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Intellectual Output 3 (IO3)

VR/AR INTERACTION SOLUTIONS:

LEARNING ACTIVITY - course unit´s description
SCENARIOS IN VR- description for visualization step by step

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LIST OF SCENARIOS WITHIN MODEL HAZARD

No.	Hazard type	No. of scenario	Scenario
1.	Fall hazard	1.1	Fall from height when working on roof structures
		1.2	Falling from a mobile scaffold
		1.3	Fall from ladders
		1.4	Fall from an unprotected edge
2.	Tripping hazard	2.1	Tripping on slab rebar
		2.2	Tripping when walking through the construction site
3.	Struck by	3.1	Angle grinder accidents
		3.2	Hazards when concreting with a pump
		3.3	Objects flying in the worker's eyes
		3.4	Fall of objects from height
		3.5	Fall of object from a crane
		3.6	Worker struck by construction machinery
		3.7	Collision with a vehicle
		3.8	Trench cave in
4.	Cuts and amputations	4	Table saw accidents
5.	Object falling on a worker	5.1	Formwork collapsing on a worker
		5.2	Wall and column formwork overturning and falling on a worker
6.	Electrocution	6	Electrocution due to faulty wires or tools

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1.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	Fall from height when working on roof structures
2	Unit code	*U.1.1*
3	Unit description	*Present virtual scenarios showing all roof-work operations should be pre-planned and properly supervised. Roof work should only be undertaken by workers who are physically and psychologically fit and have the necessary knowledge and experience for such work. Work on roofs should not be carried on in weather conditions that threaten the safety of workers. Crawling boards, walkways and roof ladders should be securely fastened to a firm structure. Roofing brackets should fit the slope of the roof and be securely supported. Where it is necessary for a person to kneel or crouch near the edge of the roof an intermediate rail should be provided unless other precautions, such as the use of a safety harness, are taken. On a large roof where work does not have to be carried out at or near the edge, a simple barrier consisting of crossed scaffold tubes supporting a tubing guardrail may be provided. Such barriers should be positioned at least 2 m from the edge. All covers for openings in roofs should be of substantial construction and be secured in position. Roofs with a pitch of more than 1/10 should be treated as sloping. When work is being carried out on sloping roofs, sufficient and suitable crawling boards or roof ladders should be provided and firmly secured in position as soon as it is practicable. During extensive work on the roof, strong barriers or guard-rails and toe-boards should be provided to stop a person from falling off the roof. Where workers are required to work on or near roofs or other places covered with fragile material, through which they are liable to fall, they should be provided with sufficient suitable roof ladders or crawling boards strong enough, when spanning across the supports for the roof covering, to support those workers. A minimum of two boards should be provided so that it is not necessary for a person to stand on a fragile roof to move a board or a ladder, or for any other reason. To prevent danger, suitable material such as steel wire mesh should be placed in position before any roof sheeting of asbestos cement or other fragile material is placed upon it. Purlins or other intermediate supports for fragile roofing material should be sufficiently close together to prevent danger. Where a valley or parapet gutter of a fragile roof is used for access, protection against falling through the fragile material should be provided by covering the adjacent fragile material to a minimum distance of 1 m up the roof. Buildings with fragile roofs should have a warning notice prominently displayed at the approaches to the roof edges with insufficient fall protection like guardrails, horizontal net, safety harness or*

		other restraining device.
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with working in roofs;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with risky roof work situations using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with roof work risks.*
11	Key words	*Fall, roof, preventive measures, simulation, structure*

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DESCRIPTION FOR VISUALIZATION
step by step

Scenario – 1.1 – Fall from height when working on roof structures

1. Environment

Roof made of tile with hole needing repair. Avatar needs to progress near the hole and perform operations of replacement of tiles.

2. Mission

All preventive measures are displayed incorrectly one by one. Avatar needs to correct for each of the situations the incorrect preventive measure. Avatar can proceed only after choosing all the correct preventive measures.

3. Procedure

Use the images and scripts of

https://www.youtube.com/watch?v=i79gobGrMjY or
https://www.youtube.com/watch?v=u25CmTDFZ2s

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Falling from a mobile scaffold*
2	Unit code	*1.2*
3	Unit description	*Present virtual scenarios with fall from a mobile scaffold because of its insecurity with insufficient designed or laid mobile scaffold (unlocked mobile scaffold, scaffold not used on solid, smooth and horizontal surface, standing on a moving mobile scaffolding). Learner will identify from each scenario the localization where the risk is present. After the identification learner will have to choose, the preventive measure preferred. The possible preventive measures will be shown in images. After identification of preventive measure to use the respective details will be presented. These details include list of costs, necessary training, and examples of consequences of applying, implementation process and effectiveness. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations these will be displayed one by one.*
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with fall from a mobile scaffold;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with risky mobile scaffold using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*

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	and title)	
10	Unit schedule	*Available at any time for training in specific scenarios with edge fall risks.*
11	Key words	*Fall, height, mobile scaffold, lock, surface, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 1. - Fall from height – Scenario – 1.2 - FALLING FROM A MOBILE SCAFFOLD

1. Environment

- The learner is a construction worker painting and finishing of electrical installations in the interior of the building (e.g. first floor). He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building, which is in the stage of interior finishing works.
- Avatar has to paint the rooms and finish of electrical installations (e.g. on the first floor). A mobile scaffolding must be used to carry out this work.

