

Cofinanciado por el programa Erasmus+ de la Unión Europea

Virtual Reality applied to road training in European construction

IO1. Series of learning results in COEX works.

A3. Handy Guide



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3. PRESENTATION

VRoad

Presentation

The purpose of this Guide is to provide useful information for trainers and students in the application of Virtual Reality (VR) to the three activities related to road conservation and operation (COEX), which will be developed using this technology applied to learning and fundamentally based on "serious games".

Vocational training provides specific technical training for work in occupations. These programmes generally focus on providing students with practical instruction and may make it possible to obtain a diploma or certificate. The ability to experience 360° training is invaluable, imagine future road workers replacing a vertical signal or a section of guardrail without leaving the classroom.

Among the elements to be included in this Guide, a key aspect would be related to how to use VR: the minimum requirements (hardware and software); the complements that are possible to use and those that are not; the way to activate the devices or elements related to the interaction, i.e. controllers (TOUCH), motion controls...

Is there justification for this document, the work carried out and the focus reflected in the learning¹ outcomes and objectives proposed? The data reflected in the statistics seem to support it.

OCCUPATIONAL ACCIDENTS OCCURRING IN ROAD WORKS (COEX)		
34 accidents classified according to:		
Severity:		
21 fatal accidents ► 25 victims		
13 serious or very serious accidents ► 15 victims		
The involvement of third parties:		
22 accidents a vehicle outside the construction site that invades the work		
area established for conservation and maintenance work		
The operations that were being performed at the time of the accident:		

¹ Since the Bologna process, they are defined as "a statement of what the student is expected to know, understand and be able to do at the end of a **learning** period". In the specific context of VRoad the end of the learning period would be the successful completion of the VR activity (lane cutting, replacement of vertical signal and guardrail, emergency response).



4. PRESENTATION

15 accidents ►Signposting (placing or removing signs, signposting, etc.)

19 accidents > Conservation and maintenance (cleaning, clearing, etc.)

(Table 1). Data State Observatory of Working Conditions (OECT period 2009-2011).



5. INTRODUCTION TO VIRTUAL REALITY (VR) AND ITS INSTRUMENTS

1. Introduction to Virtual Reality (VR) and its instruments

In relation to road maintenance and operation activities (road works), specifically the safe execution of their work, the VR will be the vehicle to be used for students to acquire the learning outcomes of the VRoad project.

It is important to know what VR is: basically it is a technology that "tricks" the mind of the user, specifically it is the visual cortex and the parts of the brain that perceive movement that convince the user that he/she is in that virtual environment generated by a computer. When we speak of "immersion" we mean precisely this. Let's say that the reality that is perceived as such is applied although in a virtual environment and, therefore, safe, as the accidents at work or the user run over, for example, are not real.

Virtual reality, together with other technologies linked to artificial intelligence and automatic learning, are intended for not only to transform the leisure and entertainment sector, but also to substantially modify the way in which we learn, and even the way in which we live our daily lives. And in this sense, the majority of experts in pedagogy agree that virtual reality is a real revolution in the classroom.

THE GOAL OF VIRTUAL REALITY

The worlds (in our specific case road works) that are experienced through virtual reality have to be created from scratch, either adapting them from real environments or being completely fictitious. This implies that, in essence, we can create infinite worlds: virtual reality is infinite in terms of its possibilities. In this case the importance of being able to create an environment as realistic as possible that shows the risk situations of the tasks performed, but with the advantage of not directly exposing the worker to the consequences of the same (in the form of health damages, accidents at work - accidents - run over).

One of the keys to virtual reality in education is that it opens up a world of possibilities without leaving the classroom. This allows students to investigate without getting out of the chair. This is the great asset of virtual reality in education and its great virtue: to expand the possibilities for our students. However, we should not overlook the importance of studentworkers being in touch with the reality around them. Virtual reality is by no means going to be a substitute for the explanations of trainers and theoretical contents (knowledge), but rather an increasingly important complement.



2. Coordination and teaching

This tool is a complement to the training actions that are currently being developed in the sector's training centres and which are aimed at the activity in the subsector of road works. Due to the fact that the contents on occupational risk prevention are included in each of the training actions, this VR-based tool has the usefulness of being able to use training techniques closer to real experience that can be used to complete the training contents with practices (immersive) that facilitate the acquisition of skills, the change of attitude (psychomotor objectives of training) and the acquisition of knowledge on safety and health at work.

2.1. Student profile

This training action is aimed at both employed and unemployed workers who either develop their activity in small, medium and large companies belonging to the Construction sector (road works subsector), or wish to undertake training that allows them access to them.

Academic studies are not required, that is, a degree is not required and although it is recommended to have a primary school degree for its completion, a specific level of training is not essential. However, the participant must always have the training and previous knowledge necessary for the correct development of the action (knowledge of PRL, at least basic concepts). That is to say, this tool can be used both in the practical application of the concepts shown in a theoretical way, and in the constant practice that serves as a reminder, updating and acceptance of those preventive concepts on which it is fundamentally based.

EQF	Knowledge	Skills	Competences		
Level 2	Basic factual knowledge of a field of work or study	basic cognitive and practical skills needed to use relevant information to carry out tasks and solve routine problems using simple rules and tools	work or study under supervision with some autonomy		
Level 3 ²	Knowledge of facts, principles, processes and general concepts in a field of work or study	A set of cognitive and practical skills needed to perform tasks and solve problems by selecting and applying basic methods, tools, materials and information.	 Taking responsibility for completing tasks at work or school Adapting one's behaviour to circumstances to solve problems 		

The potential learners targeted by this type of training will range from the least qualified profiles (pawns who are classified in level 2) to level 3 of the EQF (European Qualifications Framework):

² Compared to the proposal offered by the European Qualifications Framework, the different national frameworks do not vary much from one another, although due to the peculiarities in each case we will take as a reference this more generic framework common to all the participating countries.



(Table 2) Definition of the levels proposed in the European Qualifications Framework.

NOTE: Initially the profile to be addressed would be framed in Level 3 of the EQF (European Qualifications Framework). Among the participating countries, this level of training is related to obtaining a diploma, so in this case the level considered most appropriate for training based on virtual reality as a tool and in terms of H&S must be associated with level 2 of the EQF (and therefore aimed at pawns, first and second officers). This premise has been used in the development of road conservation and operation activities (road works) with VR.

2.2. **Trainer profile**

The best profile for this training is that of a professional who knows the pedagogical requirements of a training that is fundamentally aimed at practice. You must have a thorough knowledge of road works, as well as the prevention of occupational hazards, their legal requirements and their application to the specific activity and its risks.

A desirable profile for the trainer would be:

- Teacher with experience in the civil works sector.
- Work experience in the profession of road works and operation.
- Accredited knowledge in the field of occupational risk prevention.

