

***SIMULATED  
REALITY, A  
SPACE FOR  
CREATIVITY***

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***SIMULATED REALITY,  
A SPACE FOR CREATIVITY***

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Summer Semester 2017

Master of Arts in Integrated Design  
Anhalt University of Applied Sciences  
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Printed by  
Grafische Werkstatt der Hochschule Anhalt





# **ABSTRACT**

The project has as purpose creating a concept of a space for working that provides helpful tools in order to improve the workflow and the creativity of the user, this space may have as characteristic the possibility of adaptation to the needs and preferences of the users and their specific work.

In order to alter a space for working, the research starts with questioning the reality and finding out if it is possible to create alternative ones. Then it is explained what is a simulation, focusing on what will be used for improving the reality. Next, are explained the ways of enhancing the reality and what is possible to do nowadays, with technologies such as virtual reality (VR), augmented reality (AR) and mixed reality MR.

Later on is described what is required to have a good space for working and how can somebody feel comfortable in a place, in order to improve the creativity and the way of working. As well for understanding how to adapt a place for this purpose, it is necessary to understand what is creativity and some methods to improve it.

As next step, it is shown the experimentation process with the goal of finding out how could the elements of the project have a better adaptation in a space for working. Some of the experiments include self testing, a survey for learning about the preferences of people, the interface creation, the implementation of the main characteristics of the system and the way of using it. Finally, it is shown the result of an enhanced reality system in a space for working based on the whole research.



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# 1. INTRODUCTION

## **1.1 INSPIRATION FOR CREATING A DIFFERENT REALITY**

'How can we understand the world in which we find ourselves? How does the universe behave? What is the nature of reality? Where did all this come from?' ([Hawkings, 2012](#)).

With difficulties to find a personal answer to this statement, and try to find a reason why people is looking for to experience different realities. After studying different methods of faking the reality with physical objects, it was born the idea of creating something meaningful for our lives, something that enhances our reality and motivates us and help us to resolve our daily tasks at our space for working in a creative way.

Having that in mind, the main idea of this project is looking for making a concept of a space for creation with an enhanced reality that allows the users to work more comfortable and to have tools that provide helpful information at the moment of working.

## 1.2 QUESTIONING AND HYPOTHESIS

This project involved several philosophical complex questions, like what is the reality? Is the reality the true reality or do the humans live in a simulation? very difficult questions to answer and statements that at the same time create more questions.

Without still having an answer for this, it is called on question why is it being created an artificial world? For instance, there are used some materials that pretend to be others, plastic that looks like metal, porcelain tiles that look like wood, there are videos of wood fire played on screens and many other simulations that fake the reality.

Further on thinking about this, a new statement to be resolved is analysed, can we create new realities? A hypothesis for this statements is that we only have as reality what we all share as something real and tangible and that we have as escape from our reality several activities that make us forget our ordinary life.

## **1.3 DESIGNING METHOD AND EX- PECTED GOALS**

The research process started by studying the different possibilities of modification of physical objects applied on several fields of design, these changes were made on the size, texture, materials and colors of the objects, in order to change the identity, meaning and relevance of themselves.

This study created questions about why that modification process was done in several other aspects of the world, that were not necessarily applied to the design field; according to those modifications on the physical objects, it seemed that there is a need of faking materials with a specific purpose, for instance, the aesthetics, price, durability and accessibility of a material may change the common application of an object.

Continuing the research about the reality and the ways of modifying it, the technological approaches for this purpose were founded as very relevant. The virtual reality (VR), augmented reality (AR) and

Mixed Reality (MR), it was noticed that those systems are able to modify virtual objects, as well to customise tangible objects without creating physical alterations on the real world. Those systems as well have been improving in order to be more relevant for several aspects, the one that this project is interested about is working.

So if the technology provides the possibility of modifying the reality, it creates the purpose of doing so in order to improve the way that things are created in a specific space.

Further, on the research, the main design goal of the project is to create a simulation of an enhanced reality that explains how could the future technology provide help into our space for working. It will be necessary to study which methods are used until our time for creating a good approach. There will be used 3d rendering and photography in order to create this environment.

In order to start with the graphic process, there will be done sketches of the scenario and the interface that the new reality will have, having that already done, it is possible to create the conceptual design of what is about to be the final product.

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Then it is necessary to find a physical Venue and create several photographs of it and measure the required objects of the place in order to have a realistic base of the environment, texture and lighting, after that it is going to be created a 3d model of the developed scenario that simulates a space for working with an enhanced reality in the software Autodesk 3ds Max, then the UVs of the model will be cut and flattened, this means that the 3d models need to be developed in order to allow the 3d software to understand the position of the texture coordinates, this process is followed for the projection of the textures, made in a 3d texture projection software (Mary by the foundry).

When this is already done, the bitmap of the textures will be applied to the objects in the 3d scene using Vray shaders, the lighting will be created with an EXR file, and the render will be created in the Autodesk 3ds Max by using the software Vray.

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# 2. RE- ALITY SIMUL- TION



Several philosophers try to explain what is the reality, with several interpretations and points of view, nevertheless, there is a tangible world that we all share, a physical reality which is studied by the sciences, where the things simply exist or not as a fact without any doubt.

Humans have been trying to change this "real" reality in order to please their self-preferences and they even have been creating simulations of this reality with the purpose of studying it, use it as an art expression and make experiments.

This "real" reality has been as well enhanced, faked and changed, but contrasting with this fact, the reality has been simulated in several other ways, better and worse realities come out from the human imagination and they are shared with different goals.



# 2.1

# WHAT IS REAL?

[Baudrillard \(1994\)](#) explains that real is what is true, is a fact, is the opposite of what is false or imaginary, what is real can be reproduced an infinite number of times, it is operational, it does not require to be compared next to an adverse. It is important to acknowledge what is real in order to enhance the reality, what is real is what can not be denied because it is somehow tangible, it is in there and it can be perceived with the human senses, it is completely evident.

The other "realities" may be based on the real reality, on a completely fictional reality, or in a mix of both of them ([Fuchs, 2017](#)), but even when we improve or change the reality in order to escape from it, what is real is real for everybody, is not a believe, it is an undeniable fact. The reality is different from a simulation, a simulation is faking, the reality is true ([Baudrillard 1994](#)).

**ANOTHER REALITY DEFINITION IS:**

**'THE STATE OF THINGS AS THEY ARE, RATHER THAN AS THEY ARE IMAGINED TO BE.  
- HE ESCAPED FROM REALITY BY GOING TO THE CINEMA EVERY AFTERNOON.'**  
**CAMBRIDGE DICTIONARIES.**

Due that people do several activities to change their reality, by changing the reality of the space for working, this project is looking forward creating a concept that shows how comfortable may be for people to adapt the space according to their needs and preferences.

As explained for [Miller, Casey & Konchar \(2014\)](#) due that changing the space where we work allow us to behave in a more productive way, the project aim show a possible evolution of the way we are used to working, a more complete and efficient style for creating and a better approach to our everyday "reality".

As well a related concept to reality is the realism, the definition of fine arts by [Oxford dictionary](#) is 'An artistic or literary movement or style characterised by the representation of people or things as they actually are.'



**IMAGE #1**

According to this definition, it can be inferred that when the reality is represented, it should look as it does in reality, even so, it still remains as a reproduction and not as a tangible reality. For instance René Magritte (1929) seems to express in the painting painting "The Treachery of Images (This is Not a Pipe)" that is impossible to connect images, text and objects; even when the artwork looks realistic, the pipe is not a real pipe, is only a representation of a tangible one ([Los Angeles County Museum of Art](#)).

In other productions like on the cinema, is questioned what is the reality, for instance, the movie "Enter the Matrix" has a focus on this query, it contains a theory based on some philosophical literature like "simulacra and simulacrum".

According to this theory, it could be interpreted that if our senses fully perceive something as real, then we are convinced that it is real. This when applied in a space for working, creates the possibility of projecting a reality that may be perceived as real for the user that is immersed in this space. This part of the script from the movie may explain what is conceived as "real":

**“WHAT IS REAL? HOW DO YOU DEFINE REAL? IF YOU’RE TALKING ABOUT YOUR SENSES, WHAT YOU FEEL, TASTE, SMELL, OR SEE, THEN ALL YOU’RE TALKING ABOUT ARE ELECTRICAL SIGNALS INTERPRETED BY YOUR BRAIN.”  
(THE WACHOWSKI BROTHERS, 1999)**

# 2.2

## **IS IT POSSIBLE TO CREATE NEW REALITIES?**

The answer to this question is simple, yes we can. Due that reality could be understood as what is true, what is a fact [Baudrillard \(1994\)](#), but as well as what we face in the everyday life or daily basis routine, it is considered to escape from the reality when we change these ordinary life events ([Oxford dictionaries](#)) and because we escape from it, everything that changes these ordinary things of the day may be considered a new reality.

One of the reasons for escaping from the reality is that everyone has personal preferences, one of them is at the moment of choosing an environment, as an example of a daily basis environment regarding to this project is the place for working and according to [Miller, Casey & Konchar \(2014\)](#) there is not a place that fits to everyone, reason why several companies are looking for learning how to keep their workers in a comfortable environment.

We can change the reality by changing our environments, for illustrate this, the fine arts and the architecture achieve that in several ways, they represent the reality or even create them in different ways, some of the art movements named on [Google Arts and Culture](#) are surrealism, expressionism, dada, constructivism, cubism, de Stijl etc.

Further than the reality, we face every day and thanks to technology advances, today it is possible to create enhanced realities, like virtual reality (VR), augmented reality (AR) and Mixed Reality (MR). The VR creates a completely digital environment, that allows the user to get immersed into a 3d digital world. The AR enhance the tangible reality with digital content and the MR uses a combination of electronic devices that enhance the real world without the need of a see-through device like a headset.

## 2.3 WHAT IS A

# SIMULATION?

According to [Baudrillard \(1994\)](#), a simulation is an imitation of how something works in the real world generating an artificial story, it is different from pretending, it consist into faking something that is not there or it does not have, it is an absence. A simulation of the reality tries to fake and disguise as one, but it continues being unreal, the tangible reality is the one that may be considered as reality, a simulation can not replace the physical reality, it can only create an artificial replica of it.

According to the [Oxford dictionary](#), a simulation is 'the production of a computer model of something, especially for the purpose of study. The method was tested by computer simulation'. By using several techniques in computer graphics and animation, It is possible to create procedural models, which are simulated structures with an elevated level of complexity. Even when they are created by humans, it is not possible to have full control or full understanding

of how it works, it must be conceived and adapted to the requirements but it is still directed by the user. This complex method is related to the evolution theory of Darwin, due that using genetic algorithms for creating very complex structures is easier than designing them. These genetic algorithms create random variations, which aesthetic result is evaluated by a human, due that is technically too difficult for a simulation to do it automatically (Baudrillard, 1994).

Is it possible as well to generate textures that evolve, by calculating an equation that uses as information the color of every pixel on a 2d image (with coordinates  $x,y$ ), later on, is read by the computer as gradients, gaussian filters, fractal patterns and others. When a new variable is added, a Z vector, it is possible to have further results, they can be projected on a three-dimensional space, they evolve with a volume that can be easier pre-visualised in a sphere or a cube (Sims, 1991).



As explained for Wong & Wang (2014) a simulation can be made on real time, it consists of the process of creating a sequence of frames with a visual indication of a depth projection from objects. This object is located in a three-dimensional space, they are expressed by geometric called polygons, they can be triangles or squares that use 3d coordinates. Each of this points located in a three-dimensional space is called vertice. In order to modify all of this objects, they must have the same coordinate system. For having a correct render of this objects they may be related to attributes like normals (direction of the polygon face), texture coordinates, and several other ones.

For transforming this 3d objects, they need a coordinate system, that includes a camera, geometry with coordinates x,y and z-axis (the z is the depth information), virtual lighting, and culling, which refers

to the part of the polygons not shown on the scene. All of these parameters on a coordinate system are displayed in a 2d image on a physical screen, all of the vertices in the scene, are transformed into pixels using the frame buffer, where all of the elements on the scene converge and are able to display depth, textures and colors. As well is it possible to render shaders in real time, they can use pixels or vertex, and have attributes like shadows, bump, translucency and others (Wong & Wang, 2014)

According to Ecclesiastes, as cited by Baudrillard (1994) "The simulacrum is never what hides the truth - it is truth that hides the fact that there is none. The simulacrum is true."

This statement may invite us to think about if a simulation is true or it is not and to analyze if the abstraction of the reality is a close enough simulation to what is considered a real reality.

The image features a solid red background with several thin, dark blue lines that meander across the frame, creating an abstract, scribbled effect. The text is centered and reads:

**3. VIRTUAL  
AUGMENT  
AND MIXED  
REALITY**

# AL, TED ED



Thanks to the technological advances, the virtual, augmented and mixed reality bring to us the possibilities to have innovative applications to several disciplines like arts, medicine, military, entertainment and many others. Is it possible that you are already using some of these realities, for instance, several mobile apps like Snapchat are already using augmented reality ([The Verge](#)) and some others with the help of a headset provides a virtual reality experience, like on the case of the Facebook, which is as well developing augmented reality applications ([Facebook for developers](#)); or even if you have used a video beam, you already had a mixed reality experience.

