run by the young group of artists. The entrepreneurial approach has been also re-discussed. To illustrate, Tracey Amin and Sarah Lucas rent a space together and call it “The Shop”. Seen as an alternative art space, the two artists start to work, install their works, ignite live discussions, and produce art exhibitions for selling their solo and collaborative works. This alternative brought by the YBA took place at a time when the environment was on the verge of “transformation from a parochial art scene to today’s commercial powerhouse.” (Als H., Coles S., Daly P., Emin T., Lucas S., Muir G., & Evans C. 2021.)

Nowadays, in the contemporary art world, having a solo exhibition is considered a significant part of one’s artistic development. An exhibition that focuses only on one artist is seen as a professional achievement, as it gives the unique possibility for the artist to express the concepts that they are interested in, on a deeper level. This creates also a more comprehensive image of the art show. Solo shows can bring to the audience a better comprehension of the topics explored by the artist. The concept of internationalization is also encouraged in the current art practices. The list of international exhibitions in an artist’s CV shows the relevance of his work outside the home borders

At the same time, there are contemporary artists who are able to navigate within the conventional frame of the contemporary world with the intention of bringing to the surface other truths and new perspectives on what art can be. A suitable example, in this case, is Polish artist Pawel Althamer (born in 1967). In November 2019, Helsinki Art Museum (HAM) hosted a retrospective of the artist’s work with multiple installations, sculptures, and video documentations. One of the gallery spaces of HAM was “reorganized” into a completely white blank space, where visitors were asked to leave all their belongings and cover themselves in a white overall for having a no stimuli art experience. In an interview explaining the exhibition process, the artist opens a discussion on the power of art in times of conflict and what important tool art can be, explaining that art is not only about beauty, but it is a tool that can heal the traumatized human vision of who we are. Althamer explains further his aim behind his artistic practices, stating that the intention of

his art projects is, in some way, to transform the conventional methods of culture and education for showing people how free they are. (Metsola & Tuulikangas 2019, 31-33.) The Polish artist is also known for his collaborative works with local communities, combining art with education. For instance, for his retrospective exhibition in HAM, the artist had additional projects created with the Youth Community of Jakomäki, one of the neighbourhoods of Helsinki. The results from the collaborative participation named “It’s Raining Art in Jakomäki” included the local Finnish community in the exhibition, after first-hand meetings between the youngsters and the artist, where they shared ideas on the role of art in society, wrote song lyrics together and filmed a documentary.

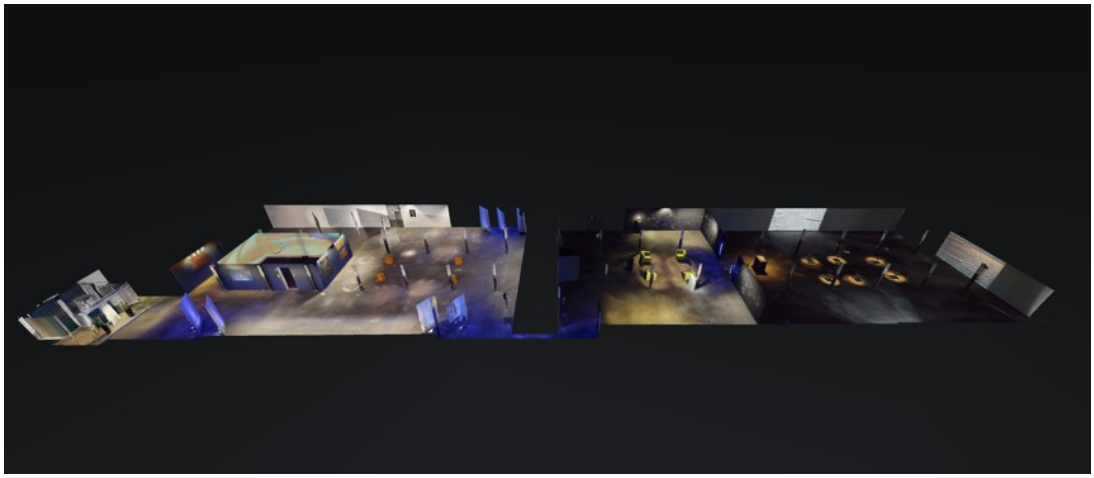
Conversely, another interesting example of an art production model was brought into the Finnish culture in 2018 by TeamLab, the Tokyo-based art collective, for the inaugural exhibition of Amos Rex Museum in Helsinki. TeamLab creation model is based on collaborative practice, interdisciplinarity and the use and design of new technologies. The collective was established in 2001 and currently has a vast community of artists, programmers, engineers, CG animators, mathematicians, and architects. The aim of this collaboration is to explore the relationship between humans and nature through art, in a time where digital technology allows humanity to liberate itself from the physical and transcend the boundaries. (TeamLab n.d.)

Due to the current environmental, economic and social global challenges, it can be stated that there are cultural concepts that might need to be reviewed and readjusted. In response, artists and cultural institutions can collaborate at a different level, where art becomes the co-creation tool through which local communities can be closely heard and understood. If in the cultural field, visual art can be also seen as a tool for transforming society, then another look at how art exhibitions are designed and distributed is necessary.

The “Aerial Roots” project aspired, from the beginning, to contemplate the role of art exhibitions in contemporary society, addressing questions and looking for new formulas on how art is understood, produced, shared, and consumed. The need for another model of understanding art exhibitions was generated from constant discussions with multiple young artists and other creative people, who were not

necessarily familiar with contemporary art practices. After various discussions with various young emerging professionals, two main objectives were chosen in the project implementation: to find alternative ways for delivering art that can contribute to a better understanding of the current global issues and ignite self-healing through art among the local community.

To fulfil these two objectives, the interest was directed toward designing an immersive visual journey that can activate mindfulness and playfulness via the active participation of the audience. Focusing on emotional engagement, the interest was directed toward each personal experience. Within a space of approximately 1000 m^2, five interactive art installations and four photography series were installed in the two rooms of the gallery space. “Aerial Roots” portrays the two rooms of the gallery as two contrasting spaces, distinctive from each other not only by the artworks they include but by the additional lighting and soundscapes they incorporate.



PICTURE 5. Luiza Preda, Allan Castellanos, Edgars Zinovjevs, Piia Aho, Ian McIntosh, Gabriella Presnal. Overview of the “Aerial Roots” exhibition from the Matterport 3D tour

Instead of looking at the pandemic regulations as a set of additional challenges, the production team decided to embrace the change. The perspective shifted from collaboration to co-creation. The ruptures in the initial production flow brought, in the end, the team closer together and encouraged the artists Luiza Preda and Allan Castellanos to invite all members to collaborate and re-design the art installations together. In this way, the exhibition became a hybrid, not only

from the perspective of its digital imprint as a virtual exhibition but also from the new way of collaboration formed between the members of the team. Combining the first concepts of the artworks with the new perspectives and ideas from each team member, the artworks merged and transformed the gallery into a place of interaction.

”Aerial Roots” exhibition upgraded from a solo exhibition to a co-created exhibition in the first two months of the production. The members of the team came from different cultures and had professional backgrounds. This aspect changed positively the working atmosphere in the team and brought innovative ways of art creation and fresh perspectives to the exhibition design.

3.2 The Physical Experience

By looking back at the art history, it can be identified an etiquette for the museum spectator that dates back to the eighteenth century. The spectator knows that one must not jump, run, climb, or touch anything in an art space. However, during the twentieth century, art rules and norms have been challenged by modern artists (Cubists, Dadaists, Conceptualists) and new ways of experiencing and using visual arts arise. Nowadays, artists are far from focusing on the static gaze of the eighteen-century spectator. The current aim is to create art which can be experienced differently, using multiple senses. Art now can be moved, smelled or even eaten. (Constance C. 2016, 115.) Concomitantly, in the contemporary art sphere, the exhibition model is changing accordingly with the new needs of the artists and the feedback of the public. The general interest of the contemporary museum is to engage its visitors and create a more immersive art experience for the public. (Constance C. 2016, 118.)

” Aerial Roots” exhibition took place physically from the 4th of February until the 25th of February at Himmelblau Gallery in Tampere, Finland. The physical experience aimed to create a more intimate space of interaction, where one can wake up the senses and interact with the artwork for receiving a calmer state of mind. The production team was formed by six Art, Music and Media students and alumni from Tampere University of Applied Sciences: Luiza Preda (artist and pro-

ducer), Allan Castellanos (artist and co-producer), Ian McIntosh (production assistant), Maria Jackson (curator), Gabriella Presnal (marketing manager and graphic designer assistant), Piia Aho (lighting designer) and Edgars Zinovjevs (technical assistant). The word “alternative” was chosen for a different purpose in the beginning. Originally, the exhibition aimed to invite the participants to activate all their senses in order to create a more durable and vivid art experience for the viewer.

Unfortunately, the exhibition was not able to offer its audience the holistic sensorial experience originally aimed for, at least not at this time, due to the new wave of restrictions during the pandemic. The original idea needed to be put on hold for the near future. The pandemic restrictions challenged the means of delivering the event. Alternatively, it shifted the perspective of the whole production team and brought significant technical innovation to the physical art space. Due to the restrictions, some of the artworks were re-discussed in terms of the installation in the space and the type of interaction they could have been offered. Other artworks needed to be excluded completely. To make this possible, the first phases of the production were fundamental for understanding the tools and AV equipment that was needed to re-create the original vision, this time together with the whole team.

PICTURE 9. Luiza Preda, Sky Series, 2022, Installation view, Room One, “Aerial Roots” exhibition

Room One consisted of an open space where photography series were simply placed on the gallery walls, keeping the classical look of any photography exhibition (Figure 2). “The Nordic Forecast” photography project was split into three correlating photo series that documented the weather cyclicity in Finland during

2020. The exhibition introduces the participant with “Self-Portrait in the Nordic Landscape”. Initially, the self-portraits were printed on paper and glued to the wall. This directly implied that the prints cannot be used afterwards. This installation method did not prove as a sustainable solution. It was decided that a better choice is to print them on a material that can be re-used, that it is resistant, can be transported easily, and be exhibited outdoors for future public art installations. The end result included three ”floating” photographs of two meters in width, placed diagonally at different heights, at the entrance of the gallery space. The series discussed self-climatization in a foreign environment and introduced the local community to a familiar, yet foreign environment (Appendix 3).

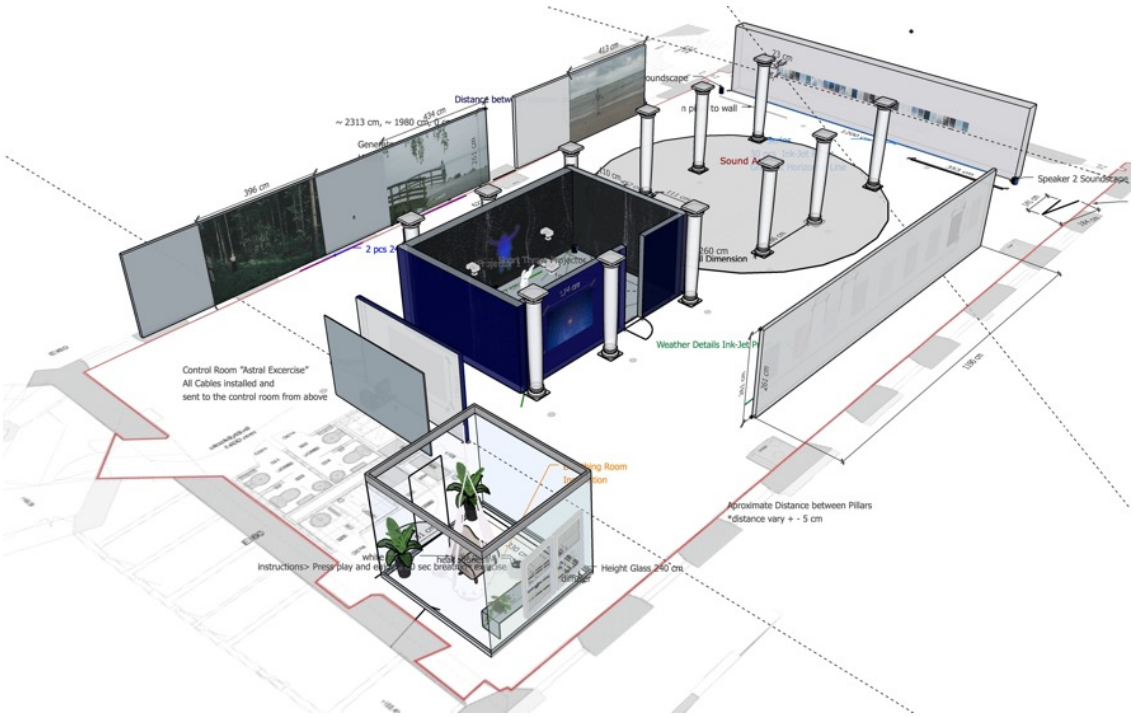


FIGURE 2. “Aerial Roots” Room One 3D Digital Maquette designed using Sketch Up

As one continues the journey inside “Aerial Roots”, the left wall continues with two photographs introducing the “Weather Details” series, inviting the spectator to start to feel their environment and get in touch with their senses, as they delve deeper into their journey (Appendix 4). The “Sky Series” is the second thing the audience can see while coming to the center of the room. This series presented a visual diary of one specific part of the sky, photographed from the same spot during the strong Nordic seasonal transition from the long summer days to the dark winter nights. The sky extracts were presented in a gradient blue line with

shades of orange, pink and grey portraying the major Nordic light shift from summer to autumn (Appendix 5). While travelling along the skyline, on the right side of the room, the rest of the “Weather Details” series unfolds, presenting close-ups of the patterns found in Finnish nature in the metamorphosis from one season to another.