2. Mission

- The goal of the scenario is to teach the worker of the hazards he faces when working by the mobile scaffolding. He will learn that he needs to be aware of the hazards he is faced with and whether there are additional circumstances, which could make the work even more hazardous.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

Mobile scaffolding requirements:

1. The wheels must be locked when work is carried out from the scaffold, regardless of the height of the scaffold.
2. Mobile scaffold should only be used on solid, smooth and horizontal surface.
3. When moving, it is not allowed to stay on the scaffold.
4. Loose material is removed or secured from falling.
5. Mobile scaffolding may only be moved by hand.

It is necessary to paint and complete the electrical installations inside the building. The worker must use a mobile scaffolding. The use of mobile scaffolding allows work at a height.

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- In the first part of the scenario, the wheels of the scaffold are not fixed and when the worker starts working, the scaffold moves and the worker falls. The worker must first make sure that the scaffold's wheels are locked in place. If they are not, they need to be locked in place.
- In the second part of the scenario, after locking the wheels, when the worker starts working, the the scaffold is unstable and the worker loses balance (and falls). He must check that the scaffolding is used on solid, smooth and horizontal surface. If not, worker must provide a horizontal surface.
- In the third scenario, another worker moves the mobile scaffolding where the worker located together with the building material are. The worker loses balance (and falls). This is not allowed. When moving, it is not allowed to stay on the scaffold; and loose material is removed or secured from falling.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Fall from ladders*
2	Unit code	*1.3*
3	Unit description	*Present virtual scenarios with fall from height with insufficient designed or laid ladder (unsatisfactory length, slope or overlap of ladder). Learner will identify from each scenario the localization where the risk is present. After the identification learner will have to choose the preventive measure preferred. The possible preventive measures will be shown in images. After identification of preventive measure to use the respective details will be presented. These details include list of costs, necessary training, examples of consequences of applying, implementation process and effectiveness. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations these will be displayed one by one.*
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with fall from the ladders;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with risky ladders using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with edge fall risks.*

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11	Key words	*Fall, height, slope, overlap, ladder, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 1. - Fall from height – Scenario – 1.3 - FALL FROM LADDERS

1. Environment

- The participant's avatar, who has completed interactive training, stands in front of the reinforced concrete skeleton on the construction site. The skeleton consists of a three-storey structure in the module coordination - the first floor 4x2; second floor 3x2; third floor 2x2 (columns).
- Vertical movement of the avatar is allowed by the three ladders, which are individually placed on each floor

2. Mission

- Each of the three ladders will contain a mistake (safety problem). Unless the participant detects an safety problem, he will not be able to climb the ladder. He will be able to climb the ladder and move to a higher floor only when he detects and corrects the mistake. The participant's task is to climb the ladders to the upper third floor.
- On the third floor, the participant will see a recapitulation of new information and knowledge which obtained, and will receive a "star - helmet". Competitiveness will support by the measurement of the time it took to get to the top floor.

3. Procedure

3 A) The first ladder from the ground floor to the first floor - the ladder is made wooden and has an unsatisfactory length.

*(Regulation: Wooden ladders can only be used exceptionally for access to scaffolding floors (but not for work); these ladders must be technically documented and their **maximum length has to be 3.5 m**.)*

- The participant stands in front to the ladder and he sees that a warning flashing exclamation mark „!" near by the ladder. The ladder is obviously wooden and is marked with the label "ladder length - 4m". At the same time, the participant perceives that the application does not want to let him use (climb) the ladder.

- After clicking on the exclamation mark, a notice about non-compliance the regulation will be displayed. Then, participant has to detect and correct the mistake.

- The participant identifies the problem after visual inspection of situation.

- The participant opens the menu of his tools where he has various options (*replace, move, turn on, turn off, tighten, release, extend, shorten, take the equipment, get rid of,* ...).

- In the menu, he finds and selects the "replace" option, Then the wooden ladder will be "replace by aluminum ledder with appropriate length " sub-option is automatically displayed.

- After this adjustment, participan can move to a higher floor by ladder.

- Other options from the menu will also show alternative solutions for this situation, but will be false (eg move ladder because of change the slope, extend the ladder, etc.).

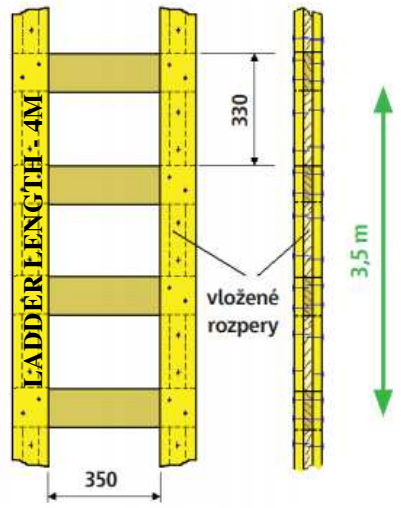


Fig. 1 Illustration of the regulation (Skanska.sk)

3 B) The second ladder from the first floor to the second floor - the ladder is at an unsatisfactory slope

(Regulation: The ladder is built in the range of inclination of at least 2.5: 1)

- The participant stands in front to the ladder and he sees that a warning flashing exclamation mark „!" near by the ladder. The ladder is obviously incorrectly inclined. At the same time, he perceives that the application does not want to let him climb the ladder.