2.3. Learning outcomes

Learning outcomes consist of what it is considered necessary for a worker to know, know how to do and do with responsibility and autonomy. In this case, these learning outcomes refer to the performance of the selected activities in road works and operation, and specifically in the area of health and safety.

The methodology to delimit them and relate them in a differentiated way, in each of the three selected activities was based on groups of experts and a survey of students and trainers. Responses to the survey and input from transnational expert groups have set the cognitive needs, skills or responsibilities and level of autonomy that trainees must achieve after the implementation of this tool (VR).



ACTIVITIES	RELATED RISKS
	 Hit-and-run with vehicles (run overs).
LANE CUTTING	 Exposure to extreme temperatures
	• Entrapment by overturning of machines or vehicles
	 Fall of handling objects.
	• Noise
	 Falls at height
GUARDRAII	 Blows/cutting by objects or tools
GOARDIAL	 Falling objects due to a collapse
	Vibrations
	 Footprints on sharp objects
	 Hit-and-run with vehicles (run overs)
	 Exposure to noxious or toxic substances

(Table 3). Activities of road works and related risks.

Below is a list of specific learning outcomes³ for each of the activities:

LANE CUTTING					
	Know the working procedure established by the service company or officially.				
	Distinguish the types of signals required				
	Be able to select the right signal model				
KNOWLEDGE	Recognize the different elements necessary for a diversion of traffic				
	Be able to choose the right tool for the type of work				
	Distinguish the individual (PPE) and collective protective equipment (CPE) needed to do the job				
CVIII C	Apply the individual or collective protection equipment corresponding to the activity				
SKILLS	Choose the safest way to apply the working procedure according to the traffic				
	To be able to relate the different risks of the activity with the sources that originate them.				
COMPETENCES	Classify, select and foresee the collective and individual protection equipment necessary to carry out the activity.				

³ List of learning outcomes derived from the proposals made by the experts in the focus groups and from the answers given to the survey by trainers and trainees.



GUARDRAIL REPLACEMENT AND VERTICAL SIGNALLING				
	Know the working procedure established by the service company or officially.			
	Be able to choose the right tool for the type of work			
KNOWLEDGE	Recognize the work teams necessary for the activity			
	Distinguish the individual and collective protective equipment needed to do the job			
	Interpreting the safe use of work equipment and tools			
SKILLS	Install the road sign/s with the appropriate means (tools, machines)			
	Safe use of different tools and work equipment			
	To be able to relate the different risks of the activity with the sources that originate them.			
COMPETENCES	Classify, select and foresee the collective (CPE) and individual protection equipment (PPE) necessary to carry out the activity.			

EMERGENCY RESPONSE				
	Know the working procedure established by the service company or by official rules.			
KNOWLEDGE	To know how to act in case of adverse conditions (low visibility, bad weather conditions) in emergency situations.			
	Know the requirements for joint action with the emergency services (112: traffic police, medical services)			
SKILLS	Report any incident/suggestion regarding safety and health to the responsible person.			
COMPETENCES	To be able to relate the different risks of the activity with the sources that originate them.			

(Table 4) Learning outcomes for each activity.



10. AIMS AND OBJECTIVES

3. Aims and Objectives

THE PURPOSE OF THE PROJECT (FORMATIVE EXPERIENCE)

Due to the technical improvement of work equipment, workplaces are becoming safer and safer. However, in addition to technical aspects, workers' behaviour plays an important role in occupational safety and health. If the safety of work equipment reaches its limit, improvements will only be achieved through changes in attitude. Therefore, the training approach proposed by VRoad improves the attitude of workers towards health and safety at work through the systematisation of training. A safety package with a practical orientation is included in the standard training of the trainees.

The purposes of the VRoad project are:

- Optimisation of learning.
- Raising the awareness of apprentices on health and safety at work in road works.
- Better formation of trainers/teachers.
- Better tools to be used by trainers in training actions.
- Better integration of apprentices into operational activities.
- Better retention of personnel by companies through better learning.

Translating the objectives of the project to those of the training, starting from the field work carried out in the first phase of the VRoad project (4 groups of experts and surveys in the four participating countries carried out on trainees and trainers) specifically:

GENERAL:

• The main objective of this course is to train and raise the awareness of workers in the prevention of occupational risks in road works. In particular in relation to the most present risk whose consequences are most serious, i.e. the risk of being run over.

SPECIFIC:

- To know the tasks that integrate the works associated with the three chosen activities of road works, in order to identify the working conditions in which the workers carry them out: lane cutting; replacement of guardrail and traffic signs; procedure in case of accident.
- To identify the main labour risks generated during the performance of the three activities.
- To know the general preventive measures to be implemented during the performance of road works for the elimination or reduction and control of risks. (Collective and individual protection equipment, characteristics of tools and work equipment...)
- Observe the basic safety regulations applicable to the use of auxiliary means, work equipment and tools.



11. AIMS AND OBJECTIVES

Understand the importance of planning tasks from a preventive point of view ٠ depending on the workplace and its environment, focusing specially on the risk of being run over.



4. Contents

They are based on learning outcomes drawn from information gathered in the field.

The contents that must be integrated into the Virtual Reality experience for each of the activities are shown in the following table.

1.1	.LANE CLOSURE
-	Types of roads and characteristics.
-	Work equipment used in the activity (signalling trolley and transport
	vehicle).
-	Means of personal protection: placement, uses, obligations and
	maintenance.
-	Portable signalling required. Installation and removal.
-	Risks inherent to this activity and appropriate preventive measures.
-	Recognition of inappropriate tasks-actions (intervening factors).
1.2	REPLACEMENT OF GUARDRAIL AND SIGNALS
-	Work equipment used in the activity (pole presser, pneumatic hammer).
-	Means of collective protection, especially in portable equipment.
-	Means of personal protection.
-	Portable signalling required.
-	Risks inherent to this activity and preventive measures.
-	Recognition of inappropriate tasks-actions.
1.3	PROCEDURE IN THE EVENT OF AN ACCIDENT
-	Expected learning outcomes, drawn from the application of the fieldwork
	and inputs provided by the experts.
-	Means of personal protection (PPE).
-	Portable signalling required.
-	Risks inherent to this activity, and preventive measures (directly related to
	cleaning tasks, hand tools, etc.).
-	Recognition of inappropriate tasks-actions ⁴
	The initial second sector of the second second is a second s

(Table 5) Training contents. Learning units.

⁴ Health and Safety Authority_UK. "Guidelines for working on roads"



4.1. HEALTH AND SAFETY CONTENT. LINE CUTTING ACTIVITY

NOTE (IN CITY): In general, the majority of town councils do not have regulations governing the signalling of works on public roads (streets, squares, avenues, etc.), as the regulations⁵ on Signposting Works, is applicable to roads outside towns and their examples are entirely designed to act in these. Yet they can be used to apply their principles to specific cases on urban roads.

