O2

Production of 3D Training Tool for application of nanomaterials in Stone Sector

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Erasmus+

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1. Introduction

Nowadays, the wide availability of information has led to a revolution in the way society selects the content it accesses. Numerous studies show that nowadays animated digital content is the most used option by users to access any kind of information. An example of this is the great impact generated by audio-visual content platforms and educational videogames.

One of the pillars on which the project is based is the creation of an interactive multimedia learning tool to be made available to all workers in the stone sector, with the main objective of generating safe working environments for the use and application of nanomaterials to stone products. The reason is because there is a wide lack of knowledge about the consequences of their use. The lack of information on the risks derived from the use of nanomaterials is mainly based on the fact that research and commercial development of these materials is going much faster than the study of the health and safety problems they generate.

Therefore, the necessity to develop this tool is focused on raise awareness and to put on the table the existing risk derived from the application and use of these nanocomposites, and to make available to the educational and professional community all the necessary training materials, as well as to take advantage of the different possibilities offered by new technologies as a means of diffusion and visualization of the multimedia materials that has been developed in the IO2 of NanoSafe project.

Taking advantage of this trend, NanoSafe consortium has produced a 3D Training Tool that has included 10 3D risk scenarios based on the application and safe use of nanomaterials in the stone sector that show the main risks derived from their use, as well as the preventive measures needed for their mitigation.

This 3D Training Tool is available for free on the project's platform in the project, which can be used as support material for the courses that will be developed for awareness and learning about safe environments in the stone industry for the application of nanomaterials. These 3D animations will be designed and produced on the basis of all the previous information developed in the project, to support the implementation of NanoSafe training courses and the OER.

The training tool can be downloaded here: https://www.nanosafeproject.eu/nanosafe-products/

2. Nanosafe user guide.

This section contains the different observations necessary for the correct use of the tool developed in this project.

2.1. System components

The equipment necessary to be able to carry out tests and trials of the positions included in this tool is shown below.

1. A Virtual Reality device.
2. A computer to install the application.
3. A USB cable.

2.2. Before the first use

It is important to follow the following steps in order to install the application:

- A Virtual Reality device and, if required, a computer. Unity specifies the following features:

VR Device	Refresh Rate
Gear VR	60hz
Oculus Rift	90hz
Vive	90hz

Software

- **Windows**: Windows 7, 8, 8.1, y Windows 10 son todos compatibles.
- **Android**: Android OS Lollipop 5.1 o superior.
- **OS X**: OSX 10.9+ con Oculus 0.5.0.1 runtime. Sin embargo, Oculus ha pausado el desarrollo para OS X, entonces utilice Windows para una funcionalidad VR nativa en Unity.
- **Graphics card drivers**: Asegúrese de que sus drivers (controladores) estén actualizados. Cada dispositivo se mantiene al día con los drives más nuevos, por lo que los drivers más viejos podrían no estar soportados.

Figure 1: Necessary performance of the equipment to be used.

Use the cable included with the Virtual Reality device to connect it to a computer.

- Check that the connection is correct.
- In the case of using Oculus, it will be necessary to provide permissions to unknown in order to continue.

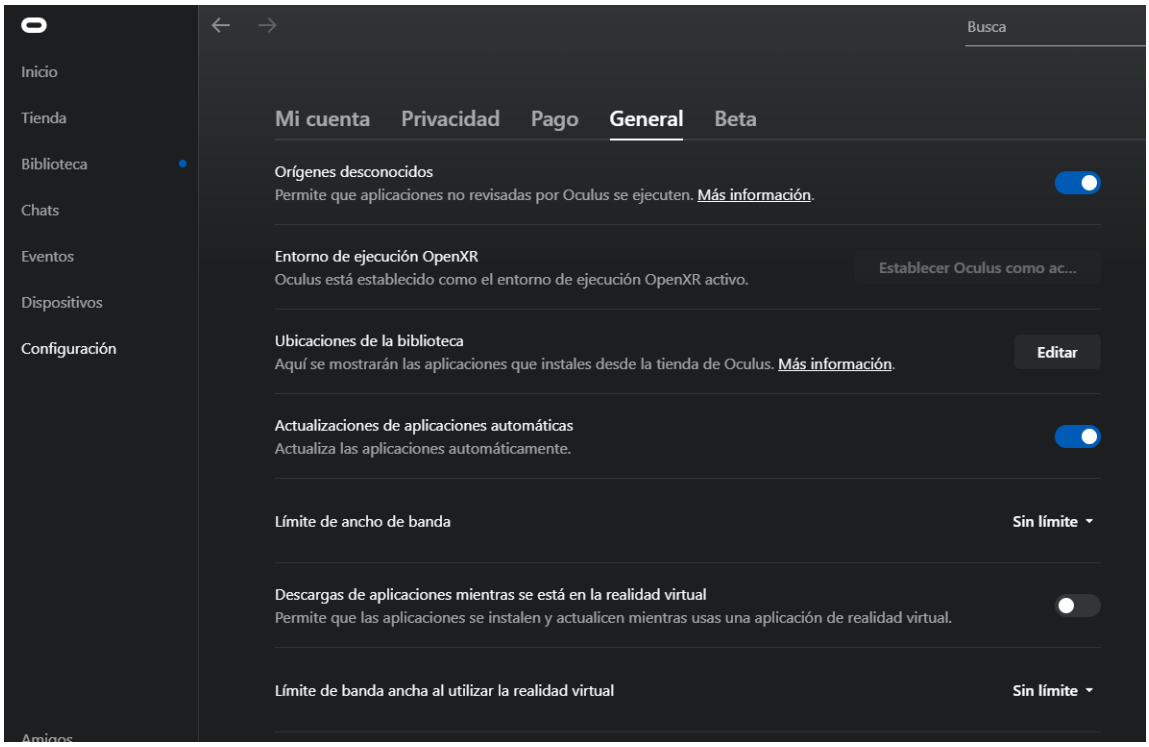


Figure 2: Provide permissions to Oculus.

Once connected to the computer, in case of Oculus via oculus link:

- Download the standalone application provided on the NanoSafe website onto the computer.
- Once this is done, open the executable of the standalone application on the computer.
- The interaction can then begin.

2.3. Using NanoSafe

The NanoSafe user experience follows the structure outlined in the functionality development section. The steps that the user will follow when using the tool are as follows:

1. At the start of the experience, the user will be presented with the main menu.
2. First, the language is chosen.
3. Secondly, the user chooses the scene to be evaluated.
4. Next, you will enter the scene and you will have to read the welcome information and instructions that are displayed.
5. After this, you will move on to the first mission. Here you will have to choose your personal protective equipment.

6. If you pass this mission, you will move on to the next one. And so on until you reach the last mission.

After this, you will be given the option to return to the main menu to repeat each of the steps again with any of the scenes.

3. NanoSafe OER

The general objective of NanoSafe project (https://www.nanosafeproject.eu/) is to develop an innovative training tool, through the development of multimedia materials based on a guide to best practices of manufacturing and handling for nanomaterials, aimed at training and qualifying professionals in the stone sector from an integrated approach to worker health and environmental safety.

The specific objectives assigned to the project are:

- Provide stone workers with a better understanding of risk and safety at workplace and contribute to their knowledge and use of related preventive measures and working procedures.
- Promoting an ecological approach to working methods using nanomaterials in stone industries.
- Production of training materials in order to support to initial and continuous training of VET teachers, trainers, tutors and institution managers

You can watch a promotional video of the project here.

3.1. The 3D training tool

NanoSafe consortium has produced a 3D Training Tool (on the project's website you can consult it here) that has included 10 3D risk scenarios based on the application and safe use of nanomaterials in the stone sector that show the main risks derived from their use, as well as the preventive measures needed for their mitigation.

This 3D Training Tool is available for free on the project's platform in the project, which can be used as support material for the courses that will be developed for awareness and learning about safe environments in the stone industry for the application of nanomaterials. These 3D animations will be designed and produced on the basis of all the previous information developed in the project, to support the implementation of NanoSafe training courses and the OER.

The training tool can be downloaded here to be used with a VR Glasses.

Please, in order to have more specifications about how to use of hardware requirement, check the technical documents in NanoSafe 3D animations here. A video about the main menu of the tool that can help you to use the tool, is here.

3.2. Scenarios of the project

If you would like to see more visual information about the tool, in the following playlist you can watch videos with the examples developed in the 10 scenarios of the project, access area to the scenarios, as well as a promotional video of the NanoSafe project: the link to the playlist of NanoSafe Project is here.

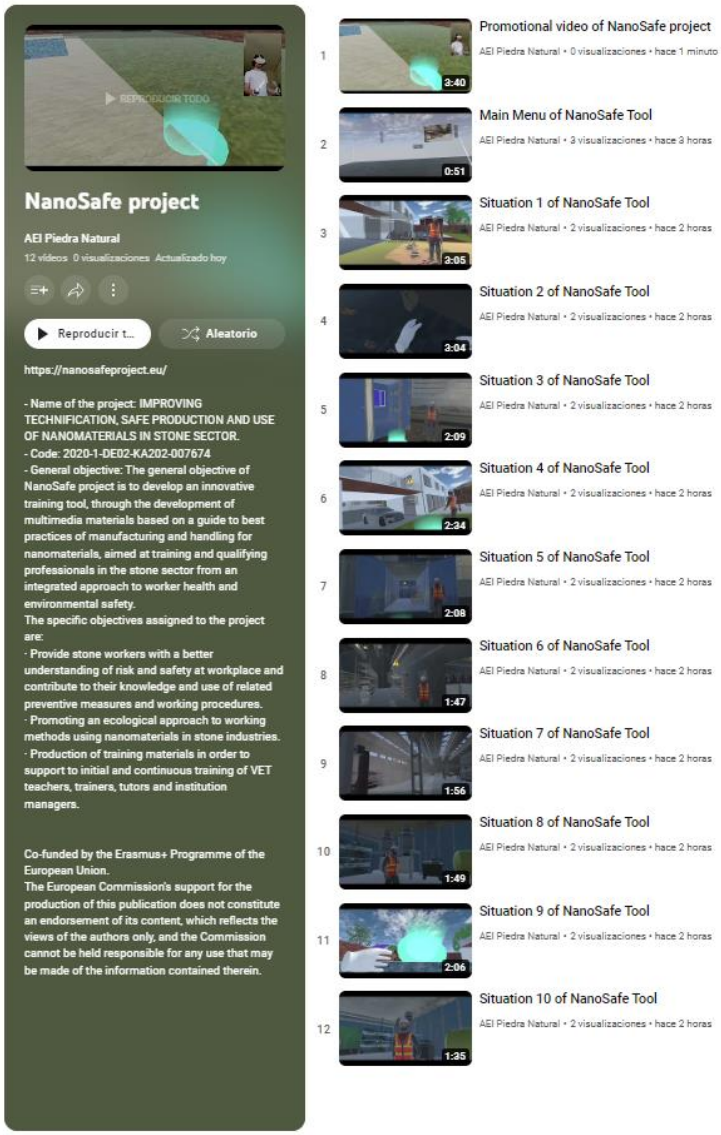


Figure 3: YouTube NanoSafe Playlist.

Below is a list of the scenarios with links to their videos:

3.2.1. Situation 1 of NanoSafe Tool: cutting stones to size at construction site.

The link to view this scenario is: https://youtu.be/5CEdwN-19Kw

Figure 4: Situation 1.

3.2.2. Situation 2 of NanoSafe Tool: application depending on the nanoproduct at factory

The link to view this scenario is: https://youtu.be/SWYrHhELNr4

Figure 5: Situation 2.

3.2.3. Situation 3 of NanoSafe Tool: pouring of nanomaterial powder into a liquid matrix to create a mixture.

The link to view this scenario is: https://youtu.be/VhbbkfkwyUQ

Figure 6: Situation 3.

3.2.4. Situation 4 of NanoSafe Tool: liquid nanomaterial applied with a spray-gun on a stone material surface.

The link to view this scenario is: https://youtu.be/ibACQCKGYos

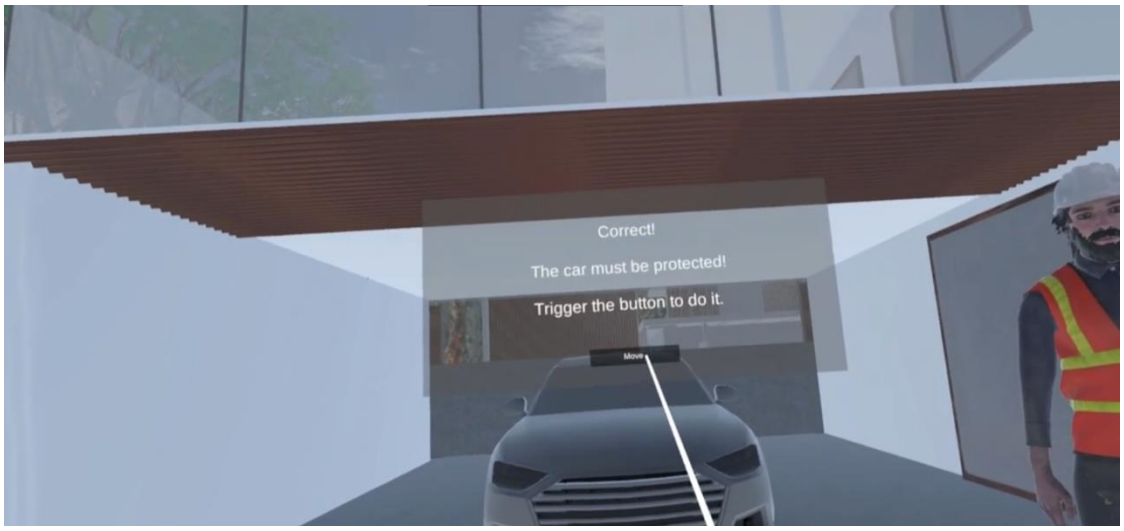


Figure 7: Situation 4.

3.2.5. Situation 5 of NanoSafe Tool: nanomaterial fixed in a solid matrix which is being drilled.

The link to view this scenario is: https://youtu.be/ZF9e47yx1jQ

Figure 8: Situation 5.

3.2.6. Situation 6 of NanoSafe Tool: nanomaterial in liquid matrix applied with paint roller.

The link to view this scenario is: https://youtu.be/fzLkO9mG7NY

Figure 9: Situation 6.

3.2.7. Situation 7 of NanoSafe Tool: dust-air mixtures in a factory.

The link to view this scenario is: https://youtu.be/V9CsS8lMk74

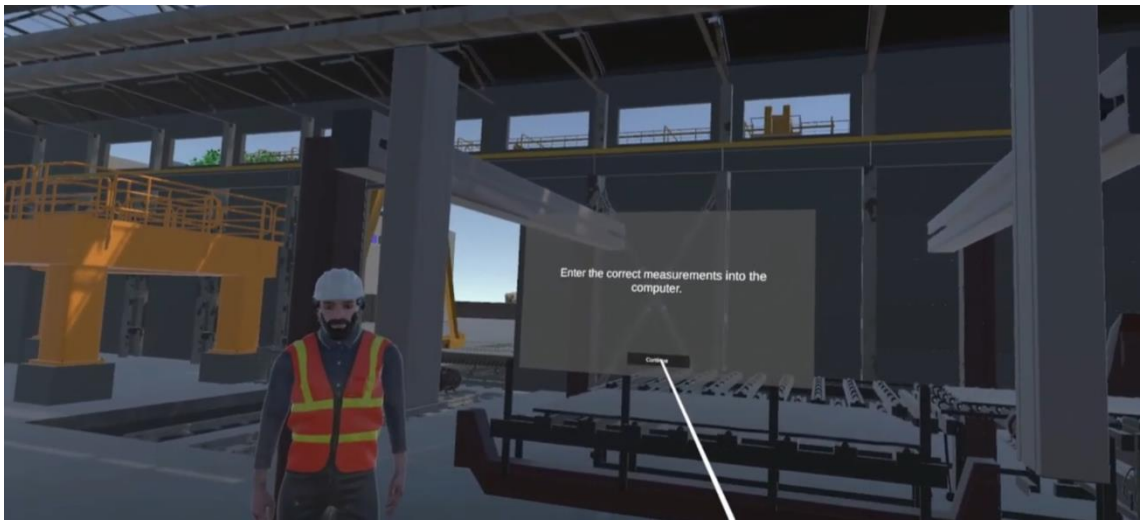


Figure 10: Situation 7.