Additionally, in Room One, two smaller rooms accommodated two more interactive installations. The “Breathing Room” installation invited people to close their eyes and relax completely in a comfortable armchair of the 3 by 4 meters glass room. The audience was asked to pay attention only to the way they breathe while being protected by a white canopy surrounded by natural aromatherapy oils. “Astral Exercise” gave people the freedom to move their bodies freely and dance while creating music. Each individual was encouraged to interact with their environment while observing what changes his actions make in the surroundings. Another aspect that was taken into consideration when designing the experience of the first room was that both installations might also facilitate a clearer state of mind for the viewer, which might eventually offer a better visual experience for “The Nordic Forecast” photography series.

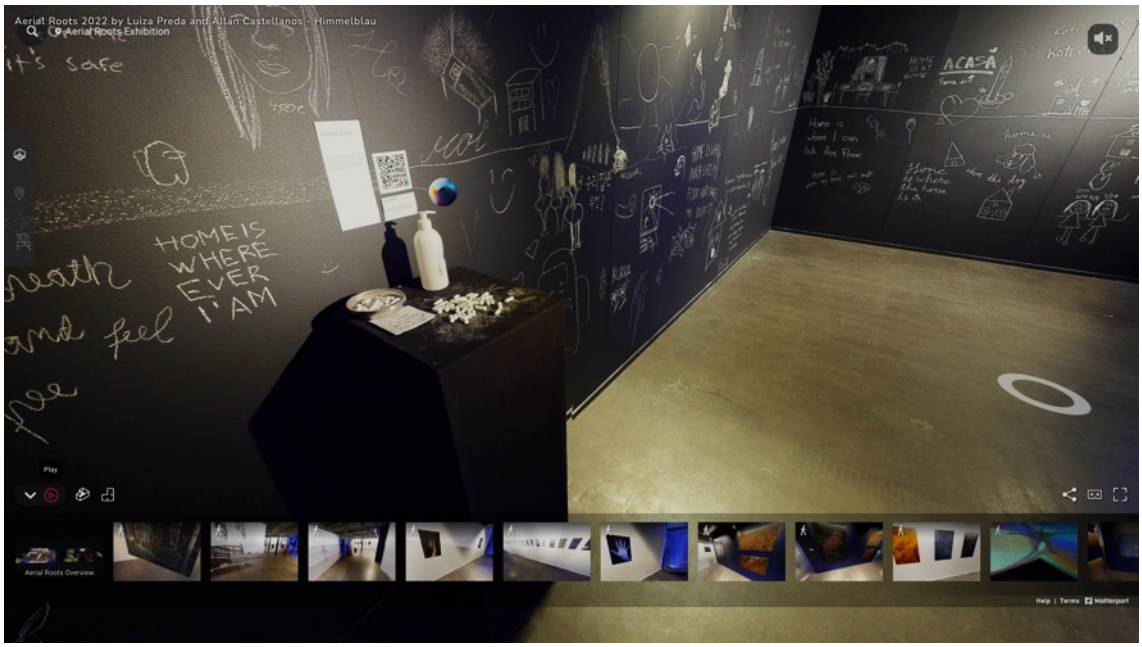
Room Two invites the audience into a distinctive atmosphere, more serious, cold, and heavier. The art projects talk about migration, cultural heritage and homesickness and consist of two art installations and one photography series as slideshow projection. All three works were installed in a place of approximately 500 square meters.

” The Drawing Room” invites people to become children again. Each individual can use the empty gallery walls to draw or write with white charcoal an expression of what home means to them (Appendix 6). “Houses and Homes” is a photography project that documents classical Finnish wooden houses from the oldest neighbourhoods of Tampere city. It was decided not to present the photography series printed but create a digital slideshow that can emphasize the atmosphere of Room Two. (Appendix 7)

An interesting point to note about Room Two is that all three projects chosen for the space were chosen as individual parts with their singularity. “The Drawing

Room" was not connected with the" Houses and Homes" project beforehand, nor with "Aerial Roots (Habitat)". The installation idea that was designed later in Room Two started, in fact, with a suggestion from the technical assistant, Edgars Zinovjevs. When the team was forced to take out one important installation from the gallery space due to pandemic restrictions, the walls had been already mounted and painted by the production team. Another artwork needed to fit the space fast, but unfortunately, there was none that Luiza Preda or Allan Castellanos could have fit such a big space.

Edgars' idea came as a smart and feasible solution that raised the public engagement of the exhibition significantly. From the verbal feedback from the audience, people found "The Drawing Room" among the most entertaining and encouraged other families with small kids to come and visit the exhibition. In the end, this interactive installation became a group work, as the lighting designer, Piia Aho highly contributed to the design of the atmosphere and Ian McIntosh, the production assistant, contributed actively during the whole process.



PICTURE 6. Luiza Preda, Allan Castellanos, Edgars Zinovjevs, Piia Aho, Ian McIntosh. The Drawing Room. Interactive installation. Screenshot from virtual tour, 2022

The entire "Aerial Roots" journey ends with a hypnotic and minimalist atmosphere created by the last interactive installation, named "Aerial Roots (Habitat)". When the participant enters the room, they are surrounded by three projections of four

meters wide, compiling a one-year visual experimental documentation of Näsijärvi Lake, the largest lake in Tampere, Finland (Appendix 8). The audience is invited to sit down in one of the individually designed six areas of the installation, for getting in touch with stories from other cultures while visually contemplating the water cycles of Näsijärvi lake from summer to winter. The audio stories are presented as a mass of whispering voices surrounding the gallery space. The six stories are presented as anonymous monologues. They are part of the "Homebook" project, an electronic book that compiles a collection of interviews extracts conducted via Skype during 2019-2020. The book includes extracts from eighteen young people, who are sharing their experiences on how homesickness feels for them and what are the challenges and advantages of living in a different cultural background (Appendix 8).

When entering the installation space, the audience is surrounded by a mass of whispers, all combined with the intense general soundscape that covers the whole of Room Two. For the voices to become audible, each participant will need to follow each voice and find its destined place where it can be listened to. "Aerial Roots (Habitat)" was one installation that required external technical support.

The production team contacted Pro Av Art Oy, a Finnish company recognized around the world for building multimedia installations for biennales and art exhibitions of various kinds (Pro Av 2022). Jorma Saarikko, the CEO of the company consulted on the project in November 2021 and discussed it in more detail in a physical meeting with the team. After the overview of the project and understanding of the artistic requirements, Saarikko offered a set of alternatives on how two of the multimedia installations from "Aerial Roots" can be created inside Himmelblau gallery space. The possibilities for creating the "Astral Exercise" experience were fairly clear from the beginning. After Luiza Preda and Allan Castellanos received the suggestions from Jorma Saarikko, it was possible to create a clear installation plan with all the details required for its completion.

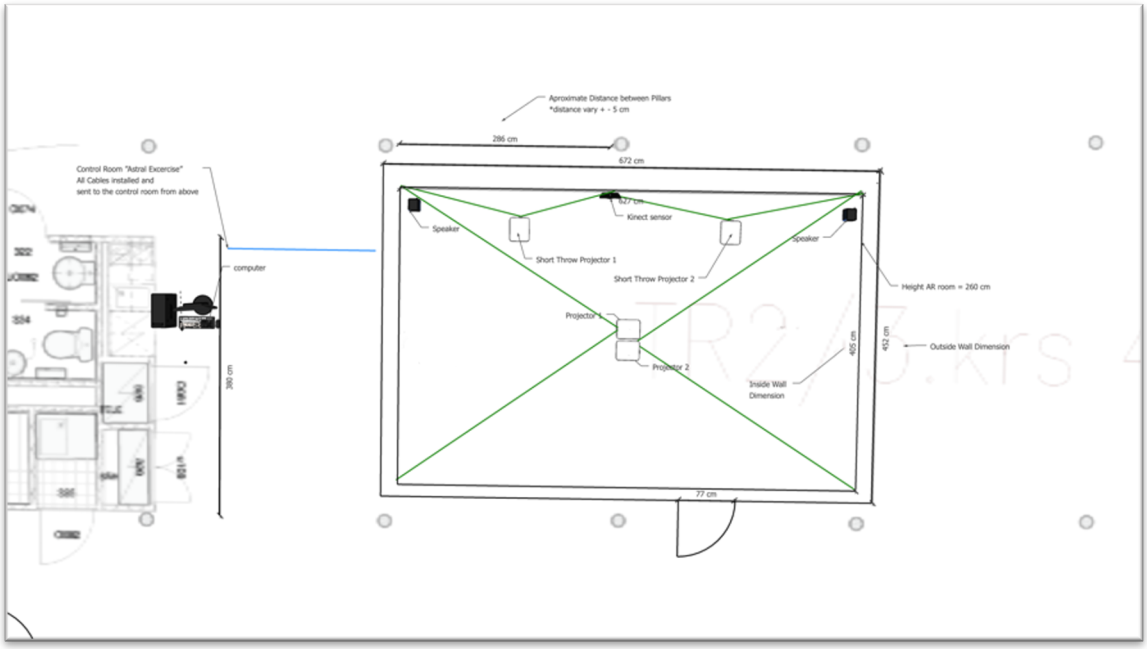


FIGURE 3. Installation Plan “Astral Exercise” after the ProAV consultancy

PICTURE X. Jorma Saarikko from ProAV documenting the “Astral Exercise” installation

After several discussions via email on “Aerial Roots (Habitat) project and additional measurements on-site, it has been concluded that the initial installation plan would not physically work according to the initial plan due to the placement of the

concrete pillars cannot provide the required space for the projector's light to travel until the wall. After a thorough discussion of the possibilities of solving the spatial problem created by the pillars, it was concluded that two feasible solutions can be either the use of short-throw video projectors or changing the projection surface. Both solutions implied a high number of resources that would have exceeded the allocated budget for the project, therefore another alternative needed to be found inside the production team of "Aerial Roots".

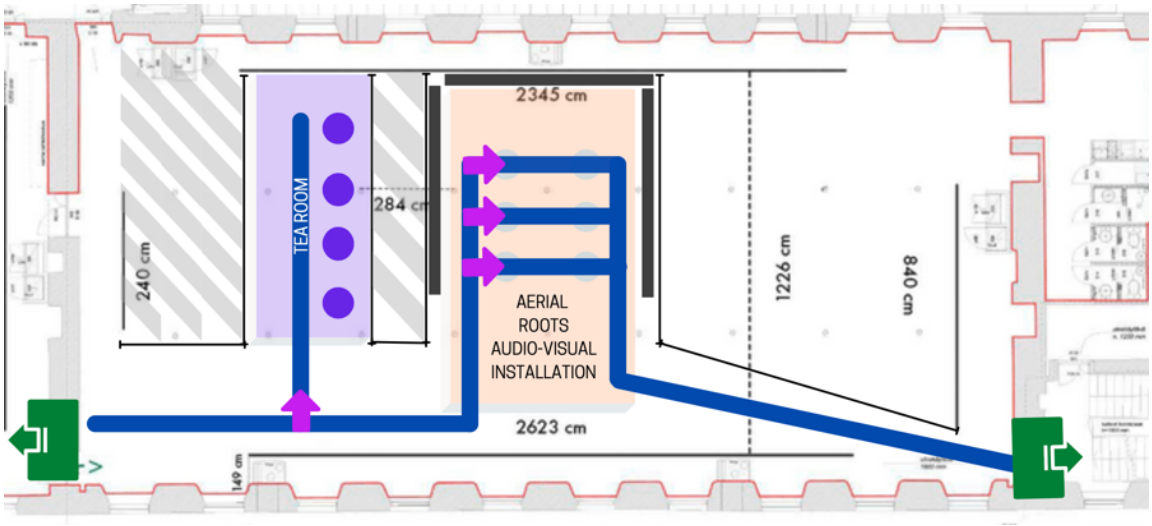


FIGURE 4. "Aerial Roots (Habitat)" Initial Installation Plan for Room Two

In the end, the production of the physical experience transformed during the process, due to the new pandemic regulations at that time. The result was a space of 1000 square meters with two distinctive atmospheres and a variety of interactive art projects that encouraged not only the audience but also the production team, to get in touch with art in a different way. Even though at that time of the production, changing the installation plans to fit with the restrictions brought significant changes, the next production steps engaged everyone, and it soon became a co-creation process that was challenging in the beginning but strengthened the finally balanced the roles within the team. It also brought a set of new technological skills and more importantly, inspired the members to have new aspirations for the future (Appendix 9).