With all of this, urban road works sometimes have little budget for it and, therefore, less expenditure on signposting workers' operations. **But it** must be recognized that the speed limits in the city are stricter, which can help to reduce the impacts on the hit-and-run, a major risk in road works.

In general terms, all the activities carried out on the platform (road) require temporary work signalling tasks.

It is important to remember that the regulations on temporary signposting of road works must be respected and that the workers involved must have all the necessary elements to carry out these tasks (e.g. high visibility clothing) and have the necessary training and information.

The work to be carried out on the road exposes workers to the risk of being run over by vehicles outside the work site. Knowing this circumstance, it is advisable to adopt all measures aimed at preventing accidents or incidents.

Usually the first thing to be done when marking and signalling the action area is to park the transport vehicle (with luminous elements), if possible, out of traffic, or on the verge, in an area that precedes the place where the intervention is to be carried out.

Before carrying out any task on the tracks, it is advisable to have an action plan in which each of the operators knows exactly what their functions are and how to carry them out safely. The desirability of supplementing the indications in the standard with other additional actions, or with additional devices to protect workers engaged in specific maintenance tasks, may be determined.

RISKS AND PREVENTIVE MEASURES FOR TEMPORARY SITE SIGNALLING (LANE CUTTING)

TEMPORARY SIGNALLING

It is essential to warn road users of the work to be carried out, by means of a signalling system:

Precise. Adequate. Easy and quick to dispose and collect.

⁵ In Spain the norm: 8.3-IC of 1987.



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A safe operational proposal for the execution of a lane cut on a conventional road is as follows:

- The early warning is located on the verge and separated from the traffic area, preceding the transport vehicle with signs and beacons. This notice can be fixed or transported on a signalling trolley (although this is not mandatory⁶).
- Start placing signs by safely unloading them from the vehicle (side or rear zone, without interrupting the vehicle's own trajectory, away from traffic).
- If signs are to be posted on both sides, the worker crossing is monitored and supported.
- Once the road has been signposted in the necessary directions, the area where the work is to be carried out is signposted.
- It is convenient to retain the traffic on the part of the signallers ("flags" or also traffic lights) in both directions of the circulation.
- The installation of beacons begins by safely unloading them from the vehicle (side or rear zone, without interrupting the vehicle's own trajectory, away from traffic).
- An alternative crossing system is established so that traffic can circulate, under the control of signallers (or synchronisation of traffic lights), after the completion of the beaconing of the works area.
- Once the working area has been marked out, the workers and vehicles involved must always be located within the zone under control, marked out.
- Once the work has been completed, it is withdrawn, in the opposite way to that of placing beacons and signs, with the safety of the workers being a priority.
- It is recommended to finish the process by removing the transport vehicle in penultimate place if the notice is fixed, and at the same time vehicle and notice if it is associated with a car.

Without overlooking other risks also present in the described activity:

- Risk of exposure to extreme temperatures (high temperatures). Some preventive measures: shielding the main source of radiation that would be solar radiation (sun-protected and cool areas, for example the interior of an air-conditioned vehicle).
- Risk of entrapment due to rollover of vehicles. This can occur as a result of parking vehicles in uneven areas or with insufficient space on the platform...
- Manual handling of loads, in this case temporary signals. For which it is recommended, at least, the knowledge of the basic principles that involve the load using the strength of the legs and not the back for example.

⁶ In Spain: according to order 8.3-IC of 1987, if included in service note 2/2017.



4.2. HEALTH AND SAFETY CONTENT. ACTIVITY, REPLACEMENT OF VERTICAL SIGNALING AND GUARDRAIL

Vertical signal

In the first place and before starting any activity, the area affected by the works must be signposted. Before placing the sign, it shall be verified that the sign in all its elements (plate, support elements and anchors) meets the required requirements, requesting quality certificates from the manufacturer, checking shapes and dimensions, minimum thickness of galvanized, reflective material and plate, quality of the reflective part and that the sign has all the necessary fastening accessories (clamps, screws, etc.).

The foundation for the concrete footing will be excavated, previously restated in accordance with the aforementioned criteria. As an example, for a triangular sign of 1.35 m on each side, the approximate dimensions will be 0.60 m perpendicular to the axis of the road, 0.40 m in parallel and 0.70 m deep (triangular of 1.35 m, circular of 0.90 m), concrete will be set and a metal sheath of slightly larger dimensions than the pole of 0.70 m long will be embedded. Once the concrete is ready, the post with the signal already mounted will be introduced into the sheath and it will be verified that the situation, height and characteristics of the signal correspond to what is established in the regulations.

Finally, the area will be cleaned.

Guardrail

As in all activities carried out on the road or in its area of influence, the first thing to do is to indicate the area affected by the operation to be carried out. In case of replacement of damaged sections, all damaged parts (posts, belts, terminals) should first be removed and the screws of the adjacent parts should be loosened. Before starting any assembly, a careful stakeout will be carried out to guarantee the correct completion of the work, according to the criteria indicated above.

The installation will begin with the driving or foundation of the posts, depending on the characteristics of the terrain.

Subsequently, the spacers will be provisionally placed in the sections required, then the new metal barrier sections will be placed, fastened with a single screw. Level the guardrail so that it is perfectly aligned.

Once this has been checked, the screws are tightened definitively, and the corresponding headlamps and edge milestones are fitted. Once the assembly has been completed, check whether the safety barrier has been installed correctly.

Finally, cleaning of the área.



4.3. HEALTH AND SAFETY CONTENT. ACTIVITY, EMERGENCY RESPONSE (ACCIDENT)

The situation in which the intervention of road work's professionals takes place is different in the case of accidents due to the fact that the conditions in which they take place are very varied.

The responsibility for the accident, the injured, and the traffic is the Traffic Police (Guardia Civil in Spanish case) but road work's professionals must assess the situation (reporting on it, assessing the estimated time it may take to remove the vehicle ...).

Once it has been confirmed that the removal of the vehicle will require more than one hour of communication to determine the necessary means (humans and materials such as vertical signalling, cones...); that is to say, at this point the lane cutting activity would begin as has been carried out in activity 1 although in this case not for the purpose of carrying out maintenance operations but to protect all the personnel who have to work in the intervention area (in this case it is the area in which the accident occurred).

Once the emergency services have carried out their work, it would be necessary to clean the area; repair the damaged elements in the accident (guardrail, vertical signs...) and remove the provisional signalling elements.

Without exception in this case the cleaning of the area is the last task for road workers.