3.2.8. Situation 8 of NanoSafe Tool: nano-waste management environmental protection.

The link to view this scenario is: https://youtu.be/61WYS_g-ZeQ

Figure 11: Situation 8.

3.2.9. Situation 9 of NanoSafe Tool: nanomaterial applied as an aerosol.

The link to view this scenario is: https://youtu.be/Td7GUAc8XE0

Figure 12: Situation 9.

3.2.10. Situation 10 of NanoSafe Tool: waste cleaning or disposal after working hours.

The link to view this scenario is: https://youtu.be/03KUiVZPZ6Q

Figure 13: Situation 10.

Annex I: Structuring the main 10 key situations.

This report is included in the task “O2-A2. Structuring the main 10 key risk situations”, corresponding to Intellectual Output 2 " Guideline of risks, health and environmental prevention measures in safe production and use of nanomaterials in Stone Sector" of the NanoSafe project has been created.

After fixing all the key situations in the previous task, they have been structured in 10 sketches, each sketch representing a specific situation.

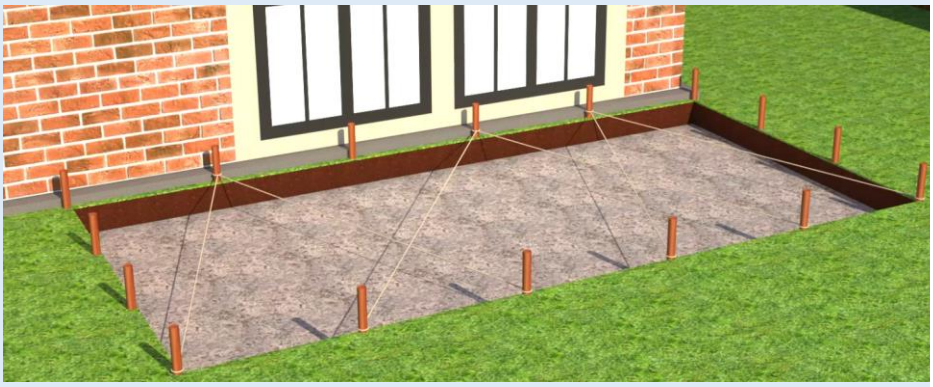
Due to the similarity of most of the risks in different situations this task has involved a lot of work to represent the selected risk situations and at the same time create pleasant scenes to make them attractive to use.

1. Situation 1. Cutting stones to size at construction site.

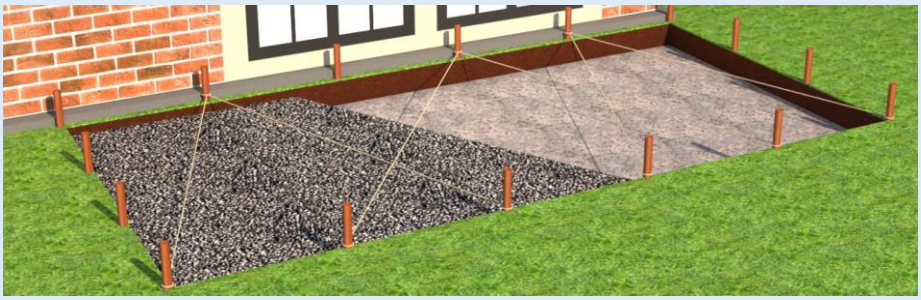
SITUATION 1. CUTTING STONES TO SIZE AT CONSTRUCTION SITE.

SITE: Location pictures

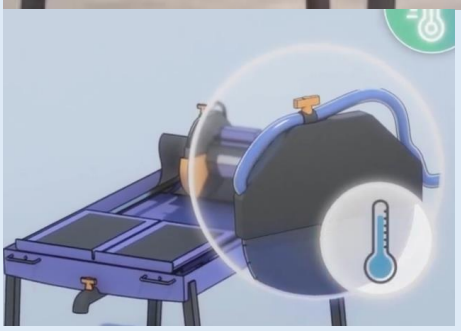
A new terrace area to be paved with natural stone in the outdoor area



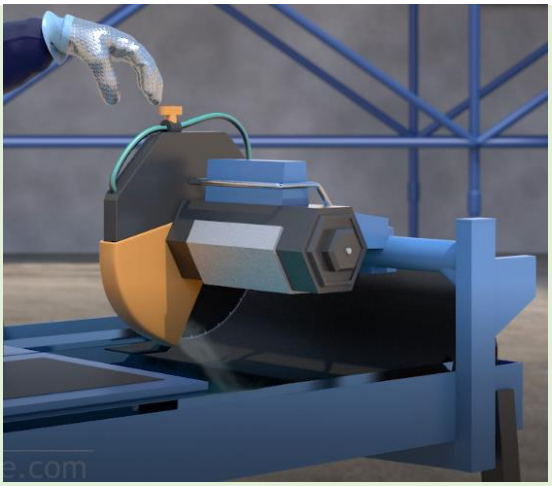
Source: BIMStone project website



MATERIAL:	**Natural Stone**
APPLICATION:	**Use of mobile sawing machine at construction site**

	   **Source: safestoneplace.com (animation 7)**
PRODUCT:	**Sawing machine with water cooling to reduce dust**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **a. Water cooling** **b. Water hose** **Individual:** **c. Safety Gloves** **d. Full face mask or half mask and close-fitting safety glasses** **e. Hearing protection**
MISSION 1	
Introduction	**The mission takes place at the new terrace area of a residential house, where paving stones have to be cut and laid in a sand bed.** **This mission shows two new workers who are going to work at the construction.** **They arrive in a transport vehicle and open the back doors.**

	The workers unload the mobile sawing machine from the transport vehicle and set it up in a safe place. Then they connect the sawing machine to the water supply with a water hose. **The image of the mission starts with the transport vehicle and then needs to focus more on the construction area.**
Performance	**Animated photos of the worker opening the transport vehicle.** **Zoom on the mobile sawing machine.** **The worker must find a plain area near to the to the water-tap to place the sawing machine.** **After this they have to connect the sawing machine to the water-tap with a water hose**
Media	**Ambient sounds.** **The animation shows 3 places to set the sawing machine:** **a) A flat place with clean surface** **b) A place with pieces of rock on the surface** **c) A sloping surface** **The user has to collect the right place** **2a. If the user chooses b) or c), an error sound will appear next to this icon.** **2b. If the worker chooses a), a sound of approval or applause appears next to the following icon.**
Interaction	**2a. The worker must connect the water-hose to the water-tap and to the sawing machine. Then he has to open the water-tap at the house and also at the sawing machine.** **2b. If the user selects the option to open the water-tap at the house an at the sawing machine, the water run into the sawing machine**



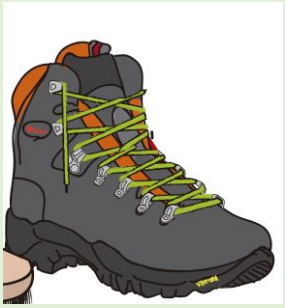
MISSION 2

Introduction

Inside of the transport vehicle are the following safety equipment:

- Safety glasses

- Safety footwear



- Safety harness

- Mask

- Rubber gloves

- Safety helmet

- Hearing protection

- Reflective waistcoat

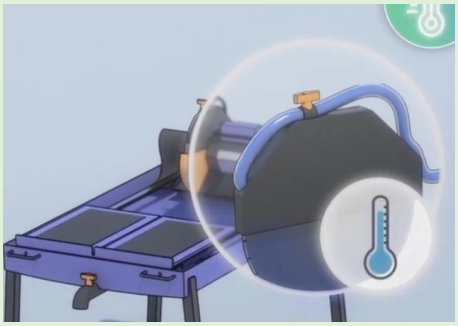
- Electrical protective gloves

- Safety belt

- Waterproof suit

- Safety gloves

Performance	**The presentation of the environment can be done through an animation from the eyes of one of the workers looking into the transport vehicle.** **The task to be performed is the selection of PPE by the user for the workers.**
Media	**Ambient sounds in the background.** **One of the new workers (user) chooses the necessaries PPEs for him (Safety Gloves, Full face mask or half mask and close-fitting safety glasses, Hearing protection)** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for normal work, the error sound is heard, and the following icon is displayed:**
Interaction	**2a. In case the new worker selects the right PPE, he can continue his mission and get ready to go to the sawing machine.** **2b. The worker has not correctly selected his PPE, so he cannot go. The task has failed.**
MISSION 3	
Introduction	**This mission shows two new workers who are going to measure the natural stone slabs and to saw them.**

Performance	**Animated photos of the worker with his uniform and PPE.** **Zoom on the sawing machine and the water .**  **The worker must use enough water to avoid dust exposure.**
Media	**Ambient sounds.** **The user can choose 3 levels of running water:** **a) Low water quantity** **b) Medium water quantity** **c) Large water quantity** **2a. If the worker chooses a), an error sound will appear next to this icon.** **2b. If the worker chooses b) or c), a sound of approval or applause appears next to the following icon.**
Interaction	**2a. In case the worker selects the option a) mission will fail.** **2b. If the user selects the option b) or c). he/she can continue with the mission and saw the stones.**

MISSION 4

Introduction	**In this mission, the water tank of the sawing machine is full and needs to be emptied. To do this, open the water-tap at the sawing machine and fill the waste container with water.**
Performance	**View on the place of the sawing machine and zoom in on the full water tank.** **The worker must apply the way to empty the water tank to solve the problem.**
Media	**Ambient sounds.** **The pop-up window will appear with two options:** **3a. The water run into a waste container** **3b. the water run to the floor area at the sawing machine**
Interaction	**If the worker selects option 3a, the mission can continue and an "Extra question" will appear: What do you do with the waste container?** **a. I dump the bucket into the next canal.** **b. I use it to water the lawn.** **c. I run it through a filter system and dispose the grinding scrap.** **After selecting the correct option c, applause will appear and sound.**

When an incorrect answer is selected, the error sound will sound and a red cross will appear.

If the worker selects option 3b, the mission will fail.

MISSION 5	
Introduction	**The workers are ready with sawing and have now to clean the sawing machine**
Performance	**You can see an animation in which the user applies the product correctly and the other worker calls his attention to engage in a conversation.** **After selecting the answers below. You can see the two of them applying the product correctly.**
Media	**Ambient sounds.** **The pop-up window will appear with three options:** **3a. The saw machine is cleaned with a vacuum cleaner**

	3b. The saw machine is cleaned with the garden hose **3c. The saw machine is cleaned with a broom**
Interaction	**After selecting the correct option a, applause will appear and sound.** **When an incorrect answer is selected, the error sound will sound and a red cross will appear.** **If the worker selects option 3b or 3c, the mission will fail.**

2. Situation 2. Application depending on the nanoproduct at factory.

SITUATION 2. APPLICATION DEPENDING ON THE NANOPRODUCT AT FACTORY

SITE: Location pictures	**In a factory**

	   Photo: http://marmolesarca.com.mx/noticias/tiendademarmolenmexico/
MATERIAL:	**Not applicable**
APPLICATION:	**Different types of application**
PRODUCT:	**Different types of nanoproducts**
ASOCIATED RISKS:	**Skin and eye contact** **Inhalation and genotoxic effects** **Inflammatory effect in the lung** **Progressive fibrosis**
EQUIPMENT:	**Collective:** **a. Extraction systems** **b. Suction systems** **c. Application in areas with a good ventilation** **Individual:** **d. Full face mask or half mask and close-fitting safety glasses**

	e. Gloves **Work coverall**
MISSION 1	
Introduction	**The mission takes place in a stone material processing factory.** **In this first mission, two workers (one of them the user) are in the chemical warehouse. You can see the mess of the warehouse, all the chemicals are mixed without any kind of order criteria, some of them on the floor and others open.**
Performance	**The environment can be seen through a 360° image from the user's eyes.** **The task to be carried out is to collect and place the different chemical products and place them as appropriate. Separate those that are in poor condition so**

	that they can be removed by the relevant waste manager and place a file with the safety data sheets of each product in the room.
Media	**First, the user must select the products he/she wishes to place on the shelves.** **Only products that are in good condition can be selected. In case of trying to place those that are leaking, broken, etc. the error sound is heard, and the following icon is displayed:** **If the user has selected it properly, an acceptance sound is heard and this icon appears:**
Interaction	**If the worker places all the products where they belong, the mission can continue and an "Extra question" will appear:** **The user will be asked if everything is in order or wants to finish with some of the following options:** **a. Mop the floor and put some air freshener on it to make it smell nice.** **b. Place a dossier with the safety data sheets of the products in order.** **c. Put the products in alphabetical order to make it easier to find them. It is not necessary to take into account their chemical nature.** **d. Throw away products that are in poor condition.** **e. Call the waste manager to remove products that are in bad condition.** **If the user selects the correct answers, applause will appear. If they are not, they will not be able to continue to the next mission until they select all the correct options.**

MISSION 2	
Introduction	**This scene will take place in the same scenario as mission 1. The boss appears and wants to check that he has the necessary knowledge about the products he is working with. Suddenly a pop-up window will appear for the user that will make him relate the pictogram to its associated chemical risk.**
Performance	**A new animation will not be necessary. The one from mission 1 will do.**
Media	**A warning sound will appear at the same time as the pop-up window with the new task: In the task you will have to link the following pictograms with their meaning.** EXPLOSIVE HEALTH HAZARD FLAMMABLE

DANGEROUS FOR THE ENVIRONMENT

TOXIC

CORROSIVE

	OXIDIZING HARMFUL/IRRITANT COMPRESSED GAS **If the user joins correctly, a green tick will appear.** **If it is incorrect, a red cross will appear.**
Interaction	**When all pictograms are correctly associated with their risks, a pop-up window with Good job will appear and the user will be able to advance to the next mission.**

MISSION 3

Introduction

This scenario takes place in the fabrication area. The workers are applying a water repellent to the stone with a brush (they are properly equipped with helmet, mask, work uniform, gloves, etc.). You can clearly see in the HYDROFUGANT tank and the worker has a small container in which he is pouring the product so that he does not have to bend down.

Next, the employees are going to apply an antifungal.