All of those realities have a huge potential and they may be the present development for the future standard; and as the name of them explain it, they are realities, created to change our daily basis "reality".

## **3.1 VIRTUAL REALITY**

Virtual reality (VR) is a technology that allows the user to have the perception of being in a virtual world, it replace the normal vision sight of a person, by using a headset that shows 2 different images to each eye, tricking the brain in such a way that creates an experience of being in a three-dimensional space.

It requires several devices in order to create a proper immersion, for instance, a vision headset, control inputs, cameras that calculate the position of the user on the space, hand and body trackers and many others depending on the function of each application on a system.

As a personal experience, before testing the PlayStation virtual reality system, I had the idea that it was blurred and pixelated, this idea was generated because I tested the Samsung VR with a Samsung Galaxy S7 before and it did not look very sharp. I had the experience of testing the VR video game "Eagle Flight" using the "Playstation VR" Headset on a "Playstation 4 Pro", with a "Playstation Camera" which is used as a body tracking device with a 3d depth sensing.

Additionally to this, as a security measure in the place where I test it (Saturn store), are some bars around you covered with a padded and soft material. At first sight, the images on the Playstation menu did look a bit blurry and separated on each eye, a couple of minutes later when the game menu appears it looks very sharp and covered the whole sight of vision.

I started the experience with a vertigo sensation, due that I saw I was at a very high altitude on the digital world, which was a representation of Paris. Once the game begins, it has a first person camera that makes you feel you are the eagle, you control the flight by moving your head.

When you see down, the velocity of the flight seems very fast. I can say this experience felt so real, that I had side effects like sweating, and losing my body equilibrium on several occasions, even when I knew it was totally safe. In other words, I had the sensation of having entered into that digital world for some minutes and completely forgetting where I was standing.





IMAGE #2





IMAGE #3



The Virtual reality by definition is: 'The computer-generated simulation of a three-dimensional image or environment that can be interacted with in a seemingly real or physical way by a person using special electronic equipment, such as a helmet with a screen inside or gloves fitted with sensors.' (Oxford dictionary).

Virtual reality is a medium where people can feel immersion in experiences, (Immersion is a 'deep mental involvement in something' Oxford dictionary) it requires technological components such a display and a motion tracking hardware, as well it can be found in different price ranges and experience level, for instance, today some possibilities are the Oculus Rift, the Samsung Gear VR and the Google Cardboard.

As well is it possible to create content using software like Unity3d and Unreal Engine, which are becoming native engines for developing VR content for video games in mobile and desktop platforms. As well VR is now on the web, where is possible to have browser-based VR experiences (Parisi ,2015).

As stated by Fuchs (2017) 'The purpose of virtual reality is to make possible a sensorimotor and cognitive activity for a person (or persons) in a digitally created artificial world, which can be imaginary, symbolic or a simulation of certain aspects of the real world.' Virtual reality has as a goal to make the senses of a person believe that they are interacting with an environment even if this one is completely artificial.

Designers of virtual reality environments can not add every aspect of the reality into a VR program, so they have to determine which aspects of the "real"

reality are important in order to add them to the application they are about to work on. So the objective is more focused on what can they modify from the “real” reality that works better for the direction they are aiming, for instance, they can create an environment without physical vulnerability for the user.

Furthermore, they can use symbols for a better understanding of the world they are simulating. In contrast to this real world based applications, designers can also work in an unreal world, and it is not a “real” world based simulation, they can be science-fiction or fantasy worlds.

As a result of the absence of a perceptible lag on virtual reality, it is possible to achieve a real-time interaction, but as it does not allow us to act like in a real world, it is called a “pseudo-natural immersion”, where are captured some actions of the user like voice or movements, it needs the interaction through a software or interface, and then this commands are sent to a calculator, which understand those command to alter the environment and having reactions to the images, sound etc, and it is based on the known reactions of the known environment by humans (Fuchs, 2017).

In a space for working application, virtual reality would allow the user to learn how to use certain tools without having any real physical risk (for instance how to use a sharp tool for sculpting without having the risk of hurting a hand), in addition to having the possibility to learn about how to use certain tools that are too difficult to reach due to the price, size, permissions or any other variable in the real world that does not allow a user to handle it in an easy way.

As well it would be possible to help the user to be more acquainted with the environment where this tool is about to be used in the real life, providing a closer perception of how does it look like and feel. Additionally, it would possible to see in a VR simulation, how an object react when there is interaction with a certain tool, also how the object gets modified according to the manipulation of the virtual tool made by the user.

Parisi (2015), explains that the main idea of the virtual reality is to convince the users that they are in another place, this is a trick done in the visual cortex of the brain that recognises the motion. As well he mentions that some of the technologies to achieve this are:

Stereoscopic displays: This are as well called head mounted displays, they separate what each eye is able to see, tricking our brain with its reference to the perceived position of the objects.

The motion pictures should have at least 60 fps and if possible 120 fps, this in order to keep the latency and eliminate the probability of Lag. Some examples of a commercial head-mounted display on the moment are the Oculus Rift and the PlayStation VR.



**IMAGE #4**

Another hardware element for VR applications is the motion tracking hardware: It is used to having an inertial measurement unit (IMU), it is used to give the user a feedback when he moves the head, so on the software recognize these movements and update the position into the virtual reality platform, providing an even more immersive experience.

An additional technology used for VR are the Input devices: An account of it is uncomfortable to manipulate a mouse or a keyboard without being able to see where are they physically located, they are other inputs that allow a better immersion, for instance, game controller's, hand tracking motion, input sensors and wireless hand and body trackers. At this moment there is not a standard input as VR input, it depends more into the application that the user is about to use and it is in process of research.

## 3.2

# AUGMENTED REALITY

According to Fuhr (2011), the augmented reality consist into melting elements from the view of the real world with images that provide virtual information generated by a computer, usually in real time in order to interact with the surrounding environment. AR refers to augmented reality and attempts to be attached to the real world, and AV refers to augmented virtuality and it is closer to a completely virtual environment.

There are several applications by using augmented reality, for example, rehabilitation, safety, GPS, medicine, education, psychology, product development and many others. In contrast with virtual reality, augmented reality does not require any specific device like a headset for using it, it is not limited to the vision because it is possible to apply AR to every human sense like smelling, touching, hearing etc.

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In addition augmented reality requires eliminating physical objects of the environment, besides complementing with virtual objects.

As well, [Furht \(2011\)](#) explains that there are several technologies that are used for augmented reality, one of them consists of adding 3d virtual objects to a real environment, using the same point of view tracked with cameras. The main idea is to recognise some point of interest viewed by the camera and then tracking those points, then it is possible to add 2d images into the 3d world.

Those tracking systems depends on the environment, it can be indoor or outdoor, and the application needs to make a calculation before, to know where are located the three-dimensional physical objects. When there is not information about the entire environment, the application can calculate the relative position of the 3d models, this process is called Simultaneous Localisation And Mapping (SLAM). Nowadays even when visual tracking has the ability to interpret several things, some of them are really difficult to identify and difference by using only this technique, further on augmented reality relies on accelerometers and GPS.

For creating an augmented reality space for working, it becomes really useful to have further relevant information in an enhanced virtual form that helps the task that somebody is about to make, for instance, if a person needs to assemble a prefabricated physical object, with a lot of components, that person needs to read a manual, look for each component, try to match it and see if it

works, unassemble it and then if the component do not belong to certain place, it is necessary to test other components and maybe at the end re-start the whole process.

If you place the components of a prefabricated object in the space where you are about to assemble it and you have the help of an augmented reality system, then before you start working, you should be able to know where is each piece, where it belongs, the order to assemble it and how to do properly the process.

One of the several AR devices are displays, for instance, head mounted displays that can be video see-through or optical see-through, and use monocular or binocular display optic. The video see-through consist on a display with 2 cameras on the front, one of them provides the real world part, and the other one adds the virtual objects that create the augmented reality. The calculation process needs to be made before enhancing the real world with virtual objects, even so, the outside environment should not have any delay (Furht, 2011).

As explained for Johnson and Sun (2013), nowadays exploring augmented reality without needing a head mounted display is achievable, due that some technologies as Microsoft Kinect are able to make a real time tracking of the human body, is it accessible to project rendered images over real objects, in such of advances that image projection over the human body on real time is possible. This technology has been tested as educational systems, projecting the inside parts of the body projected over a real body as an object in real time.



Having the potential for an augmented reality system capable of projecting rendered information over the human body and over other physical objects is a great chance for developing conceptual designs about new ways of interacting with our environment in order to create, taking advantage of the new technologies, and creating new realities that enhance the possibilities with new options that we do not use at the moment.

There are some other input devices for Augmented reality system described by [Furht \(2011\)](#), like gloves, wristbands and a smartphone itself. They may adapt to the usability of the application by the user, so if the user needs to be hands free, it may work that way, as well it should not require unnatural gestures, as well the interface should be really intuitive. Additionally, in order to process the images from the camera, augmented reality needs a high capacity CPU and an appreciable amount of RAM, which have been improved on technologies like smartphones and tablets.

It is possible to have Augmented Reality applications with interfaces that interact with tangible objects and tools, such as reorganise the objects on a room. Other interfaces for augmented reality are collaborative, they are used in cases with several environments, users and situations, they can incorporate teleconferences in applications like medicine.

In some cases it is not known the situation that the virtual reality is going to be facing, because of this there are hybrid interfaces, which does not have a plan for every next environment and objects that they are about to calculate, so they get a feedback by using physical interaction devices. The future of augmented re-

ality will be for sure preferred by using a projection of information on surfaces and objects, and they will be used with a natural gesture or with interaction from the user with the object itself. For instance, the sixth sense project on MIT allows the user to interact the user with walls and objects as described (Furht, 2011).

There are several augmented reality platforms, depending on where are about to be used, for instance, fixed indoors, fixed outdoors, mobile indoors, mobile outdoors and mobile hybrids.

Because of the massivity of the smartphones and its components like accelerometers, GPS and magnetometers, nowadays mobile augmented reality is very common. Even with the advantages of the smartphones, they have some limitations on the capacity, so the information is sent to a remote server, where the AR is processed, this is as well imitated for the bandwidth of the phones.

In order to be socially accepted, augmented reality devices should count with some characteristics, like being fashionable and natural for the user to interact with, for instance, phones are acceptable because the user is able to decide how to interact with it, when to do it and receive notifications that can be read privately.

As well Augmented Reality needs to has a natural way to use it, if it does not, the user will have an awkward feeling when doing it in front of other people and would not use it, one good example of natural interaction are the wireless wristbands, that use an accelerometer and the user is able to interact with touch gestures.

In addition, the users would not use an accessory that looks weird, going into the street with a headset is not accepted at the moment, so researchers at MIT are working on making the AR devices not so visible or fashionable acceptable (Furth, 2011).

In some museums people can interact with 3d objects, like reconstructions and information, they can do it with natural gestures like using their voice and gestures. These applications can be projected with stereoscopic or holographic displays, a task that can be only made by programmers, but the most ideal way, is to be made by designers reason why it is been implemented interfaces where designers are able to link actions without programming knowledge (Sanna et al; 2016).

# 3.3 MIXED REALITY

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A third way to simulate a reality is the Mixed Reality (MR), it combines the benefits of the digital content applied into the real world by using tangible technology. One of the advantages of mixed reality systems is that the user has the possibility of interacting with physical objects instead of using a digital system or a computer as the main source of interaction, it has the ability to enhance the reality without using any device that may feel unnatural or uncomfortable to use to some users.

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According to [Tamura, Yamamoto, & Katayama \(2001\)](#) Mixed reality (MR) is a virtual reality that is more extended than the augmented reality, it enhances the real world by using electronic fabrications. The immersiveness from MR is created by the use of digital and physical objects, where the users interact with physical objects and not directly with a computer, as well receiving a direct feedback allows the user to know which actions are more effective at the moment of interaction ([Nakevska, 2017](#)).

As shown in the research made by [Lange et al \(2016\)](#) mixed reality allows the user to create a digital painting projection over a 3d physical object, making possible to change the shader (material), the texture, and the colors of a real object without really altering the object itself.

This system uses a desktop workstation, 2 HD projectors, an object tracking device, a DSLR camera (Canon 5D Mark III) for calibrating the projectors and 2 controller Razer Hydra for using as painting device. Using the Razer Hydra the user can select the desired material, then it is possible to select the color and brush size for painting, this digital painting will have a behaviour according to the chosen material. The user can change the lighting of the object and receive a real-time feedback, even when there are not physical lights posi-

tioned around the object, the projection simulates the lighting position and by using the VR inputs allows the user to pick up the number of lights to illuminate and its color. A video explaining how it works can be found on this link <https://vimeo.com/161289655>.