4.4. THE VISIBILITY, GENERATOR OF INCIDENCES....: ("ENVIRONMENTAL RISKS")

1. Methodological structure (based on the principles of: expositive clarity; referring to an experience in the work context; importance of the regulations in force -integrated within the VR experience-; observation of safety requirements).

Participatory Method.	The expository part will be developed, as far as possible, with participative techniques to study specific situations and problems, presented in real details, thus achieving the motivation of the student and his involvement in the specific case.
Active	Development of practical cases. Once the practice has been carried out,
Method.	the corresponding evaluation will be carried out. Due to the characteristics of this tool, the evaluation is integrated into the concrete action and will derive from the adequate achievement of the same or not. Even displaying the accident (hit-and-run for example) as a result of an inadequate or incorrect response.

• Introduction_Instructions

Integrated within a more complete formative action as they can be:

- COEX (road works) training itineraries (in Spain) or
- as a concrete formative experience or



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- complementary to theoretical training in preventive matters.

In any case, it must be associated with instructions on the structure of VR experiences, first reading or reference to theoretical content.

Example for **lane cutting**: The task proposed to the student is the realization of a lane cutting. Maintenance work (pavement repair) will be carried out on the right lane of a one-lane roadway in each direction (conventional road), with separation (median). The width of each lane is 3.5 m. The maximum speed allowed on this road is 100 kms / hour. The cut will last approximately five hours and the works will be carried out during the day. The works are not expected to last longer and it will not be necessary to establish an alternative route for all or part of the circulation.

At the end of the formative action the student will know:

- What is the most appropriate way to signal a lane cut.
- How signs and other items are to be transported to the place where the signage is to begin.
- How is the process, the order in which the signals and other beaconing elements must be placed?
- The various variables to be taken into account for signalling: duration of the detour, characteristics of the road, weather conditions, etc.
- Theoretical resources_Planning

A theoretical approach is necessary, i.e. the contents of the syllabus as a reference for its application in the practical experience (Virtual Reality) to be evaluated. That is, the student will find information about:

- How to choose the most suitable signals for correct signalling.
- The most appropriate procedure for placing them on the specific track, taking into account the rules on PRL.

Through the detail of what types of signs exist, and the recommendations for use depending on different variables: visibility, time needed to cut traffic and divert it to the adjacent lane, etc⁷.

Example: Some of the theoretical contents may be developed not only in writing but also in other formats such as video: <u>http://www.lineaprevencion.com/lptv</u>

• Application_Implementation_Evaluation

Consisting of the resolution, the game itself, in which the student must integrate the specifically theoretical content with the theoretical resources raised for the resolution of the most correct way the game proposed. That is to say, at this point the student must select among the different elements that are found those that best fit the proposed situation: signs (number, type and order of placement depending on the characteristics of the cut lane), beaconing elements (depending

⁷ In the Spanish case, the procedure for placing the signals is detailed in a standardized Manual.

on lighting conditions), individual protection equipment, vehicle (selecting the most appropriate depending on the characteristics of the area to be cut)...

The evaluation will result from the correct or incorrect practical development of the game. To complete the mission set out in the virtual environment and which will consist of reaching the end of the activity following the rules of safety and health at work (PRL).

In addition to the result (good, bad, regular...), it will be necessary to give feedback or reference to the contents of the syllabus that give a correct or more adequate answer.



5. HARDWARE MANUAL. Virtual training for road maintenance and operation workers VRoad

5.1. **GENERAL CONSIDERATIONS**

The project has been developed with Unity3D Professional under MS Windows; Unity is the development platform for interactive 3D environments chosen by the majority of professionals in Industry 4.0 and is compatible with the programming language .Net.

Under this platform, executable simulations will be developed for Windows environments, free of royalties. The applications will make use of virtual reality viewers (HDMs) to offer immersive simulations. The simulations will be training experiences for a single user, with: Recording and capture of activity data.

Compatible Virtual Reality Viewers (HDMs) are: Windows Mixed Reality.

5.2. PREPARATION OF EQUIPMENT

In order to execute the experience correctly, the following equipment and characteristics will be required:

- Portable or fixed computer with:
 - Windows 10
 - o Bluetooth
 - 8GB RAM minimum
 - SSD Storage
 - Nvidia GTX 1050 graphics card (equivalent or higher)
 - Intel Core i5 processor (equivalent or higher)
 - Internet connection for the first installation.
 - You can check the equipment at the following link
- WMR glasses also called HMD (head-mounted display).
- WMR Controls
- Optional headphones
- Steam software installed
- Windows Mixed Reality for SteamVR software (free download via Steam).

To start the experience, follow these steps:

- Connect your laptop (computer) to the mains.
- Connect glasses to HDMI/USB laptop (computer).



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- Turn on your laptop (computer).
- Connect headphones to glasses (optional).

NOTE: WMR controllers use AAA batteries, so it is always a good idea to have rechargeable batteries or a good number of spare batteries.

5.3. **INSTALLATION OF THE EXPERIENCE IN** A NEW EQUIPMENT

The experience is provided in digital format, so it can be installed on as many computers as necessary. It will be delivered as a compressed file (ZIP for being the most common) that only needs to be decompressed.

As it is compatible with the WMR environment, it works with any of the glasses on the WMR market (ACER, Asus, Lenovo, HP, Samsung, etc.) and with the compatible controls.

Note: The installation process proposed below will only be necessary if it is the first time an RV experience is installed or run on the computer. If the user has already used Steam-based WMR, these steps can be bypassed.

Step 1

The process is as follows:

- WMR installation will be required for Steam, after which it can be continued.
- When you connect a pair of glasses for the first time, the following pop-up screen appears, which will guide you through all the steps up to their configuration.





Step 2

The first thing it does is to check that the minimum requirements are met. •

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		You're good to go			
	Your P	C has what it takes to run Windows Mixed Reality.			
	Graphics card	NVIDIA GeForce GTX 1070			
C _ 100 (100 (100 (100 (100 (100 (100 (10	Graphics driver	22.21.13.8494 (WDDM 2.2)			
	СРО	Intel(R) Xeon(R) CPU E5-1660 v4 @ 3.20GHz			
A CONTRACT OF A CONTRACT OF	RAM	32 GB			
	Disk space	746 GB			
	USB				
	Operating system	Windows 10 Fall Creators Update or later			
	Bluetooth (for controllers)	4.0+			
1	Your PC look exact setup. Y pr	is good, but performance may vary depending on your ou'll also need to make sure your computer has the righ orts for the headset you choose. <u>Learn more</u> Discover Windows Mixed Reality	4		
	L				



Step 3

Below is information about the HMD and each of its components •



Step 4

The controls are then paired. •





Step 5

The system guides and explains the controls •



Step 6

We matched the controls. They are bluetooth devices, so they can be paired later • like any other device.