- After clicking on the exclamation mark, a notice about non-compliance the regulation will be displayed. Then, participant will detect and correct the mistake.
- The participant identifies the problem after visual inspection of situation
- The participant opens the menu of his tools where he has various options (*replace, move, turn on, turn off, tighten, release, extend, shorten, take the equipment, get rid of*, ...).
- In the menu, he finds and selects the "move" option, Then "move the ladder for change slope" sub-option is automatically displayed.
- After this adjustment, participan can move to a higher floor by ladder.
- Other options from the menu will also show alternative solutions for this situation, but will be false (eg replace the ladder, extend the ladder, etc.).

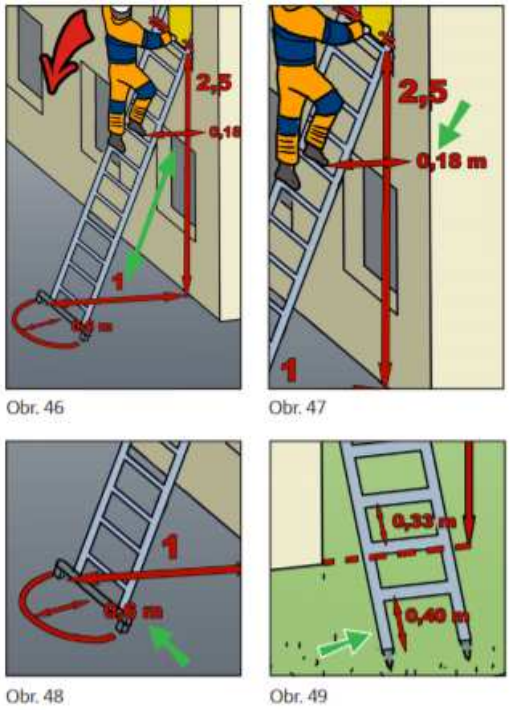


Fig. 2 Illustration of the regulation (Skanska.sk)

3 C) Third ladder from the second floor to the third floor - the ladder has an unsatisfactory extention overlap

(Regulation: Used ladders must exceed the ascent (descent) platform by at least 1,1 m with their upper end)

- The participant stands in front to the ladder and he sees that a warning flashing exclamation mark „!" near by the ladder. The ladder is obviously incorrectly inclined. At the same time, he perceives that the application does not want to let him climb the ladder.

- After clicking on the exclamation mark, a notice about non-compliance the regulation will be displayed. Then, participant will detect and correct the mistake.

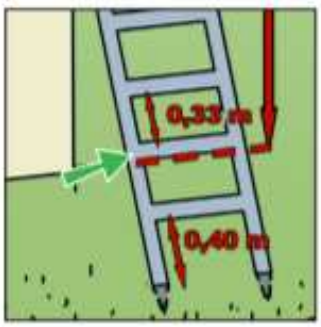
- The participant identifies the problem after visual inspection of situation

- The participant opens the menu of his tools where he has various options (*replace, move, turn on, turn off, tighten, release, extend, shorten, take the equipment, get rid of*, ...).

- In the menu, he finds and selects the "extend" option, Then " extention ladder overlap " sub-option is automatically displayed.

- After this adjustment, participan can move to a higher floor by ladder.

- Other options from the menu will also show alternative solutions for this situation, but will be false (eg replace the ladder, move the ladder, etc.).



Obr. 50

Obr. 51

Fig. 3 Illustration of the regulation (Skanska.sk)

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Edge Fall*
2	Unit code	*U.F.1*
3	Unit description	*Present virtual scenarios with edges with insufficient fall protection like guardrails, horizontal net, safety harness or other restraining device. Learner will identify from each scenario the localization where the risk is present. After the identification learner will have to choose the preventive measure preferred. The possible preventive measures will be shown in images. After identification of preventive measure to use the respective details will be presented. These details include costs, necessary training, examples of consequences of applying, implementation process and effectiveness. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations these will be displayed one by one. Where necessary to guard against danger, or where the height of a structure or its slope exceeds that prescribed by national laws or regulations, preventive measures should be taken against the fall of workers and tools or other objects or materials. Elevated workplaces, including roofs more than 2 m or as prescribed, above the floor or ground should be protected on all open sides by guard-rails and toe-boards complying with the relevant national laws and regulations. Wherever guard-rails and toe-boards cannot be provided, adequate safety harnesses should be provided and used. Elevated workplaces including roofs should be provided with safe means of access and egress such as stairs, ramps or ladders complying with the relevant national laws and regulations. If guard-rails are not practicable, persons employed at elevated workplaces including roofs from which they are liable to fall more than 2 m or as prescribed should be protected by means of adequate safety nets or safety sheets or platforms, or be secured by safety harnesses with lifelines securely attached.*
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with edges;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with risky edges using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*

7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with edge fall risks.*
11	Key words	*Fall, height, free edge, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 12. - Fall from height – Scenario – 1.4 – Edge Fall

1. Environment

- Building slab or hole in slab with free edge. Avatar requests indication of preventive measures.

2. Mission

- Preventive measures are displayed in accordance with each of the situations indicated in the module description. Avatar needs to choose the most appropriate measure. Avatar can continue after finding the right one(s). For each inappropriate choice avatar is presented with the advantages of that option.