3.3 The Virtual Experience

Tampere University of Applied Sciences provided for its students with the Matterport platform, including the 3D camera for the pre-production and the Matterport account for the production and post-production phase. The virtual tour was created by the producers of “Aerial Roots”, Luiza Preda and Allan Castellanos. It is important to consider that a virtual tour offers a visual experience different from the physical one. The “rules” in a virtual space change, therefore a copy of the physical experience in the virtual space was not considered. Instead, the decision was to explore the possibilities given by the Matterport Software and deliver an accessible and smooth virtual art experience.

The way how the space will be experienced depends on the camera positions chosen in the scanning phase, therefore understanding the whole exhibition space was an essential step in designing a fluid participant journey. Before the scanning phase, a check-up of the whole gallery space was needed for adjusting all the artworks, closing all the doors and windows and cleaning up or moving unnecessary objects that might interfere with the camera positions. The different lighting conditions of the gallery space represented one big challenge when it came to the scanning of the two rooms. All windows needed to be covered and all lighting equipment checked. Different lighting temperatures or intensities can affect the quality of the scan therefore it was necessary to adjust all light sources for ensuring a constant lighting state during the whole scanning process.

After adjusting the gallery space and having the journey design ready, the camera equipment was prepared by mounting the camera on the tripod and connecting it to the Matterport App for further technical adjustments. An iPad was used together with the Matterport Pro2 3D camera for creating and adjusting the scans. Starting from the main door, a personal journey was imagined. During this process, we needed to retake multiple times the scans, because of problems with light and camera position. This forced us to move the camera and test different positions for better accuracy.

The scanning for the entire participant journey took approximately ten hours and included a total of 165 scan positions. The visual experience was designed from the point of view of the first user, who has never travelled in a virtual space before. The virtual experience invited the user to be curious, explore the exhibition and play. Subtle elements of gamification were considered for providing a digital interaction.

After the 165 scans were taken, the next step was to upload and create a backup of the project inside Matterport´s platform. It took approximately twelve hours for Matterport to process the scans and stitch them into a 3D model. This automatic process was possible by utilizing the Matterport's Cortex AI system which was able to read the depth of each scan and merge all the scans together. (Matterport Inc. n.d.) The next step after the 3D model was delivered to the Matterport account was to prepare the journey of the participant by hiding unnecessary scans from the 3D model and creating a smoother travelling path.

The Mattertags were an important feature within the "Aerial Roots" 3D model, guiding the user in his virtual journey. They were seen as a way of communication between the creators and the audience, offering the feeling of exploration and learning during the virtual experience. Adding Mattertags was seen also as an efficient way of highlighting the exhibition concept and delivering it in a more personal way to the audience.

PICTURE 7. Luiza Preda, Allan Castellanos. Using Mattertags for personalizing the participant journey. Extract from the virtual tour of "Aerial Roots" exhibition

The vision for the ”Aerial Roots”, the virtual tour, was to create a digital experience that keeps the characteristics of the physical experience but provides different interactive elements. The set of interactive elements was explored by testing third-party platforms connected with Matterport. The aim was to deliver a digital art exhibition where people can get in contact with visual art in a more playful way and for a longer period.

To add a more personalized experience that replicates the physical exhibition, the production team decided to use Captur3d and Unity as tools to explore what can be done during the postproduction. The Creator Studio is a tool inside Captur3D that allows the user to visually customize Mattertags, create location-based audio experiences and add pictures and videos freely inside the 3D space. The Highlight Reel was another useful tool provided by Creator Studio, which allows the user to create a quick overview of the space by creating a slideshow video from the camera positions chosen by the editor user of the 3D model. This feature was used for offering an option to users who might not be familiar with travelling in a virtual space.

FIGURE 5. Creator Studio Beta, Audio Map (Captur3D 2022)

The sound in the “Aerial Roots” space became an important part of designing the virtual experience. For making it possible, with the Creator Studio was possible to add original music pieces produced for the physical space. Using the Location-Based Audio tool, it was possible to create different zones inside the gallery space. What the Location-Based feature provided was, in fact, a graphic interface for assigning audio files to specific scan points (Figure 5). With the help of Creator

Studio, it was possible to enrich the virtual experience of the art exhibition by adding not only sound but different media files such as videos, pictures, illustrations and 3D objects that facilitated the digital immersion of the user inside the virtual space.

However, the process of exploring and using the tools provided by Creator Studio came with a variety of challenges and technical problems that slowed down the creation process and affected the end-user experience. In the production phase, it became important to postpone the delivery of the virtual experience for understanding better of the new technological tools and to find the smart alternatives for solving the issues that were affecting the user experience.

If the physical exhibition gathered approximately 450 participants from the local community, the virtual exhibition brought an additional number of 105 participants from various countries. This statistic brings an important viewpoint when it comes to how art exhibition participation is analyzed. The number of people who visited the virtual show is lower than the number of participants on-site, but the total views are almost tripled (Figure 6). This shows that the virtual audience chose to come back and experience the exhibition again. In the physical world, it is more unlikely for this to happen.

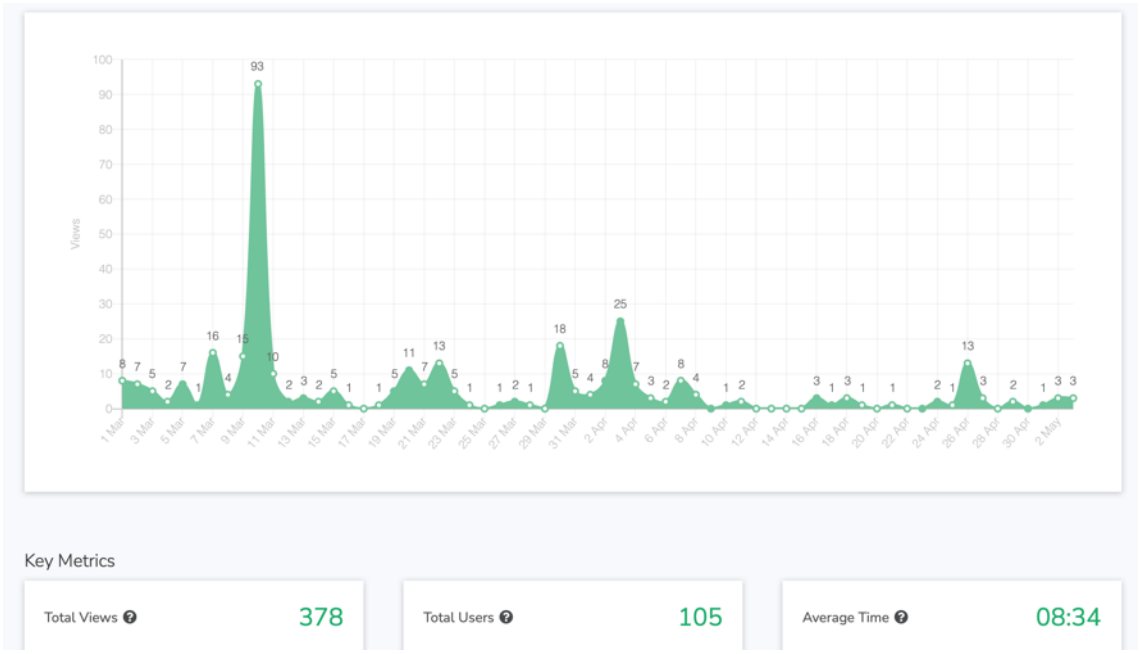


FIGURE 6. Captur3D User Analytics for the virtual tour of the “Aerial Roots” hybrid exhibition (Captur3D 2022)

In the end, the first impressions after creating the virtual experience were not highly positive. Matterport offers a fluid user experience inside the 3D environment but remains slightly limited when it comes to the customization of the 3D model. The Mattertags are a very effective way to attach important information to a virtual art exhibition, but their features remain rigid. The possibility of integration to third-party platforms for more customization was seen as necessary. Adding elements of gamification with different media files such as videos, animated 3D objects or high-resolution photographs was extremely important not only for the aesthetic of the “Aerial Roots” digital twin but for the level of interaction the virtual exhibition could have offered.

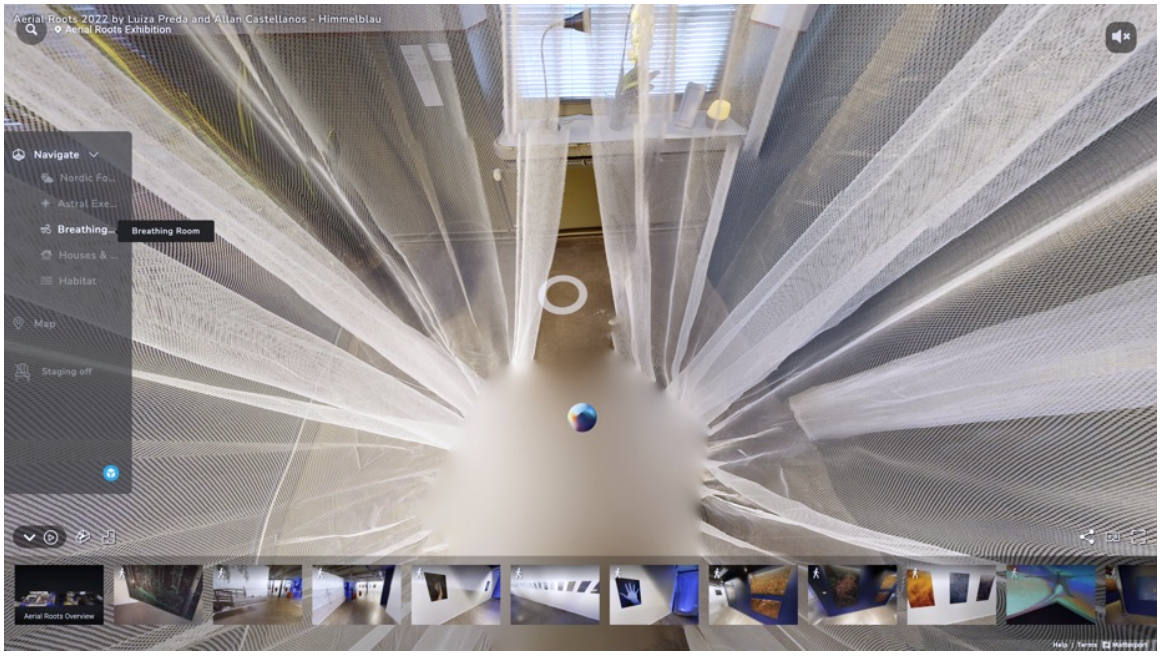
After experimenting with the 3D model of the “Aerial Roots” exhibition, it can be stated that there are possibilities to create a digital twin of the Matterport virtual tour inside other 3D modelling programs for adding interactive elements and creating an engaging virtual art experience (Figure 4). Unfortunately, the process of exporting and working with the Matterport 3D model cannot be considered easily available to the general user. To summarize, for designing immersive art experiences, strong technical knowledge is generally needed, regardless of the virtual or physical space.

3.4 The Sonic Experience

Room One portrays the warm side of the Nordic weather cyclicity. In the beginning, when “The Nordic Forecast” was selected for the exhibition, the choice was to bring more immersion to the visual experience. The choice of adding sound over the three-photography series empowered the concept of “The Nordic Forecast” project and brought a deeper understanding to the viewer. The sonic experience aimed for focused on the idea of metamorphosis, a sound piece that can evolve in an ever-changing atmosphere, evoking a sense of clarity and freshness. Through gradual sound shifts, the listener is transported into contemplation of an ethereal world. This audio-visual experience aimed to bring the emotional state of each participant to a point of stillness and calm.

In “The Nordic Forecast”, the goal was to create a space that feels warm and inviting. The sound will gradually allure the viewer to come closer and interact with the artwork. The soundscape of the first room covered uniformly the central area of the room with a 2.1 system of D&B loudspeakers. For simplicity and portability, Raspberry Pi 4 was used as an audio player to continuously loop the music piece.

Additionally, two other sound pieces were created. One was designed as a guided meditation for the “Breathing Room” and the other is a sensor-based system for the “Astral Exercise” interactive room. For the sound in “Breathing Room”, the idea was to create a sonic experience that could guide the participant in a step-by-step two-minute meditation exercise. For “Astral Exercise”, the sound was destined to be the main element, as it generates images and sounds based on how the participant moves inside the space. More concisely, the audience becomes part of the artwork. The possibility of using a Kinect 2 for Xbox was done by combining Ableton Live and Touch Designer. The Kinect CHOP, an Operator Family within Touch Designer uses a Kinect depth camera to read skeletal tracking data, for up to six people. This data is gathered and used for creating the interaction with the visuals and the sound.