÷			
	Let's connect		
	Turn on your controllers and put them into Bluetooth pairing mode. We'll do the rest.		
1	Proces and held the Windows button 🖷 for 2		
	seconds to turn on your controllers.		
2.	Press and hold the Bluetooth pairing button until the lights flash.		
	Left controller: Searching ? Pairing button		
	Right controller: Searching t		
	Get help Use gamepad or mouse instead		



Pa	ir Device	×	
	Pair device?		
"Motion Controller" would like to pair to this Windows device. Do you want to allow this?			
	Allow	Cancel	

Step 7

We choose the type of installation. •





Step 8

We don't use voice commands. So the option to choose is "Later". •



Step 9

And the configuration process ends with the download. •

	-	D	×
Wait while we finish some downloads			
76 %			



5.4. **USE RECOMMENDATIONS**

- Avoid modifying the Operating System or its critical components. •
- Avoid any misuse of the equipment that could damage it, such as falls, blows, splashes of liquids, etc. ...
- The computer (even if it is portable and has a battery) must always be connected to the mains, as a drop in equipment performance caused by power-saving modes can cause a slowdown in sending the signal to the glasses, which can cause dizziness.
- RV devices should not be used while performing certain physical activities and safe • locations or areas should always be selected, without obstacles that may interfere with the user's movements.
- Some VR audiovisual stimuli may NOT be recommended for people suffering from nervous type disorders and/or related, for example, to epilepsy (the latter should not have access to experience).

5.5. START THE EXPERIENCE

Step 1

Activate Windows Mixed Reality for Steam:





Step 2

Start the .exe, something similar to the following:

Nombre	Fecha de modifica	Tipo	Tamaño
MonoBleedingEdge	20/08/2019 14:42	Carpeta de archivos	
👵 VRSteam_Data	02/08/2019 12:31	Carpeta de archivos	
🔊 actions.json	05/07/2019 12:45	Archivo JSON	5 KB
🔊 binding_holographic_hmd.json	30/01/2019 22:35	Archivo JSON	1 KB
퓅 binding_rift.json	30/01/2019 22:34	Archivo JSON	1 KB
🔊 binding_vive.json	30/01/2019 22:36	Archivo JSON	1 KB
🔊 binding_vive_pro.json	30/01/2019 22:38	Archivo JSON	1 KB
inding_vive_tracker_camera.json	02/08/2019 12:31	Archivo JSON	1 KB
indings_holographic_controller.json	02/08/2019 12:31	Archivo JSON	12 KB
indings_knuckles.json	02/08/2019 12:31	Archivo JSON	8 KB
indings_oculus_touch.json	02/08/2019 12:31	Archivo JSON	8 KB
indings_vive_controller.json	02/08/2019 12:31	Archivo JSON	7 KB
🚳 UnityCrashHandler64.exe	09/05/2019 16:42	Aplicación	1.421 KB
🔊 UnityPlayer.dll	09/05/2019 16:42	Extensión de la ap	23.377 KB
🚳 VRSteam.exe	09/05/2019 16:40	Aplicación	636 KB

5.6 SPECIFIC CONSIDERATIONS

The case of the simulation of the activities that VRoad carries out for road works (COEX) consists of 5 well-differentiated parts:

- Home
- Tutorial
- Scene 1
- Scene 2
- Scene 3

Ноте

It is the space in which the user makes first contact, it consists of several elements:

- Welcome with project identification, disclaimer, and partner logos.
- Language selection menu: Spanish, English, French, English and Italian.
- Brief explanation of hardware (glasses and controls).
- Access menu to: tutorial and scenes.





Language Menu Sample



@VRoad



Hardware explanation sample-2



Sample navigation menu



Tutorial

A specific tutorial of all the functionalities included in the training experience has been developed in a neutral environment that does not distract the user's attention and allows him to focus on the handling of the controls and the HMD (head-mounted display).

Use of each of the functions and verification of information fixation.



Sample Tutorial Space-1-Advance



Sample Tutorial Space-2-Take and Leave Objects





Sample of the tutorial space-3-Instructions

Scenes 1, 2 and 3

They will be developed according to the foreseen scripts, with menus and buttons for exit, restart and return to the main menu.

VR				
ROAI	DS CON	SERVA	ION	
 Road		N-420		
Initial PK / Road		646,680 / Sin	gle	
Sector		TE – 03		
Class Tyoe Subtype		Roadway dan Earthworks >>	nage >> > Landslides	
Description		Sliding coveri	ng gutter. MD	
Date of knowledge	8	00:00 01/01/2	2019	
 TO CONTINUE,	PRESS THE A	CTION BUTTO		
× /	/	. /		K



Sample work order



Sample van design



Design-Scenario and Objects Sample

Once the game mechanism is understood, the way of configuring and using it, as well as navigating through the menu, only remains to play it, resulting in the learning and practice, ultimately, of the skills envisaged, based on the knowledge highlighted in the VRoad framework and the field work developed prior to the design of the VR.



ANNEX I. KNOWLEDGE SKILLS AND COMPETENCES (ACCORDING TO RESULTS REPORT)

The results report, developed in this project, collects the data obtained from the study carried out using qualitative techniques (focus groups) and quantitative techniques (survey carried out among trainers and trainees); the contributions made by both the NAG (National Advisory Group) and experts involved in these activities are also included in this report; as well as by the TAG (Technical Advisory Group), a heterogeneous group of technicians with knowledge and experience both in the field of occupational risk prevention and in the field of COEX work or professional training.

	LANE CUTTING	REPLACEMENT OF GUARDRAIL AND SIGNALLING	ACTION IN THE EVENT OF AN ACCIDENT	EVALUATION (EXAMPLES)	LEARNING UNITS
					BASIC CONCEPTS
					ABOUT ROADS.
	Know the types of roads				SPECIAL SECTIONS
	(motorways and dual	Know the types of roads	Know the types of roads		(TUNNELS,
	carriageways,	(motorways and dual	(motorways and dual		VIADUCTS, ETC.).
	conventional roads, ring	carriageways, conventional	carriageways, conventional	Identify them from an	EQUIPMENT AND
	roads, tunnels)	roads, ring roads, tunnels)	roads, ring roads, tunnels)	image	FACILITIES
					GENERAL ASPECTS OF
KNOWLEDGE	Know the working		Know the working	Relate working	CONSERVATION AND
	procedure established	Know the working procedure	procedure established by	procedures to types of	EXPLOITATION.
	by the service company	established by the service	the service company or	pathways (drug and	OPERATIONS AND
	or officially (DGC)	company or officially (DGC)	officially (DGC)	drop i.e.)	ACTIVITIES.
	Distinguish the types of			Identify signs of	
	signals required, their	Distinguish the types of	Distinguish the types of	prohibition, obligation,	ROAD SAFETY.
	dimensions and the	signals, their dimensions and	signals, their dimensions	firefighting and	SIGNALLING AND
	elements that make	the elements that make	and the elements that	evacuation and	BEACONING.
	them up	them up	make them up	determine their size	LIGHTING