This technique is a very good sample of how could be enhanced a space for creating, due that it would be possible to simulate changes on physical objects without altering the object itself. It would save testing time, materials etc. and would create a closer approach to what the user wants to create. As well it would be possible to adequate the space according to the task that is about to be made, the preferences (lighting, color, texture, environment) and mood of the user. This technique can be a conclusion of a complete mixed reality environment that has the potential to help to develop the creativity and the technical process of several disciplines.

As researched by [Gabellone et al \(2016\)](#) it is a possibility to enhance architectural buildings adding three dimensional models in order to understand the structure. In this case, the project was applied to a Gothic church, creating a virtual enhancement in order to help the tourist to understand better the building as well for being used in the restoration work of the place. The project made evident that the realism of the three di-

mensional renders was very limited to the computing capacity of the mobile devices where it was about to be processed, it is not really possible to render very complex 3d models with very high quality textures on a tablet.

The solution for that was to create an augmented reality system, by rendering high-resolution VR panoramas simulating the light of the building and superimposing the images over the building. It was even possible to make a digital restoration of paintings placed on the place. This mixed reality system has an advantage that with very few pictures is possible to cover the required space about to be enhanced. In addition using this mixed reality composed of an augmented reality system enhanced with a virtual environment has a really good learning process.

Even when the advances on mobile devices allow us to create new realities, this kind of developments provides working solutions that do not require extreme processing specifications to achieve some complex tasks. When applied to a future space for working space, the specifications of mobile devices will be improved, then creating new realities that look very close to our own would not be a science fictional fact anymore.

**THIS TECHNIQUE EXPLAINED BY GABELLONE ET ALL (2016), ADDS PRE-RENDERED IMAGES TO REAL LIFE, SHOWING THAT IT IS POSSIBLE TO ENHANCE THE REALITY WITH HIGH QUALITY TEXTURES AND MODELS, WHICH ALREADY ARE VERY CLOSE TO A TANGIBLE REALITY.**



**4. DESIGN  
OF A SPACE  
FOR CRE-  
ATIVITY**

# IN SPACE

Most of our works require of being creative in order to resolve the daily basis tasks and each of us needs different ways to get motivated in order to being creative. There is not one way of working or a space that fits the needs and preferences from all of us, for that reason there is the need of creating a space that mutates and adapts to our predilect way of resolving those tasks that require creativity.

Because of this reason, this research wants to experiment the creation of concepts in order to find out a way of making an enhanced space that motivates the people to be more creative and to improve their usual workflow.

# 4.1

## WHAT IS A SPACE FOR WORKING?

People may have different ambient preferences according to their gender, lifestyle, culture, clothing etc. However, during the history, buildings have been made looking for a standard size that fits most of the needs. It is not common to have a place to work that allows the user to adjust the lighting, the noise, the temperature or the air (Heerwagen, 1998). For creating a workspace it is important that the position of the worker does not require physical effort for the legs or arms and always in healthy positions. The choice of staying seated or standing should be a choice made by the worker. An ideal environment for working, should reduce the stress and help the people on the environment to make their task without uncomfortably (Corlett, 1995).

For instance, at Google headquarters, they listen first to their employees in order to support their needs and design their space for working looking for inspiring, motivate and keep their employees healthy. They think there is not a "one size fit all solution" and the creating an employee experience is a priority. Spaces have to be evolving, by doing the same things, there will not be different results. As well space can work as a tool for producing innovation, it has the power to

change the behaviour of the people. The space for working has been severely changing, many people have to work outside the office and look for new places to feel comfortable, for instance changing the office temporally and going to work in a hotel room with work-friendly spaces, a table in Starbucks or an empty office in a building (there is an app for renting temporal offices called "liquid space"). To create a proper space for working, it is necessary to study how is the person that is about to work, if this worker is introvert or extrovert and listening to the specific needs for working more comfortable (Miller, Casey, Konchar; 2014).

Due that the environment of a space of work on an inside place mostly looks for being functional for everybody, this project could provide the possibility of creating the perception of being on a new place, by changing the reality of the space for creating, for instance changing the background of the walls for something that makes the user comfortable, altering the lighting according to the required task, adapting colors of the place according to the user preferences and needs and even adapting the space for working into a tool that provides an enhanced experience to the work that the user is about to do.

# 4.2 WHAT IS TO BE CRE- ATIVE?

Kelley and Kelley (2013) explain that usually, creativity tends to be associated with arts, but creating something in the world by the use of our imagination, is being creative, everybody has the ability to be creative and it does not require to be in a certain position in order to be highly creative. According to Howells (2015) creativity is a necessary effort for human beings showing their direction to create a better world.

Creativity as well involves utopias like the human tendency to invest on artefacts with a good aesthetic approach that seems creative instead of checking the practical value that they have, it is known that is more important to make something "special" instead of only making it "better". This behaviour has been seen in native cultures, which worked on creating decorative forms and textures on their fabrics, some of them like the Zapotec in Mexico, used to have special crops in order to dye their fabrics with special color patterns. Some of this patterns are still an inspiration for contemporary clothes designers.

Having acknowledged that creativity and creative objects are a high interest for humans, is a creative challenge to make a space for working with a focus on being creative. It is a challenge to think about how to provide a tool to people that allow them not only to work better but to

motivate into a creative thinking. As well it is a creative task to resolve, how to make a reality that looks and feel natural to people and provide them comfort at the moment of working with physical or virtual tools and assemble them as new and innovative creations.

Onarheim (2015) says that creativity is related to every aspect of success in life. As well he explains that the being creative consist on having the ability to put together 2 or more things or concepts that are not common between each other and make something functional, practical and conceived as something new. In his talk, Onarheim explains that we lose our creativity as we get older, but there are several exercises that can help us to be more creative, for instance having a continuous practice of naming random objects with any relation to an object used in a specific situation. Another example is using the sleep for being creative, it consist into thinking or reading about a problem that is wanted to be resolved, then wake up after 6 or 7 hours and write what we dream about, it is highly probable that the dreams have a direct relationship with the problem and the way to resolve it. This happens because in the dreams there are no boundaries or rules for thinking. The last example talks about relating a random article from Wikipedia and somehow assemble it with a current problem looking forward a solution.

# 5. SIM- ULATE REALIT

# D Y

This chapter explains the experimentation process and technical work that was done in order to create a simulation of a space for working. As well is described how does the system works and what is required to make it functional.



# 5.1 PROCESS



IMAGE #5



One of the first ideas was to have a space where it is possible to change the lighting, in order to create a realistic space in a 3d software, it is created an EXR file, which is in essence, a panoramic that merge several photographs in different expositions into an image that is placed into a 3d software and is used as a map for illuminating a virtual environment with the use of the real illumination of the place where the photographs were taken.

The first sample was created in a meeting room during a sunny time of the day in the city of Frankfurt am Main, the idea was to use the lighting to recreated a real like environment on a virtual 3d platform. Those panoramics has as an additional purpose, to be used as textures for the three dimensional virtual elements in the 3d software, because of the illumination of the objects is the same one captured in the EXR file, it helps to produce a real life looking rendered scene.

Creating a space for working that is comfortable and provides helpful tools, depends a lot on personal preferences, due that this space was full with distracting objects, it was very complicated to find out a comfortable way of working according to personal preferences, it was found out that the best way to do it, was by using a completely empty space, walking over it in order to perceive the scale and imagine which tools were required for working, its size and its functionality.

Then as an experiment, it was created in a tangible space a physical representation of real objects required for creating, it contains a table that would hold objects for writing, sketching or any other application that requires a table, in addition of several screens that were supposed to provide useful information for working, some of them are placed on the floor and the walls with the idea of changing the environment according to the personal preferences of the user. It was made by using a tripod and an DSLR camera (Canon 60D), it was made by creating several pictures with somebody holding the simulated tools (using cardboard), and then the images were composed by layers in photoshop.