PICTURE.10 Luiza Preda: The Breathing Room, 2022, interactive installation, extract from the virtual tour, part of Aerial Roots virtual exhibition

The process of creating the soundscapes started with choosing all the music tools that met the artistic requirements. Because of its modularity and midi capabilities, Ableton Live was chosen as the main production workstation. Additionally, several sounds from the Finnish nature that were recorded during the summer of 2021, were also included in the composition. Finding suitable sounds was initially hard and time-consuming. Due to the different types of synthesis, Omnisphere by Spectrasonics and Alchemy by Camel Audio was used for exploring additional sounds that matched the desired mood. Using sound design techniques, such as layering, and envelope modulation sound, the transitions between elements were created. The use of minor music chords was essential during the whole creation, adding a soft feeling of melancholy. For adding more interactivity during the creation process, Omni TR App was used on an iPad to control and perform Omnisphere using the touch screen.

During the production of the soundscapes, one of the biggest challenges was to recreate sonically the sensation of breathing for the “Breathing Room”. To achieve a good sounding mix through the whole art space Eventide Ultra-Harmonizer “DSP4000” and the Eventide Harmonizer “Orville” were used for adding glue and cohesion between elements, both being used as reverberation units. Additionally, a virtual equalizer from Ableton, EQ Eight was applied to all channels, with a 30 Hz high-pass filter turned on, to remove unwanted frequencies and facilitate the mixing process.

In Room Two, the audio system used to reproduce the sound in “Aerial Roots (Habitat)” was done using Ableton Live 10 together with a live video mixing software, Resolume 7. In this way, it was possible to sync the video and audio files and route them to multiple loudspeakers. For designing the immersive audio environment, a 5.1 surround system was incorporated for enriching the depth of sound reproduction by using D&B Audiotechnik loudspeakers. In Live Event situations, an audio mixing console is generally used to mix, control, and monitor the audio system. In “Aerial Roots (Habitat), the audio mixing console was not needed. Ableton virtual mixer was used to mix and control the audio channels. This method was applied to allow an easy way to control and connect a large number of loudspeakers. All audio systems functioned for twenty-five days in a row. Only a few times, some of the systems froze and needed to be restarted

quickly. In the end, the sound design of the exhibition became an essential element that refined the visual experience and unified the concept of the exhibition by connecting all the artworks together.

Thanks to the constant experimentation and experience using audio software with different virtual instruments and effects, unique sounds that fulfilled the artistic vision was created. By challenging the rules and not following the common methods of art production, the result was an original exhibition that brought fresh ideas about how art exhibitions can be produced.

4 TECHNOLOGICAL CHALLENGES AND NEW POSSIBILITIES

The initial aim of the “Aerial Roots” exhibition was to create a unique immersive art experience for the public, inviting the audience to interact with the works together with other individuals and dance, draw, eat a snack, drink tea, and connect with all the artworks physically, using different human senses such as touch, taste or smell. During the production process, due to the COVID-19 pandemic regulations, the original intention of the exhibition needed to be re-discussed and changed. For the risk of not having too many participants in the exhibition due to the update of pandemic regulations, it was decided that the exhibition must be translated digitally. At the same time, the installations in the physical place needed to be changed or readjusted to fit with the new safety regulations.

The digital twin of the “Aerial Roots” exhibition was an important part of the virtual exhibition, as it brought some intriguing aspects to the surface. Firstly, Matterport VR mode showed different results than the web-based model. This came as a surprise, as it was not clearly stated on their website. The 3D virtual tour was tested using Oculus Quest 2 and the Oculus Rift extension. When entering inside the virtual 3D model, it was surprising to not see any of the Mattertags or Capture 3D assets. It has been observed that there is a Matterport app that can facilitate better navigation inside the Matterport virtual spaces. Unfortunately, this app is not available for Oculus Quest and neither for Oculus Rift. This led to access the virtual tour via URL, using the navigation browser in the Oculus system.

One important finding was that when using the VR goggles, what Matterport offers at the moment is just the possibility to see the virtual space and move through the space. Unfortunately, all the assets offered, including the Mattertags or any other media file added in the 3D space were not completely integrated. In other words, the usability of the Oculus App, in which the Matterport virtual tour is the best implemented, is highly limited at the moment and it did not serve the purpose for the ”Aerial Roots”, the virtual art exhibition, until the end, as the audience is able only to travel around the space, without interacting with any of the artworks. On the other hand, the possibility to access the 3D virtual tour without VR glasses

can be considered a very useful feature, as it makes it more accessible for people that are not yet familiar with VR technology.

Another significant limitation found in Matterport was the sound. There was no option available on the Matterport platform for adding Location-Based Audio or, at least, any Background Audio for the virtual tour. As a solution for this, we opted for Capture3D which provided location-based audio. Any camera scan can be chosen for becoming an audio zone.

A promising feature found in the Creator Studio of Captur3D was the Virtual Staging, opening the possibility for adding 3D static or moving objects in the Matterport 3D Model. Additionally, it offers a gallery with a variety of 3D assets, many of which are free of charge. Unfortunately, while using it, multiple problems were found. Unfortunately, it did not fulfil the requirements for creating a virtual exhibition. Incompatibility with Safari 11 made the navigation through an Apple iPhone 11 and iPad 8, very difficult most of the time and completely impossible at certain times, depending on the number of assets included in the 3D model. When Captur3D team was contacted through email, the response did not offer any concrete solution to the problem, as it only offered suggestions directed to the end-user: It was recommended to optimize the browser by clearing the history and cache. It was further explained that lagging can be the result of a few issues - internet speed connection, the hardware used to view the tour (desktop or phone - which types of phones, laptops etc), and the number of 3D assets placed in a tour (Captur3D 2022). As animated assets are usually bigger files, the more of these are placed in the virtual space, the more performance is affected. In the end, the production team of the “Aerial Roots” exhibition was informed that, unfortunately, there are too many variables to ensure a perfect performing tour across all devices and internet servers used to access the content.

After the Scanning phase, using only the Matterport platform was not seen as a final solution due to the lack of customization for the virtual experience. However, it can be stated that is one of the easiest to be implemented. The encountered limitation pushed the limits of the digitalization of “Aerial Roots”, raising the following question: Is there any possibility to create a VR experience by integrating Matterport with Unity? How can we make this exhibition more digitally interactive?

With these ideas in mind, the decision was to import the 3D model included in the Matterpak Bundle to Unity version 2020.3.30f1. Unity was seen as an option to add interactive elements and use the Matterport 3D model as a base for a 360 virtual world. Using Unity allows a fully customizable design that can lead to a more complex and immersive art experience. Additionally, the navigation model provided by Unity gives the freedom to the user to move wherever in the space, explore much more freely and have different viewpoints of the space and the objects in the space. It was decided to add the Matterport 3D model in Unity for achieving an improved VR user experience. Getting the 3D model out of Matterport was a complicated process.

Since 2021, Matterport is offering a section of Add-ons for getting the most out of every project. One of these Add-ons, the Matterpak Bundle, is a set of assets generated from Matterport 3D data where 2D visual data is combined for creating a textured 3D mesh that can be ultimately turned into an OBJ file, the standard format for 3D objects. These 3D assets can be downloaded and imported into third-party programs such as Unity or Meshlab, allowing VR developers to start their projects with a 3D model of a real-world place. This option was considered to be the most challenging, but essential for creating a new type of virtual art tour.

For importing a Matterport model into Unity it was necessary to select the 3D OBJ file included in the Matterpak Bundle, in companion with an MTL file, which is a material setting instruction for the material textures. In our case, the MTL file was corrupted and made it impossible to use the model. Unfortunately, when Matterport was contacted to report this anomaly, the reply did not come in a reasonable time. After one month, the reply endorsed visiting an internet article that examines the possible factors that can affect the quality of a Matterport model. Based on the recommended article, it was assumed that in our scanning process, extra scans were necessary. For this reason, the MTL file was corrupted in this case. After a few more weeks, Matterport's support team provided an updated version of the Matterpak Bundle. In this new version, the material setting file was working properly, allowing to have a functional digital 3D model inside Unity. The team assumed that Matterport needed time to analyse the technical problems of the "Aerial Roots" 3D model and find the solution for fixing them. The last response from Matterport Technical Support raised the team's interest again.

After importing the model into Unity, the first impressions were that the Matterpak Bundle could be used as a data source for creating a 3D virtual reality environment. This option can allow developers to create realistic 3D environments starting from physical spaces. Moreover, Unity offers a library of assets for VR support, such as Oculus Integration, an asset that brings pre-built scripts, plug-ins, and tools into the development of VR applications for Oculus. By 2023, the team decided to explore the possibilities of creating an interactive digital exhibition based on the “Aerial Roots” virtual tour.

As an alternative to Unity, Sketchfab is the company that became one of the main platforms for publishing and downloading interactive 3D models. A VR mode is available for certain 3D models. It is also possible to use Google Cardboard or a VR headset such as Oculus Quest or Oculus Rift. While browsing through Sketchfab models, one immediate finding was that the navigation experience inside the 3D spaces is not as smooth as in Matterport, leading to moments of confusion. Without using the annotation marks, the navigation becomes at certain times disorientating. Annotations are similar to Mattertags, they are tags to guide the user inside the space and show detailed information. Additionally, an AR mode is available in some of the 3D models. It has been tested with an iPhone 11 with Safari mobile browser, showing poor performance and instability. In the end, Captur3D, Unity and Sketchfab have been tested with the “Aerial Roots” 3D model.

Figure 4. Comparative Table between 3 Matterport post-processing possibilities

SOFTWARE	**PROS**	**CONS**
UNITY	Robust and stable Unlimited possibilities for enhancing the virtual experience Compatible with most of the headsets and AR	Requires experience in coding Requires WebGL for hosting
CAPTUR3D	Easy to implement It offers Creator Studio feature, with free 3D assets First 3D model is free	Is on Beta stage, multiple bugs founded Not compatible with all browsers. Lowest satisfaction with Safari
SKETCHFAB	Free online service Promotional market AR and VR available Easy to access	Poor performance Nor for professional use

When it comes to the problems that aroused in the physical place, several interesting aspects can be discussed. For example, installing a lot of technological gear in the gallery space brought an aesthetical problem. When it came to the overall aesthetics of the exhibition, the sound systems, lighting gear, sensors, motion cameras and directional speakers created at first a visual issue. The 1000 meters of cables that needed to be installed throughout the whole gallery space needed to be well organized or hidden.

For instance, one big technical challenge was the concrete pillars alternating in two straight lines in the middle of the exhibition space. The artistic vision needed to be changed to adjust to the space limitations. Initially, interactive elements that involved touch and taste were expected in the exhibition. Following the procedures brought by the pandemic," Aerial Roots" transformed into a touch-free exhibition, where a set of new technologies were used for creating an environment where COVID-19 would not spread easily.

For "The Breathing Room" a smart and feasible technical solution was found for the pandemic restrictions. A motion sensor detects the new physical presence in the room and a voice starts to guide the participant. The voice invites the person to take a seat and explains the rules of the breathing exercise. The exercise is done by syncing one's breath with the music, until the end of the composition.

PICTURE.6 Luiza Preda: The Breathing Room, 2022, interactive art installation, installation view, part of Aerial Roots exhibition, Himmelblau Gallery, Tampere

One of the main challenges in “The Breathing Room” was to find a suitable technological solution that overcome all the COVID-19 restrictions and that offered a satisfactory experience. Using a Raspberry Pi4 and a PIR motion sensor, we found an accessible solution that sensed motion in a specific area of the room. Using a Raspberry Pi4 that is a very small computer, loaded with Raspberry Pi OS, a free of charge operative system, that fits into a microSD card. Raspberry Pi4 supports Python 3, a popular coding language and is compatible with a large number of sensors and other electronic devices. Connecting a PIR motion sensor to the Raspberry Pi4 mainboard was the first step in creating this system.

Afterwards, it was required to code a program using Python3, to automate the audio player for playing the sound file only when the PIR motion sensor was detecting movement. While testing, the team experienced a moment of frustration. A constant signal was received from the PIR motion sensor. Initially, it was thought that the sensor might be broken. To solve this problem, a set of new PIR motion sensors was bought to be further tested. Later, it was proven that the pins from the PIR motion sensor were not properly connected to the mainboard of the Raspberry Pi4, causing the incoming signal to malfunction. Another challenge that arose, was finding a way to reduce the area of sensitivity where the sensor is activated. When adjusting the motion sensitivity on the sensor panel, the areas outside the installation remain within the sensitivity area. Using conventional masking tape to cover the sides of the sensor, helped reduce the sensitivity area more efficiently.

Situated in a different room of the gallery space, “Astral Exercise” is an interactive audio-visual installation that creates an “astral avatar” for each participant who enters the space. The avatar is projected in a continuously changing visual environment, offering a 180 degrees computer-generated immersive perspective to the viewer. Furthermore, the movement of the participant is captured with a motion camera and used to also record the movements of the person in front of it. The invitation is to move freely between four walls, dance, run, lay down, jump, or any other action imagined while observing how the body generates sounds and modifies the projected visuals.