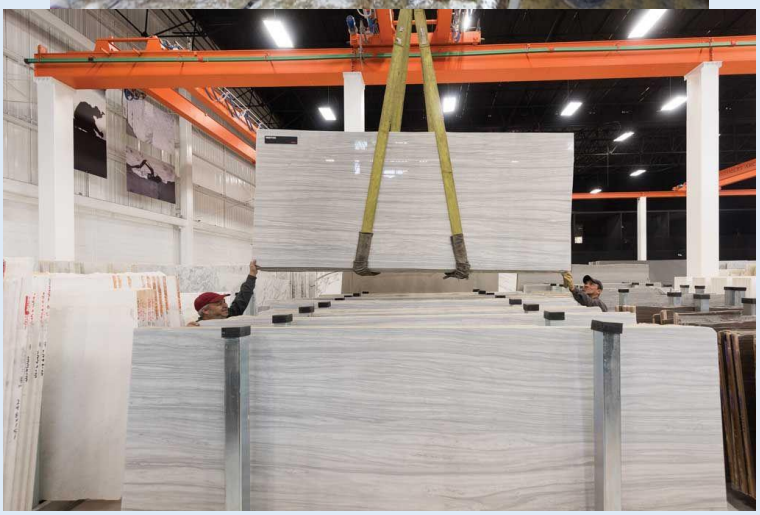


Photo: Orlando Fombellida Claro **Photo: realestatemarket.com.mx**

Performance	**An animation will be displayed showing the user applying the water repellent to the surface of the stone with the brush.** **Then the same animation will be shown, but now instead of "HYDROFOUGANT" it will say "ANTIFUNGAL".**
Media	**The sound of the crane transporting the marble slabs can be heard in the background.** **The conversation can be read in which the worker tells the user that they are going to apply an antifungal product on the new marble slab. The worker will tell the user that he must add the new product on the container to apply it. It is very urgent and we must start now.** **The user will have two options.** **a. Listen to the worker and start immediately with the application of the antifungal.**

	b. Clean the paint container and brush first so as not to mix products. **If the user chooses option a, an error message will sound and the following icon will appear:** **If the user selects option b an approval sound and the following icon will appear:**
Interaction	**If the user selects the wrong option the mission will fail.** **However, if the user selects the correct option, the mission will continue and the animation with the "antifungal" on the product carafe will play.**
MISSION 4	
Introduction	**This is the same scenario as in mission 3, but in this case, you see "antifungal" spilled on the ground. The colleague painting without a mask and gloves and a sandwich next to the work area.** **The worker's mission will be to spot the mistakes in the scene.**
Performance	**An animation of all the above will be shown and could be zoomed in if the situation is not very clear.**
Media	**The sound of the factory will be heard.** **The user must click on the objects that he/she considers to be incorrect in order to make the workplace safe.** **When clicking on an object to be modified to make the scene safe, it will be marked with a circle.**
Interaction	**Once everything that poses a danger has been selected, applause will sound and the user can continue.**

Until all of them have been detected, you will not be able to continue to the next mission.

3. Situation 3. Pouring of nanomaterial powder into a liquid matrix to create a mixture.

SITUATION 3. POURING OF NANOMATERIAL POWDER INTO A LIQUID MATRIX TO CREATE A MIXTURE

SITE: Location pictures

Foundations walls being built in a construction site

	 https://theconstructor.org/practical-guide/concrete-wall-construction/25959/ **https://www.thebalancesmb.com/how-to-build-foundation-walls-845114**
MATERIAL:	**Mortar**
APPLICATION:	**Add the SiO_2 powder into a liquid matrix**
PRODUCT:	**SiO_2 powder to fill mortar microstructure and improve mechanical properties. SiO_2 also promotes pozzolanic reaction**
ASSOCIATED RISKS:	**Respiratory hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **f. Suction systems** **g. Confinement** **Individual:** **h. Gloves**

	i. Full face mask or half mask and close-fitting safety glasses j. Coverall
MISSION 1	
Introduction	**The mission takes place at a construction site, where the foundation walls are being built. Before the mixture is prepared, the workers have to choose their PPE.** **They arrive with a van at the construction site, and then pick the proper protective equipment.** **The image of the mission starts with the transport vehicle and then needs to focus more on the construction area.**
Performance	**The view of the image is through a passenger sitting to the right of the driver. The back of the van has tools and PPE properly hanged. The view is third-person now, showing the worker choosing PPE. Zoom on the equipment.**
Media	**Construction site sounds.** **The animation shows all PPE components, all being click-on.** **PPE components are:** **Nitrile gloves,** **latex gloves,** **Electrical protective gloves**

working gloves,

heavy duty gloves

Half face mask

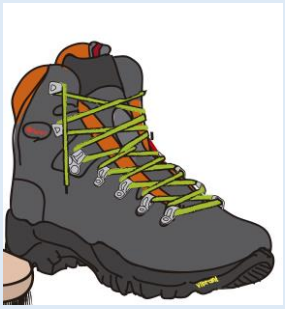
Full face mask

Safety glasses

Safety goggles

Safety harness

Safety footwear



- Safety helmet

- Hearing protection

- Reflective waistcoat

- Safety belt

Work coverall

The appropriate choice is the following:
Nitrile or latex gloves, half mask and goggles OR full face mask, and work coverall

Alert user regarding the proper way to adjust half face mask to the nose, and that the gloves have to be worn last

If the user incorrectly chooses a PPE configuration, an error sound will appear next to this icon.

If the worker chooses the right one, this icon will be shown along with the sound of approval

Interaction	**The worker gets to decide whether to pick up PPE or proceed with the mixing task** **If they select to wear PPE, they proceed with the proper choice of equipment as described above**

MISSION 2

Introduction	**This mission describes the process of weighing the components before the mixing. The components are two, for the sake of the animation: The nanomaterial powder and the liquid matrix (solvent). The worker faces the following decision making steps:** **a) Where the proper place to perform the weighing and the mixing is** **b) Never leave the containers open** **c) As close to the application point as possible**
Performance	**The presentation of the environment can be done through an animation from the eyes of one of the workers looking into the place where closed packed, separate ingredients are placed.**
Media	**Sounds depending on the weather in the background.** **The weather is windy, hence the weighing and mixing has to take place at a wind covered area.** **A. A pop up window asks the worker whether to transfer the two containers and the scale, to a wind covered area.** **After the transfer wind blowing sound level is decreased.** **The ingredients are taken from the containers, and the worker closes the containers (this is suggested with a warning sign and a message in a popup window as well). Ingredients are weighed separately.** **B. The worker has to decide, still first person view, whether to place the powder or the matrix first. The right choice is to place the liquid matrix first, because in this way the powder thrown doesn't create excessive dust in the air close to the worker.** **1a. If the choices are correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect, the error sound is heard, and the following icon is displayed:**

Interaction	**2a. In case the new worker selects the proper place to weigh and do the mixing, he can continue his mission** **2b. The worker has not correctly selected to go someplace not windy, (or decided to put the powder first) so the animation shows dust blocking their vision. The task has failed.**
MISSION 3	
Introduction	**This mission showcases some parameters regarding the mixing of the powder into the liquid matrix**
Performance	**Animation of the worker's view of the mixing place**
Media	**Ambient sounds.** **After placing the ingredients (mission 2), the worker has to decide regarding stirring:** **a) At which speed should the electric stirrer work** **b) How to move the stirring device inside the container** **3a. Before the stirring, the user is asked what the proper movement of the stirring machine is.** **The available choices are:** **I. Keep the stirrer at a constant spot inside the container** **II. Move the stirrer in circles at a constant height in the container** **III. Move the stirrer at all heights in the container with a circular path, in order to effectively break aggregates** **Each choice is illustrated with a moving image of the container and the stirrer from a top position** **If III is chosen successfully** **appears with a sound of acceptance.** **For every other choice** **appears with an error sound.**

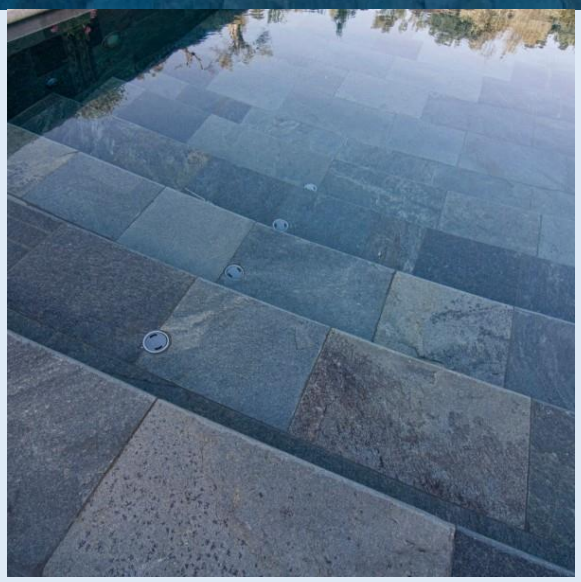
	3b. The point of view is first person. On the stirrer, there are three speed levels. The proper way to start the stirring is with level 1, until the mixture is partially homogenized. **When there are aggregates formed, the user is asked what the next speed level should be. The proper choice is level 2.** **When the aggregates are broken and the mixture looks more homogenized, the worker must apply level 3 speed.** **After each step is implemented successfully,** **appears with a sound of acceptance.** **For every wrong choice,** **appears with an error sound.**
Interaction	**If the user successfully implements 3a, they can proceed with 3b. For 3b, only when they choose the correct speed level the can proceed.**
MISSION 4	
Introduction	**After the mixing, the stirring device, the scale and the separate containers for the weighing process have to be cleaned.**
Performance	**View on the dirty equipment mentioned above.** **The worker must apply the way to empty the water tank to solve the problem.**

Media	**Construction site sounds, same as mission 3 regarding volume.** **The pop-up window will appear with two options:** **Mixing job completed. Leave location?** **If the user selects YES,** **icon appears with an error sound. If the user selects NO,** **appears with a sound of approval.** **A popup window asks the user which objects should be cleaned. If the stirring device, the scale and the weighing containers are chosen,** **appears with a sound of approval.**
Interaction	**After the correct choices are made following the popup questions, a popup window appears, stating that the mission is complete.**

4. Situation 4. Nanomaterial applied with a spray-gun on a stone material surface.

SITUATION 4. NANOMATERIAL APPLIED WITH A SPRAY-GUN ON A STONE MATERIAL SURFACE.

SITE: Location pictures	**An empty natural stone swimming pool**



Source: http://aubapool.es/codeless_portfolio/piscina-con-revestimiento-de-piedra-natural/

MATERIAL:	**Natural Stone**

APPLICATION:	**With a spray-gun**

PRODUCT:	**Consolidant and water repellent**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **a. Extraction systems** **b. Suction systems** **c. Confinement** **Individual:** **d. Gloves** **e. Coverall** **f. Full face mask or half mask and close-fitting safety glasses**
MISSION 1	

Introduction

The mission takes place at the swimming pool of a beachfront hotel that is preparing to welcome its summer visitors. "HOTEL" can be seen in the background above the building, but no guests are visible.

It is windy, which can be reflected in the movement of the hotel flags or the waves.

This mission shows two new maintenance workers who are going to apply the product and the hotel manager who is waiting for them with several boxes with "EPIs" written on them. What is inside the boxes is the following:

- Safety glasses

- Safety footwear

- Safety harness

- Mask

- Rubber gloves

- Safety helmet

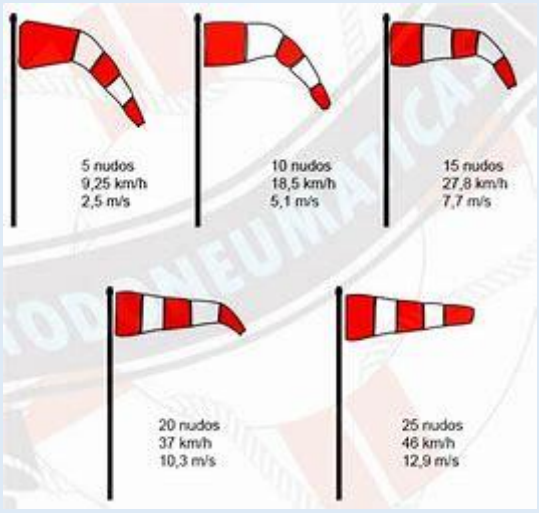
- Hearing protection

- Reflective waistcoat

- Electrical protective gloves

- Safety belt

- Waterproof suit



Performance	**The presentation of the environment can be done through a 360° animation from the eyes of one of the workers.** **The task to be performed is the selection of PPE by the user for the workers.** **The hotel manager will welcome the new maintenance workers and tell them to take all the PPE they think they need for their work.**
Media	**Ambient sounds of the sea in the background and a bit of wind.** **The new worker (user) chooses the necessaries PPEs for him.** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:**

	1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for normal work, the error sound is heard, and the following icon is displayed:
Interaction	**2a. In case the new worker selects the right PPE, he can continue his mission and get ready to enter the site with all his PPE on.** **2b. The worker has not correctly selected his PPE, so the boss does not allow him to enter the site. The task has failed.**
MISSION 2	
Introduction	**The workers, already dressed in their PPE, go to the pool to fix it. The natural stone at the crown of the pool is looking a bit deteriorated, with salt accumulation from the sea.** **The image of the mission now needs to focus more on the pool area.**
Performance	**Animated photos of the worker with his uniform and PPE.** **Zoom on the salt accumulation in the pool and on the cracks.** **The worker must apply the product to solve the problems so that the hotel can reopen to the public.**
Media	**Ambient sounds of the sea playing in the background and a bit of wind.** **A pop-up window will appear with a question:** **Can the consolidant and water repellent be applied on the salt present on the stone?** **2a. If the worker answers yes, an error sound will appear next to this icon.** **2b. If the worker answers no, a sound of approval or applause appears next to the following icon.**

Interaction	**2a. In case the worker selects the option to apply the consolidant-hydrofugant without first cleaning the mission will fail.** **2b. If the user selects the option not to apply if not cleaned. He/she can continue with the mission. The option to clean will appear on a button.**
MISSION 3	
Introduction	**In this mission, the scene will appear clean, otherwise it will be the same as in mission 2, but in this case the hotel manager's car is parked by the pool.**
Performance	**360º view from the user's point of view.** **Zoom in on the attendant's car.** **The worker must apply the product to solve the problems so that the hotel can reopen to the public.**

Media	**You should hear and see the air in the palm trees in the background, in the waves of the sea, etc.** **The pop-up window will appear with two options:** **3a. Tell the attendant that he must remove the car to apply the product. A button saying "move the car" will appear. If the worker selects this option, a sound of approval or applause will appear next to the following icon.** **3b. Apply the product. Nothing will happen if it falls on the car. A window will appear that says "apply the product". If the worker selects this option, an error sound will appear next to this icon.**
Interaction	**If the worker selects option 3a, the mission can continue and an "Extra question" will appear: What is the reason for moving the car away from the product application area?** **a. The car is new and we don't want it to get dirty.** **b. Small droplets of product could adhere to the surface of the glass and not be removed later.** **c. If the product comes into contact with the wheels of the car, they could explode due to the overpressure caused.** **After selecting the correct option, applause will appear and sound.** **When an incorrect answer is selected, the error sound will sound and a red cross will appear.**

	 If the worker selects option 3b, the mission will fail.
MISSION 4	
Introduction	**The scenario is the same as in the previous mission. Now our co-worker has taken off his safety goggles and put on his sunglasses so that he is not disturbed in his work.**
Performance	**You can see an animation in which the user applies the product correctly and the other worker calls his attention to engage in a conversation.** **After selecting the answers below. You can see the two of them applying the product correctly.**
Media	**The air should be heard and seen in the palm trees in the background, in the waves of the sea, etc.** **The dialogue between the two partners can be read at any time. The user will be able to choose between several options. It will be an interactive dialogue.** **W: Hey, did you see what glasses I bought last week?** **U: Option 1: How cool are they!** **U: Option 2: I don't like them.** **W: Why don't you wear yours? Then you won't be bothered by the sun.** **U: Option 1: I'll get them right away.** **U: Option 2: We should wear the goggles.**