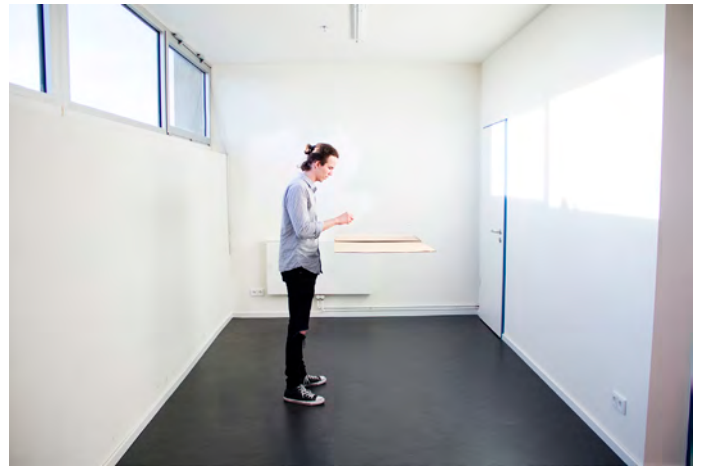
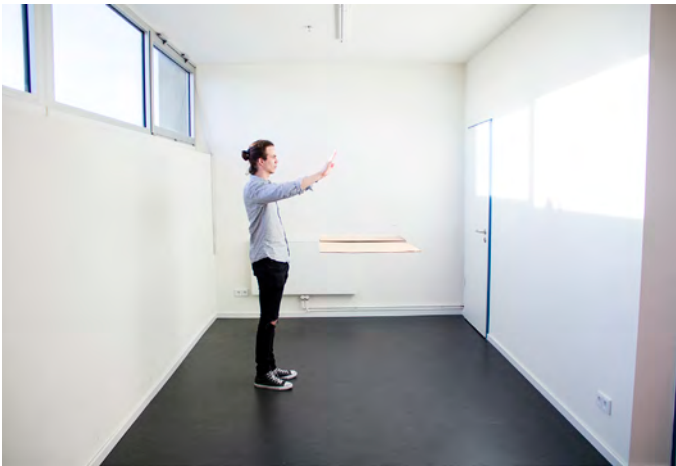
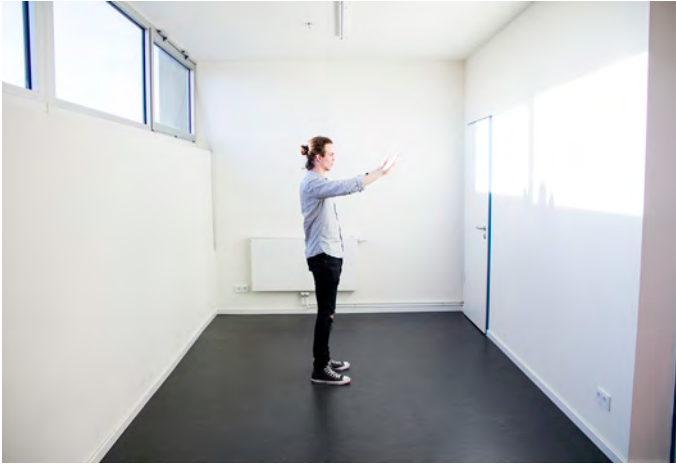
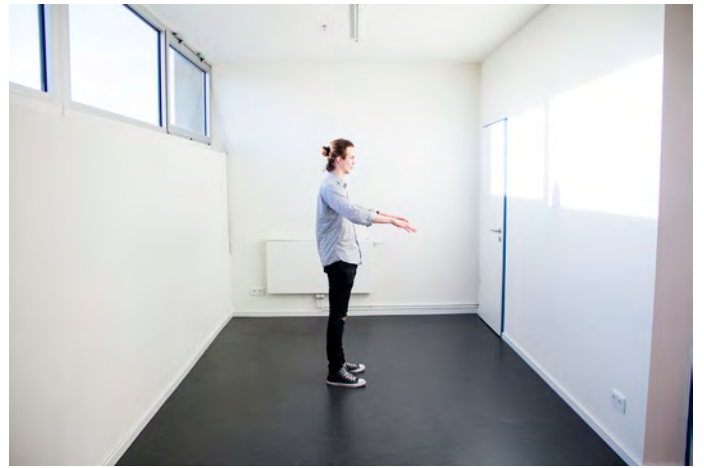
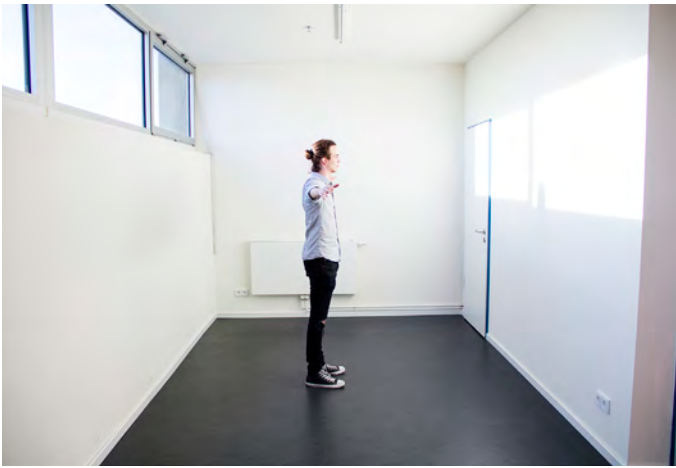
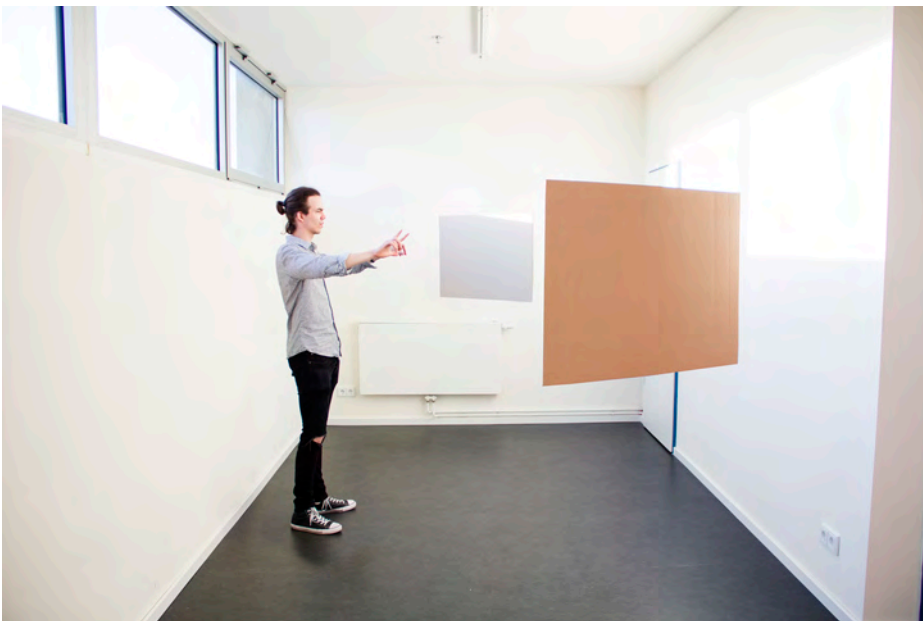
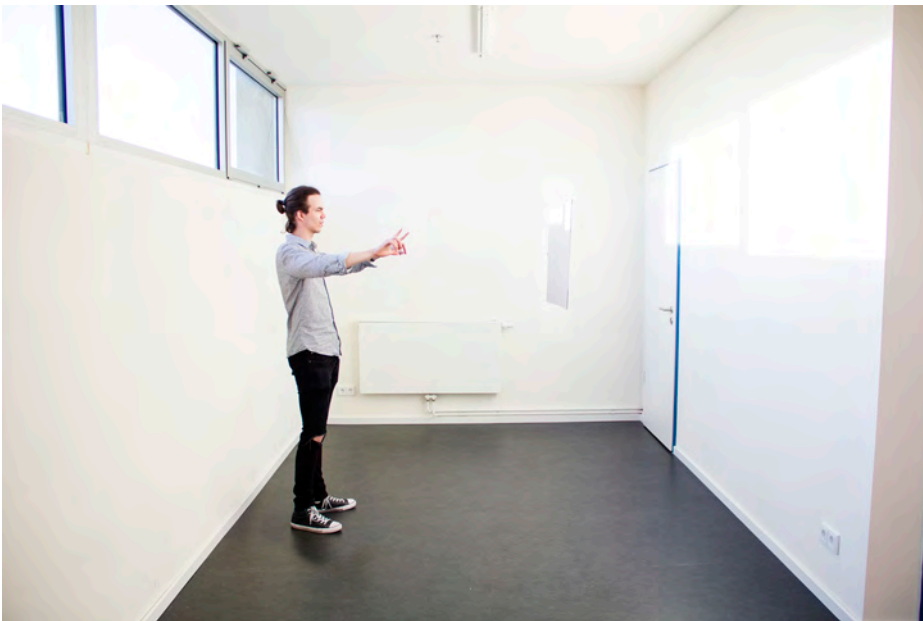
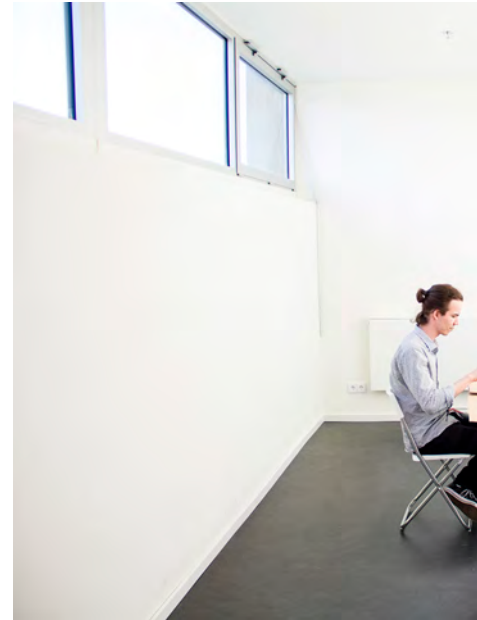
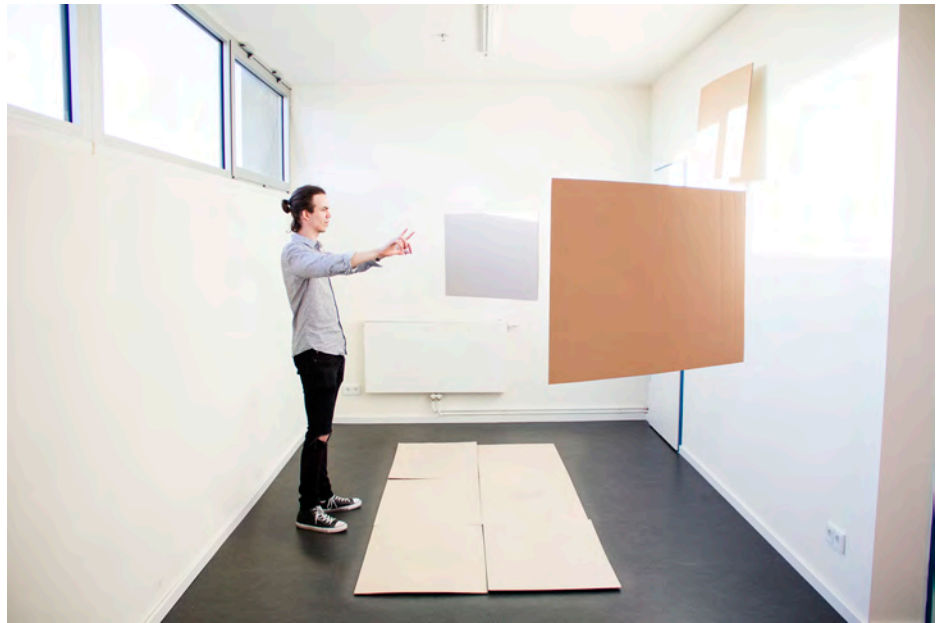
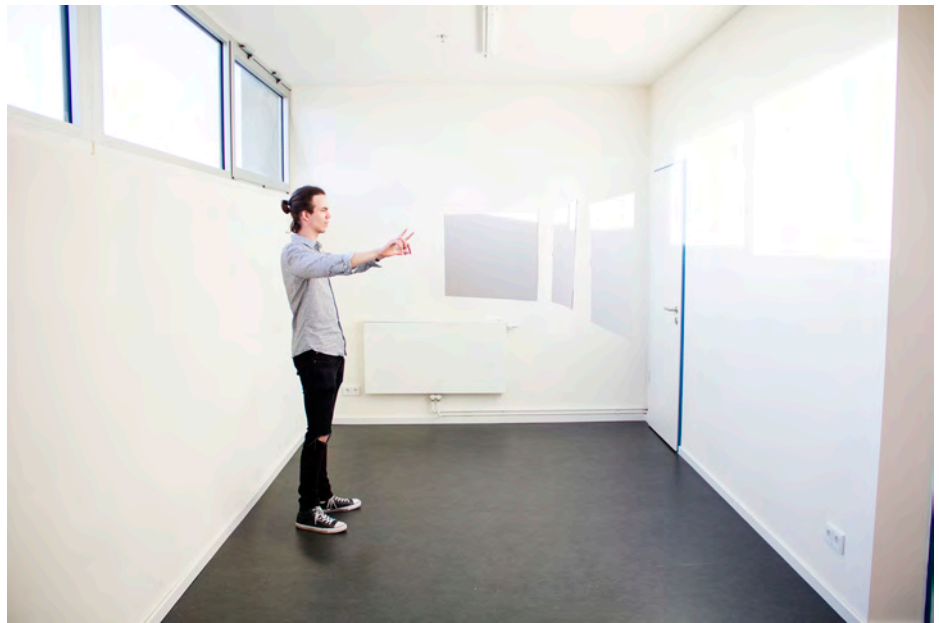
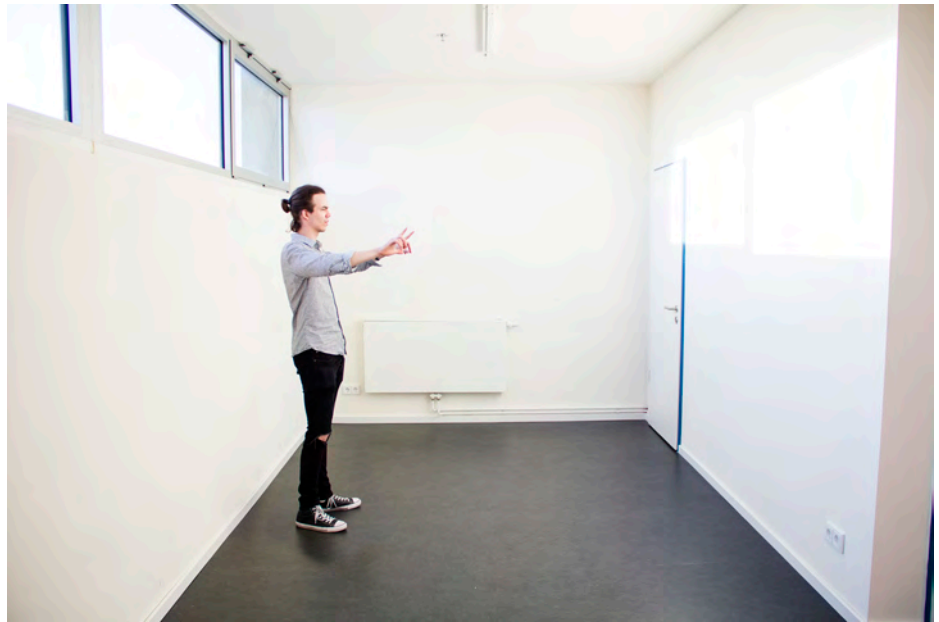


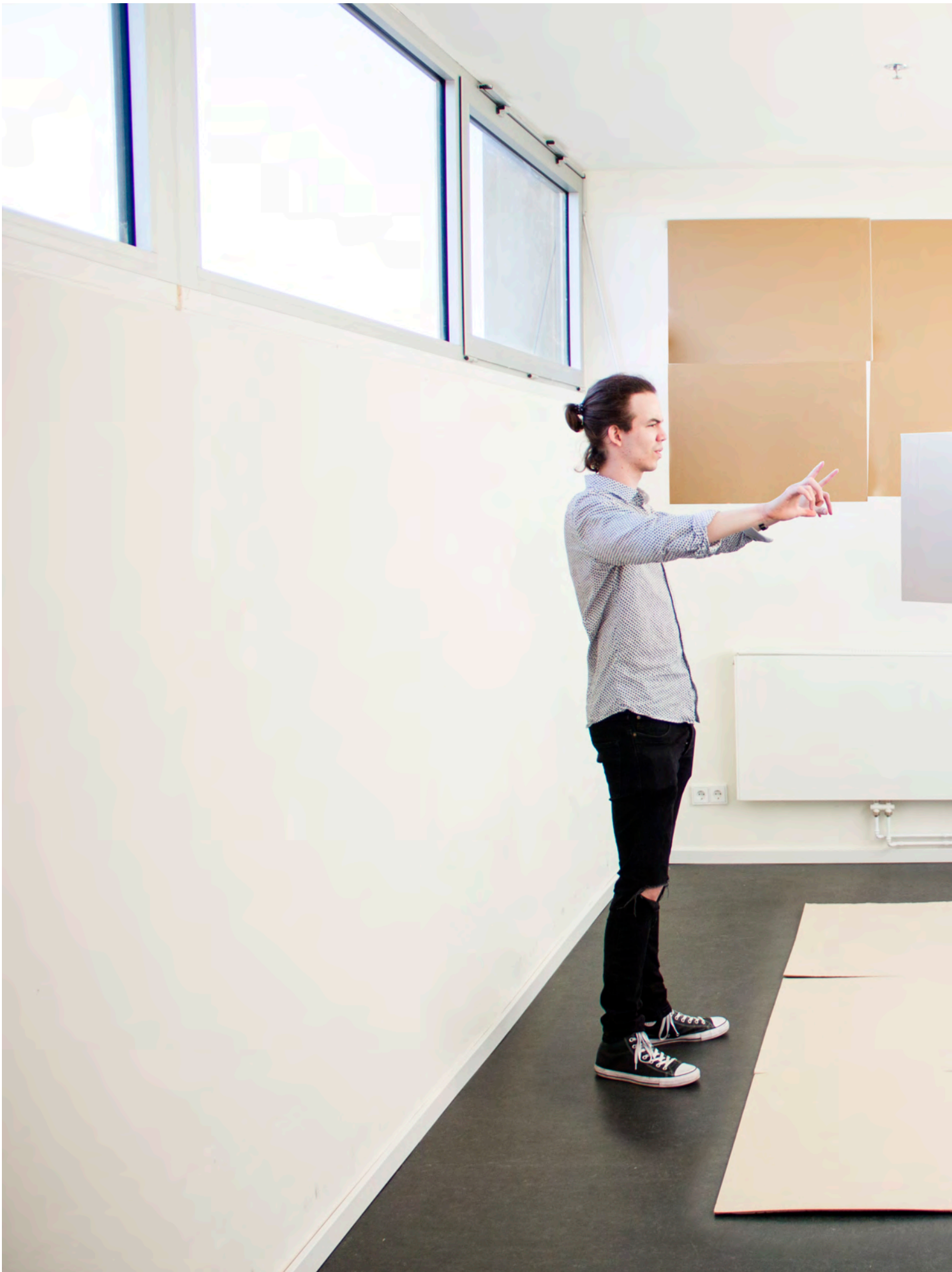
IMAGE #6







**IMAGE #7**







**IMAGE #8**



This empty room had a better approach for having a clear idea of how the space for working was desired, then there were taken several photographs with the purpose of creating an EXR file for illuminating the room and as reference for creating the 3d models, additionally to this captures, some others are taken in order to be used as texture projection. The room was measured, for using the same length in the 3d model of the place and making easier to apply the textures by projecting the taken photograph over the 3d model. Part of the process involved to add red points in some points of the walls to help the software understand wich points of the pictures were in the same positions and being able to connect them to create a panoramic.