PICTURE 8. Allan Castellanos: “Astral Exercise” interactive installation, part of “Aerial Roots” exhibition, Himmelblau Gallery, Tampere

After researching 3D vision cameras for possible usability, it was found that the depth of a physical space can be scanned with 3D cameras through sensor technology. For the “Astral Exercise” case, we used the Kinect 2 for Xbox to receive skeleton tracking data for modulating the sound and capture 3D vision data to generate the interactive visuals. At first, the test was done with the Intel Realsense 415 using the Skeleton Tracking SDK from Cubemos, a company which stopped selling its services at the beginning of January 2022. Because of this, Kinect for Xbox became the only camera available that can provide skeleton tracking support within Touch Designer. In our case, we were interested in obtaining data from the body movement of each participant, in order to create an artwork that can interact with the spectator in a real-time situation.

Due to COVID-19 restrictions, one of the challenges that arose was to find ways on how technologies can create a touch-free safe environment. A technological solution that helped to achieve this, was the use of QR codes inside the exhibition. Users were able to access the online booklet, the official website and one electronic book for Aerial Roots (Habitat) using their mobile phones. This decision reduced a considerable quantity of the materials needed to be purchased avoiding high printing costs.

New technologies can be combined for creating an art experience that is destined for an immersive and engaging space. The exploration and the different combinations of AV gear can bring exciting new ways of experiencing art. In event production, the atmosphere is seen as an essential part of the event experience. An art exhibition can have a predetermined atmosphere, too. Engaging with art is seen more and more as a place where you can access and get unique experiences. For this to happen, different technological tools are playing an important role at the moment in bringing more interactivity and engagement to art.

It can be affirmed that the development of virtual art exhibitions requires technical knowledge and therefore, a need for collaboration with external companies or individuals working in the IT field.

In the SWOT analysis (Appendix 8) made with the team members, the use of new technologies was seen as an opportunity and an advantage for upgrading skill sets and gaining new perspectives for the future. Learning new technologies required time for understanding, testing and experimentation.

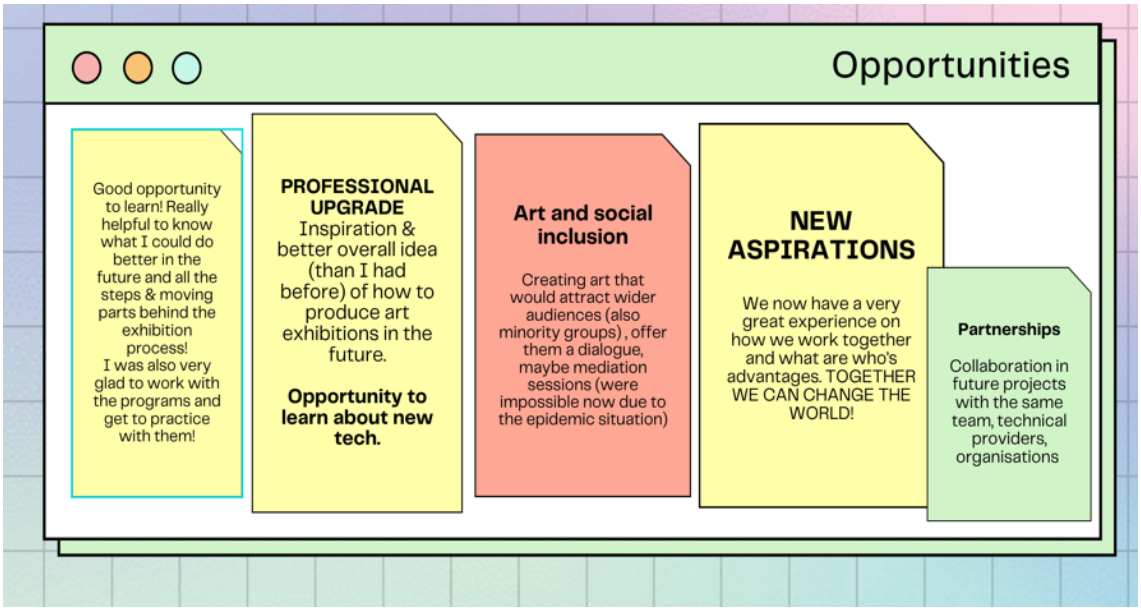


FIGURE 5. Written digital notes from the production team. Extract from SWOT Analysis with the opportunities envisioned after the production of the “Aerial Roots” exhibition

To summarize, it can be stated that there is not a dedicated system that brings all the necessary tools for creating an interactive virtual tour in a feasible way.

Even with the latest technologies available on the market, it is not easy to create a virtual art exhibition starting from a physical one, as there are no clear implementations or tools that can offer a safe place for experimentation at this moment. Regardless, Matterport is going forward with the development of virtual tours. For creating a virtual art exhibition with Matterport, the currently available features are very limited. Even though third-party platforms offer some extra features for a Matterport virtual tour, many of the important features needed for designing the interactivity, such as 3D assets, videos or sound, are not properly implemented as they are bringing consistent latency and lagging, and therefore, cannot be used.

5 CONCLUSIONS AND DISCUSSION

In the last three years, COVID-19 restrictions changed the way we see and understand our lives. Since the pandemic started, humanity had more time to reflect on their desires and needs on both individual and societal levels. To establish constant constructive behavior among individuals, society can look for the possibilities that exist, already laying in front of each individual, in order to stop an avoidable extinction.

For instance, it is generally known that new technologies require time to be fully understood, prototyped, and tested. However, COVID-19 restrictions accelerated this process and brought humanity in front of a set of alternative solutions that can help society to evolve faster. For any possible future, it is essential that humanity acts fast in finding alternative ways of living and adopts behaviours that might not feel satisfactory at first but are necessary for evolution. When a safer social and environmental interaction is required, it has been proved that the technological solutions for the future are already around us (Sinha 2022). With the current technology and the necessary awareness for imagining this future, the global issues can start to be re-analyzed from a different perspective.

The aim of this study was to propose a new exhibition model that can combine traditional ways of delivering art, with several AV technologies available on the market, for envisioning new modalities for creating and experiencing art. Artists are embracing the change and igniting action through art and technology for the younger generations (Abramovic 2018.) Some are co-creating with art museums and collaborating with the local communities for sharing new learning methods through art (Metsola & Tuulikangas 2019, 31-33). Allowing the latest technology on their premises, art museums (Louvre Museum 2022; TeamLab n.d.) create new pathways on the road to collaboration and co-creation, by working with tech companies able to support the immersive art experiences needed for engaging their audiences (Pro Av 2022; HTC 2019).

When the production combines various creative fields, the team becomes also a more complex organism that asks for new ways of exploration and creation. Using the latest technologies on the market and combining methods from different creative industries, ”Aerial Roots” became a hybrid exhibition that opened new discussions among the participants, the partners and collaborators, and the production team itself (Appendix 10). Another finding is that the digitalization of art already offers new alternatives to how art exhibitions can become more engaging, accessible, and innovative. For instance, Virtual Reality is an available technology that can be seen as a solution, not as the only way for change. It can be stated that new technologies, such as VR, can be used creatively for delivering more sustainable ways of exhibiting and consuming art.

With these new tools, emerging artists can visualize their artistic progress and create simulations of the art exhibits they imagine to have. Virtual art exhibitions are not limited by physical space, therefore curators can simultaneously engage a bigger number of artists. In this way, the art institutions, private galleries, and museums can also offer a new alternative for accessibility and inclusiveness.

Furthermore, digital archives can be seen as a safer way of collecting and preserving art for future generations. Transporting physical art exhibitions into the digital world, opens a new world for conserving, transporting, and collecting art. Unfortunately, the new alternatives and infinite possibilities that VR is currently offering highly ask for faster implementations, as they are not entirely familiar to many individuals. If artists use the new technologies, this will encourage curators and art institutions to embrace these new technologies and use them more extensively. In this way, contemporary society will not only become more familiar with the new technological tools, but more people will be open to understanding, engaging, and learning through art.

Despite the current shortcomings of VR technology’s accessibility, it can be concluded that humanity is on the verge of accessing a new world full of creative alternatives. The bond between technology and visual arts brings new ways of creation, and new business models for artists, digital creators and other professionals from the creative industry field. At the same time, the embrace of these

new technologies might bring new monetary models for art institutions, foundations, cultural organizations and/or art collectors, that need to be further analyzed and understood. For an environmentally sustainable solution, creating a VR artwork related to climate change, with elements of gamification, can bring youngsters closer to art, and more importantly, to the understanding of the current global problems (Abramovic 2018). For a socially sustainable solution, new technologies bring actors from all creative industries closer to the art world and new methods of co-creation arise (TeamLab n.d.) Softwares and programs that can deliver a quick way of bringing physical exhibition into the digital realm already exist (Matterport Inc. n.d.).

How can art exhibitions push contemporary society toward a more sustainable future remains an open question. Fortunately, technology is an already available tool that offers alternatives for different methods of production that can bring new solutions to the current global problems. Some of these alternatives are directed more towards sustainability than others, depending on the way how they manifest in relation to the public and the environment. However, when it comes to more complex virtual art exhibitions that are based on an immersive virtual experience, there is an opportunity for developers to create new platforms that are easy to use and that include all the required elements for interactivity.

To summarize, technological advancements changed the way how humans think and feel about the future, bringing to the surface innovative artistic practices that can switch art into a transformative tool for society. From here on, the biggest learning is the understanding that at this moment in time, everything is becoming possible. This provides the necessary space for looking at the existing alternatives and making the conscious steps towards smart evolution and sustainable living. Using the experience from the past with the new technologies of the future, and collaborating closely with other individuals, companies, cultural institutions, and organizations, we will dedicate our time for creating innovative methods that lead to harmonious ways of living together as humans. After this experience, our interest as entrepreneurs is to create an art development center based on sustainability and human transformation. With the use of new technologies and the collaborations with other creative minds from our local community, we will continue exploring the idea of using art as vehicle for global transformation.

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IMAGES

PICTURE 1. Extract from Virtual Exhibition Archive, Henri Matisse's exhibition by Museum of Modern Art, New York (MoMa 1931) https://www.moma.org/calendar/exhibitions/1903?installation_image_index=0

PICTURE 2. View from the virtual tour of the "Visual Catalysts" art exhibition https://cicat2025.turkuamk.fi/en/visual-catalysts/exhibition/ (Tampere University of Applied Sciences 2021)

PICTURE 3. Marina Abramovic. 2018. Rising. VR and AR application (Acute Art 2022)
https://acuteart.com/marina-abramovic-rising-app/

PICTURE 4. Mona Lisa VR application (Louvre Museum 2022)
https://www.louvre.fr/en/what-s-on/life-at-the-museum/the-mona-lisa-in-virtual-reality-in-your-own-home

PICTURE 5. The dollhouse of the "Aerial Roots" exhibition from Matterport 3D tour https://captur3d.io/view/tamk/aerialroots

PICTURE 6. Luiza Preda, Allan Castellanos, Edgars Zinovjevs, Piia Aho, Ian McIntosh. The Drawing Room. interactive installation. Screenshot from the virtual tour

PICTURE 7. Luiza Preda, Allan Castellanos. Using Mattertags for personalizing the participant journey. Extract from the virtual tour of "Aerial Roots" exhibition

PICTURE 8. Creator Studio Beta, Audio Map (Captur3D 2022)

PICTURE 9. Luiza Preda, Sky Series, 2022, Installation view in Room One of "Aerial Roots"