3. Procedure

Use the images and scripts of https://www.youtube.com/watch?v=rhbDbR9Z47g or https://www.youtube.com/watch?v=spr7YeYajx8 or https://www.youtube.com/watch?v=iqtz-vvJVY0 or https://www.youtube.com/watch?v=66A7TaAmtRc

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Tripping on slab rebar*
2	Unit code	*2.1*
3	Unit description	*The unit presents virtual scenarios with hazards related to falls on the same level, specifically a tripping hazard.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with tripping hazards;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with tripping hazards.*
11	Key words	*Tripping hazard, slab rebar, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 2. – Tripping hazard – Scenario – 2.1 – TRIPPING ON SLAB REBAR

1. Environment

- The learner is a construction worker working on rebar placement. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker the hazards faced when walking on rebar. The scenario will teach the lesson on how to correctly identify the hazard and how to mitigate them.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The scenario consists of a tripping hazard and of breaking an ankle because of improper and not careful walking on slab rebar. The scenario starts with a foreman telling the worker to transport steel bars across the slab to the place where the rebar is being placed. The worker starts walking on the rebar and after a few meters, his leg falls through and he hurts himself. The scenario is reset to the beginning and the worker gets a hint that he should be careful how he walks, that it is not safe to walk on the armature because he can get injured. If he tries again, he will fall again. The second time the scenario is reset, the worker gets a hint that he needs to look at how he can secure his transition over the rebar. Next to the place where he takes the rebar, there are boards that he should place on the

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rebar so that he can walk over them. Once he has set up the boards, he can safely pass and complete his task.
When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Worker struck by construction machinery*
2	Unit code	*2.1*
3	Unit description	*The unit presents virtual scenarios with hazards related to construction machinery, specifically hazards where workers can be struck by moving parts of the machines. In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence. The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with working next to construction machinery;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with edge fall risks.*
11	Key words	*Struck by, construction machinery, preventive measures,*

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		simulation

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 2. – Struck by – Scenario – 2.1 – STRUCK BY CONSTRUCTION MACHINERY

1. Environment

- The learner is a construction worker working on rebar placement. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar, is standing on a construction site of a building in the earlyest stage, during excavation work and foundation slab concrete works. There are excavators, dump trucks and concrete mixers on the site, as well as 20 construction workers.
- Movement is allowed on the site, but extra precausion is needed around construction machinery, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the learner the dangers of working near construction machinery and how the dangers can be avoided. Each of the three scenarios will teach an important lesson regarding the struck by construction machinery hazards.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

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3. Procedure

The learning scenario consists of three struck by construction machinery hazards the worker needs to safely overcome to reach the end.

Scenario starts with a foreman telling the learner (in a role of a construction worker placing rebar for the foundation slab) to retrieve a tool which is in the warehouse on the other side of the construction site, and he needs to do it in a short amount of time. The worker can choose to go slowly around all the hazard, but that path will take him much longer than the time limit. The alternative is to go straight across the construction site and among the construction machinery.

1st hazard
The worker starts walking across the site, when he encounters an excavator digging soil and disposing it behind, by tuning 180 degrees. When the worker gets close, the excavator hits him with a bucket. The worker starts the scenario again, and this time should think what can he do to not get injured. He needs to open a menu and choose an appropriate action. First, he needs to put on his reflective vest, which he wasn't wearing. If he then tries to pass again, the excavator will still hit him. What he needs to do is to wait until the driver sees him, wave so that he can signal that he wants to pass. He again needs to wait until the driver signals him that it is safe to pass.

2nd hazard
Soon after the first hazard, the worker needs to pass between an excavator and a dump truck. The excavator is loading soil in the truck and if the worker wishes to pass he gets hit by rear end of the excavator.

If the worker decides to simply wait for the driver to notice him, it will not happen because the excavator is not facing in his direction. The learner needs to find a construction worker with a walkie-talkie who is in contact with the excavator driver and ask him to allow for a passage. Only when he gets the okay, can he safely pass next to the excavator.

3rd hazard
Finally, the worker is near the warehouse, he only needs to pass a part of the site where concrete is poured for the foundation slab. There are several cement mixers driving around the site, directly on the route the worker needs to take. If he steps on the road, he gets hit by the mixer. He needs to start over and see what safety measures can he take. He can try to get a drivers attention and if he does, the driver lets him through. However, another truck will still hit him and he will need to start again. The third time, the worker will need to see what else can he do. He tries to look for the signal worker but he is nowhere to be found. The worker then needs to use his cell phone to call a foreman and to report a hazardous activity. The foreman will then assign a signal worker and commend the learner for improving site safety. The worker can now finally get to the warehouse and retrieve the tool he was sent to get.

When he gets back, his foreman is disappointed because the worker should have taken the safer route in the start, no matter how much longer it would take.

Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Tripping when walking through the construction site*
2	Unit code	*2.2*
3	Unit description	*The unit presents virtual scenarios with hazards related to falls on the same level, specifically a tripping hazard.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with tripping and fall hazards;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with tripping hazards.*
11	Key words	*Tripping hazard, fall on the same level, preventive measures,*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 2. – Tripping hazard – Scenario – 2.2 – TRIPPING WHEN WALKING THROUGH THE CONSTRUCTION SITE

1. Environment

- The learner is a construction worker working on transporting tools and materials to other workers. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker the hazards faced when walking on the construction site. The scenario will teach the lesson on how to correctly identify the hazard and how to mitigate them.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The scenario consists of the tripping hazard and falling at the same level hazard, due to congestion and untidyness of the construction site. The worker is given the task of going to the place where construction materials are unloaded and stored and bringing the box with the materiala to the worker of his work group. The construction site is in a very untidy state, with garbage, materials and tools lying on the floor. When passing for the first time without a load, the worker passes normally, but should notice that the road is not clear. When he picks up the box and heads back, he stumbles and falls. An additional problem is that the box that the worker carries is bulky, so it obscures part of his field of vision.