	If in this question the worker selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon. **If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.**
Interaction	**If the worker selects the wrong answer, he/she will not be able to continue with the mission.** **If the worker selects the correct answer, he/she will be able to continue with the mission.**
MISSION 5	
Introduction	**The scene is the same as in the previous missions. In this case, in the pool you can see the area where the product has already been applied.** **Now they sit under a palm tree to have breakfast. The colleague does not take off the gloves with which he has been applying the product and is about to eat the sandwich and a soft drink.** **The user should alert the partner not to ingest the product indirectly after the gloves come into contact with the sandwich.**
Performance	**Animation in which the colleague takes off his mask to eat and keeps his gloves on. Zoom on the gloves as he is carrying a soft drink to toast to a job well done.**
Media	**Sound of opening the can and the beach in the background.** **Partner pop-up message: Cheers for a job well done!** **The user can choose between two options:** **5a. Toast!** **5b. Tell the partner that it is a health hazard to ingest food with gloves that have come into contact with the product.** **If the user selects option 5a, the sound of the cans colliding will play and then an error sound will appear next to this icon.**

	 If the user selects option 5b the other worker will be shown without gloves and an audio approval or applause will sound next to the following icon.
Interaction	**If the user selects option 5a they will fail their mission.** **If the user selects option 5b, he/she can continue.** **A document may appear stating the different risks of ingesting this type of product or the user can read the technical data sheet.** **The user will have access to the document that is selected from the two on the following icon.**
MISSION 6	
Introduction	**In the scenario of mission 4, the workers are seen returning to their posts correctly equipped except that the other worker is not wearing a mask, he has left it in the place where they ate.** **The user must warn the colleague to put on the mask.**
Performance	**360º image from the user's point of view in which you can see both the unmasked partner and the mask in the place where they have eaten.** **Zoom in on the mask on the ground.**
Media	**Sound of the beach in the background and the wind. Sound of the unmasked partner whistling to attract more attention.**

	A pop-up window will appear with a list of options. The question will be: What should we do to get everything in order? **a. The colleague is whistling and it bothers me, I should tell him to keep quiet.** **b. Tell the colleague that he should wear a mask to protect himself from the products being applied.** **c. Take off our mask. It is very hot and we could suffer from lipotimia.** **d. Tell the colleague to pick up the mask from the floor and put it on.** **e. Warn the partner not to leave it on the floor, as there could be insects or other substances on the floor.** **f. Play music to liven up the working day.** **If the worker selects the correct answers, a "Good job" message and the sound of applause will appear.** **If the worker selects incorrect answers, an error sound will be played and the following icon will appear.**
Interaction	**If the worker selects the correct answers, he/she can proceed to the next screen.**

	If the worker does not select the correct answers, he/she will not be able to complete the mission.

5. Situation 5. Nanomaterial fixed in a solid matrix which is being drilled.

SITUATION 5: NANOMATERIAL FIXED IN A SOLID MATRIX WHICH IS BEING DRILLED	
SITE: Location pictures	**Construction site, DayLight**
MATERIAL:	**Stone**
APPLICATION:	**Drilling coated stone surface for putting electric wiring for outdoor lamps.**
PRODUCT:	**Water repellent coating (nanosilica based)**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**EQUIPMENT: Collective:** **- Suction systems** **- Confinement** **- Tools with systems for powder elimination/extraction** **- dry work** **Individual:** **- Gloves** **- Full face mask or half mask and close-fitting safety glasses** **- Coverall**
MISSION 1	
Introduction	**The mission takes place at a building constructionn site. A worker is received by the construction manager and instructed to perform some drilling operations on a facade wall for putting electrical wiring, Besides there are several boxes with the inscription Personal Protective Equipment which include along with other work-related objects:** **- Safety glasses:**

- **Safety footwear:**

- **Mask:**

- **Gloves:**

- **Safety helmet:**

- **Mobile scaffold with a gin wheel for lifing objects:**

- **Reflective waistcoat:**

	- **500-gauge polyethylene sheeting and duct tape:** - **Warning tape and notices:** - **Hearing protection:**
Performance	**The presentation of the environment can be done through a 360° animation from the eyes of one of the workers.** **The task to be performed is the selection of PPE by the user for the worker. The hotel manager will welcome the new maintenance workers and tell them to take all the PPE and other objects they think they need for their work.**
Media	**The new worker (user) chooses the necessaries PPEs for him.** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for normal work, the error sound is heard, and the following icon is displayed:**
Interaction	**2a. In case the new worker selects the right PPE, he can continue his mission and get ready to enter the site with all his PPE on.** **2b. The worker has not correctly selected his PPE, so the boss does not allow him to enter the site. The task has failed.**
MISSION 2	
Introduction	**The worker, already dressed in their PPE, is approaching the scaffold with construction manager**

Performance	**The worker has to check scaffold for any faults and verify the existence of the "Safe to Use" scaffold Notice, which displays information the safe loading of the scaffold i.e. the load of persons, equipment and machinery,**
Media	**The dialogue between the two partners can be read at any time. The user will be able to choose between several options. It will be an interactive dialogue: C. M.: - Hey, you should check the scaffold for any faults and that there is a "Safe to Use" notice U: Option 1: No I don't think so! It looks fine! U: Option 2: Yes, you are right! Let's fdo this! If the user selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon.** **1b. If the user selects options 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.**
Interaction	**If the worker selects the wrong answer, he/she will not be able to continue with the mission. If the worker selects the correct answer, he/she will be able to continue with the mission.**
MISSION 3	
Introduction	**The worker accompanied by the construction manager moves the mobile scaffold and places it close to the facade wall**
Performance	**The worker must have all the castors locked on the wheels to prevent movements :**
Media	**The worker tries to climb up the internal scaffold ladder to the platform, then a dialogue between the two appears: W: I an going up to the scaffold platform! C.M: No, it is a mobile scaffold. The scaffold must never be accessed until all**

	castors are locked to prevent movements **W: Option 1: No, it is ok** **C. M.: Construction Manager gets mad! And shouts : 'Leave immediately!'** **W: Option 2: Oh, yes! I almost have forgotten it! I will have them locked right away!** **If in this question the worker selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon.** **If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.**
Interaction	**If the worker selects the wrong answer, he/she will not be able to continue with the mission.** **If the worker selects the correct answer, he/she will be able to continue with the mission**
MISSION 4	
Introduction	**The scene now is the same. Warning tape and notices have been put around the work area. The worker is climbing up to the scaffold platform through the internal ladder. The worker is approaching the scaffold hoist and activates the mechanism for lifting a scaffold lifting cage containing polyethylene sheeting and duct tape**
Performance	**The worker looks at the basket**
Media	**The worker says: interactive text apperas with two options)** **W: Option 1: Really, do I need this!** **W: Option 2: Ah yes! I have to protect the platfrom from contamination from debris.** **If the worker selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon.**

	If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.
Interaction	**If the worker selects the wrong answer, he/she will not be able to continue with the mission.** **If the worker selects the correct answer, he/she will be able to continue with the mission**
MISSION 5	
Introduction	**The worker is on the platform having applied the polyethylene cover on the platfrom with duct tape. He operates again the scaffold hoist mechanism to transport the drilling machine with universal dust extractor to be integrated on the drilling machine (no hoses, no cords).**
Performance	**The worker looks at the basket and has to choose the equipment for the drilling:** **-Rotary hammer drill:** **-Dedicated dust extractor:**
Media	**Focus on the basket: (Interactive environment for collecting objetcs).** **Text appaeras: collect the necessary objects for doing the job.** **Option 1: Pick up drilling machine and continue** **Option 2: Pick up dust extractor and contine** **Option 3: Pick up drilling machine and dust extractor , connect them and continue**

	 If the worker selects option 1 & 2, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon. **If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.**
Interaction	**If the worker selects option 1 & 2, he/she will fail the mission.** **If the worker selects option 3, continues with mission, and animation will show the worker drilling on the Stone Wall..**
MISSION 6	
Introduction	**The worker finishes drilling operation, puts the drilling equipment inside the lifting cage**
Performance	**The worker says: (Interactive text)** **'Another job task is finished' Option 1: Lets go directly fro lunch** **Option 2: I have to collect the polythylene sheet inside a waste bag**
Media	**If the worker selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon.** **If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.**
Interaction	**If the worker selects option 1, he/she will fail the mission.**

	If the worker selects option 2, completed successfully his task, and animation will show the worker putting the waste bag on the lifting cage, operating the scaffold hoist to putt he cage on the ground, climbing don the internal scaffold ladder, taking off his PPE, going to wash his hands and face and finaly reaching his personal bag to take his lunch. a "Good job" message and the sound of applause will appear.

6. Situation 6. Nanomaterial in liquid matrix applied with paint roller.

SITUATION 6. NANOMATERIAL IN LIQUID MATRIX APPLIED WITH PAINT ROLLER	
SITE: Location pictures	**Worktops from stone are produced in factory, adding hydrophobicity/anti-stain characteristics.** **https://www.npr.org/sections/health-shots/2019/12/02/782958005/there-s-no-good-dust-what-happens-after-quartz-countertops-leave-the-factory?t=1633005934391**
MATERIAL:	**Worktop**

APPLICATION:	**Apply the nanomaterial coating with paint roller**
PRODUCT:	**SiO_2 nanoparticles in liquid matrix to enhance hydrophobicity/ Anti-stain coating**
ASSOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **k. Extraction systems** **l. Suction systems** **m. Confinement** **Individual:** **n. Gloves**

	o. Coverall Full face mask or half mask and close-fitting safety glasses
MISSION 1	
Introduction	**The mission takes place at the factory, where natural stone worktops are ready to be coated with SiO_2 antistain coating. The coating (which is in liquid form) will be applied with paint roller. Before proceeding with the application, the worker has to choose the appropriate personal protective equipment (PPE)**
Performance	**The view of the site image is through the eyes of the worker. A stack of worktops is visible. The worktop that is about to get coated is in front of the worker, with the paint roller and the liquid coating in a container. The working bench has tools and PPE properly hanged. The view is first person, showing the worker choosing PPE. Zoom on the equipment.**
Media	**Construction site sounds.** **The animation shows all PPE components, all being click-on. PPE components are:** **Nitrile gloves,** **latex gloves,** **Electrical protective gloves**

working gloves,

heavy duty gloves

Half face mask

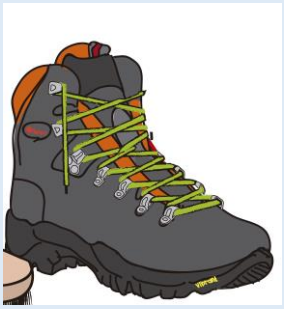
Full face mask

Safety glasses

Safety goggles

Safety harness

Safety footwear



- Safety helmet

- Hearing protection

- Reflective waistcoat

- Safety belt

Work coverall

The appropriate choice is the following:
Nitrile or latex gloves, half mask and goggles OR full face mask. Work coverall should also be chosen.

Alert user regarding the proper way to adjust half face mask to the nose, and that the gloves have to be worn last
PPE is hanged on a wall in front of the worker (and the user in first person view) in a neat way.

If the user incorrectly chooses a PPE configuration, an error sound will appear next to this icon.

If the user forgets to use safety glasses, an animation with droplets from a roller splash in the container should be displayed.

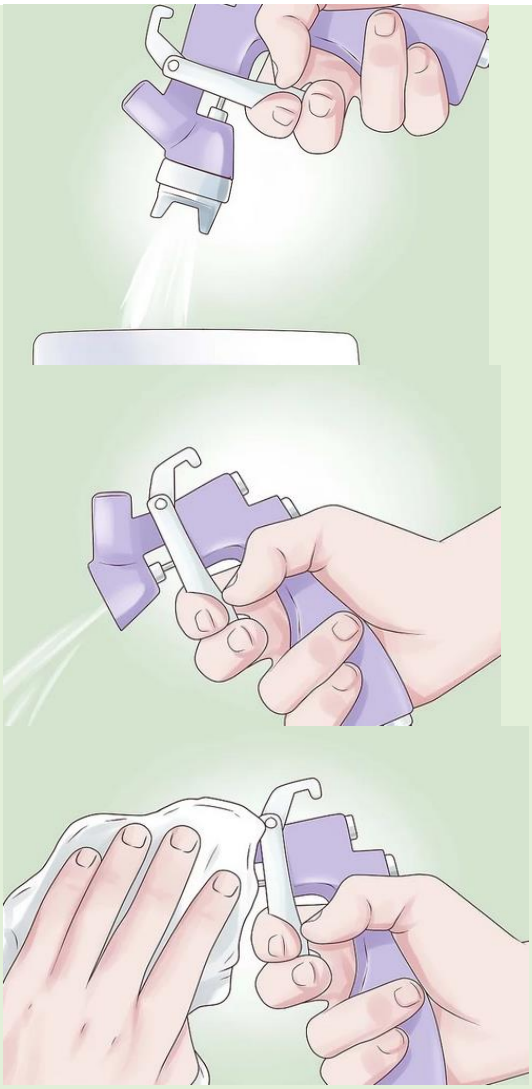
If the worker chooses the right one, this icon will be shown along with the sound of approval

Interaction	**The worker gets to decide whether to pick up PPE or proceed with the paint roller application** **For every correct choice of PPE, the can proceed with the next one**

MISSION 2	
Introduction	**This mission describes the surface preparation before the application. The worker has to decide:** **d) Whether they perform surface preparation** **e) Whether to use PPE (especially for surface preparation)** **Source link: https://www.123rf.com/photo_3915884_apartment-repair-processing-of-a-wall-by-an-sandpaper.html**
Performance	**The presentation of the environment can be done through an animation from the eyes of one of the workers looking onto the bench where the worktop is placed. The aim is for the worker to perform the surface preparation taking all protective measures needed.**
Media	**Factory sounds surround the environment.** **The first shot shows the worker standing by the bench. The next shot is the view through the worker's eyes.** **The worker gets to choose whether to prepare surface with sanding and decontamination, or apply coating. The proper steps are the following:** **a. Use of FFP2 mask for the dust and nitrile or latex gloves**

	b. Sandpaper the surface (sounds of sandpapering) **c. Clear the surface with water or acetone. (relevant sounds)** **If any of the above steps is not implemented, error sound is heard** **When they implement a step, acceptance sound is heard.**
Interaction	**The user, before starting the surface preparation task, is given the choice to wear mask and gloves. If they choose to wear those, they can proceed with the simulation of the surface preparation. Otherwise, the task fails**
MISSION 3	
Introduction	**Since the application is being held in an enclosed workspace, proper ventilation enhancement should be present. The absence of such a system, can result in an increasing concentration of SiO2 rich aerosols, along with often toxic solvent fumes. The worker has to make sure that a temporary isolated workspace will be set in the area, with ventilation systems and/or hepa filters installed** **Source: Dreamstop.com**
Performance	**The view is through the worker's eyes. They have to make sure they work in a ventilated, isolated area. There are 4-5 workers around.**

Media	**When the worker has worn the appropriate PPE and prepared the Surface for application, the get the choice to proceed with the spray gun application or make sure they work in a ventilated área. If they choose correctly, the icon appears with sound of approval. Otherwise, appears with error sound.**
Interaction	**When the correct choice is made by the worker, the view focuses on the collective protective equipment (i.e. ventilation system with hepa filters) . The text in the brackets appears in a pop-up window. The spray gun is animated with third person view.** **When the user chooses incorrectly to proceed without ensuring ventilation is present, their co-workers look uncomofrtable with the solvents smell and the aerosol applied. The task fails.**
MISSION 4	
Introduction	**After the spray application, the spray gun must be cleaned with solvent. The mission's concept lies on the worker disposing the liquids in special containers away from heat source rather than in trash.**