FIGURES

FIGURE 1. Aerial Roots Room One 3D Digital Maquette designed using Sketch Up

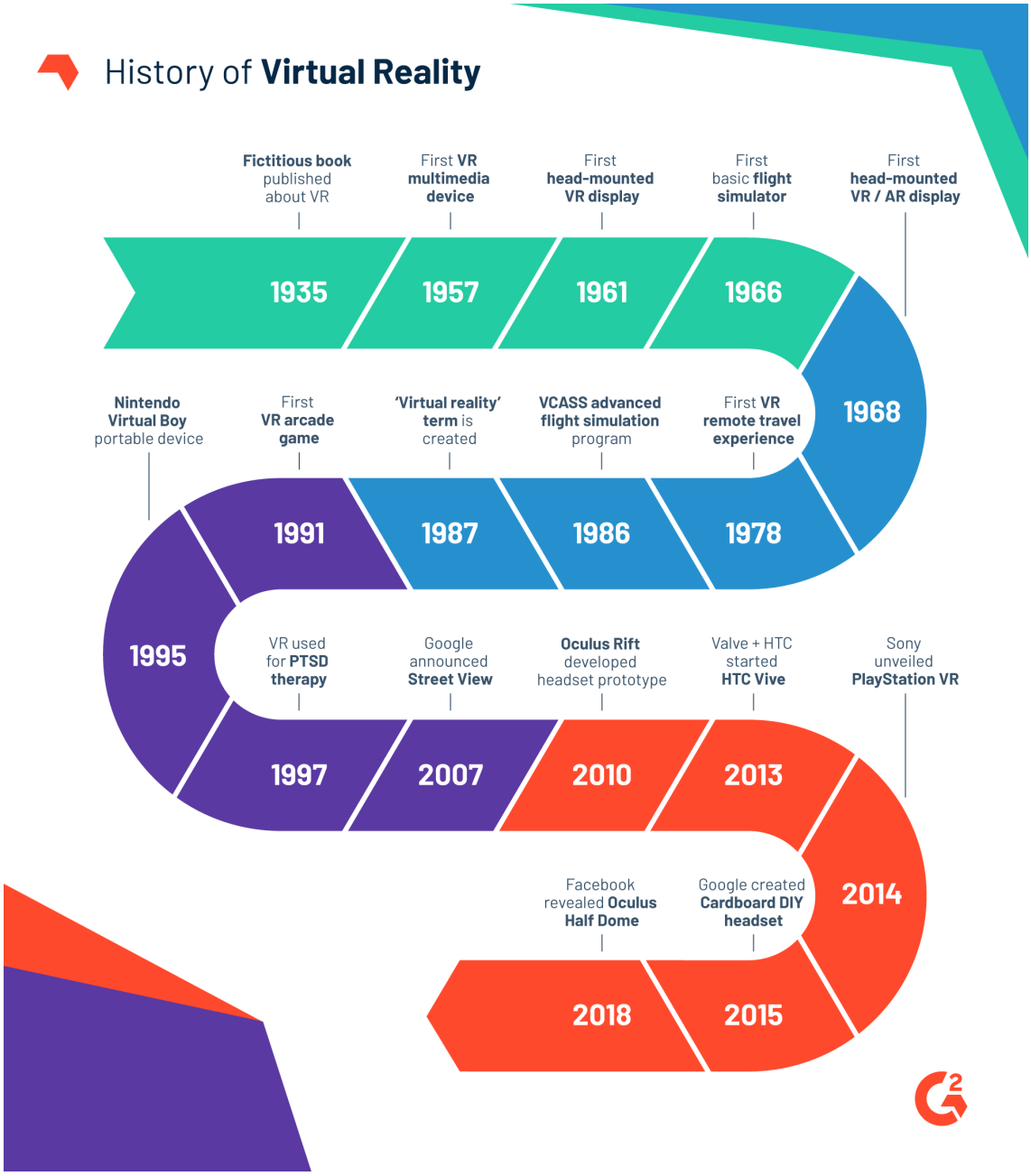
FIGURE 2. Aerial Roots (Habitat) Initial Installation Plan for Room Two

FIGURE 3. Installation Plan "Astral Exercise" after the ProAV consultancy

FIGURE 4. Captur3D User Analytics for the virtual tour of the "Aerial Roots" hybrid exhibition (Captur3D 2022)

APPENDICES

Appendix 1. History of Virtual Reality (Bridget Poetker 2019)



Appendix 2. “Self-Portraits in Nordic Landscape” Photography Series
https://www.predaluiza.com/selfportrait-nordiclandscape

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Appendix 3.” Weather Details” photography series
https://www.predaluiza.com/weather-details

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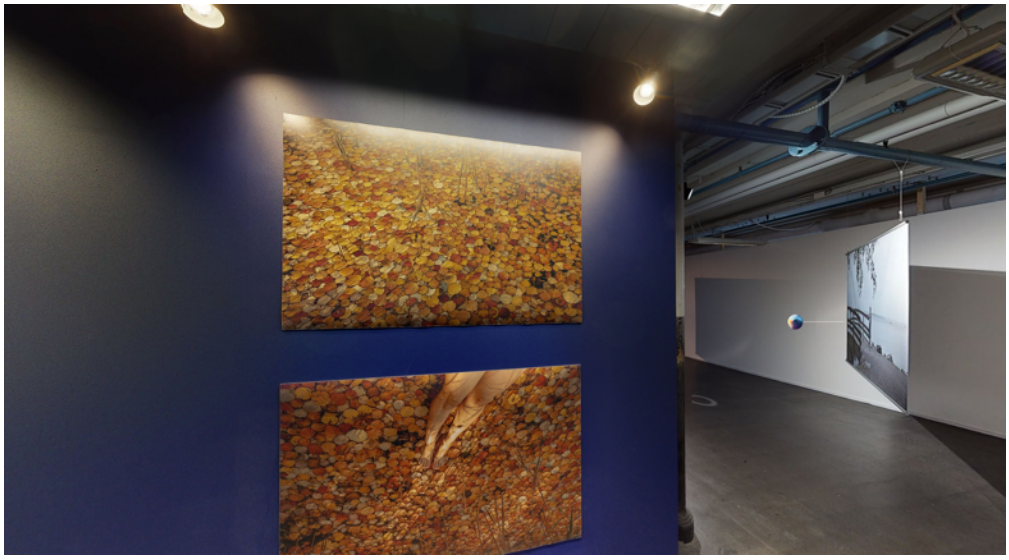
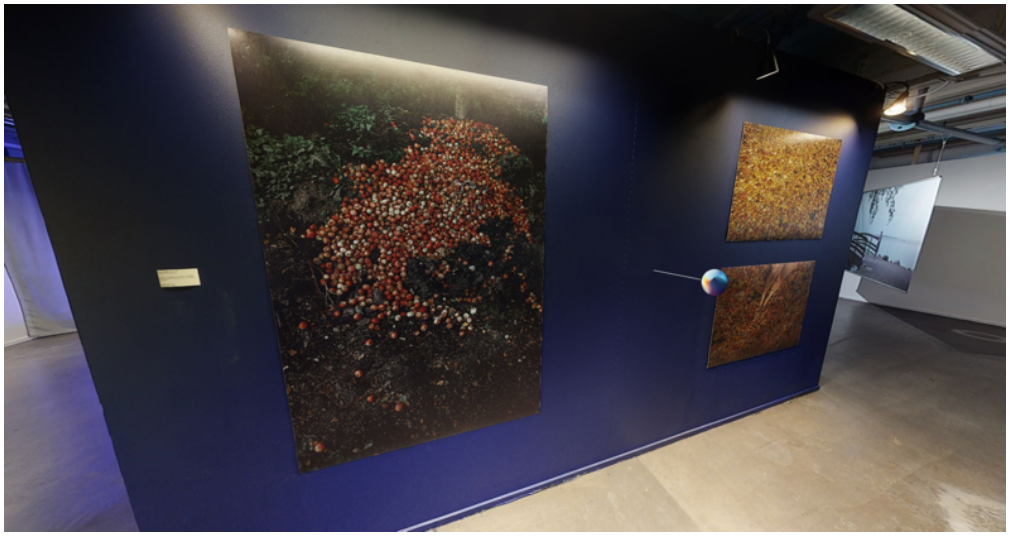
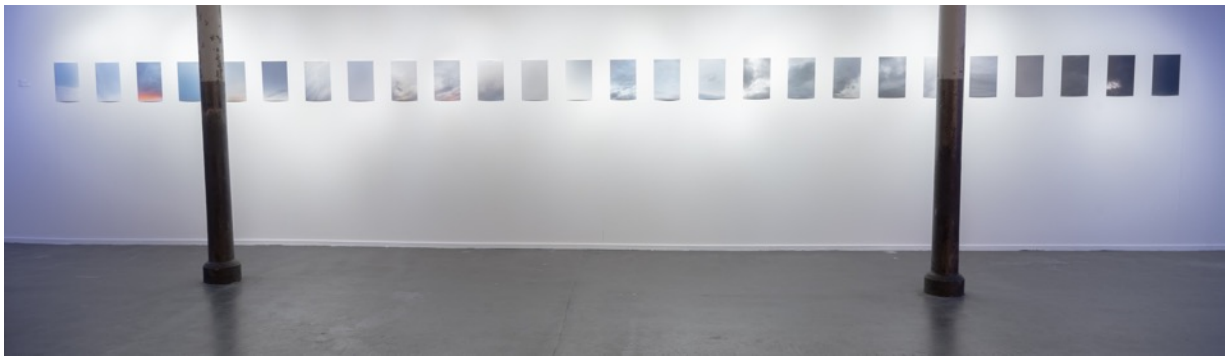
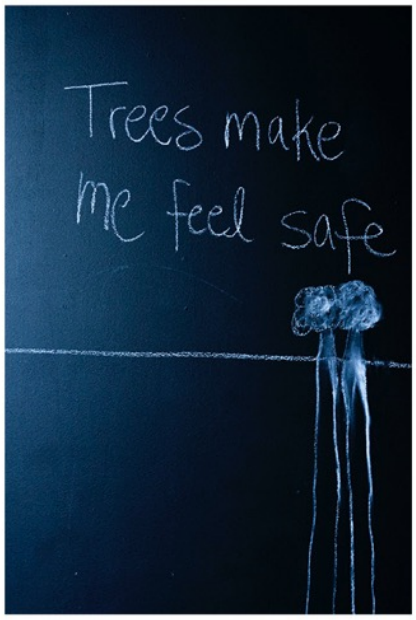


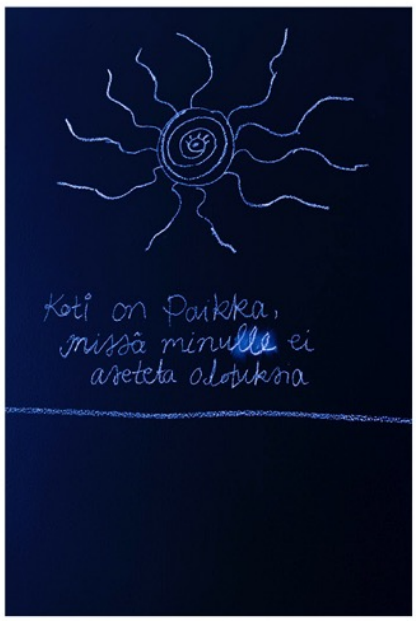


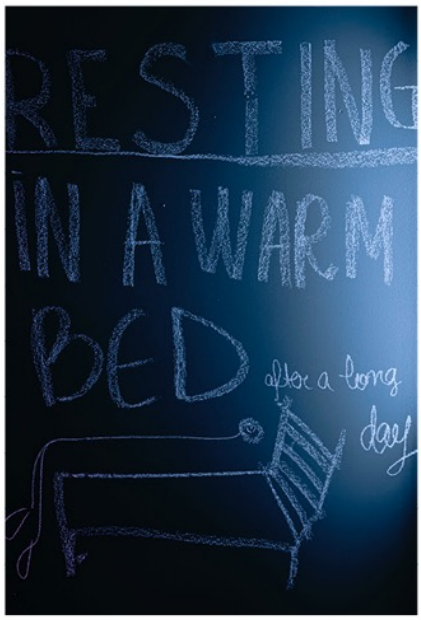
Appendix 4. “Sky Series” Photography Series
https://www.predaluiza.com/skyseries

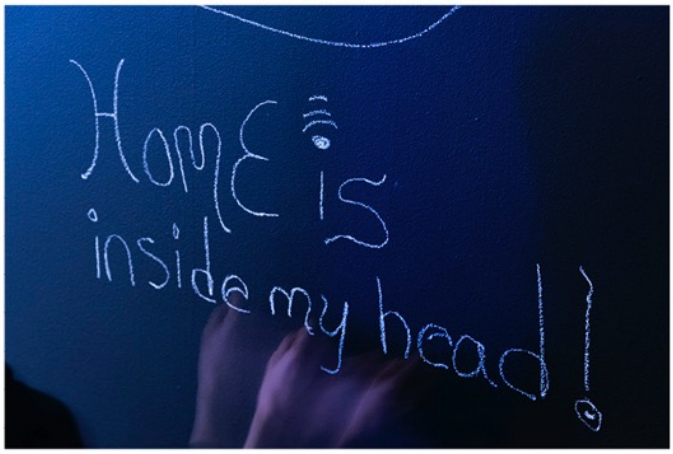


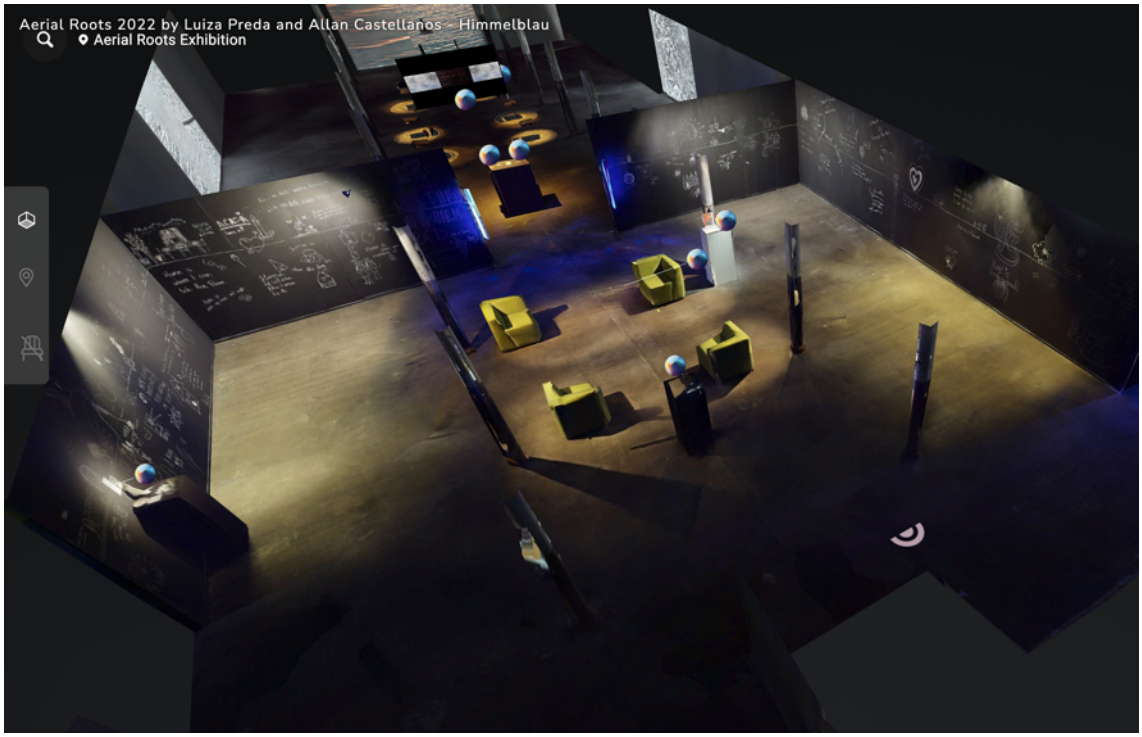
Appendix 5. Extracts from the “Drawing Room” collaborative installation