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After he falls, the worker is at the beginning of the scenario again. He has options to visually inspect the route it will take and to clean and secure the route. If he does so, he can safely pass with the box as well.
An additional option that can be implemented is to announce the dangers to his colleagues and warn that the construction site should be kept as clean as possible.
The point a worker needs to learn is that the construction site must be cleaned regularly and materials and tools must not be disposed of in passage areas.
When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Angle grinder accidents*
2	Unit code	*3.1.*
3	Unit description	*The unit presents virtual scenarios with hazards related angle grinder accidents.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with angle grinder hazards;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Angle grinder hazard, struck by hazard, preventive measures,*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by hazard – Scenario – 3.1 – ANGLE GRINDER ACCIDENTS

1. Environment

- The learner is a construction worker working on rebar cutting. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- The location for this hazard is a small work bench on the construction site with all tools and safety equipment needed to carry out the task safely.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker the hazards when working with an angle grinder and by extension with other similar power tools. The scenario will teach the lesson on how to correctly identify the hazard and how to mitigate them. The learner will also be made aware that all safety equipment must be used at all times and that he needs to check whether the tools he is working with are in working condition and that they can be used safely.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker is given the task of cutting a piece of reinforcement rebar that is too long. When he reaches the workplace, he sees a clear sign that he must adhere to all safety measures at work and inspect all equipment before work. If he does not inspect and starts working, the cutting board cracks and hits the worker. In the second iteration, the worker may notice that he has protective equipment on the counter, consisting of goggles, an

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apron, and gloves, which he must wear. When he starts working again, an accident happens again and he goes back to the beginning of the scenario. He has to inspect the tool and see that he has to tighten the cutting board before he starts working. Only then can he successfully and safely complete his activity.
When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Hazards when concreting with a pump*
2	Unit code	*3.2.*
3	Unit description	*The unit presents virtual scenarios with hazards when concreting with a pump.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with concreting with a pump;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Hazards when concreting with a pump, struck by hazard,*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by hazard – Scenario – 3.2 – HAZARDS WHEN CONCRETING WITH A PUMP

1. Environment

- The learner is a construction worker working concreting a slab on the second floor (the same slab from hazard 2.1). He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker of the hazards he faces when concreting with a pump. He will learn that he needs to be aware of the hazards he is faced with and whether there are additional circumstances which could make the work even more hazardous. Also, he will learn that he needs to ask other workers for help if he cannot complete the task safely on his own.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

Workers begin concreting the slab with a concrete pump. The worker is given the task of receiving the hose, which is located near the unprotected edge, and holding it while the concrete is being poured. When the worker receives the hose, nothing happens for a while, but after a few seconds the hose throws him and he falls off the building. In the second attempt, the worker has the opportunity to notice that the fall protection has not been installed and to request that the edge of the building be protected. The fence is then set

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up and the scenario starts all over again. However, the hose hits him again, only it doesn't fall down but hits the fence. In the third iteration, he gets a hint that he might need to call a colleague to help him hold the hose because initially the pressure is too strong for only one worker to hold it.
When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Objects flying in the worker's eyes*
2	Unit code	*3.3.*
3	Unit description	*The unit presents virtual scenarios with hazards of objects flying in the worker's eyes.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with objects flying in the worker's eyes;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Objects flying in the worker's eyes, struck by hazard,*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by hazard – Scenario – 3.3 – OBJECTS FLYING IN THE WORKER'S EYES

1. Environment

- The learner is a construction masonry worker working on the second floor of the construction site described in hazard 2.2. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker of the hazards he is faced with when working with hand tools. He will learn that all protective equipment must be worn. on his own.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker has the task of building a brick wall. The row needs to be completed, but the whole brick is too large, more specifically, he has to shorten it. Next to him he sees a hammer and the protective equipment he needs (goggles and gloves). If he doesn't put on protective gear and just takes the hammer and starts breaking the brick, the piece will fly off his eye and injure him. Then the scenario starts again, and the worker gets the hint that he has to use protective equipment. After putting on his glasses and gloves, he is able to safely break the brick and place it.

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When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Fall of objects from height*
2	Unit code	*3.4.*
3	Unit description	*The unit presents virtual scenarios with hazards of fall of objects from height.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with fall of objects from height;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Fall of objects from height, struck by hazard, preventive*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by hazard – Scenario – 3.4 – FALL OF OBJECTS FROM HEIGHT

1. Environment

- The learner is a construction worker placing thermal insulation cladding on the 2nd floor of the building from the scaffold. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on the 4th story above ground. Parallel to structural works, the external thermal insulation is being placed from the erected scaffold. Next to the scaffold there is a path construction workers use regularly.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker of the hazards he presents to other workers around him. Through the scenario he will learn how to safely work at height, how to secure the tools and materials from falling and how to signal that an area is hazardous.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker has the task to climb the scaffolding and start placing the insulation on the outer wall of the building. When he climbs up and starts spreading the glue, a trowel falls out of his hand and injures the worker passing underneath. Then the scenario starts again and the worker is notified that he has to watch out for other workers. While on the ground, it is possible to check whether the lower board is placed on the scaffolding, to fence off places where something may fall off the scaffolding and to place a danger sign. When he climbs up, he has the option to tie the tool to himself so that it cannot fall off the scaffolding. If he doesn't do all of that, the passing worker still gets injured and the