	 **Source: https://www.wikihow.com/Clean-an-Automotive-Paint-Gun**
Performance	**The worker is supposed to keep the PPE on (gloves and mask, regardless of the pictures above – they are for illustrative purposes) since a solvent with significant fugacity or toxicity might be used. The liquid and the paper used must be disposed at a special container.**
Media	**Factory sounds. First person view through the worker's eyes. After the completion of mission 3, a pop-up window appears, asking to leave the workspace as it is. If the user agrees,** **appears with error sound. If the user disagrees, the** **icon appears with sound of approval. Then a popup window suggests cleaning the spray gun and the**

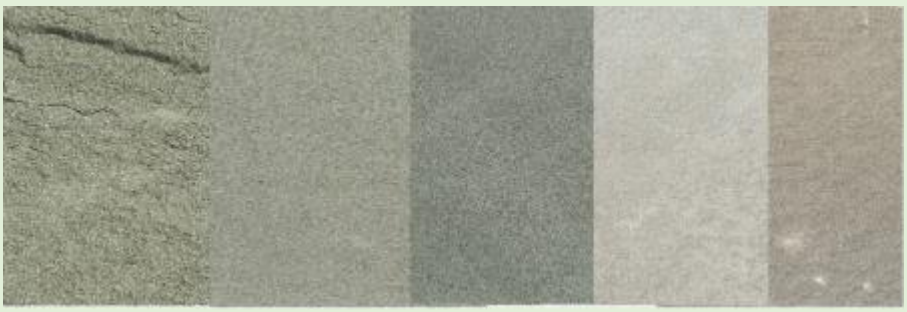
	workspace. This process is animated (with the relevant sounds), and afterwards, the user is asked (again with a popup window) whether to dispose leftovers in the trash bin or in a container for used solvents. If the user picks the last one, the icon appears with sound of approval, otherwise appears with error sound.
Interaction	**The user must complete all questions correctly in order for them to proceed to the next question. If all questions are correctly answered, the mission is accomplished. In any other case, the mission fails.**

7. Situation 7. Dust-air mixtures in a factory.

SITUATION 7. DUST-AIR MIXTURES IN A FACTORY

SITE: Location pictures	**In a stone factory that is commissioned to make natural stone of a certain size to be installed in a church. The image of the church can be seen in photos or on a computer screen.**

Source: Own photograph

MATERIAL:	**Natural Stone**  **Source:** Own photographs/photo composition **The arches and pillars are made of natural sandstone.**
APPLICATION:	**Use of stationary sawing machine in the factory for the preparation of the material.**

	 Source: https://www.expondo.ie/
PRODUCT:	**Sawing machine with water cooling to reduce dust**
ASOCIATED RISKS:	**Respiratory hazard** **Fire and explosion**
EQUIPMENT:	**Collective:** **a. Water cooling** **b. Extraction systems for dusts, including filters** **c. Extraction units for aerosols** **d. Barriers to prevent unauthorised entry into the danger zone (if necessary)** **Individual:** **e. Safety Gloves** **f. Safety footwear** **g. Safety goggles** **h. Helmet** **i. Full face mask or half mask and close-fitting safety glasses** **j. Hearing protection** **k. Fresh air filter mask during coating**
MISSION 1	

Introduction	**The mission starts in the factory hall of a natural stone company. There, the stones for the arches and pillars of the church are cut and prepared (profile, dimensions, surface design, etc.).** **The executing construction company has drawn up a setting plan for the arches. This shows all the necessary information about dimensions, shaping and required properties. Two employeesof the natural stone company work on the sandstone blocks according to this plan.** **The blocks are already in place on the saw. On the computer you can see the dimensions of the blocks.**
Performance	**The presentation of the environment can be done through an animation from the eyes of one of the workers looking into the natural stone factory.** **I) Zoom on the sawing machine: Enter the required data (dimensions) into the control unit; press the start button → Swivel to the saw blade**
Media	**Factory ambient sounds.** **A window appears to enter the measurements of the part to be cut (they must be the same data initially provided by the builder: height, width and depth).** **If the user enters the correct measurements, the icon will appear:** **If the user does not enter the correct measurements, the icon will appear:**
Interaction	**If the user enters the correct data, the saw will start cutting (sound of saw).**

8. Situation 8. Nano-waste management environmental protection.

SITUATION 8. NANO-WASTE MANAGEMENT ENVIRONMENTAL PROTECTION

SITE: Location pictures	**In a natural stone factory.** Source: **dguv.de**; **directindustry.de**
MATERIAL:	**Any Nano waste.**
APPLICATION:	**Use of extraction and filter systems for air and water pollution control in the factory.**

	Source: dguv.de; directindustry.de; umweltbundesamt.de
PRODUCT:	**Extraction systems for aerosols, filter systems for dust, retention systems for contaminated water, incinerators for nanowaste, Closed, lockable waste containers**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **p. Extraction systems for dusts, including filters** **q. Extraction units for aerosols** **r. retention systems for contaminated water** **s. Closed, lockable waste containers** **t. Barriers to prevent unauthorised entry into the danger zone (if necessary)** **Individual:** **u. Safety Gloves** **v. Safety footwear** **w. Safety goggles** **x. Helmet** **y. Full face mask or half mask and close-fitting safety glasses** **z. Hearing protection** **aa. Fresh air filter mask**

MISSION 1

Introduction	**The mission takes place in a nanomaterials factory. The equipment (referred to above in pictures) must be visualised.**

-Safety glasses

- Safety footwear

- Mask

- Safety gloves

- Safety helmet

- Hearing protection

	 - Dustproof coverall **Source: schutzgut.de** **- Waterproof suit (necessary for cleaning and maintenance work on waste water systems)** **In addition, there should be other (senseless) equipment that is not necessary: Welding umbrella, safety harness, diving goggles, safety net, etc.**
Performance	**The presentation of the environment can be done through an animation from the eyes of one of the workers looking into the natural stone factory .** **The two employees have the task of checking the extraction and filter systems and informing the factory management about any cleaning and maintenance work. In addition, they should also visually inspect the sewage pipes. Thirdly, they have the task of checking the containers for nano-waste for proper condition.**
Media	**Ambient sounds in the background.** **Interactive animation in which the employees put on their protective equipment (coverall, Safety glasses, safety goggles, safety footwear, helmet, mask)** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for this work, the error sound is heard, and the following icon is displayed:**

Interaction	**1a. In case the new worker selects the right PPE, he can continue his mission and can start their control tour.** **1b. Otherwise the task must be repeated.**
MISSION 2	
Introduction	**The employees first check the control unit of the dust extraction system. The operating hours display is particularly important. They notice that there are still several hours left until the next maintenance. However, the dust collection container is almost full. They decide to empty it.**
Performance	 **Source: fitzer-industriesauger.de** **Employees must switch off the extraction system (cut off the power) and mark or lock it in such a way that no one can start it up again as long as the work continues. The head of the factory is notified of the temporary shutdown.** **Source: jh-profishop** **At the same time, they ask a forklift driver to pick up the filter bag. They make sure that the filter bag is closed and that the forklift has a pick-up crossbar.** **A new filter bag is then installed and the system is switched on again.** **An alert may simply appear saying check the control unit of the suction system. And the user has to select the steps to follow in the correct order.**

Media	**Ambient sounds.** **The user must describe the filter change in the correct order:** **d) Inform factory management** **e) De-energise the system** **f) Secure the system against unintentional restart** **g) Order forklift with traverse** **h) Close filter bag** **i) Remove filter bag for final disposal (closed, dust-tight container)** **j) Installation of a new filter bag** **k) Restart the extraction system** **If the user chooses a wrong order, the following symbol occurs.** **This icon occurs when the order is correct.**
Interaction	**The user can view a short instruction manual for changing the filter (e.g. pop-up window).**
MISSION 3	
Introduction	**There is too much dust in the air.** **The employees check the concentration of nanomaterial in the air.** **Source: DGUV**
Performance	**The two employees measure the concentration of nanoparticles in the air.**
Media	**You can hear the suction systems and the natural stone saw.** **A pop-up window will appear with a question:** **Is it necessary to measure the concentration of nanoparticles in the air at several locations in the factory?**

	3a. No, the air and thus the concentration of nanoparticles is distributed homogeneously throughout the factory. **3b. Yes, it is necessary for the safety of workers and the environment.** **If the worker answers 3a, an error sound will appear next to this icon.** **If the worker answers 3b, a sound of approval or applause appears next to the following icon.**
Interaction	**If the worker selects the correct answers, he/she can proceed to the next screen.** **If the worker does not select the correct answers, he/she will not be able to complete the mission.**

9. Situation 9. Nanomaterial applied as an aerosol.

SITUATION 9. NANOMATERIAL APPLIED AS AN AEROSOL

SITE: Location pictures	**Construction site**
MATERIAL:	**Pool deck stone**

APPLICATION:	**As an aerosol spray**
PRODUCT:	**anti-slip coating**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**
EQUIPMENT:	**Collective:** **- Extraction systems** **- Suction systems** **- Confinement** **Individual:** **- Gloves** **- Coverall** **- Full face mask or half mask and close-fitting safety glasses**
MISSION 1	
Introduction	**The mission takes place at the swimming pool deck of an under construction resort house during daylight. This mission shows one maintenance worker who is going to apply the product and the construction manager who is waiting him with a box with "PPE" written along with an aerosol safety storage cage, in a designated ware-house area protected from sunlight:** • **Aerosol safety storage cage:** • **Safety Glasses:**

	• **Nitrile gloves:** • **Protective respiratory mask** • **Safety Helmet:** • **Tyvek Jacket**
Performance	**Performance The presentation of the environment can be done through a 360° animation from the eyes of one of the workers.** **The task to be performed is the selection of PPE by the user for the workers.** **The construction manager will welcome the new maintenance worker and tell him to take all the PPE they think they need for their work.**
Media	**The new worker (user) chooses the necessaries PPEs for him.** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for normal work, the error sound is heard, and the following icon is displayed:**
Interaction	**2a. In case the new worker selects the right PPE, he can continue his mission and get ready to enter the site with all his PPE on.**

	2b. The worker has not correctly selected his PPE, so the boss does not allow him to enter the site. The task has failed.
MISSION 2	
Introduction	**Introduction The worker, already dressed in their PPE, go to the pool to fix it, carrying the aerosol safety cage. The natural stone at the poll deck has dirt accumylation on it.** **The image of the mission now needs to focus more on the pool area.**
Performance	**Animated photos of the worker with his uniform and PPE.** **Zoom on the salt accumulation in the pool and on the cracks.** **The worker must apply the product to enhance the anti-slip properties of the surface**
Media	**A pop-up window will appear with a question:** **Can the anti-slip aerosol product be applied with the dirt present on the stone?** **2a. If the worker answers yes, an error sound will appear next to this icon.** **2b. If the worker answers no, a sound of approval or applause appears next to the following icon.**
Interaction	**2a. In case the worker selects the option to apply the consolidant-hydrofugant without first cleaning the mission will fail.** **2b. If the user selects the option not to apply if not cleaned. He/she can continue with the mission. The option to clean will appear on a button.**
MISSION 3	

Introduction	**In this mission, the scene will appear clean, otherwise it will be the same as in mission 2, but the pool deck will be clean. The worker must apply the product to solve the problem of slippery surface**
Performance	**The worker must apply the product to solve the problem of slippery surface**
Media	**The pop-up window will appear with two options:** **3a. The application of the product must start from the perifery of the edge of the pool deck and then the application should continie bakwards. . If the worker selects this option, a sound of approval or applause will appear next to the following icon.** **3b. The application of the product must be done in a random way, ". If the worker selects this option, an error sound will appear next to this icon.**
Interaction	**If the worker selects option 3a, the mission can continue** **When an incorrect option 3b is selected, mission will fail.**
MISSION 4	
Introduction	**The scenario is the same as in the previous mission.**
Performance	**You can see an animation in which the user applies the product correctly. Finish his work, puts down the aeroso; can beside several other used cans, outside the EMPTY aerosol safety cage. The construction manager calls his attention to engage in a conversation.**
Media	**The dialogue between the two partners can be read at any time. The user will be able to choose between several options. It will be an interactive dialogue.** **C.M: Your action is not in accordance with good working paractices?** **W: Option 1: No, it is ok, I can leave now. I have finished with the application of the product!** **W: Option 2: Why, what I have done wrong?** **If in this question the worker selects option 1, he/she will fail the mission. If the worker selects this option, an error sound will appear next to this icon.**

	If he/she selects option 2, he/she will be able to continue. If the worker selects this option, a sound of approval or applause will appear next to the next icon.
Interaction	**If the worker selects the wrong answer, he/she will not be able to continue with the mission.** **If the worker selects the correct answer, he/she will be able to continue with the mission. A textbox will appear withe following text: Construction manager answers: " The direct sunlight may overheat the cans and they could become missiles with the possibility to harm you. You must put them in the safety cage and carry it in the warehouse. Then trained personell waearing appropriate personal protective equipemnt will perfom puncturing in a designated area for this activity and any remaining content will be removed and then can be recycled. " Animation, then will show, worker carrying the aerosol safety cage in the warehouse. Applause sound will be heard and the following image will appear** **Mission is completed**

10. Situation 10. Waste cleaning or disposal after working hours.

SITUATION 10. WASTE CLEANING OR DISPOSAL AFTER WORKING HOURS	
SITE: Location pictures	**Factory**
MATERIAL:	**All the facilities**
APPLICATION:	**Not applicable**
PRODUCT:	**Any nanoproduct**
ASOCIATED RISKS:	**Respiratory hazard** **Ingestion hazard** **Skin and eye contact**

EQUIPMENT:	**Collective:** **bb. Extraction systems** **cc. Suction systems** **dd. Confinement** **Individual:** **ee. Gloves** **ff. Coverall** **gg. Full face mask or half mask and close-fitting safety glasses**
MISSION 1	
Introduction	**The mission takes place at a locker room.** **This mission shows two new workers who are going to work at the production department; they have the task of cleaning the extraction and filter systems.**
Performance	**The task to be performed is the selection of PPE by the user for the workers.**
Media	**Ambient sounds in the background.** **Interactive animation in which the employees put on their protective equipment (coverall, Safety glasses, safety goggles, safety footwear, helmet, mask)** **- Safety glasses** **- Safety footwear** **- Safety harness**

- Mask

- Rubber gloves

- Safety helmet

- Hearing protection

- Reflective waistcoat

- Electrical protective gloves

- Safety belt

- Dustproof coverall

- Waterproof suit

- Safety gloves

	  1a. If the choice is correct, a sound heard of acceptance and this icon appears: **1b. In case the selection is incorrect either because PPE is missing or because he/she has selected PPE that is not necessary for this work, the error sound is heard, and the following icon is displayed:**
Interaction	**2a. In case the user selects the right PPE, he can continue his mission and he can get ready to go to the production department.** **2b. The user has not correctly selected PPE, so he cannot go. The task has failed.**
MISSION 2	
Introduction	**The mission takes place at the production department.** **This mission shows the new workers who are cleaning the extraction and filter systems.**
Performance	**The task to be performed is the selection by the user of the correct way of disposing the dirty HEPA filters and the waste materials produced by the cleaning of the extraction and filter systems.**
Media	**Ambient sounds.** **The user must choose how and where the different waste must be disposed:** **hh. In open bag or open box**

ii. Closed ordinary waste bag

jj. Hazardous waste bag

kk. Recyclable waste bin

ll. Ordinary waste container

mm. Closed, lockable waste container

1a. If the choice is correct, a sound heard of acceptance and this icon appears:

1b. In case the selection is incorrect, the error sound is heard, and the following icon is displayed:

Interaction	**2a. In case the user selects the right way of waste disposing, he can finish his mission and return at the locker room.** **2b. The user has not correctly selected choices, so he cannot go. The task has failed.**
MISSION 3	
Introduction	**The mission takes place at the production department.** **This mission shows the new workers who are cleaning the water treatment and water purification system.**
Performance	**The task to be performed is the selection by the user of the correct way of disposing sewage sludges and the other waste materials produced by the cleaning of the water treatment and water purification system.**
Media	**Ambient sounds.** **The user must choose how and where the different material must be disposed:** **nn. Sewer drains** **oo. Ordinary garbage can**

pp. Proper hazardous liquid waste tank

1a. If the choice is correct, a sound heard of acceptance and this icon appears:

1b. In case the selection is incorrect, the error sound is heard, and the following icon is displayed:

Interaction	**2a. In case the user selects the right way of waste disposing, he can finish his mission and return at the locker room.** **2b. The user has not correctly selected choices, so he cannot go. The task has failed.**

MISSION 4	
Introduction	**The mission takes place at a locker room.** **This mission shows two new workers who have finished their workshift; they cleaned the extraction and filter systems or the water treatment and water purification system.**
Performance	**The task to be performed is the selection of correct treatment of used PPE by the user for the workers.**
Media	**Ambient sounds in the background.** **Interactive animation in which the employees take off their personal protective equipment (coverall, safety glasses, gloves, safety footwear, helmet, mask)** **The user must choose what is the correct treatment of each different used PPE:** **A) Disposed off** **B) Cleaned by vacuum system** **C) Washed** **D) <u>Cleaned by a damp cloth</u>** **1a. If the choice is correct, a sound heard of acceptance and this icon appears:** **1b. In case the selection is incorrect, the error sound is heard, and the following icon is displayed:**
Interaction	**2a. In case the user selects the correct treatment of each different used PPE, he can finish his workshift and return at home.** **2b. The user has not correctly selected choices, so he cannot go. The task has failed.**

Annex II: Implementation of improvements. technical improvement and 3d development

NanoSafe consortium produced a 3D Training Tool that included 10 3D risk scenarios based on the application and safe use of nanomaterials in the stone sector that show the main risks derived from their use, as well as the preventive measures needed for their mitigation.