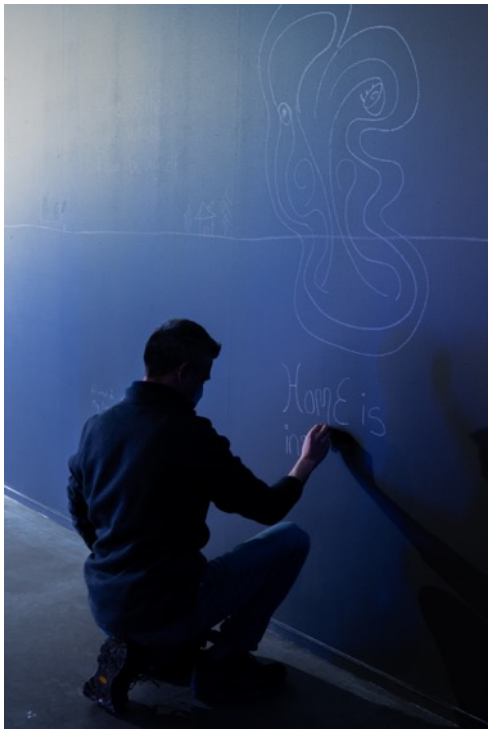









Aerial Roots 2022 by Luiza Preda and Allan Castellanos - Himmelblau
Aerial Roots Exhibition



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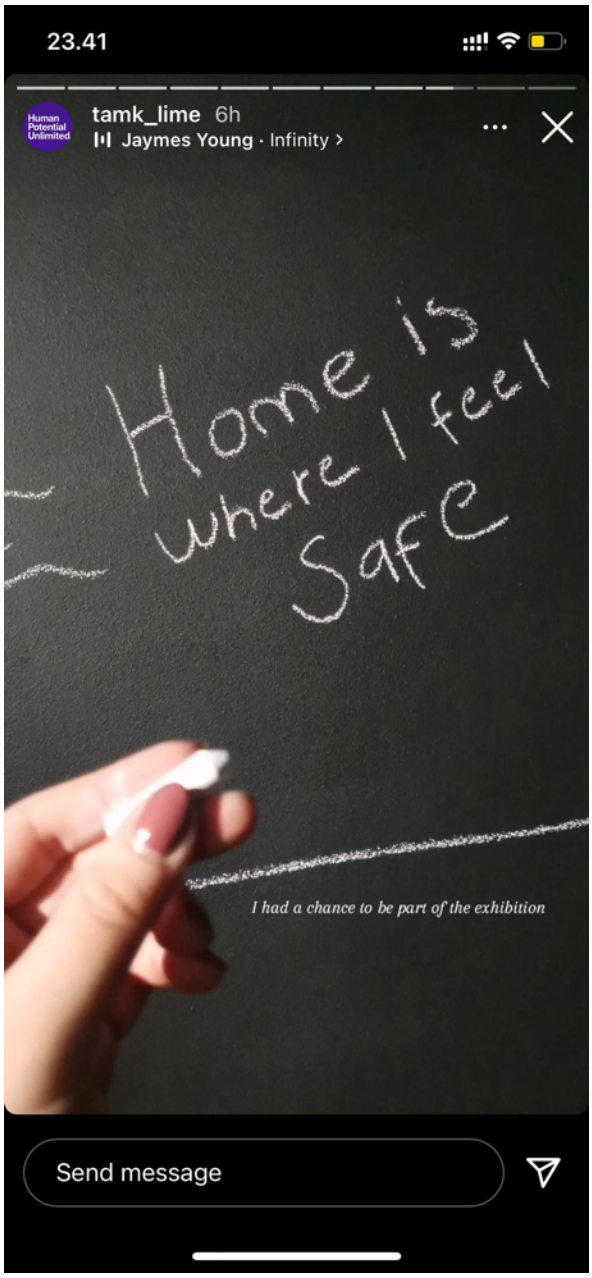
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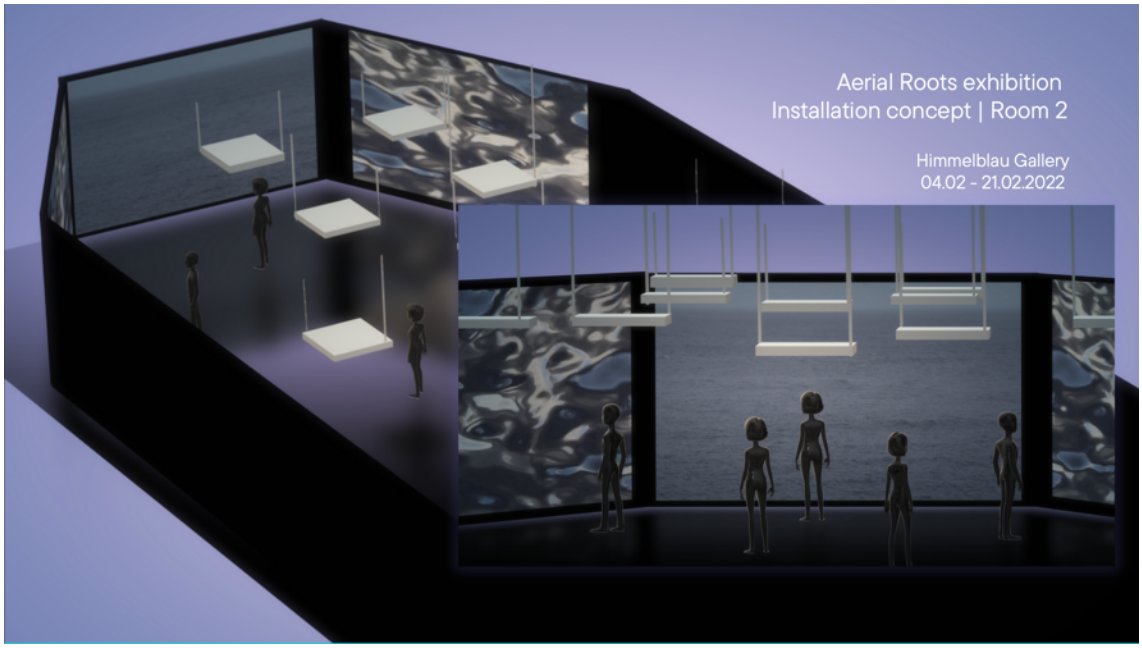
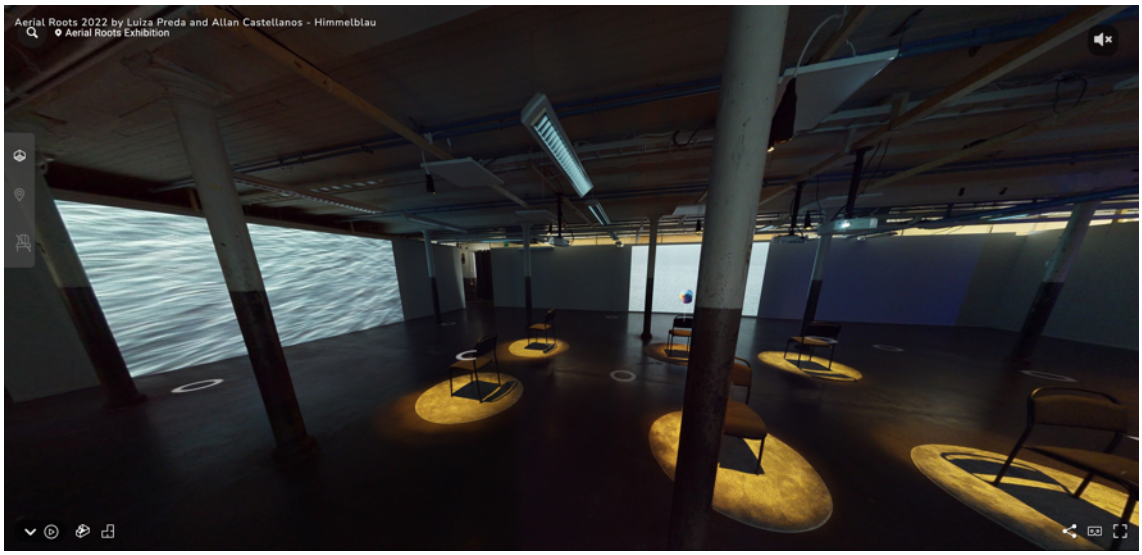
tamk_lime 6h
Jaymes Young · Infinity ›
Home is where I feel Safe
I had a chance to be part of the exhibition
Send message

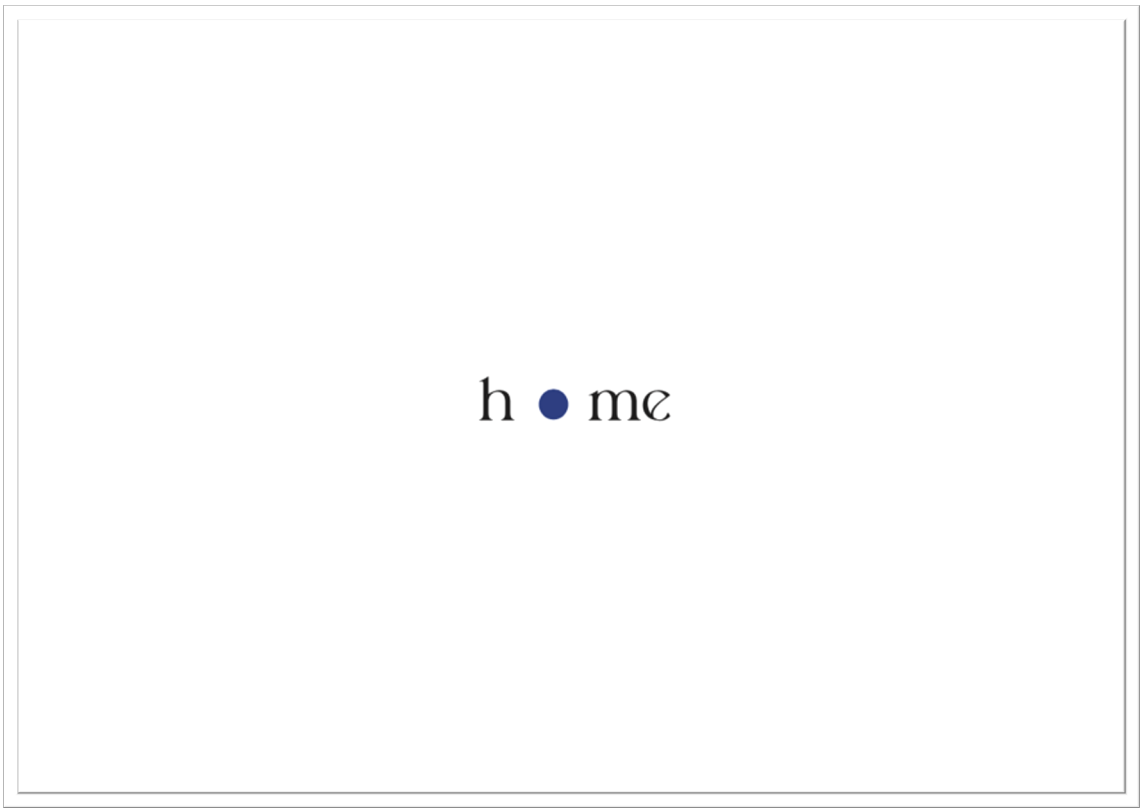
Appendix 6. “Houses and Homes” project
https://www.predaluiza.com/housesandhomes

Appendix 7. “Aerial Roots (Habitat)” project
https://www.predaluiza.com/aerialroots





Appendix 8. “Homebook” Electronic Book, part of “Aerial Roots (Habitat)” Project
https://issuu.com/luizaapredaa/docs/quotebook_singlepageview_aerialroots

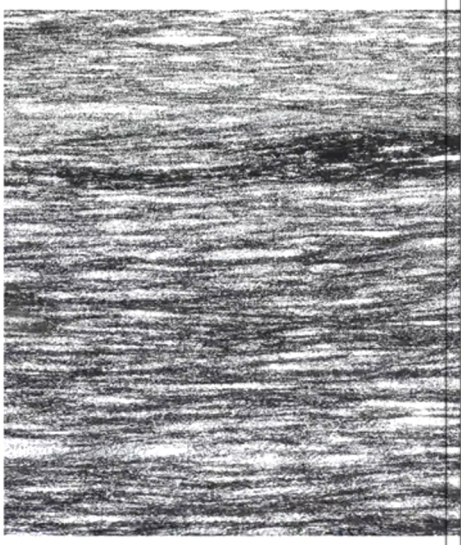


A warm thank you to all humans who participated in this project. Thank you for your time, trust and openess.