			according to a given	
			situation (different	
			depending on the	
			activity.	
			Propose a situation	
			and ask them to choose	ROAD SAFETY.
			the most appropriate	SIGNALLING AND
Be able to select the	Ability to select the right	Ability to select the right	one from among 4	BEACONING
right signal model	signal model	signal model	types of signals.	LIGHTING
0			Identify signalling	
			elements, segregation,	
			fences, luminous	ROAD SAFETY.
Recognize the different	Recognize the different	Recognize the different	elements and	SIGNALLING AND
elements necessary for a	elements necessary for a	elements necessary for a	propose them in the	BEACONING.
diversion of traffic	diversion of traffic	diversion of traffic	appropriate order.	LIGHTING
			From the previous	
			exercise now	
			determine the distance	GENERAL ASPECTS OF
Be able to observe the	Be able to observe the	Be able to observe the	between signals	CONSERVATION AND
location with respect to	location with respect to	location with respect to	depending on the type	EXPLOITATION.
other signals, distances,	other signals, distances,	other signals, distances,	of road, speed of the	OPERATIONS AND
height or position.	height, or position	height, or position	road	ACTIVITIES.
			The activity is	MACHINERY AND
			proposed: and for each	CONSERVATION
			activity different tools	EQUIPMENT.
Be able to choose the	Be able to choose the right	Be able to choose the right	are proposed (choose	DESCRIPTION AND
right tool for the job.	tool for the type of work	tool for the type of work	the most appropriate	CHARACTERISTICS



				one for the activity or specific task).	
				Same as in the previous case but	MACHINERY AND CONSERVATION
	Recognize the work			taking into account	EQUIPMENT.
	teams necessary for the	Recognize the work teams	Recognize the work teams	auxiliary equipment,	DESCRIPTION AND
	activity.	necessary for the activity	necessary for the activity	work equipment	CHARACTERISTICS
					COLLECTIVE
					PROTECTION MEANS
					(PLACEMENT, USES,
					OBLIGATIONS AND
					MAINTENANCE)
					INDIVIDUAL
					PROTECTION
	Distinguish the	Distinguish the individual and	Distinguish the individual	From the previous	
	individual and collective	collective protective	and collective protective	year select according	(PLACEMENT, USES,
	protective equipment	equipment needed to do the	equipment needed to do	to the task or activity -	OBLIGATIONS AND
_	needed to do the job.	JOD.	the job.		MAINTENANCE)
				Propose exercise of	AUXILIARY MEANS,
	Interpreting the cafe use			the right/incorrect	
	of work equipment and	Interpreting the safe use of	Interpreting the safe use of	activity that is related	AND TOOLS. KISKS
	tools	work equipment and tools	work equipment and tools	to a specific work team	MEASURES
	To know how to act in	To know how to act in	To know how to act in	Relate working	GENERAL ASPECTS OF
	adverse conditions (low	adverse conditions (low	adverse conditions (low	procedures with types	CONSERVATION AND
	visibility, bad weather	visibility. bad weather	visibility. bad weather	of road (drug and drop	EXPLOITATION.
	conditions, etc.) in	conditions, etc.) in	conditions, etc.) in	i.e.) in adverse weather	OPERATIONS AND
	emergency situations.	emergency situations.	emergency situations.	conditions.	ACTIVITIES.

	Know the guidelines for coordination with the emergency services (112: police / civil guard, health, fire, etc.).	Know the guidelines for coordination with the emergency services (112: police / civil guard, health, fire, etc.).	Know the guidelines for coordination with the emergency services (112: police / civil guard, health, fire, etc.).	Relate working procedures with types of road (drug and drop i.e.) in adverse weather conditions.	GENERAL ASPECTS OF CONSERVATION AND EXPLOITATION. OPERATIONS AND ACTIVITIES.
	LANE CUTTING	REPLACEMENT OF GUARDRAIL AND SIGNALLING	ACTION IN THE EVENT OF AN ACCIDENT	EVALUATION	LEARNING UNITS
	Select the procedure according to the type of track.	Select the procedure according to the type of track.	Select the procedure according to the type of track.	You must select the signals, their size and distance based on a given situation (including details- pictures of the type of road).	BASIC CONCEPTS ABOUT ROADS. SPECIAL SECTIONS (TUNNELS, VIADUCTS, ETC.). EQUIPMENT AND FACILITIES
SKILLS	Apply the individual or			In this case, the evaluation will consist of the student determining how to	COLLECTIVE PROTECTION MEANS (PLACEMENT, USES, OBLIGATIONS AND MAINTENANCE) INDIVIDUAL PROTECTION
	collective protection equipment corresponding to the activity	Apply the individual or collective protection equipment corresponding to the activity	Apply the individual or collective protection equipment corresponding to the activity	install or how to place the individual or collective protective equipment.	EQUIPMENT (PLACEMENT, USES, OBLIGATIONS AND MAINTENANCE)



			Ask the student to use	AUXILIARY MEANS,
Install the signposting			a nailer to carry out the	WORK EQUIPMENT
with the appropriate	Install the signposting with	Install the signposting with	steps prior to the	AND TOOLS: RISKS
means (tools,	the appropriate means	the appropriate means	installation of a vertical	AND PREVENTIVE
machines)	(tools, machines)	(tools, machines)	signal.	MEASURES
				AUXILIARY MEANS,
			Evaluate by means of	WORK EQUIPMENT
Safe use of different			correct image -	AND TOOLS: RISKS
tools and work	Safe use of different tools	Safe use of different tools	incorrect image and	AND PREVENTIVE
equipment	and work equipment	and work equipment	identification	MEASURES
			Present two	
			procedures, one	
			correct and the other	
			incorrect, which the	
			student must	
			determine correctly	
Choose the safest way to		Choose the safest way to	(for example, in one	VIALITY. ACTION IN
apply the working	Choose the safest way to	apply the working	case in front of the	THE EVENT OF
procedure according to	apply the working procedure	procedure according to the	signs and in the other	EMERGENCIES AND
the traffic	according to the traffic	traffic	behind)	INCIDENTS
				VIALITY. ACTION IN
Interpreting changes in	Interpreting changes in	Interpreting changes in	For example to raise	THE EVENT OF
performance according	performance according to	performance according to	the previous situations	EMERGENCIES AND
to weather conditions	weather conditions	weather conditions	but with snow	INCIDENTS
	Report any	Report any		BASIC CONCEPTS ON
Report any	incident/suggestion	incident/suggestion		THE PREVENTION OF
incident/suggestion	regarding safety and health	regarding safety and health	Make affirmations with	OCCUPATIONAL
regarding safety and	to the responsible person.	to the responsible person.	a V-F answer option	RISKS