The 3D Training Tool was improved, so the beta version of the tool was modified with the improvements identified in the evaluation by the collaborators, as well as the testing in courses of the participants. In addition, the technical conclusions of the International Seminars were also considered.

Methodology and operation of the application.

The research and development of NanoSafe has been divided into several distinct parts corresponding to the development of the planned work packages.

The following sections describe the evaluation methodology on which the project has been based, as well as its operation and the improvements implemented.

1. Development of the tool.

This project is based on the immersion that Virtual Reality allows us. Currently, the most common way of developing applications with this technology is by means of videogame graphic engines. That is why the procedure followed in the creation of the tool is based on the development of a video game, in this case for educational purposes.

This can be divided into three main tasks that will be covered extensively in the following sections:

- **Design of the scenes.**
- **Development of the 3D environments.**
- **Development of the functionality and immersive experience.**

In order to carry out the development efficiently and effectively, it should be noted that different technologies have been used:

- **Blender:** Multiplatform software dedicated to processing, modelling, rendering and other tasks related to 3D graphics. It is open source and has a large community with videos and documentation, which makes it very easy to learn.
- **Unity:** This is another open source software, but in this case it is a graphics engine and is usually used for the development of video games. It is highly scalable, allowing you to

add your own modules by means of code scripts, and it also has an interesting community and documentation.

- **Oculus Quest:** This is a very affordable and accessible Virtual Reality device. Developed by Meta as one of the pillars of its new philosophy. They do not require cables for use and have an easy integration with Unity.

2. Scene design.

This is the process by which each of the steps to be followed from the point of entry into the tool until the immersion is completed are devised. In other words, generating the development script for the application.

Firstly, 10 work situations have been chosen in which the use of nanomaterials in the wrong way can pose a risk to health or the state of the environment. The selected situations are the following:

- **Use of sawing machine with water cooling to reduce dust:** In this situation an area of a house is to be paved. For this purpose, a water-cooled saw is to be used to reduce dust. The player must perform the necessary steps to use this tool safely.
- **Application of different products in a stone factory (part I):** In this situation, different products will be applied to the natural stone in the factory. The correct steps must be taken to avoid endangering the product and our health.
- **Pouring of nanomaterial powder into a liquid matrix to create a mixture:** In this situation, the user will have to make a mixture of powder into a liquid matrix to be applied in a construction environment.
- **Nanomaterial applied with a spray-gun on a stone material surface:** This situation aims to prepare an outdoor working area where the nanomaterials will be applied to the stone surfaces with a spray gun. The application will take place in a swimming pool and the environmental conditions will not be optimal.
- **Nanomaterial fixed in a solid matrix which is being drilled:** In this scene, the work consists of preparing a construction environment for drilling into the coated stone surface to lay the electrical wiring for the outdoor lighting fixtures. Focusing on the prevention of risks from the generation of nanomaterials.
- **Application of different products in a stone factory (part II):** Prepare an indoor work area where the nanomaterials will be applied to the stone surfaces with a spray gun and paint roller. This will be done in the natural stone factory.
- **Dust-air mixtures in a factory:** This scene is set in a natural stone factory. Stones are asked to be cut to restore a church. The objective is to test decision-making to prevent nanomaterials from affecting the workers in the plant.
- **Nano-waste management environmental protection:** This scene will contain a series of missions aimed at air and waste management in a natural stone factory. To achieve a safe environment free of nanomaterials that could harm the workers.

- **Nanomaterial applied as an aerosol:** In this scene the pool will have to be finished using anti-slip spray. This will be done in the scene where the construction of a house is being finished. We will have to perform the correct steps in order not to damage our health.
- **Waste cleaning or disposal after working hours:** In this scene the user will have to make decisions about the waste generated in a natural stone factory.

Health and safety being the main objective of this project, an analysis of each of these situations and the decision making required for the use of the different nano-products selected for this project has been carried out. Thanks to this analysis, we can summarise each situation in the following diagram:

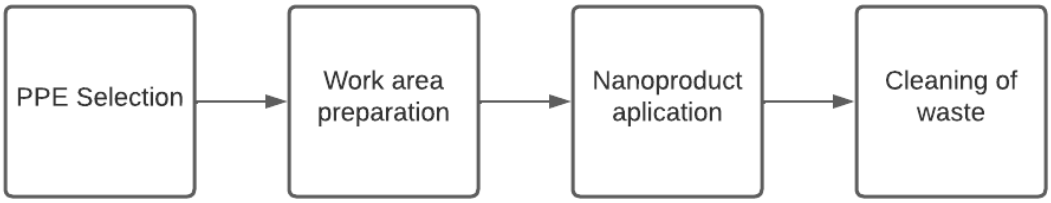


Figure 14: Outline of risk situations.

It is in this context that it was decided to create a scene model by consecutive steps or missions (as we would say in the videogame world), i.e. only if the first step is completed can the next one be carried out, and so on and so forth. In this way, the user is forced to complete the whole process safely from start to finish, and failure to do so is considered a failure in the scene.

To simulate each of the steps, different panels have been generated with information that the user will have to read to act.

The panels found in each scene can be classified into the following types.

General instructions

These are panels that appear at the beginning of each scene. They explain the procedure to follow to reach the missions, as well as general information about certain tools.

Each mission will start with a welcome panel and two panels with basic instructions:

Missions: This panel will indicate which type of signal will indicate where to find the next mission. This for guiding the user during the scene.

Missions Panel

You must complete some missions.

To find them look for the following sign:

Continue

Teleport: This panel explains the teleport tool and how to use it. This tool is important because in some situations the scenario will be much bigger than the place that you can use for the virtual reality, so walking is not an option.

Teleport Panel

To move around the stage, use the teleport tool.

This is activated using the main button (A or X).

Continue

Fail Panel

Each time a mission is failed, the following panel will appear:

You have failed the mission.

Retry

Success Panel

Each time a mission is completed, the following panel will appear:

Congratulations!

Mission completed!

Next Mission

Fail Scene Panel

This panel will appear when you fail 3 times during the scene. This is a measure taken to prevent the user from remaining immersed in virtual reality for too long, as it can cause dizziness. In addition, it is a way to force the user to grasp all the concepts of each scene.

You have failed too many times.

Please, check the manual or your teacher's info and try again.

Main Menu

PPE Mission

This mission shall be common to each and every scene. It shall consist of the selection of the personal protective equipment necessary for the task to be performed.

MISSION 1:

Select the security equipment for the task.

Continue

To select an object:

Touch it with your hand.

Pull the trigger of your middle finger. Continue
Select the objects and check if your selection is correct: Check
Checking your security equipment...

(Success Panel)	(Fail Panel) This is not the right equipment.

Mission (Example)

These panels will vary according to the task to be performed, containing information, questions, dialogues or orders to be completed. There will be between 3 and 6 missions for each situation.

MISSION 5: The tank of water is full and it must be emptied. Continue
Quiz: Where the water should be emptied? 1. The floor. 2. Into a waste container.

Take the bucket and put it in the right place to pour the water in it.	(Fail Panel)

Quiz What do you do with the waste container? 1. Run it through a filter system and dispose the grinding scrap. 2. Use it to water the lawn.

3. Dump the water into the next canal.	
(Success Panel)	(Fail Panel)

3. Development of 3d environment.

In the development of tools in videogame graphic engines, we usually work with objects. This is why the second major task consists of generating each of the objects or assets that are directly and indirectly defined in the scripts generated in the previous section.

This process is in turn divided into three tasks:

- **Modelling:** A mathematical representation of a three-dimensional object is made using specific software. In this case, Blender has been used.
- **Rigging:** This is the process by which the different parts of an object are separated in order to create a controllable system that allows effective and efficient animations. Blender has been used as the software. This will be necessary for those objects that are going to be animated.
- **Texturizado:** This is the process by which 3D objects are given colour and detail. Blender has been used as software.

The list of objects developed for this project is very wide and diverse, from very simple objects to complex machines with a lot of detail. The objects generated can be classified into the following categories.

- Containers, Buildings, Stores and many more decoration elements.

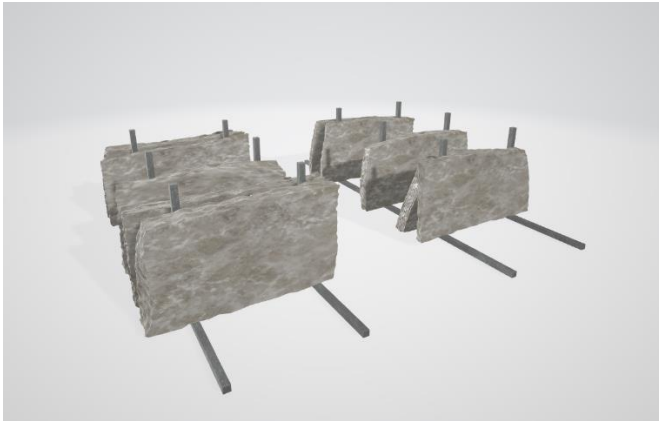


Figure 15: Stone slabs.

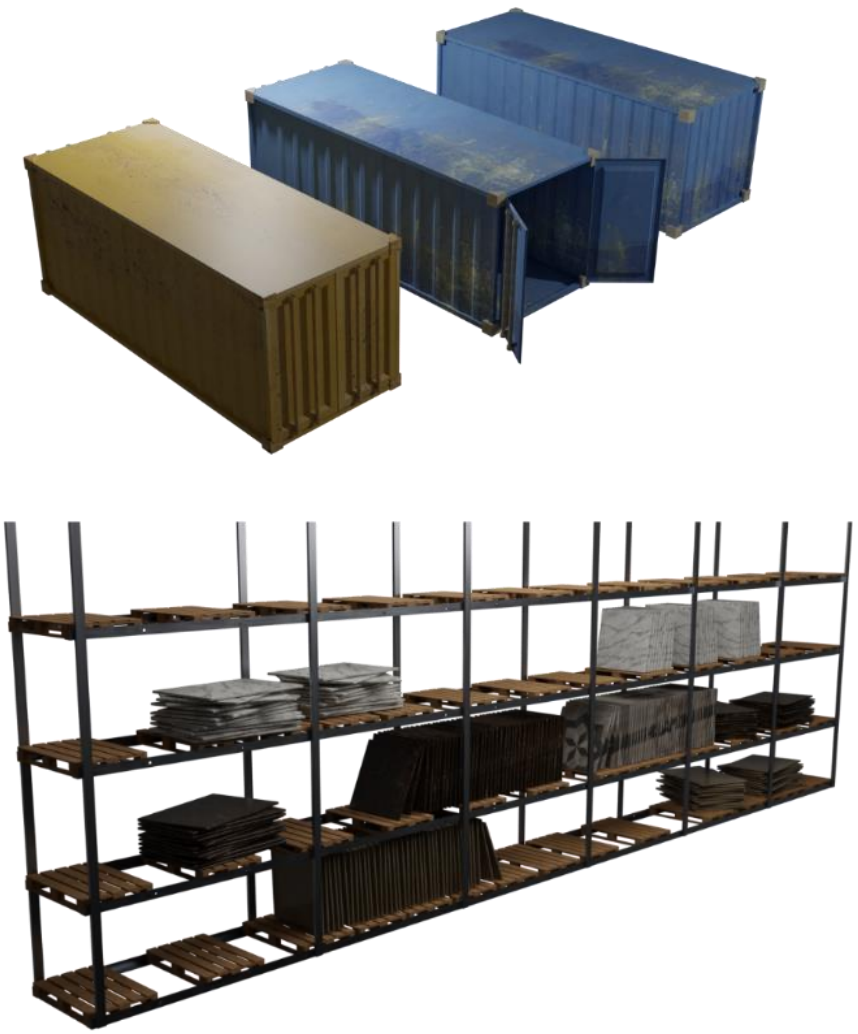


Figure 16: Containers and stores.

- Personal equipment and many handy objects.

Figure 17: Other elements.

- Specific machines for the different situations.

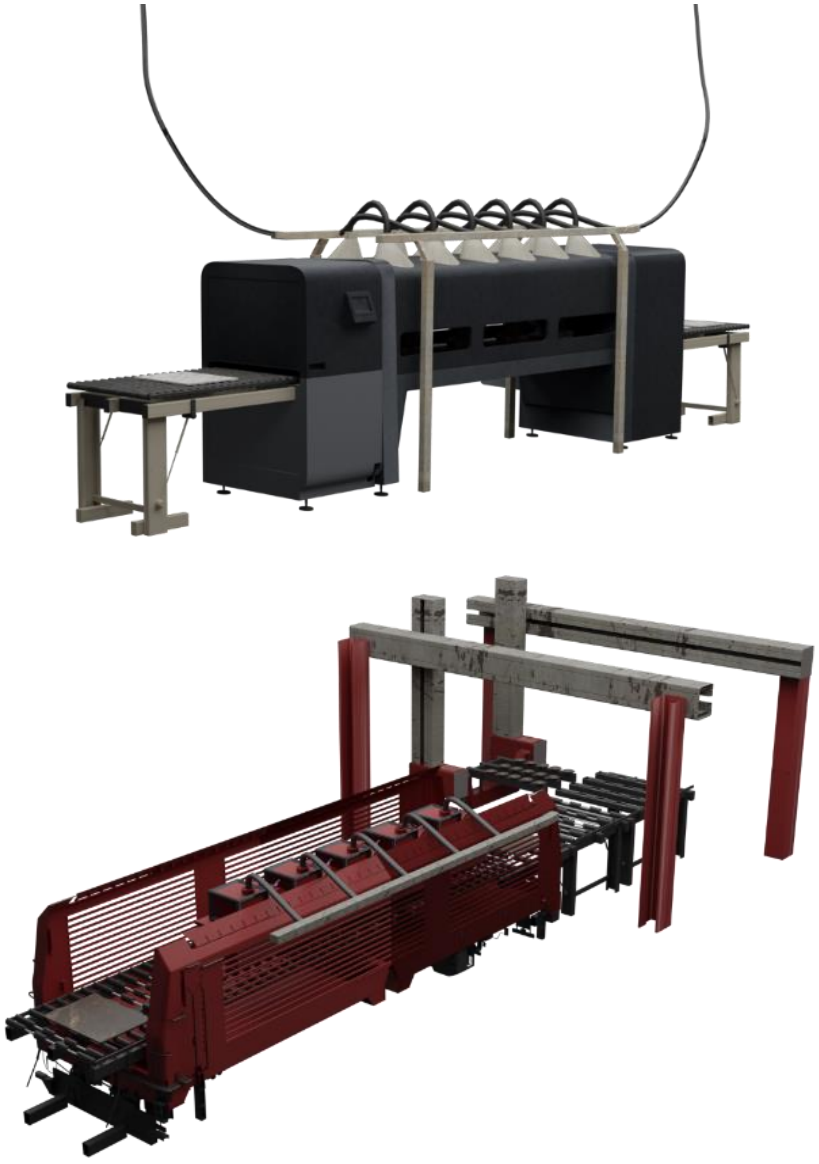


Figure 18: Specific machines.