Aatu
Anniina
Gabriel
Isabella
Jasmine
Jeremy
Jordan
Laura
Madalina
Maria
Mela
Minh
Mohammad
Phuong
Richu
Teuta
Val
Veera

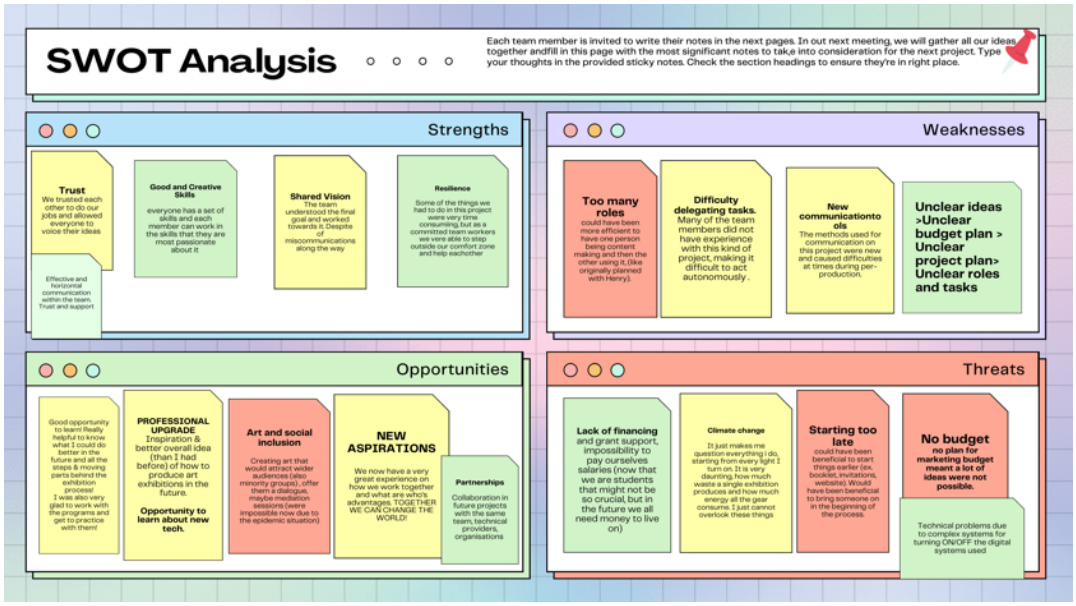
We lived in New York multiple times, so I guess that's the most home state for me. We moved to Sweden for three years, after that we went back to New York for 11 months and then moved to Canada. We lived in Halifax, Nova Scotia... We lived there for two and a half years before we moved to Finland.

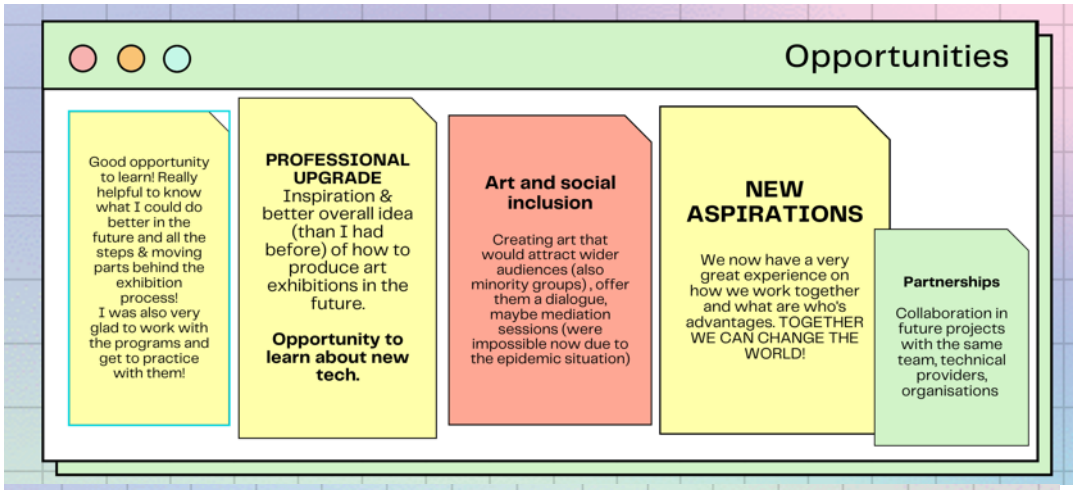
-Isabella, 19
Germany, Sweden, United States,, Canada, Finland

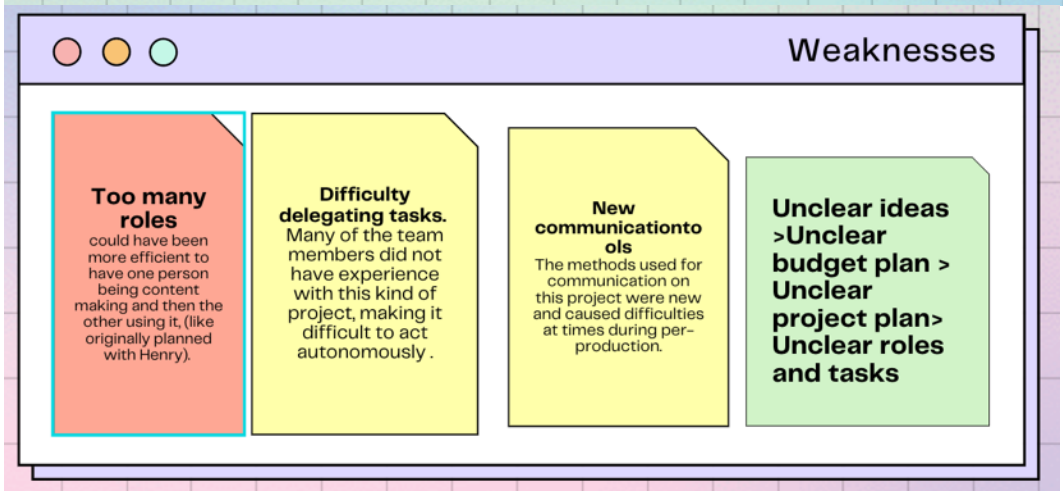


5.1 Appendix 9. SWOT Analysis Aerial Roots

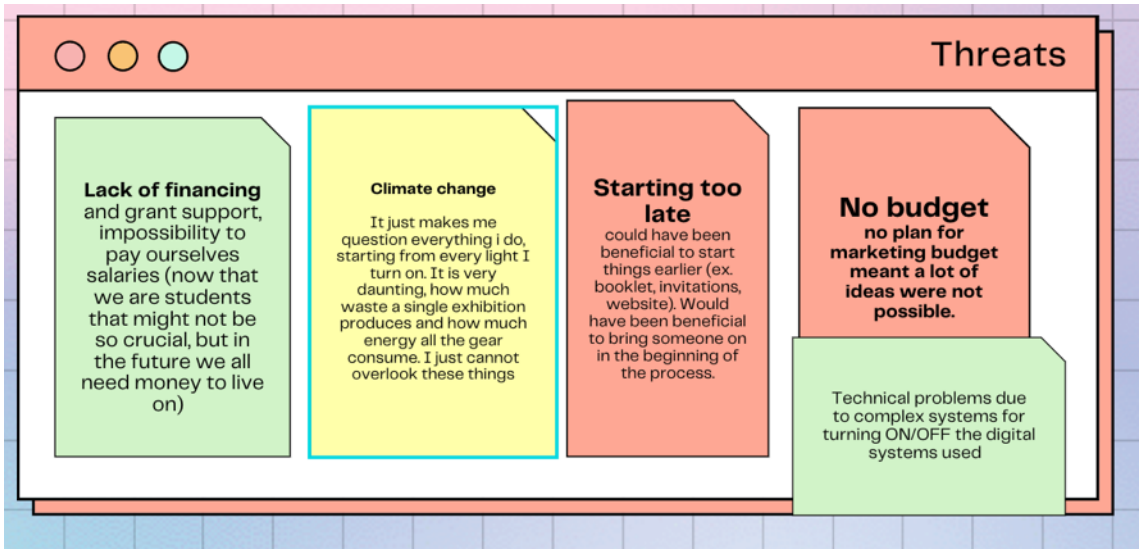
A collection of digital anonymous notes from each member of the team

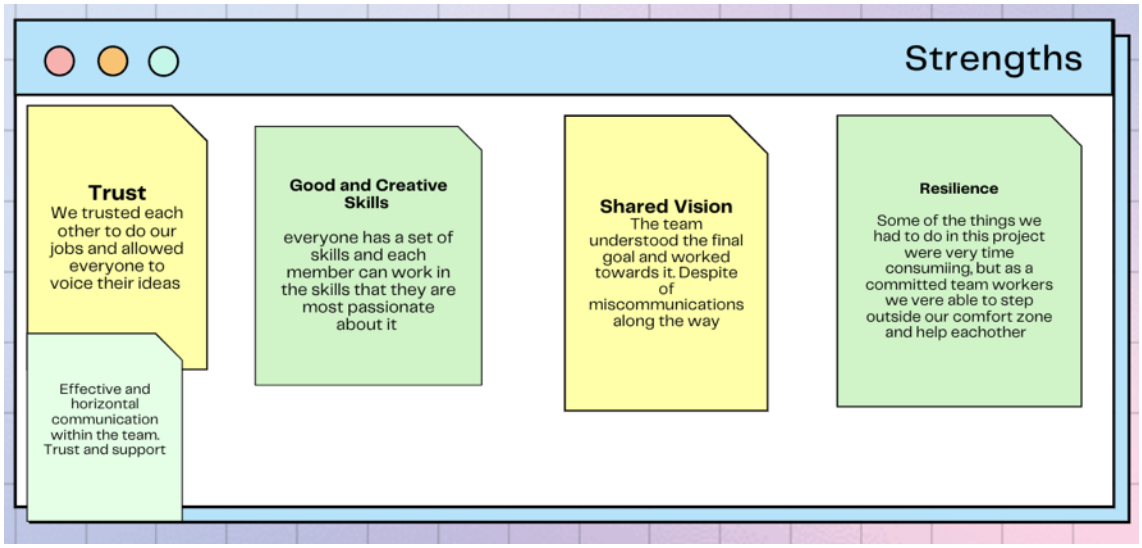






2(2)


Threats
Lack of financing and grant support, impossibility to pay ourselves salaries (now that we are students that might not be so crucial, but in the future we all need money to live on)
Climate change
It just makes me question everything i do, starting from every light I turn on. It is very daunting, how much waste a single exhibition produces and how much energy all the gear consume. I just cannot overlook these things
Starting too late
could have been beneficial to start things earlier (ex. booklet, invitations, website). Would have been beneficial to bring someone on in the beginning of the process.
No budget
no plan for marketing budget meant a lot of ideas were not possible.
Technical problems due to complex systems for turning ON/OFF the digital systems used


Strengths
Trust
We trusted each other to do our jobs and allowed everyone to voice their ideas
Effective and horizontal communication within the team. Trust and support
Good and Creative Skills
everyone has a set of skills and each member can work in the skills that they are most passionate about it
Shared Vision
The team understood the final goal and worked towards it. Despite of miscommunications along the way
Resilience
Some of the things we had to do in this project were very time consumiing, but as a committed team workers we vere able to step outside our comfort zone and help eachother

Appendix 10. Aerial Roots Exhibition Website
www.aerialroots.net