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scenario repeats itself with hints of what he still has to do to make the work safe. When he has done everything successfully, he still gets a note that it would be safest, since there is a permanent road below for workers, to build either a scaffold tunnel for safe passage. So, in the end, there is an option to ask the manager to set up permanent protection for the passage of workers.
When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Fall of object from a crane*
2	Unit code	*3.5.*
3	Unit description	*The unit presents virtual scenarios with hazards of falling objects from a crane.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with falling of objects from a crane;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Fall of object from a crane, struck by hazard, preventive*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by hazard – Scenario – 3.5 – FALL OF OBJECT FROM A CRANE

1. Environment

- The learner is a construction worker working on transporting tools and materials to other workers. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker of the general hazards which he faces while being on the construction site. The worker unfortunately does not have control over all construction hazards, but should therefore be even more careful and mindful of his surroundings.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker is given the task to go to the warehouse that is on the other side of the construction site and bring some tools. When moving through the construction site, if he looks towards the crane he can see that the load, a piece of wall formwork, is swaying heavily during transport and he should notice that it all takes place above the road he is passing through. If he continues to walk, after a short time he hears other workers shouting to stop. If he stops moving, the load from the crane falls in front of him, and if he continues, it will fall on him. When the scenario starts again, the worker has the option to wait at a safe distance for the transport to complete and warn the supervisor that the

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load is swaying too much for the transport to be safe.When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Worker struck by construction machinery*
2	Unit code	*3.6*
3	Unit description	*The unit presents virtual scenarios with hazards related to construction machinery, specifically hazards where workers can be struck by moving parts of the machines. In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence. The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with working next to construction machinery;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Struck by, construction machinery, preventive measures,*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by – Scenario – 3.6 – STRUCK BY CONSTRUCTION MACHINERY

1. Environment

- The learner is a construction worker working on rebar placement. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar, is standing on a construction site of a building in the earlyest stage, during excavation work and foundation slab concrete works. There are excavators, dump trucks and concrete mixers on the site, as well as 20 construction workers.
- Movement is allowed on the site, but extra precaution is needed around construction machinery, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the learner the dangers of working near construction machinery and how the dangers can be avoided. Each of the three scenarios will teach an important lesson regarding the struck by construction machinery hazards.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

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3. Procedure

The learning scenario consists of three struck by construction machinery hazards the worker needs to safely overcome to reach the end.

Scenario starts with a foreman telling the learner (in a role of a construction worker placing rebar for the foundation slab) to retrieve a tool which is in the warehouse on the other side of the construction site, and he needs to do it in a short amount of time. The worker can choose to go slowly around all the hazard, but that path will take him much longer than the time limit. The alternative is to go straight across the construction site and among the construction machinery.

1st hazard
The worker starts walking across the site, when he encounters an excavator digging soil and disposing it behind, by tuning 180 degrees. When the worker gets close, the excavator hits him with a bucket. The worker starts the scenario again, and this time should think what can he do to not get injured. He needs to open a menu and choose an appropriate action. First, he needs to put on his reflective vest, which he wasn't wearing. If he then tries to pass again, the excavator will still hit him. What he needs to do is to wait until the driver sees him, wave so that he can signal that he wants to pass. He again needs to wait until the driver signals him that it is safe to pass.

2nd hazard
Soon after the first hazard, the worker needs to pass between an excavator and a dump truck. The excavator is loading soil in the truck and if the worker wishes to pass he gets hit by rear end of the excavator.

If the worker decides to simply wait for the driver to notice him, it will not happen because the excavator is not facing in his direction. The learner needs to find a construction worker with a walkie-talkie who is in contact with the excavator driver and ask him to allow for a passage. Only when he gets the okay, can he safely pass next to the excavator.

3rd hazard
Finally, the worker is near the warehouse, he only needs to pass a part of the site where concrete is poured for the foundation slab. There are several cement mixers driving around the site, directly on the route the worker needs to take. If he steps on the road, he gets hit by the mixer. He needs to start over and see what safety measures can he take. He can try to get a drivers attention and if he does, the driver lets him through. However, another truck will still hit him and he will need to start again. The third time, the worker will need to see what else can he do. He tries to look for the signal worker but he is nowhere to be found. The worker then needs to use his cell phone to call a foreman and to report a hazardous activity. The foreman will then assign a signal worker and commend the learner for improving site safety. The worker can now finally get to the warehouse and retrieve the tool he was sent to get.

When he gets back, his foreman is disappointed because the worker should have taken the safer route in the start, no matter how much longer it would take.

Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Collision with a vehicle*
2	Unit code	*3.7.*
3	Unit description	*The unit presents virtual scenarios with hazards collision with a vehicle.* *In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with a collision with a vehicle;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Collision with a vehicle, struck by hazard, preventive*

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		measures, simulation

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DESCRIPTION FOR VISUALIZATION
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Hazard type: 3. – Struck by hazard – Scenario – 3.7 – COLLISION WITH A VEHICLE

1. Environment

- The learner is a construction worker working on loading and unloading of materials from trucks and who regulates traffic on the entry to the construction site. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- This particular hazard is placed at the entry to the construction site, next to the gate for vehicular traffic.
- The construction site is in the urban area with dense road traffic.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker of the hazards posed by traffic which is present next to the construction site.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker has the task of going out on the road and temporarily stopping the traffic so that the truck can get out of the construction site. If he just goes out on the road, he will be hit by a car. When the scenario is restarted, the worker is given a hint to check that all safeguards have been applied. In that case, he will see that he is not wearing a reflective vest. When he is wearing all required safety equipment and tries to stop the traffic again, the same situation happens. The third time the worker gets an extra hint to check what else he can do to insure himself. Then he may notice that there is a glowing danger sign

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next to the gate that warns drivers that a construction site is nearby. Once he puts up a sign and has a vest, he can safely go out on the road and regulate traffic.