Figure 19: Saw machine.

After the development of each of the objects to be used, the scenarios are prepared so that the development of the functionality is as accurate and as close to the final situation as possible. This process is not usually definitive, as the testing process can lead to modifications. This process has been carried out with the Unity graphics engine, as it is the one that will be used to generate the application.

If we analyse the descriptions of each of the situations described in the previous section, we can see that there are three different scenarios:

- **Stone factory:** It is a factory based on a natural stone plant. It is divided into several rooms, including the machine room, the chemical store and the waste extraction room.

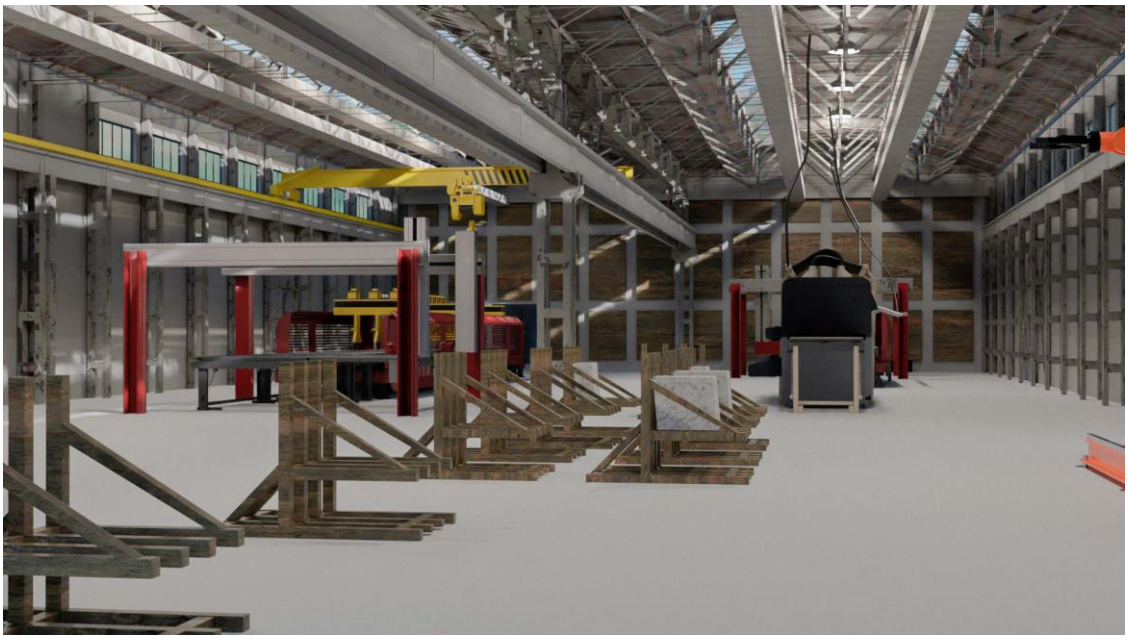


Figure 20: Stone factory scenario.

- **Construction site:** This model shows a construction site with various huts, scaffolding, the skeleton of a building and some working machines.

Figure 21: Construction site scenario.

- **House to be finished:** This is a villa with a swimming pool, with some unfinished finishes. It has a management office and some decorative objects.

Figure 22: House scenario.

4. Functionality development and immersive experience.

Functionality development is the process by which all the collected theory takes shape. In other words, the aim of this task is to make the tool usable. The Unity graphics engine has been used to develop it, as it provides a simple integration of Virtual Reality and has a large community.

Projects in Unity are divided into Scenes, which can be intertwined with events. Scenes are composed of different objects that will contain certain components, which give different characteristics or behaviours to the objects.

The development of functionality is a broad task but can be subdivided into several processes: **Design and Architecture, Data Modelling, SDK Integration and Event Management.**

4.1. Design and architecture

This is the process of shaping the script developed in previous sections, that is, devising the path and decision-making that each scene or screen will entail.

The experience of the tool has two distinct parts. The structure it will present is shown in the flowchart in Figure 9.

4.1.1. Main Menu

The first screen allows the user to adapt to the virtual environment in which he/she will be involved during the use of the tool. Although the movements are limited in order to focus the user's attention on the real objective of the scene, which is to select one of the situations proposed for the correct use of nano products. Previously, it is necessary to select the language in which we want the application to run.

The next screen will depend on the selection made on this screen.

Figure 23: Main Menu

4.1.2. Scene N

This is the important part of the tool. In this section you will find each of the missions developed, the first one being the selection of personal protective equipment (PPE).

If a mission is passed, we will move on to the next one. If it is the last mission, we will return to the main menu. In case of failure of a mission, we will have the option to try again, unless the number of failures during the scene is greater than 2.

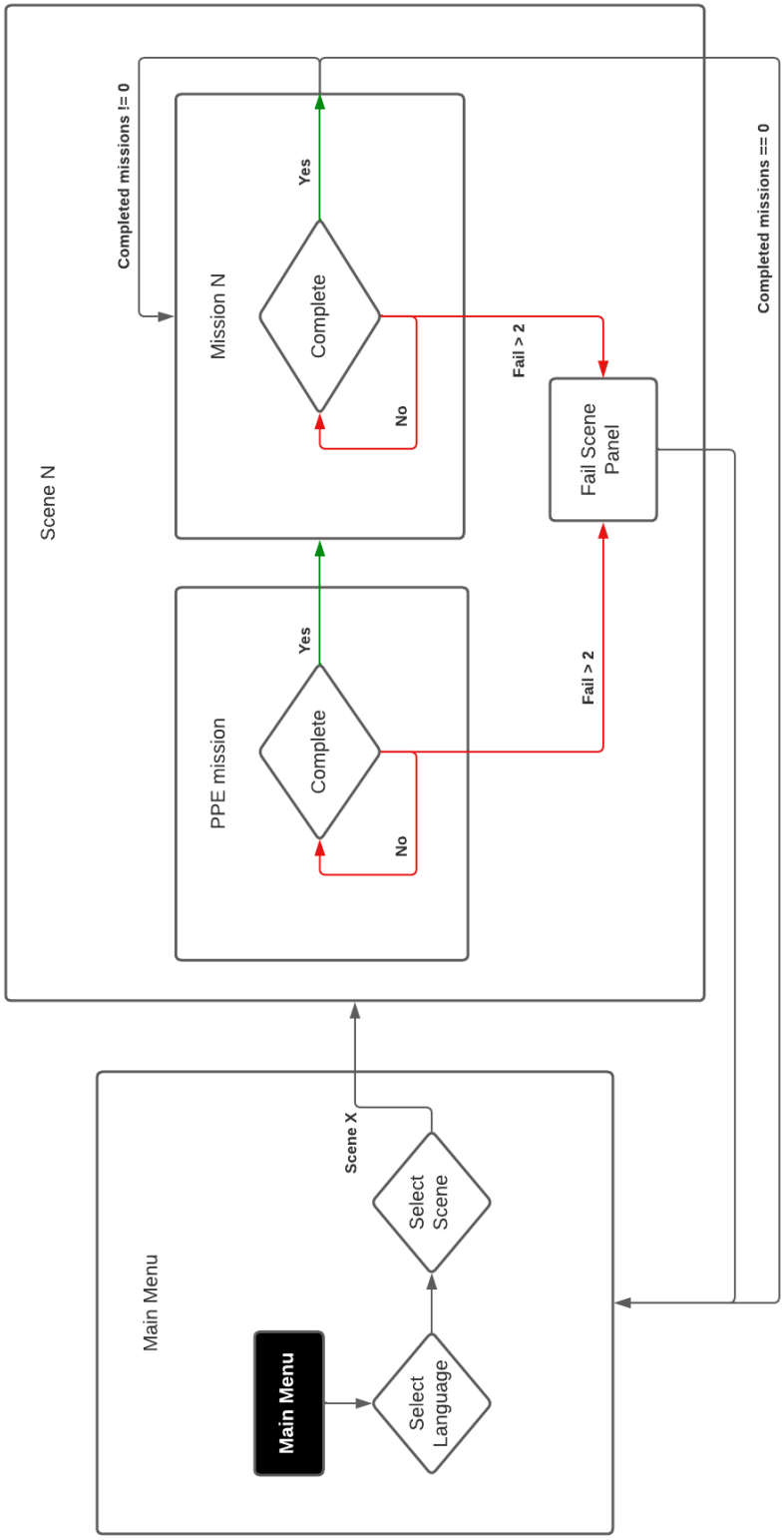


Figure 24: Tool flow diagram.

4.2. Data modeling

In this task the objective is to generate a general schema on which the information is stored and retrieved. To achieve this, the PlayerPrefs module has been used, which is a class provided by Unity that allows storing data as a key with the name of the project.

These variables in an Oculus application are stored as an XML file inside the directory /data/data/pkg-name/shared_prefs/pkg-name.v2.playerprefs.xml, where pkg-name will be the name of the application.

In addition, Unity provides a very easy accessibility to this dataset thanks to the functions provided by the PlayerPrefs class.

The only variable that will be common and that we will have to store, due to the structure of this application, will be the one that refers to the language. To do so, we will use the following functions:

- **SetString (*name, value*):** This function will allow us to write a string value on the name variable. In this case, the reference ISO code of the language selected in the menu will be entered.
- **GetString (*name*):** This function returns the value of the variable name. It will be used in each of the scenes to know which language is selected.

4.3. SDK Integration

The development of any type of Virtual Reality application requires three components. A compatible device that can be connected to the computer, a videogame graphics engine and a Software Development Kit (SDK). The first two requirements were explained at the beginning of the chapter and will be Oculus and Unity, respectively.

An SDK is any set of tools that enable a software developer in the creation process. In the case of Virtual Reality, and in particular the packages adaptable to Unity, there are several, including one specific to Oculus. But the XR Interaction Toolkit has been chosen. A package developed by Unity that allows the project or application to be adapted to any type of device. In other words, even if the tool is developed with the Oculus Quest, it can be installed on any device compatible with Unity. So, you get a wider reach.

To build a project that introduces the SDK and allows interaction in Unity, the following steps must be followed:

1. When opening the engine generate a project with the *Universal Render Pipeline* template. It is important to do it with this template as it provides optimised graphics, and this is a requirement of Virtual Reality if we want to have a correct experience.
2. Install the SDK, i.e. the XR Interaction Toolkit package. This can be done from the Package Manager window, accessed from the Window menu option.

3. We will have to indicate the type of device on which it is going to be built. To do this, activate the VR supported option in Project Settings/Player.

In this way, the Unity project is ready for Virtual Reality development. However, to start the interaction of the device with the graphical environment, the steps described in the following section must be followed.

4.4. Event management

Event management could be considered the most extensive task within the development of the functionality. It consists of using the components provided by Unity and generating small scripts to achieve the expected user-machine interaction.

This section could be too long, as each scene has a lot of specific details at interaction level. But here only the common and important points to achieve the goal will be captured.

4.4.1. Prepare the scene for VR interaction

Once the Unity project has been prepared and the scenarios have been set up or graphically prepared, the next step will be to prepare the scene so that the interaction device can be linked to a camera, and we can use it for testing during development. The process explained in the following steps will be repeated for each of the scenes to be used in the project:

1. The first thing is to remove the default camera.
2. Generate an empty object with an XR Rig component, which will be the container for all the human-machine interaction. We call it VR-Rig.
3. Generate a child object, also empty, which will be the reference position, where the user will start the interaction. This will be called Camera Offset.
4. Generate a camera as a child of Camera Offset, with a Tracked Pose Driver component. This is the object that will act as our eyes and the added component that will allow us to rotate.
5. After this, fill the variables of the XR Rig component (parent object, VR-Rig) with the reference position and the created camera. And place floor as the value of the Tracking Origin Mode attribute, this will make the camera adapt to our height automatically. This way, we get the eyes of the system fully functional.
6. To achieve mobility and visibility of the controllers, two new children are generated inside the Camera Offset object and the XR Controller attribute is added.
7. Add the model we want to use as controllers in the Model Prefab attribute.
8. Finally, to these two objects we add the XR Direct Interactor component, which will give the controllers interactivity with the rest of the objects in the scene.

4.4.2. Controller input

This is the process by which the values generated by pressing each of the buttons on the knobs are obtained. This will be used for a huge number of tasks, such as picking objects, selecting options, etc.

Before generating anything with these values, it is important to know what type of data each of the input handles. This can be seen in the *XR Interaction Debugger* window, which you can access from Window/Analysis.

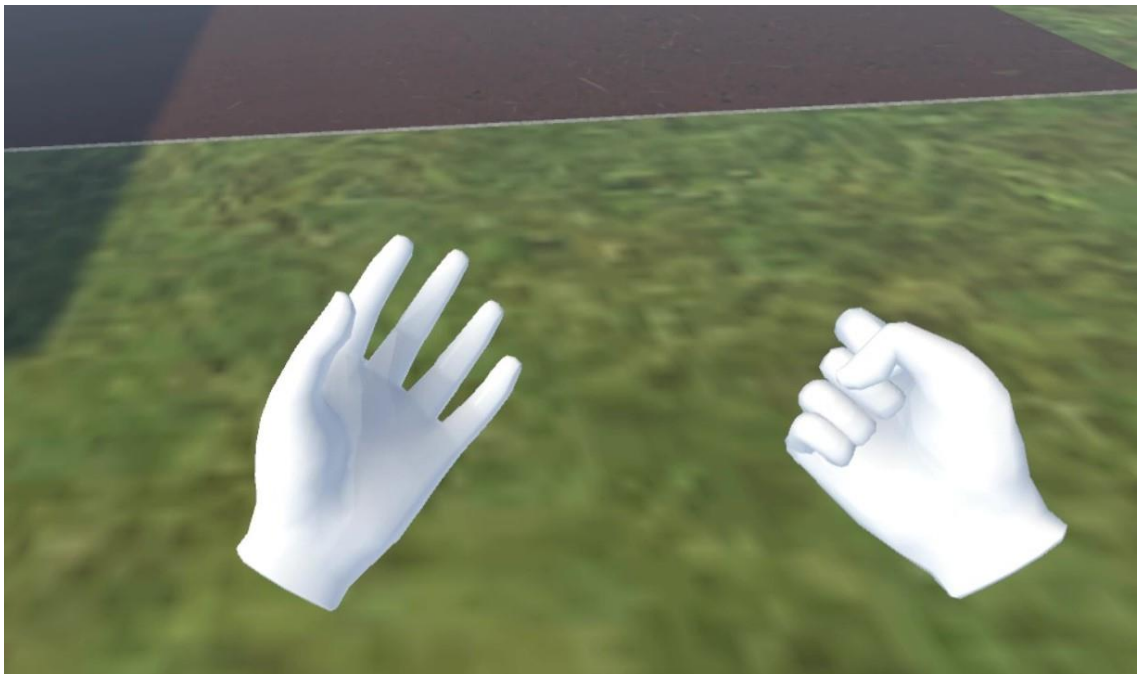


Figure 25: Hand Input.