	health to the responsible person.				
	Attend periodic maintenance of tools, equipment and vehicles	Attend periodic maintenance of tools, equipment and vehicles	Attend periodic maintenance of tools, equipment and vehicles	Make affirmations with a V-F answer option	BASIC CONCEPTS ON THE PREVENTION OF OCCUPATIONAL RISKS
	LANE CUTTING	REPLACEMENT OF GUARDRAIL AND SIGNALLING	ACTION IN THE EVENT OF AN ACCIDENT	EVALUATION	LEARNING UNITS
COMPETENCES	To be able to relate the different risks of the activity with the sources that originate them. Manage the work by distributing it according to the characteristics of the participants in the activity.	To be able to relate the different risks of the activity with the sources that originate them. Manage the work by distributing it according to the characteristics of the participants in the activity.	To be able to relate the different risks of the activity with the sources that originate them. Manage the work by distributing it according to the characteristics of the participants in the activity.	Evaluate on the performance of another. The student must determine what he or she is doing wrong and how he or she should do it correctly (e.g. the use of a tool). For example, introduce workers (3 different) and determine the activity to be performed by each.	IDENTIFICATION AND ASSESSMENT OF JOB RISKS GENERAL ASPECTS OF CONSERVATION AND EXPLOITATION. OPERATIONS AND ACTIVITIES.



Classify, select and provide the collective and individual	Classify, select and provide the collective and individual	Classify, select and provide the collective and individual	Before leaving the Conservation Centre and depending on the activity to be carried	COLLECTIVE PROTECTION MEANS (PLACEMENT, USES, OBLIGATIONS AND MAINTENANCE) INDIVIDUAL PROTECTION EQUIPMENT
protection equipment necessary to carry out the activity.	protection equipment necessary to carry out the activity.	protection equipment necessary to carry out the activity.	out, foresee and order both the tool and the PPE in the vehicle.	(PLACEMENT, USES, OBLIGATIONS AND MAINTENANCE)
Act autonomously	Act autonomously	Act autonomously	Identify a "work order" and how to manage it (taking into account related SyS issues)	IDENTIFICATION AND ASSESSMENT OF JOB RISKS
			In the absence of a superior and in the event of a change of circumstances in the development of work that requires other work equipment not	GENERAL ASPECTS OF CONSERVATION AND
Take responsibility for their own work	Take responsibility for their own work	Take responsibility for their own work	foreseen and not loaded in the vehicle, WHAT TO DO	EXPLOITATION. OPERATIONS AND ACTIVITIES.

			1 Equivalent to the	
			evaluation method for	
			the first item of	
			COMPETENCIES.	
Indicate and assume, if			2. It could also be to	
appropriate,	Indicate and assume, if	Indicate and assume, if	give precise indications	
responsibility for the	appropriate, responsibility	appropriate, responsibility	to the direct superior	IDENTIFICATION AND
safety and health of	for the safety and health of	for the safety and health of	or PRL manager about	ASSESSMENT OF JOB
others	others	others	a risk situation.	RISKS



ANNEX II

Glossary of terms

A-G

Accident = **A** collision that occurs on a public road and involves at least one moving vehicle. It can only cause damage to property or also cause physical damage.

Sidewalk = Longitudinal area of the road, elevated or not, intended for pedestrian traffic. (*Traffic Code and Road Safety*).

Overtaking = This is a manoeuvre that consists of overtaking another vehicle that circulates in the same direction but with lower speed and in front. (*European Commission of the Automobile*)

Physical agent = Those factors that can be found in the workplace and are detected in the form of energy manifestations such as: noise, vibrations, temperature, humidity, illumination, radiation, etc.

Siding = This is the widening of the roadway used for stopping vehicles, thus leaving the passage free on the main road and without intercepting traffic on the roadway. It can be used for the temporary parking of vehicles, areas of tourist or scenic interest, the stopping of collective transport vehicles and for the weighing of vehicles. It's usually paved.

Shoulder = Longitudinal paved strip adjacent to the carriageway, between the outer edge of the carriageway and the corresponding edge of the platform. Not intended for the use of motor vehicles, except in exceptional circumstances. It is an element of the cross section of the road that contributes to the structural strength of the road surface at the edge of the carriageway and improves the operating and safety conditions of the traffic circulating on the carriageway. It has different minimum widths and functions, depending on the type of track on which it is located, with a width of 1–1.5 m being normal. (*FLC Dictionary*)

Affirmed shoulder = Asphalt strip adjacent to the roadway and at the same level, intended for use by vehicles having difficulties or in the case of obstruction of the roadway.

Run over = Saying of a vehicle, violently hitting people or animals, colliding with them and causing them, in general, damage.

Overrun = Action and effect of hitting or being run over.

Motorway = **A** road specially designed, constructed and signposted as such for the exclusive circulation of automobiles, and having the following characteristics: it does not have access to adjacent properties; it does not cross at level any other path, track, railway or tram line, nor is it crossed at level by any other path, communication or easement of any kind; it consists of different carriageways for each direction of circulation, separated from each other, except at singular points or temporarily, by a strip of land not intended for circulation or, in exceptional cases, by other means.

Dual carriageway = **A** road that does not meet all the requirements of motorways, has separate carriageways for each direction of traffic and limited access to adjacent properties.



@VRoad

Bache = Hole in the pavement of streets, highways or roads, produced by use or other causes. **Pothole** = Lifting in localized zones of loose or inadequate materials, for its substitution by other selected and compacted ones.

Speed bumps = Artificial hillock that is placed across the roadway to limit the speed of vehicles (*RAE Dictionary*).

Beacon = A device installed on the road or track to guide users or signal a particular, point or linear hazard.

Beaconing = The set of devices (beacons, reflective lines, but not signs or lighting) installed along roads or highways to guide traffic and improve safety.

Safety barrier = Vehicle restraint installed on the verges or in the central division of the tracks. **Roadside** = The unpaved strip of land next to the outside of the verges. They tend to have a slight slope due mainly to being between the platform and the ditches.

Road = part of the road intended for the circulation of vehicles. It consists of a certain number of lanes. (*Traffic Code and Road Safety*)

Change of grade = A variation of the inclination or parallelism with respect to the horizontal plane. On roads, a change of grade is usually understood as a change of grade only when an initially ascending grade reduces its slope or even changes to descending grade. (*FLC Dictionary*) **Load** = Any object that can be moved.

Workload = Set of psychophysical obligations to which the worker is subjected throughout his working day. It is defined on the basis of two aspects: one physical and the other psychological, which means that the establishment of a certain workload depends on both the physical and psychological demands that the worker has at any given moment.