**IMAGE #9**

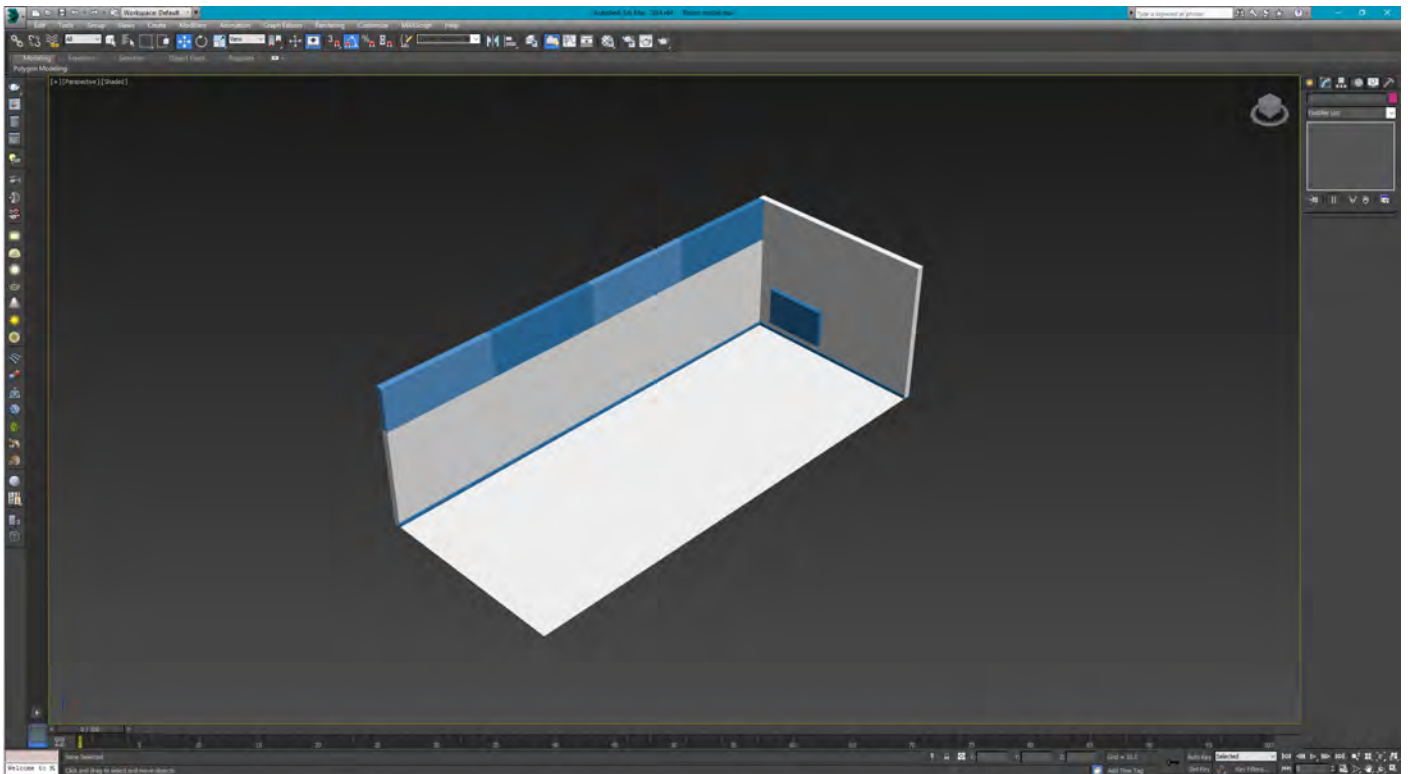
The following panoramic is the EXR image that contains luminous information required for simulating a real space in the 3d software (Autodesk 3ds Max) and the rendering plugin (Vray by Chaos Group). Some parts of the panoramic are distorted at the moment of assembling all of the photographs with different exposures, as well some points have very dark shadows, neither of the named issues affects the 3d outcome due that is used only for providing an accurate luminous file into the scene.



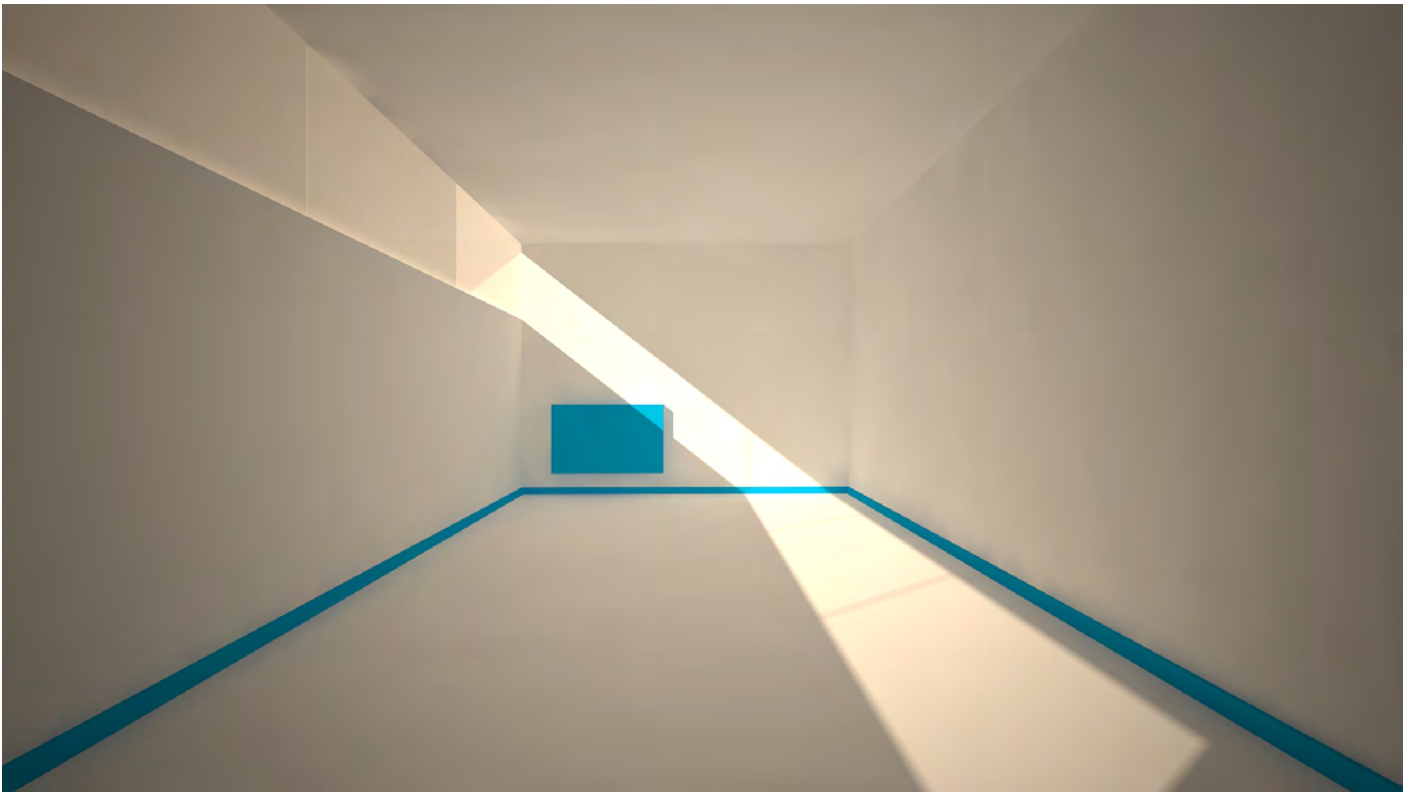


**IMAGE #10**

Next to this part of the process, a 3d model of the room was made in scale 1:1



**IMAGE #11**



**IMAGE #12**

The goal of the project includes to find out a right functionality tool that provides help in a space for creating, so there were made some sketches thinking about the enhanced reality information that would be added to the workflow of the user. The first sketch consist into having helpful information for the creation of the own space, for instance, assembling a table, instead of reading a manual and looking for each piece, the augmented reality would provide instructions about how to use the tools, where to find each piece, where to locate it and how to assemble it.



## 5.1.1 SURVEY

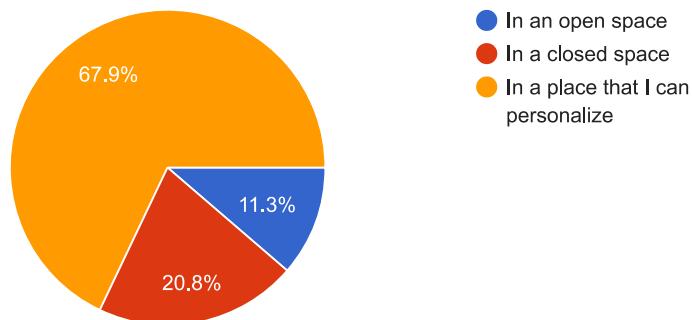
In addition, a survey was made in order to find out the preferences of some people about the place for working and some of the elements that they find out natural to use. This survey was created by using Google Forms and sharing the links in social networks and emails.

### Space for Working

53 responses

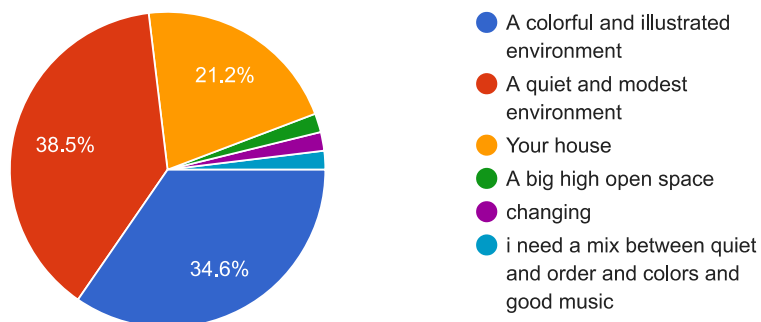
Where do you feel more comfortable working?

53 responses



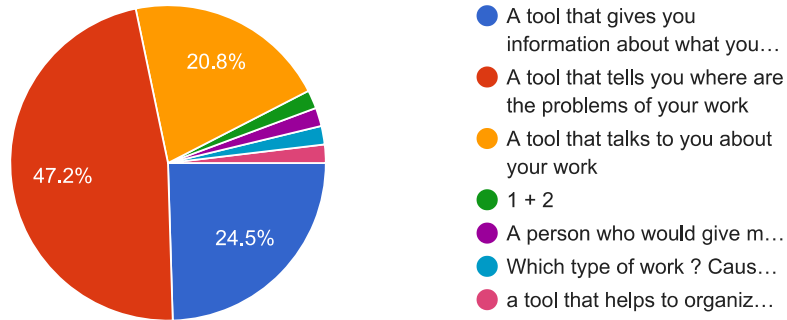
What is for you, the best environment for being creative?