With this information, the next step is to generate a script to obtain these values. The class that has been generated with this is called *HandController* and is used as a component of each of the 3D models that were added in the Model Prefab attribute of the controls. The highlights of the code are:

```
public class HandController : MonoBehaviour
{
    //Input
    private InputDevice targetDevice;

    //Controller model options
    public bool showController = false;
    public List<GameObject> controllers;
    private GameObject spawnedController;

    //Device characteristics
    public InputDeviceCharacteristics controllerChar;

    //Hand model
    public GameObject handModel;
    private GameObject spawnedHandModel;

    private Animator handAnimator;

    //Get if is Right or left
    public string isRight;

    //Input variables
    public float trigVal;
    public bool primaryButton;
    public float gripValue;
    public Vector2 axisVal;
```

Figure 26: HandController class

1. The first thing you see in the image above is the declaration of variables. Those that are public will correspond to alterable attributes of the component.
2. When generating a new script, two functions are always automatically created: *Start()*, which is executed once at the start of instantiation, and *Update()*, which is executed iteratively for the life of the component.
3. The first thing that happens inside this component is the *TryInitialize()* function, in this the VR device is obtained according to its characteristics. For each controller the characteristic will be whether it is right or left. This is achieved by calling the *GetDevicesWithCharacteristics()* function inside the *InputDevices* module.

```
//Try get input device and attach the selected model to it
void TryInitialize()
{
    //Get VR devices by characteristics
    List<InputDevice> devices = new List<InputDevice>();
    InputDevices.GetDevicesWithCharacteristics(controllerChar, devices);


    if (devices.Count > 0)
    {
        //Get target device and get a controller model
        targetDevice = devices[0];
        GameObject prefab = controllers.Find(con => con.name == targetDevice.name);

        if (prefab)
        {
            spawnedController = Instantiate(prefab, transform);
        }
        else
        {
            Debug.LogError("Did not find corresponding controller model");
            spawnedController = Instantiate(controllers[0], transform);
        }

        //Instantiate Hand Model and get Animator component
        spawnedHandModel = Instantiate(handModel, transform);
        handAnimator = spawnedHandModel.GetComponent<Animator>();
    }
}
```

Figure 27: TryInitialize() function

4. The *Update()* function is then executed, which calls the *UpdateEvents()* and *UpdateAnimations()* functions.
5. *UpdateEvents()* is responsible for obtaining each of the values generated by the controller through the *TryGetFeatureValue()* function and stores them in the public variables that were generated in the first instance.
6. UpdateAnimations() is a function created to activate the animations that each of the buttons would suppose in case of having a rigged hand model. In any case, it is not an important function in the task of obtaining the values.

```
//Update hand events
void  UpdateEvents()
{
    //Trigger event
    if(targetDevice.TryGetFeatureValue(CommonUsages.trigger, out float triggerVal))
    {
        trigVal = triggerVal;
    }

    //PrimaryButton event
    if (targetDevice.TryGetFeatureValue(CommonUsages.primaryButton, out bool primary))
    {
        primaryButton = primary;
    }

    //Grip event
    if (targetDevice.TryGetFeatureValue(CommonUsages.grip, out float gripVal))
    {
        gripValue = gripVal;
    }

    //Joystick event
    if(targetDevice.TryGetFeatureValue(CommonUsages.primary2DAxis, out Vector2 axis))
    {
        axisVal = axis;
    }
}
```

Figure 28: UpdateEvents() function.

4.4.3. Quiz Manager

To make the development easier and faster, a class called *QuizManager* was generated to standardise the process of creating panels. This element consists of the following steps:

1. Variables are generated for all the questions, the current question, the correct answer, and the UI elements.
2. The *InitQuiz()* function is generated, which is responsible for initialising each of the variables that will be needed. It will then call the *SetNextQuestion()* functions, to initialise the quiz.
3. *SetNextQuestion()* and *SetAnswerOptions()*: These functions update the variables and panel elements such as texts and buttons, setting the value of the next queued question, removing the previous one, if there was one. La función que se activa al pulsar un botón de respuesta es *SelectButton(Button but)*.
4. The function that is activated when an answer button is pressed is *SelectButton(Button but)*. In the case of a question with only one answer, this will call the *CheckResponse()* function.
5. *CheckResponse():* It is the function with the logic that is in charge of checking if the selected answer is the correct one. If it is, it will pass to the next panel, if it is not, it will

add a failure to the scene and will give rise either to the failure panel or to the scene failure panel.

Figure 29: Quiz

4.4.4. Translator

This process acts on each of the scenes in the background to provide each UI element of the tool with the texts translated into the selected language.

First, a translation of the texts into each of the languages of the participating partners has been carried out. These documents will have a format in which each word or phrase will have a key, which will allow us to access this phrase in any of the languages.

For this purpose, two classes have been created:

- *MainTranslate:* This class oversees creating the link between the translation scripts and the working environment, in this case, the code. Each time a search for this key generated in the previous script is performed, this class will return the word or phrase in the correct language.
- *SceneTranslate:* This class oversees indicating to MainTranslate at the beginning of each new situation, which is the search language selected in the menu.

With these processes in place, all you must do is change each of the lines of text you intended to enter to the next line of code:

```
text = MainTranslate.Fields[textKey];
```

Figure 30: Translation line

4.4.5. Interaction with rays

This task allows the user to interact with objects or panels at a certain distance. It involves generating a beam that comes out of the hand and allows the user to perform actions on certain objects. For this project, it will be of great importance to answer the questions that have been posed.

To generate this type of interaction, the following steps will be necessary:

1. Create a Ray Interactor object that appears in the GameObject/XR menu for each of the hands.
2. Next, select the objects to be acted upon. To do this, change the Raycast Mask parameter of the XR Ray Interactor component. This attribute will give us the option to choose on which Layer we want the ray to act, so that the objects on which we want the ray to act will have to have that Layer.
3. In this case we have selected the UI layer the panels provided by Unity.
4. Finally, so that the ray doesn't appear all the time, we will have to change the Invalid Color Gradient attribute of the XR Interactor Line Visual component to a transparent value. So that only when the hand points at a panel will the lightning bolt appear.
5. These two objects will be introduced as children of Camera Offset, an object created in the scene preparation, so that it will be included in the object referring to the VR device.

With the implementation of this section, we get the functionality that allows us to generate each of the different panels described and interact with them.

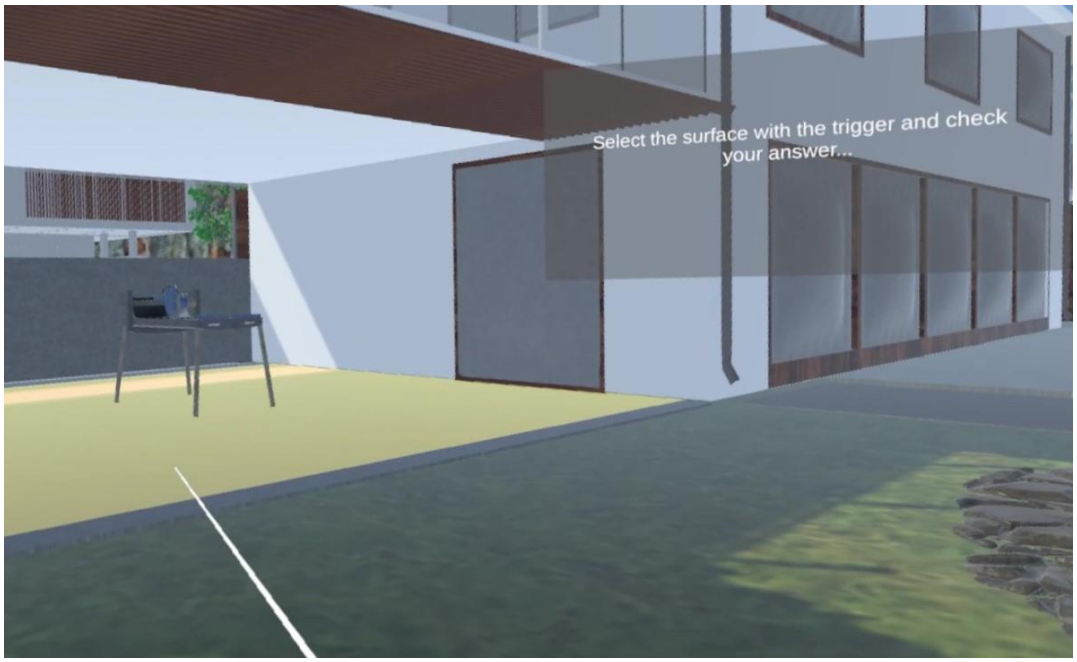


Figure 31: Ray Interactor.

4.4.6. NPC

The world of Artificial Intelligence is very broad and encompasses many different branches. In the world of video games, it is usually understood as an NPC (Non Playable Character) that makes decisions in a semi-autonomous way. In this case, it is a character that will tell the user what the next mission is and will interact with him on certain occasions.

To make the character go to the different missions, the *NPCTargetPath* class has been created, which takes advantage of the Nav-mesh functionality provided by Unity. This allows you to create an agent that moves through a space with obstacles. To generate the code fragment of this, the following steps must be followed and understood:

1. Generate the variables that are considered important. In this case, all of them will be public variables that can be modified. Mainly the destinations to which the character must move in order.
2. The *SetDestination()* function is created, which is activated from the application and is responsible for activating the next destination of the character, making it automatically go to this destination, also activating the walking animations.
3. The *Update()* function will check if the character is moving or not, to activate the static animations.

Figure 32: NPC interaction.

Annex III: Technical conclusions of international seminar in Italy

This task is included in Intellectual Output 2 "*Production of 3D Training Tool for application of nanomaterials in Stone Sector* " of the NanoSafe project.

This Multiplier Event, held on the Ferrara fair and organised by Scuola Edile Padova, focused on the use of nanomaterials in stone products and was attended by professionals from the construction and stone sector. At this multiplier event, all the results produced at this stage of the project were disseminated.

The different risks and prevention measures for the use of nanomaterials were analysed and the strengths and weaknesses of each of them were discussed as well as their adaptation to the current needs of the stone sector and whether they respect EU environmental policy. The experts' comments were used to improve this intellectual product.

This technical report compiles the main conclusions with the aim of implementing corresponding improvements in the project results.

1. Agenda

NanoSafe project

MULTIPLAYER EVENT

IMPROVING TECHNIFICATION, SAFE PRODUCTION AND USE OF NANOMATERIALS IN STONE SECTOR.

JUNE 8th, 2022

Meeting place: RESTAURO SALONE INTERNAZIONALE

FERRARA FIERE Via della Fiera 11 - 44124 Ferrara (Emilia Romagna) ITALY

SALA ASIA (primo piano - atrio)

12.00 – 12.15	0. Welcome participants by host organisation
12.15 – 12.30	1. Registration participants to FORMEDIL stand
12.30 - 13.10	2. Welcome buffet
13.15 – 14.00	3. General presentation the project - Director SCUOLA EDILE PADOVA in SALA ASIA (First floor - atrium)
14.00 – 14.30	4. Presentation of the 10 scenes in the VR device
14.30 – 15.00	5. Comments and Closure of the meeting

2. General overview of the Nanosafe project

The Multiplier Event was held by Scuola Edile Padova, which was hosted in the stand of Formedil, which is the joint national body for training, safety and employment services in Italy.

It was carried out by Mr. Andrea Pagnacco, Director of Scuola Edile Padova.

Scuola Edile Padova has been dealing with safety courses for adults and building companies for years. In addition to that, Scuola Edile Padova is also a VET school which has been active in the field of education and training to teenagers.

The seminar was attended by teachers and trainers of some VET building schools, by building and stone masonry companies in Italy and also by some teachers of the Faculty of Restoration of IUAV University in Venice.

3. Presentation of objectives, results and contents

Mr. Andrea Pagnacco gave a brief presentation of the tasks and expected results of the project, emphasizing that this project is of educational scope for training purposes for students and professionals in the sector of natural stone and related. Mr. Andrea Pagnacco described each of the deliverables of the project in detail.

4. Presentation of the scenes

Mr. Andrea Pagnacco introduced the 10 animations and how they work in the VR device.

1. Use sawing machine with water cooling to reduce dust

2. Application of different products in a factory

3. Pouring of nanomaterial powder into a liquid matrix to create a mixture

4. Nanomaterial applied with a spray-gun on a stone material surface

5. Nanomaterial fixed in a solid matrix which is being drilled

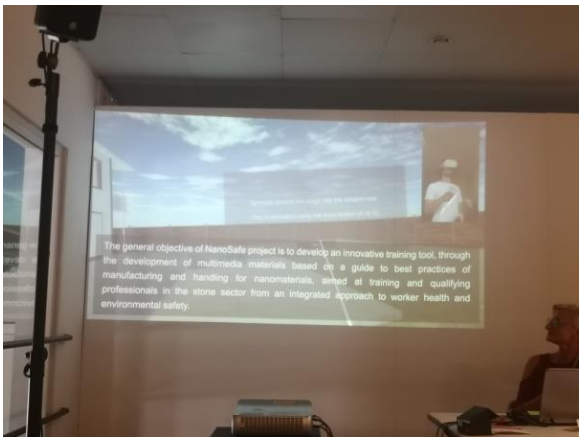
6. Application of different products in factory (part II).

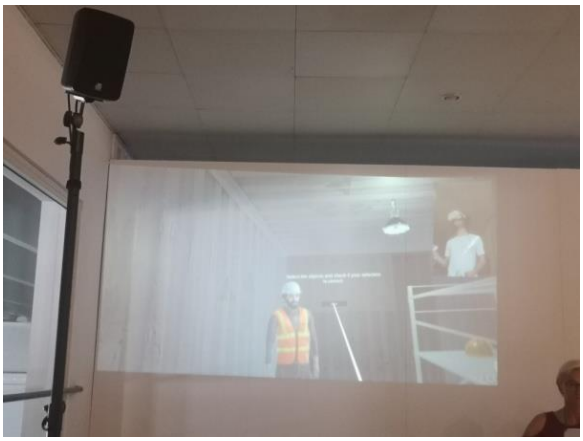
7. Dust-air mixtures in a factory

8. Nano-waste management environmental protection

9. Nanomaterial applied as an aerosol

10. Waste cleaning or disposal after working hours





5. Discussion

As the agenda established, once all presentations had been finished, a discussion was held, in which participants had the opportunity to express their doubts and concerns regarding the project to seminar speaker.

6. Number of attendees

The total attendance at the Multiplier event of the Nanosafe project was 25 external people, in addition to the project participants:

Scuola Edile Padova

- Andrea Pagnacco
- Christine Rossi
- Alessia Ranci.

Formedil

- Stefano Macale

CEFS – Centro Edile per la Formazione e la Sicurezza - Udine

CFS Napoli - Centro Formazione e Sicurezza

IUAV – Faculty of Restoration

- Professor Angela Squassina

Due to the Data Protection Law, the *Attendees list* is not available for public use.