When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Trench cave in*
2	Unit code	*3.8*
3	Unit description	*The unit presents virtual scenarios with hazards related to trench cave ins. In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks associated with working in trenches;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Trench cave in, construction machinery, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 3. – Struck by –
Scenario – 3.8 – TRENCH CAVE IN

1. Environment

- The learner is a construction worker working on placing sewage pipes in a trench, on the same construction site as for hazard 3.6. The worker has previously been trained to use the VR system and what the controls are.
- The participant's avatar, is standing on a construction site of a building in the earlyest stage, during excavation work and foundation slab concrete works. There are excavators, dump trucks and concrete mixers on the site, as well as 20 construction workers.
- This activity is carried out in a trench with 2 meters of depth.
- Movement is allowed on the site, but extra precaution is needed around construction machinery, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the learner of the hazards faced when working in a trench. He will learn how the sides of the trench need to be shored and what are the other safety measures that need to be applied.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker is given the task of laying sewer pipes in a recently excavated trench, which is 2 meters deep and into which he descends a ladder. An additional problem is that the trench is located near the road through which trucks take the earth from the excavation site. Shortly after the worker descends, the sides of the trench collapse on him because they were in no way secured and supported. When the scenario starts all over again, the worker should notice that the trench is not secured and ask the manager to install a shoring system in the trench beforehand. After setting the shoring, the worker goes down into the trench and starts working. Soon after, the sound of trucks passing along the road is heard and again the trench collapses. In the third attempt, the worker should report the

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dangerous situation to the manager and ask to fence the edge of the trench at a distance of 1 meter to prevent the trench side from collapsing.

When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.

4 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Table Saw Accidents*
2	Unit code	*U.4*
3	Unit description	*Present virtual scenarios showing that shavings, sawdust, etc., should not be removed by hand from woodworking machines or in their vicinity while the machines are working. Where provided, chip and sawdust extraction systems should be maintained in efficient working order. Mechanical feeding devices should be used whenever practicable. All cutters and saw blades should be enclosed as far as practicable. Circular saws should be provided with strong, rigid and easily adjustable hood guards for the saw blades and with riving knives of suitable design matched to the saw blade in use. The width of the opening in the table for the saw blade should be as small as practicable. Portable circular saws should be so designed that when the blade is running idle it is automatically covered. On band saws all the blade, except the operating portion, should be enclosed. Band wheels should be enclosed with stout guards. Band saws should be provided with automatic tension regulators.*
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with band and chain saws;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with chain and band saws using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with band and chain saws risks.*

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11	Key words	*Saws, wood, preventive measures, simulation, chain saw, band saw.*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazards type: 3 – Chain Saw
Scenario – 4 – Chain Saw

1. Environment

Roof made of tile with hole needing repair. Avatar needs to progress near the hole and perform operations of replacement of tiles.

2. Mission

All preventive measures are displayed incorrectly one by one. Avatar needs to correct for each of the situations the incorrect preventive measure. Avatar can proceed only after choosing all the correct preventive measures.

3. Procedure

Use the images and scripts of

https://www.youtube.com/watch?v=ciA-Xvn4z0g
or
https://www.youtube.com/watch?v=QGkyYkx2NFY

4 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Formwork Collapse*
2	Unit code	*U.5*
3	Unit description	*Present virtual scenarios showing the erection or dismantling of formwork and shoring should be carried out by trained workers only under the supervision of a competent person. Adequate precautions should be taken to guard against danger to workers arising from any temporary state of weakness or instability of a formwork or shoring. Formwork and shoring should be so designed, constructed and maintained that it will safely support all loads that may be imposed on it. Formwork should be so designed and erected that working platforms, means of access, bracing and means of handling and stabilizing are easily fixed to the formwork structure. All formwork should be properly designed. Clear and concise procedures to cover all stages of work should be prepared. A competent person should be appointed to coordinate the work and check that the procedures are being followed. No changes should be made without consulting the supervisor. All materials and scaffolding should be carefully examined and checked with the drawings before being taken into use. Foundation of formwork must be analyzed and loading capacity verified. Shuttering should be examined, erected and dismantled under the supervision of qualified and experienced persons and, as far as practicable, by workers familiar with the work. The necessary information for the erection of shuttering, including particulars of the spacing of stringers and props to stringers, should be provided for the workers in the form of sketches or scale drawings. Lumber and supports for shuttering (forms) should be adequate, having regard to the loads to be borne, spans, setting temperature and rate of pour. Where necessary to prevent danger, adequate shoring should be provided to support slabs and beams as a protection against superimposed loads. All adjustable shoring should be locked in position when adjusted. Shoring should be adequately protected from damage from moving vehicles, swinging loads, etc.. Shoring should be left in place until the concrete has acquired sufficient strength to support safely not only its own weight but also any imposed loads. It should not be removed until authorisation has been given by a competent person. Shoring should be adequately braced or tied together to prevent deformation or displacement. To prevent danger from falling parts when shuttering is being taken down, the shuttering should as far as practicable be taken down whole, or else remaining parts should be supported. Mechanical, hydraulic or pneumatic lifting appliances for handling forms should be provided with automatic holding devices to prevent danger if*

		the power of the lifting mechanism fails.
4	Educational strategy	*Based on visual display of risky situations, of preventive measures and simulation of the consequences of adopting the preventive measure.*
5	Learning outcomes (LOut)	- *Identifying risks associated with formwork and shoring;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with risky formwork and shoring using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all risky situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with formwork and shoring risks.*
11	Key words	*Formwork, shoring, preventive measures, simulation, shuttering.*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazards type: 4, 5 – Formwork Collapse – Scenario – 5 – Formwork Collapse