52 responses



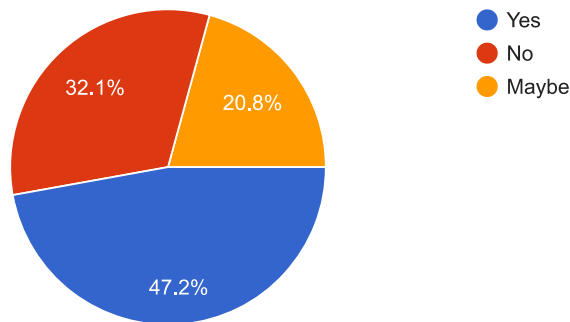
If you had the option to choose something that makes better your workflow it would be:

53 responses



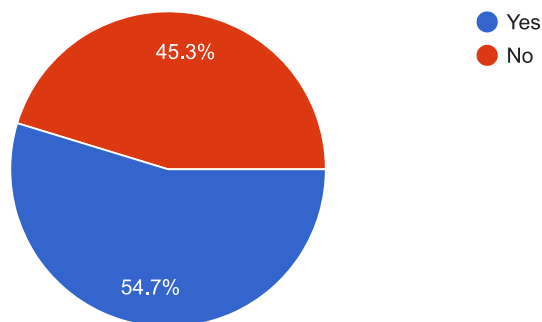
Would you feel comfortable using a headset, if it provides you helpful information to your work?

53 responses



Do you feel comfortable talking to machines, for example Siri, Google Assistant, Cortana etc?

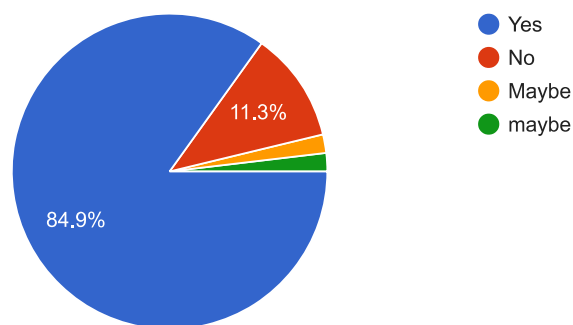
53 responses





## Would you feel comfortable using gestures for interacting with your computer? (as in the Iron Man and other movies)

53 responses



## Please provide a short description of your desired environment for working.

34 responses

Relaxing but productive

Cozy and with my music

A place with different environments that I can use depending on what I'm doing. Also a place where I can focus and have food and water within reach

A table big enough, good computer, spaces for writing/drawing/putting up post-its, nice kitchen, enough space to have other people working in the same room.

Product designer -

Something organic that I can interact analogically and digitally but still organic, not like Iron Man

It should be a nice and quiet room without anything that could distract me or stop me from doing my work . It would also be nice to be able to interact with every wall inside the room in order to be able to see all my work and all the processes in a easier way.

An office connected

Colorful, quiet and closed

I wish an environment open and I'll con personalize, it cause on me disorder, and its a cause for my creativity and good work

Consultorio amplio, fresco, bien iluminado, que huela bien, computador con una gran pantalla, silencioso

I would like to work with a big desk, in a clean place with good lights, when all the outils i need and with food

An open place, closed to nature, soft colors around the room

A place that I can personalized

if i need something it's in the reach. it's comfortable.

A medium office with a large desk and a comfortable chair, with a space for rest (armchair or something)

I would like to be able to have my own place... quiet and with all the tools a need to be reminded of special appointments or deadlines... not having to use different programs for each task... where I can be connected and allowed me to manage my time in such of way that I can spend some of it creating solutions or a new projects and leave me free time to do other personal activities like sports ... go shopping... spend quality time with my family and friends.

I would love to work in a space whetr I dont feel the pression from others like watching me working but at te same time I dont want to work in a cage, a space with a great green view and with available food

Con muchas herramientas tecnologicas, realidad aumentada, virtual y ante todo que pueda personalizarlo :3!!

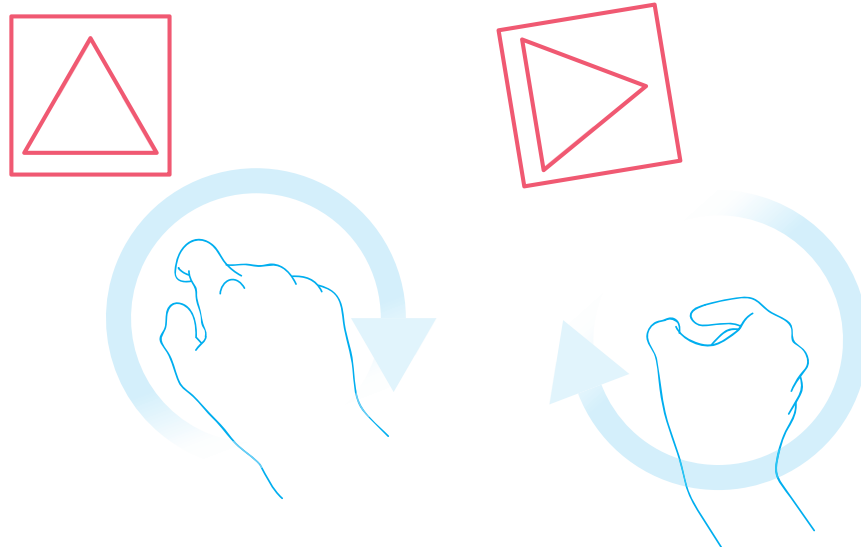
A big space with a comfortable chair, big desk, a couch and a nice decoration. Also, it should have big windows which allow a good lighting and to see the outside (pretty sight).

A simple but comfortable place, without distractions.

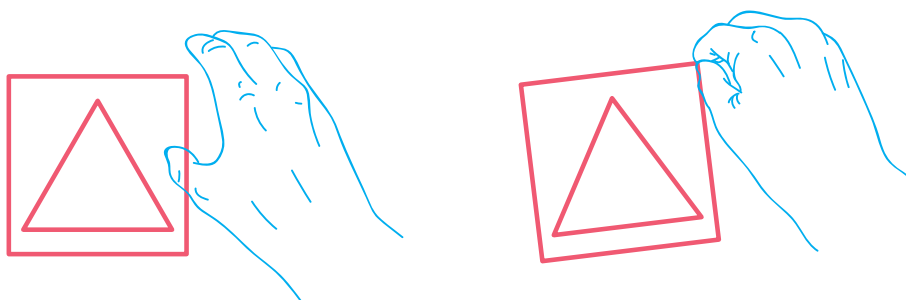
## 5.1.2 GESTURES

According to Premaratne (2014), There are certain signs that are interpreted by machines with an average of between 87% and 100% of recognition accuracy, as well he explains that they require a stereo cameras located at different points, then the software trace the movements and extract the finger positions in the x,y and z axis, with this systems is already possible to control virtual reality systems.

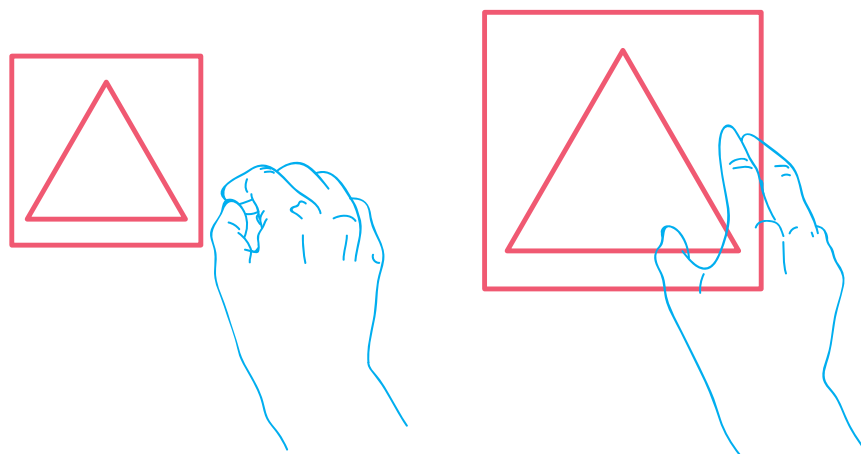
Microsoft has as well researched and developed systems to interact with a computer by using system gestures, one of those systems is called "Project Praga", the main idea behind this project is to use the interface command the hands by using those gestures that imitate the ones that we use in our daily life, the software is advanced enough to understand when we have the intention of making those gestures.



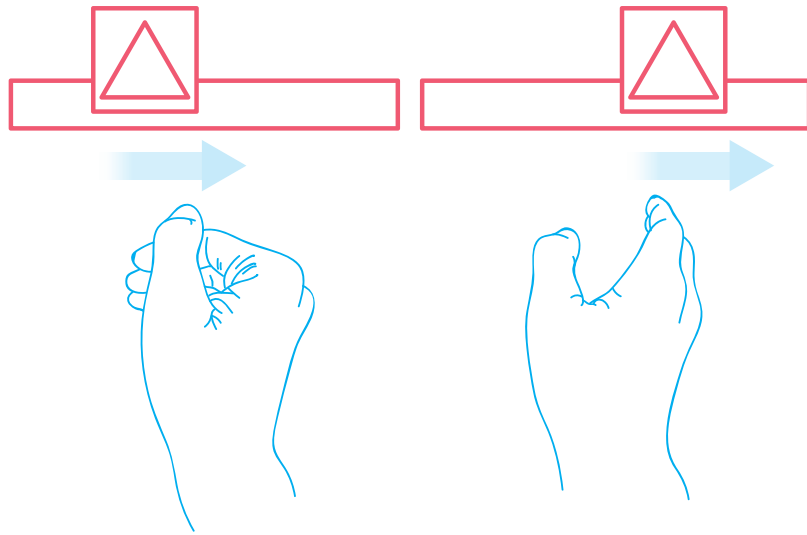
**IMAGE #13**



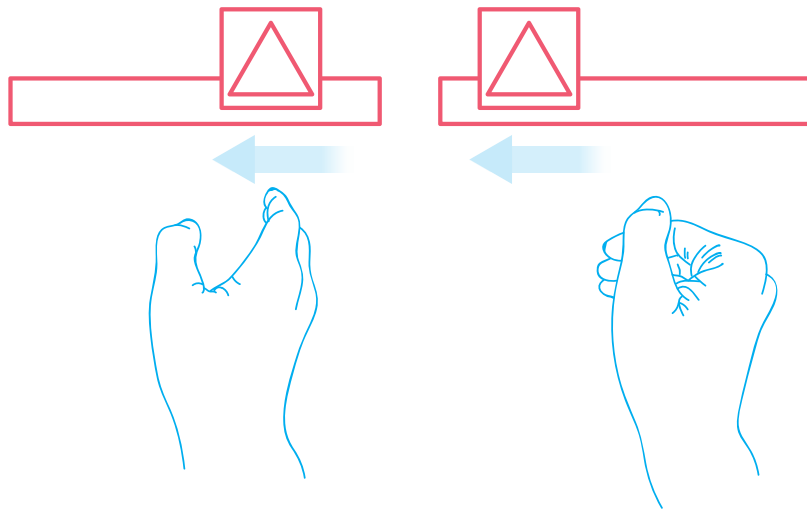
**IMAGE #14**



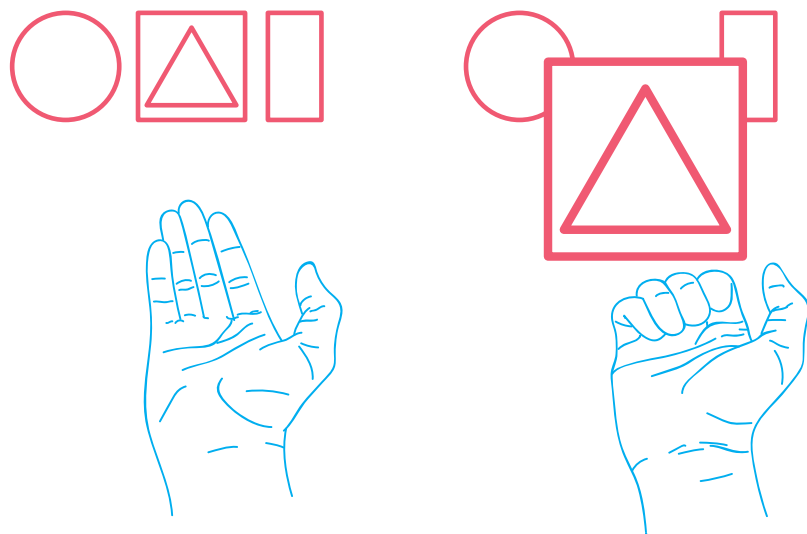
**IMAGE #15**



**IMAGE #16**



**IMAGE #17**



**IMAGE #18**

### **5.1.3 INTERFACE**

The interface of the mixed reality system is based on tools that help to develop a better pipeline during a day of work. Based on the results of the survey, most of the people said they want to personalize the space where they are working, knowing what is wrong with the work, having extra information about what they are doing and interacting with the interface by the use of gestures. There are still some gray areas, like using voice commands, where almost half of the people like it and almost the other half dislike it.

This system created to enhance the space for working, will provide a priority list, which show the most important task of the day and provide tools to solve them, for instance changing the planes due to bad weather, connect the user to a remote point, check specific things of the work that are mistaken and other things depending on the user preferences and needs.

For this specific case, it was used an architect as "persona" in order to show how would the interface looks like when this user works on it. The space for working is a room with a designed table. After talking with architects and topographers, there were founded

several problems that they have in a normal day of working, for instance, many times they can not go to the place where a building is about to be made, so a drone would be located in the construction zone, so the architect would be able to check details of the place without going in person.

Due that the system allows the projection of the physical objects, in this scenario is available the option of changing the materials and lighting of an architectural model (as well from any wall or surface in the space for working). As well there are some other tools like statistics bars that show the progress of the work made on the day according to the goals and the overall result from several past days, rulers on the table and personalized tools according to the requirements of the user.

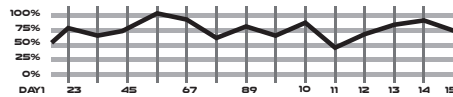
In addition, the interface contains an error output, that uses artificial intelligence in order to know several variables that contain inaccurate or missing information, wrong results on calculations and part of the work that the user may be doing wrong by mistake. This error report may save a lot of time in the workflow of the user.



**ROOM PERSONALIZATION  
PRESET: QUIET**

**TODAY GOAL  
PROGRESS: 65%**

**WORK PROGRESS STATISTICS**



**IMAGE #19**



**PRIORITY LIST**



**REORGANIZE THE MONDAY PROGRAM,  
IT WILL BE RAINING MOST PART OF THE DAY.**



**USE THE DRONE TO MEASURE THE ANGLES  
FOR THE FIRST PHASE OF CONSTRUCTION.**



**CALL THE TOPOGRAPHER  
IN ORDER TO VERIFY THE MISTAKEN DATA.**



**CHECK LIGHTING AND  
MATERIALS ON THE MODEL.**



**IMAGE #20**





## **ERROR OUTPUT**



**SATELLITE INFORMATION IS  
OUT OF PHASE AT THIS POINTS**

**IMPORTANT VARIABLES TO CHECK:**

**THERE IS A GROUP OF ROCKS ON THE TERRAIN  
THAT INTERFERES WITH THE POSITION OF  
THE BUILDING B.**

**THE VEHICLE TRAFFIC IN THE ZONE  
HAS INCREASED 80% IN THE LAST  
2 YEARS.**

**UNRESOLVED JURIDICAL TOPIC ABOUT PART  
OF THE TERRAIN WHERE WOULD BE  
LOCATED BUILDING E.**

**UNDERGROUND PARKING PLACE  
HAS 30% OF INUNDATION POSSIBILITY  
WITH THE CURRENT PARAMETERS.**



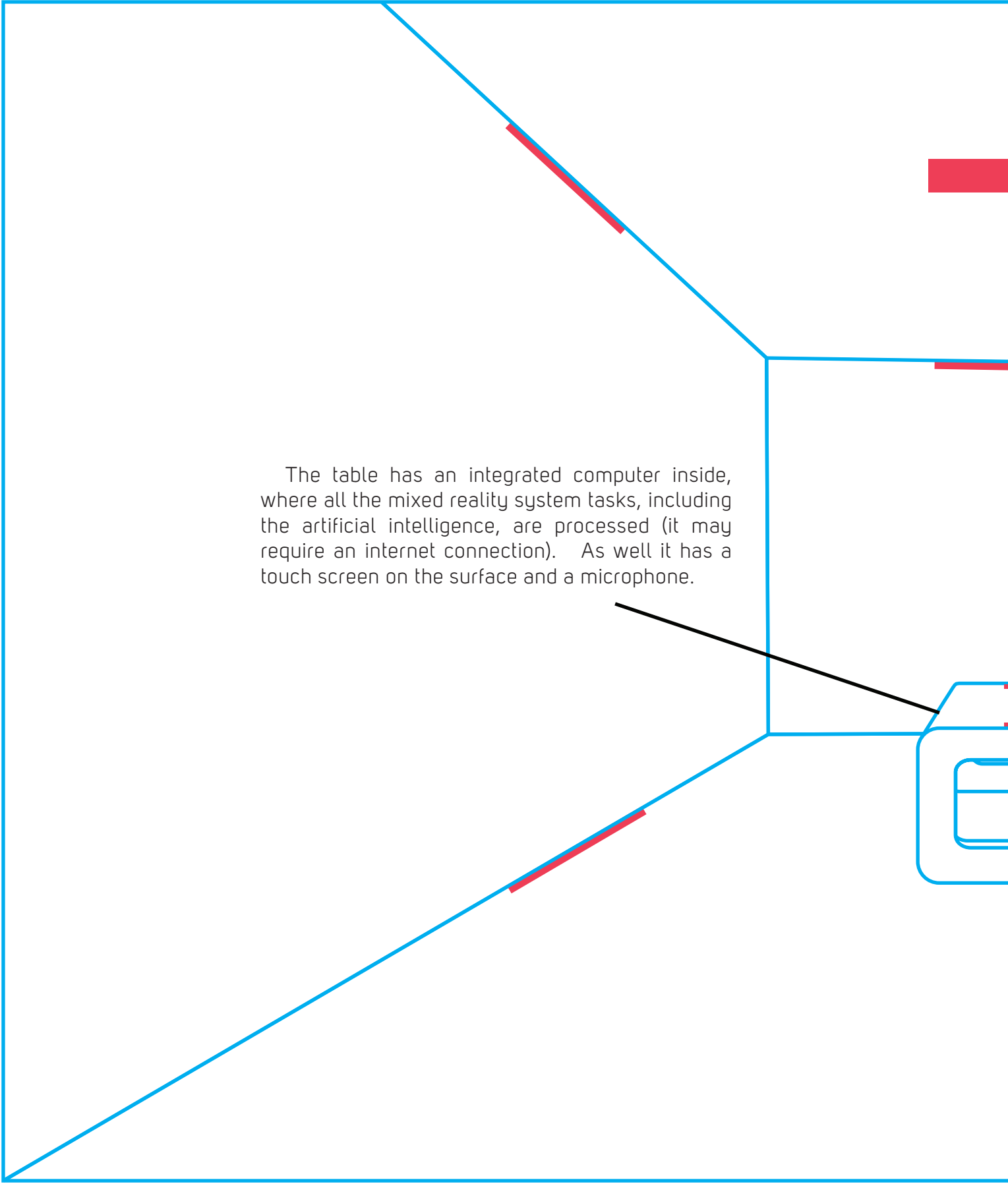
**IMAGE #21**

## 5.1.4 SYSTEM

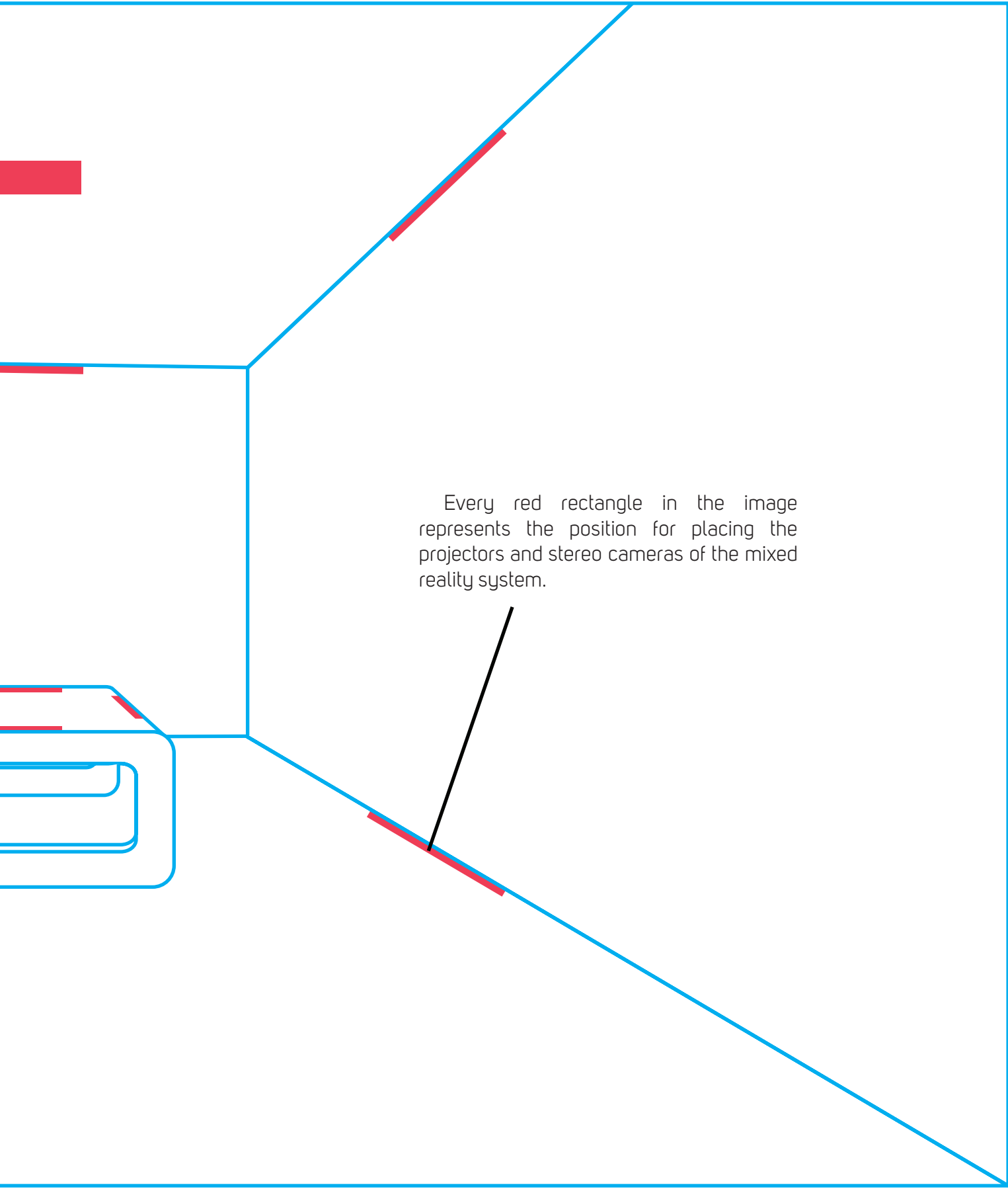
The system is conformed by projectors that set images on any surface located inside the space for working, meaning that the user will be able to create “screens” by projecting over any physical surface (even when this one is transparent), as well this projectors will allow the user to change the lighting of the space for working. In addition, the system contains several stereo cameras located on the walls and on the surface of a table that makes the tracking of the body, the hands, and the eyes.

This table in the system has a screen on the surface, with an integrated computer that power the whole mixed reality system and the artificial intelligence (AI) engine, as well a microphone for using voice commands (this characteristic will be optional for the user). The communication of the system works wirelessly and every input may content batteries.

The system is able to project textures, colors, images and modify physical objects in the space without altering them. The user will be able to configure the system to the desired needs and preferences and would have the capacity of having the required tools for the daily work into an integrated system. As well the system would be connected to several databases that will provide useful information related to the work using artificial intelligence.



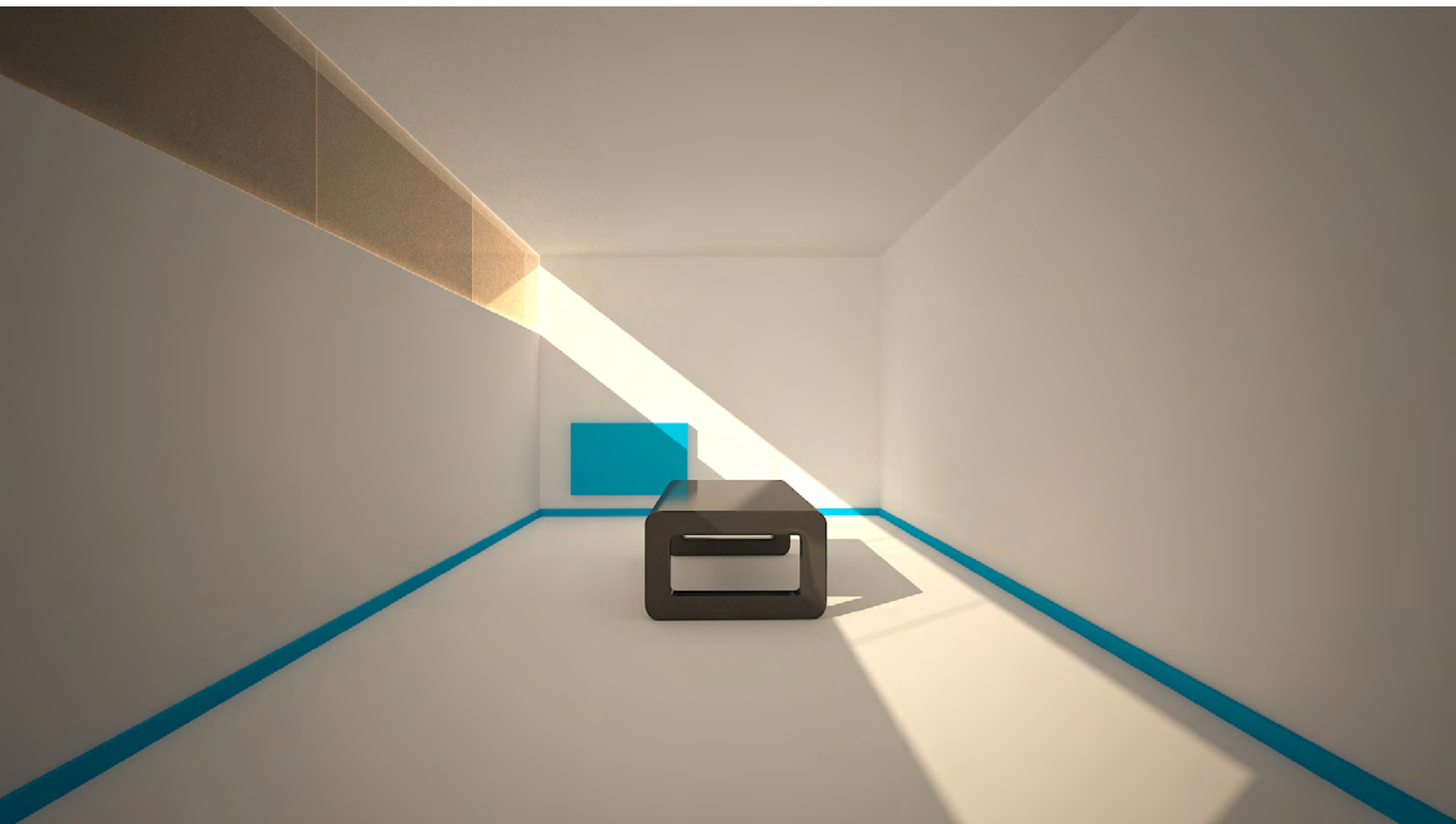
The table has an integrated computer inside, where all the mixed reality system tasks, including the artificial intelligence, are processed (it may require an internet connection). As well it has a touch screen on the surface and a microphone.