1. Environment

- Formwork and shoring of a concrete slab or a concrete retaining wall. Avatar erects formwork of a concrete slab or of a concrete retaining wall.

2. Mission

- Preventive measures of module description are displayed incorrectly one by one. Avatar needs to correct for each of the situations the incorrect preventive measure. Avatar can proceed only after choosing all the correct preventive measures.

3. Procedure

Use the images and scripts of

https://www.youtube.com/watch?v=JHuE3LCK4LQ or
https://www.youtube.com/watch?v=CAjaUm4egRY

F.1 COURSE UNIT (LEARNING ACTIVITY) DESCRIPTION		
1	Unit title	*Electrocution due to faulty wires or tools*
2	Unit code	*6.*
3	Unit description	*The unit presents virtual scenarios with electrocution hazards. In the activity the learner will need to identify the potential hazard and act to neutralize it or reduce its severity or probability of occurrence.* *The learner will be presented with potential measures which can be taken, which will be shown in images. Simulation of the use of the preventive measure will be provided so learner understands the new scenario. In case learner does not identify the risky situations, hints will be displayed.*
4	Educational strategy	*Educational strategy is to prompt learner to visually identify hazardous situations, to see what the consequences of unsafe behavior would be and to teach the learner what are the correct responses to mitigate the hazard.*
5	Learning outcomes (LOut)	- *Identifying risks electrocution hazards;* - *Describe preventive measures;* - *Compare different preventive measures;*
6	Unit core material (Learning object (LO)) (code and title)	- *Scenarios with construction machinery using BIM model using Web-based Collaborative Virtual Environments (LIRKIS G-CVE) and Preventive measures adequate for each risk using BIM;*
7	Unit additional material (code and title)	- *Non-binding guide to good practice for understanding and implementing Directive 92/57/EEC (https://op.europa.eu/s/oU0P)*
8	Collaboration objects (code and title)	- *Forum in CSETIR with user opinions and other informative materials uploaded by users*
9	Assessment objects (projects, self-evaluation exercises, etc.) (code and title)	- *Success in identifying all hazardous situations;* - *Proper choice of preventive measures.*
10	Unit schedule	*Available at any time for training in specific scenarios with struck by hazards.*
11	Key words	*Electrocution, wires or tools, struck by hazard, preventive measures, simulation*

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DESCRIPTION FOR VISUALIZATION
step by step

Hazard type: 6. – Electrocution – Scenario – 6. – ELECTROCUTION DUE TO FAULTY WIRES OR TOOLS

1. Environment

- The learner is a construction worker working on rebar cutting, same as in hazard scenario 3.1. He has previously been trained to use the VR system and what the controls are.
- The participant's avatar is working on a construction site of a building which is in the stage of building structural elements such as reinforced concrete slabs, walls, pillars,… on 2nd story above ground. On one part of the site a slab was already cast and reinforcement and formwork works for the walls and columns are in progress and on the other part, rebar for the slab is being put in place.
- On the site, there are around 30 other workers, tower cranes, trucks, concrete pump and concrete mixer trucks.
- The location for this hazard is a small work bench on the construction site with all tools and safety equipment needed to carry out the task safely.
- Movement is allowed on the site, but extra precaution is needed when walking on the site, of which the learner is warned about.

2. Mission

- The goal of the scenario is to teach the worker that he always needs to use all the safety equipment, that he needs to check whether the tool is in proper working order and can be used in a safe manner. Additionally, the worker will learn that he must not attempt to repair the tool if he is not trained and authorized to do so.
- The scenarios will be presented in such a way that the learner needs to see what dangers he is facing, and he will need to implement safety measures to safely finish the task.
- When the learner completes the task, relevant safety information will be presented to him, explaining why the safety measures were necessary.
- Additionally, at the end of the task, a score will be calculated based on the time it took to safely complete the task and on the number of attempts.

3. Procedure

The worker is given the task of cutting a piece of reinforcement that is too long. When he reaches the workplace, he sees a clear sign that he must adhere to all safety measures at work and inspect all equipment before work. When he gets to the angle grinder, he sees sparks flying out of it and it doesn't look all right. If he tries to work with it, he is struck by electricity. In a retry, he can see that he has tools at hand with which he can repair the

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tool. If it is repaired, the sparks from the tool stop flickering, but the device is not repaired and it is struck by electricity again. The only correct and safe way to complete this activity is for the worker to report to his manager that the tool is defective and to look for a safe tool. Only then can he safely carry out his activity.

When he safely completes the task, additional safety information can made available to the learner related to the hazard. Finally, the score is calculated based on the number of attempts and on the time it took the learner to complete the scenario.