Every red rectangle in the image represents the position for placing the projectors and stereo cameras of the mixed reality system.

**IMAGE #22**

# **5.2 FINAL OUTCOME**



**IMAGE #23**



**IMAGE #24**



ROOM PERSONALIZATION  
PRESET: QUIET

TODAY GOAL  
PROGRESS: 65%

WORK PROGRESS STATISTICS



## PRIORITY LIST

REORGANIZE THE MONDAY PROGRAM,  
IT WILL BE RAINING MOST PART OF THE DAY.



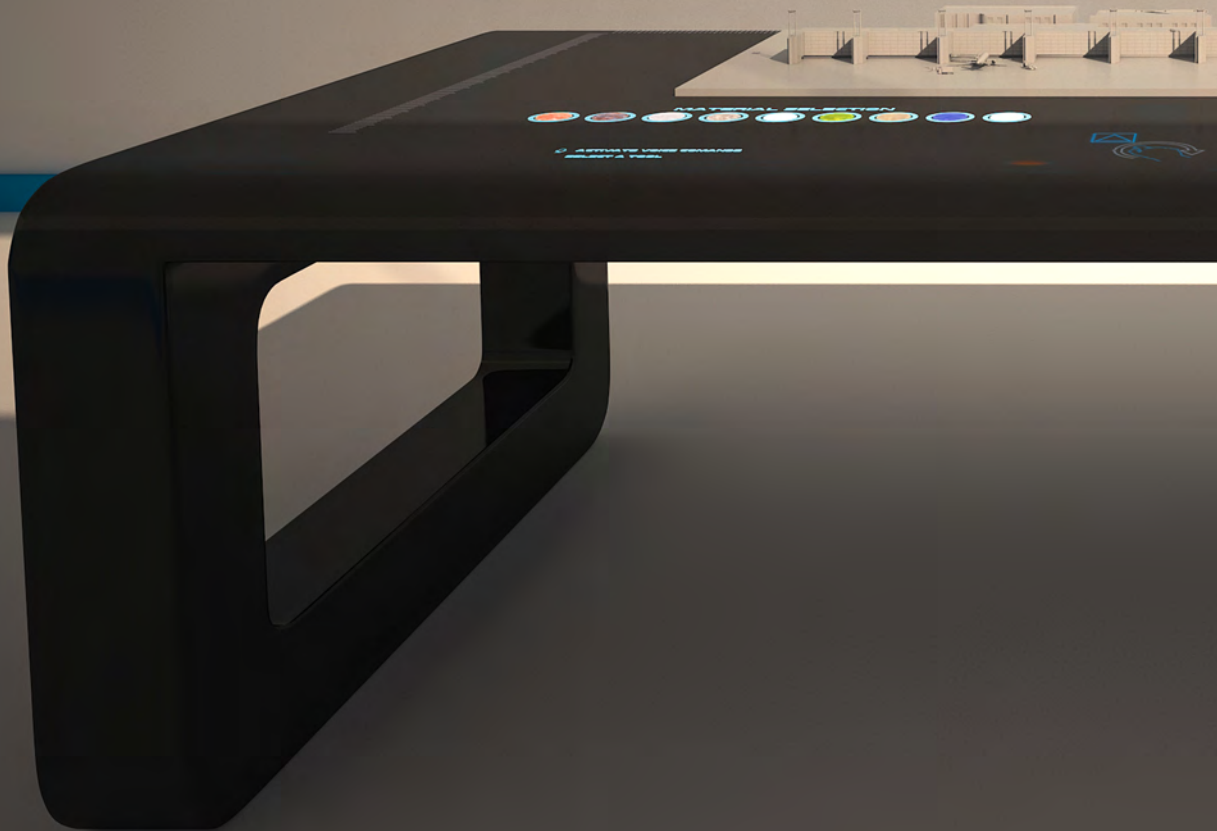
USE THE DRONE TO MEASURE THE ANGLES  
FOR THE FIRST PHASE OF CONSTRUCTION.



CALL THE TOPOGRAPHER  
IN ORDER TO VERIFY THE MISTAKEN DATA.



CHECK LIGHTING AND  
MATERIALS ON THE MODEL.





## ERROR OUTPUT

SATELLITE INFORMATION IS  
OUT OF PHASE AT THIS POINTS

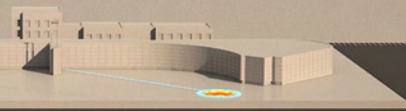
IMPORTANT VARIABLES TO CHECK:

THERE IS A GROUP OF ROCKS ON THE TERRAIN  
THAT INTERFERES WITH THE POSITION OF  
THE BUILDING B.

THE VEHICLE TRAFFIC IN THE ZONE  
HAS INCREASED 80% IN THE LAST  
2 YEARS.

UNRESOLVED JURIDICAL TOPIC ABOUT PART  
OF THE TERRAIN WHERE WOULD BE  
LOCATED BUILDING E.

UNDERGROUND PARKING PLACE  
HAS 30% OF INUNDATION POSSIBILITY  
WITH THE CURRENT PARAMETERS.





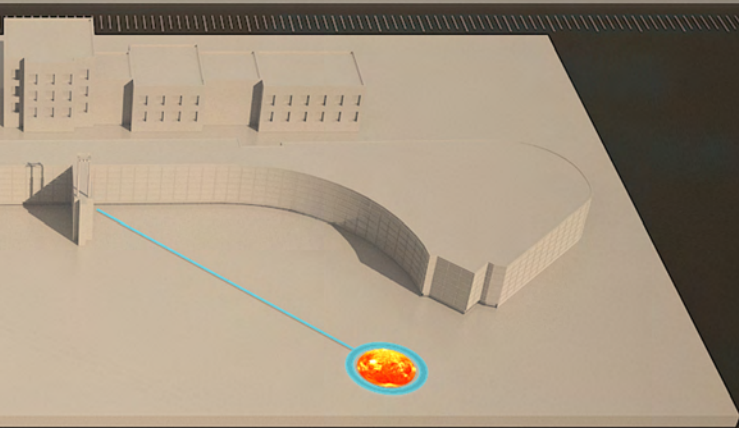
*MATERIAL SELECTION*

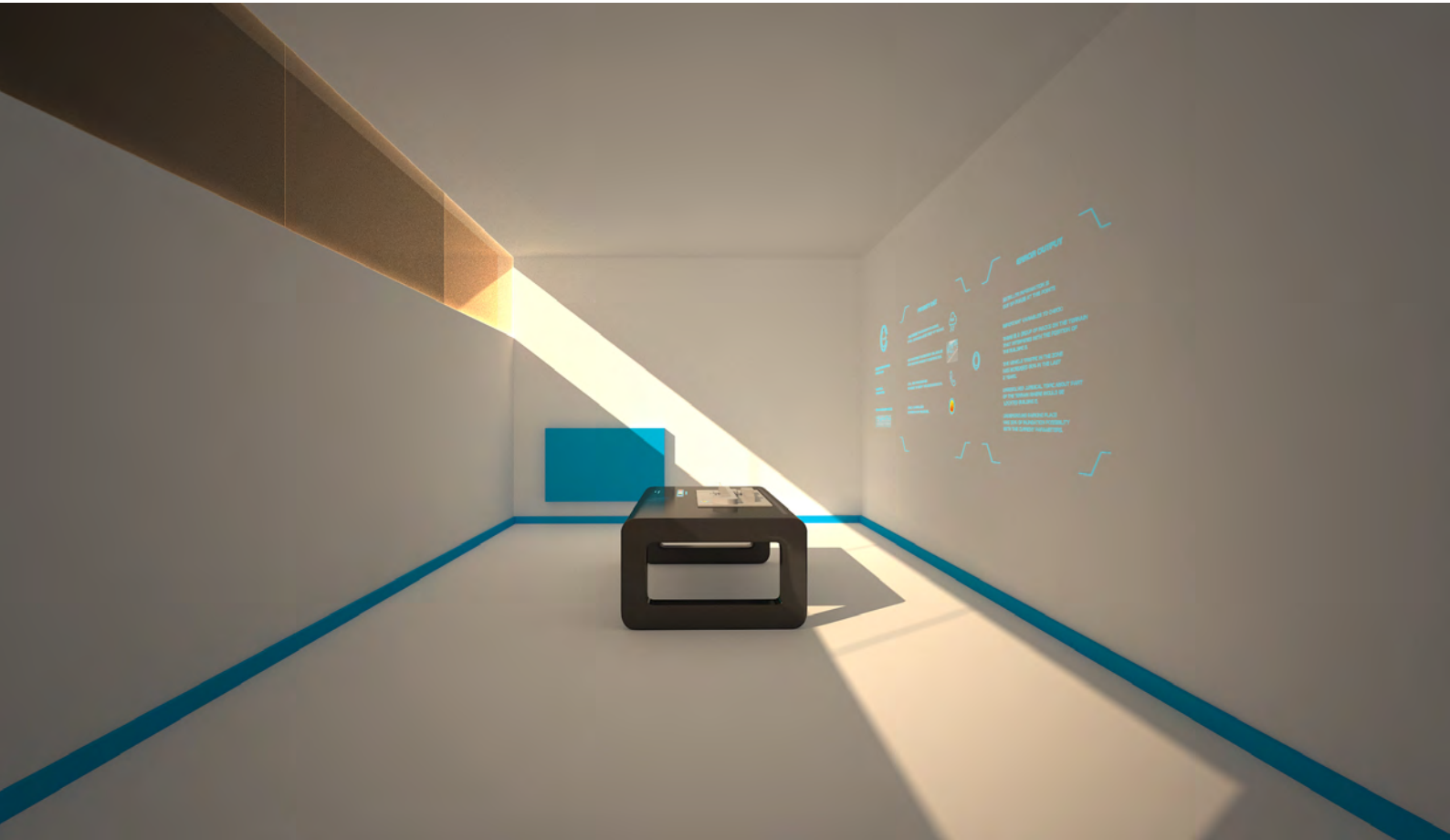


*Q* *ACTIVATE VOICE COMANDS*

*SELECT A TOOL*







**IMAGE #27**

# 6. CON- CLUSIONS

The project started with researching about how changing the characteristics of the physical objects may change the perception of the reality, after that is described the possibilities for changing and simulating the reality with a focus on improving a space for working. Then is explained how does the simulated realities, such as virtual, augmented and mixed reality work.

The final result is a simulation of a mixed reality system that would provide the user the possibility of projecting an environment according to the needs and preferences, as well an interface that is adapted to the workflow of the user with tools enhanced by artificial intelligence. This system works with hand gestures, and optional voice commands.

The concept for the space for creativity is based on technology existing or in development nowadays. For making possible that the concept occurs on a tangible reality, it is expected that in the future, projectors have enough technology to recreate lighting conditions from different places and project lifelike images. As well it is necessary a more developed artificial intelligence that understand the humans on a deeper level. Additionally it is required that the body, eyes and hand tracking devices to be more accurate.

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- Image #2 Testing the Playstation VR headset with the videogame "Eagle Flight" Photo 1, [photograph] Frankfurt am Main, Germany.
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Image #26      Andres Quintero (2017), Close up render of the space for working with the interface on the wall and on the table, as well a model of an airport.

Image #27      Andres Quintero (2017), Panoramic render of the space for working with a model of an airport on the table and the interface of the system.



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