Road = **A** paved public road outside the village, except for sections in transit. (*Traffic Code and Road Safety*).

Two-, three-, four-lane road = Road or road conditioned to allow two, three, four vehicles to pass simultaneously through the same section.

State roads = State roads are those owned, regardless of their management system, by the General State Administration, which exercises its powers over them through the Ministry of Development. (*Law 37/2015 of 29 September on Roads*).

Lane = Longitudinal strip into which the roadway may be divided, whether or not bounded by longitudinal road markings, and of sufficient width for the circulation of a row of vehicles other than motorcycles. (*Traffic Code and Road Safety*)

Reversible lane = A lane of a two-way carriageway that can be reserved for circulation in one direction or the other according to the demand of circulation or the requirements of traffic.

Retro-reflector = **A** device used to indicate the presence of the vehicle by the reflection of light from a light source independent of the vehicle, the observer being close to the source. (*Traffic Code and Road Safety*).

Traffic Management Center = Center for the control and supervision of traffic, equipped with surveillance and telecommunications systems to monitor traffic in real time in a given area, allowing authorized personnel to coordinate actions in response to situations that affect traffic. COEX = Way of referring to the works and activity of conservation and exploitation of locksmiths. **Ideal handling conditions** = Those that include an ideal handling posture (load close to the body, straight back, no twists and turns), a firm hold of the object with a neutral wrist position, gentle and spaced lifts, and favourable environmental conditions.

Road conditions = General configuration of regional or national road conditions according to climatic conditions (e.g. during winter).



Driver = A person who operates the steering mechanism or is in command of a vehicle, or is in charge of an animal or animals. The person in charge of the additional controls is considered to be the driver in vehicles that are driven for driving instruction purposes. (Traffic Code and Road Safety).

Congestion = Slow progression or immobilization due to traffic conditions.

Signalling cone = Plastic cone, usually red and white, used for temporary beaconing of an area (e.g., construction sites).

Consequence = Result of an event with damage to human health, to things or to the environment.

Traffic control = Management of traffic through road markings, vertical signage, traffic lights and other measures.

Vienna Convention on Road Signs and Signals = Multilateral treaty designed to increase road safety and assist international road traffic by standardizing the signalling system for road traffic. It was agreed by the Economic and Social Council of the United Nations and entered into force on 6 June 1978. A number of amendments were adopted in 2003 relating to the legibility of signals, priority at roundabouts and new signals to improve safety in tunnels. (Wikipedia).

Partial cuts = those which, due to the characteristics of the work being carried out on the carriageway, only affect one or more lanes, or reduce the flow of traffic on internal or external shoulders. These are specific works where one or more lanes of a roadway are affected (localized patches, extraction of witnesses for laboratory tests, repainting of road markings, etc.) and can be completed in the same working day without compromising the fluidity of the road circulation.

Total cuts = those that affect the entire roadway, requiring alternative itineraries or the use of other roads (in the case of dual carriageways) to give continuity to the circulation of the road. For example, they can be carried out in road surface renewal works (mainly on motorways), which need to carry out various activities (milling the road surface, adhering watering, paving agglomerate, painting road markings) and in this way, there is continuity in them, i.e. when one activity is completed, the next is started, without the need to dismantle the signposting from one day to the next.

Crossing = Meeting of two or more roads or highways. A distinction can be made between: level crossings, where there is no level separation between the traffic flows at the meeting point; uneven crossings or crossings at different levels, where some traffic flows are crossed at different levels.

EC Declaration of Conformity = The procedure by which the manufacturer, or his representative established in the European Union, declares that the machinery placed on the market satisfies all the relevant essential health and safety requirements (RD 1435/1992, laying down the provisions for implementing the Machinery Directive).

Traffic density = Number of vehicles per unit of length, of track or road, or part of it, at a given instant, excluding parked vehicles.

Traffic diversion = Optional alternative diversion of traffic on a congested section of a route, by means of a detection system, automatic transmission and variable signalling system remotely controlled from a computer.



Temporary detour = Alternative route to the main route, which allows traffic to avoid a congested or obstructed section (e.g. due to works).

Detention = Immobilization of a vehicle due to an emergency, traffic needs or to comply with any regulatory precept. (*Traffic Code and Road Safety*).

Braking distance = The distance travelled by a vehicle from the moment the brakes are applied until they come to a complete stop.

Stopping distance = Total distance travelled by a vehicle forced to stop as quickly as possible, measured from its position at the time the object or obstacle causing the stop appears. This includes the distance travelled during perception, reaction and braking times. (*Road Instruction*). **Safety distance** = The distance between vehicles that allows stopping in the event of sudden braking without colliding with the vehicle in front, taking into account the traffic speed and the braking and grip conditions of the road.

Beaconing elements = Reflecting devices of different shapes, colours and sizes, installed on the platform or on the road, off-road or in vehicle containment systems and specifically designed to facilitate optical guidance, with the possibility of having their own lighting.

Vehicle loading space = Space for the transport of the load, such as signalling and beaconing elements used for cutting.

Parking = **The** immobilization of a vehicle that is not in a stop-and-go situation. (*Traffic Code* and Road Safety).

High visibility (HV) equipment = Work equipment (clothing) designed to visually signal the presence of the user, in order to be detected in hazardous conditions, under any type of daylight and under the light of the headlights of a vehicle moving in the dark. (*NTP 718: High Visibility Signalling Clothing. INSHT*).

Work equipment = Any machine, apparatus, instrument or installation used in the work. The work equipment, like any other product, must have the CE marking, accrediting its adequacy through the corresponding declaration of conformity of the manufacturer, supplier or importer. **Personal Protective Equipment (PPE)** = Any equipment worn or held by the worker to protect him or her from one or more risks that may threaten his or her safety and health, as well as any complement or accessory intended for this purpose (definition in RD 773/1997, of 30 May, on minimum safety and health provisions relating to the use by workers of personal protective equipment).

Ergonomics = It is one of the disciplines that together with safety, industrial hygiene and occupational medicine make up the multidisciplinary character of the so-called occupational health. It consists of a set of techniques or procedures whose main objective is to adapt the workplace to the characteristics of the person in order to achieve maximum efficiency, safety and comfort in the activities and tasks carried out.

Road operation = A set of actions aimed at a better permanent adaptation of the supply and demand of traffic to the existing road infrastructure.

Risk factor = Any object, substance, form of energy or characteristic of the organisation of work which may contribute to an accident at work, aggravate the consequences thereof or cause, even in the long term, damage to the health of workers. Five groups of risk factors: safety conditions; physical work environment; chemical and biological contaminants; workload; and work organization.



Fatigue = Decrease in an individual's physical and mental capacity after performing work for a given period of time. Although the sensation of fatigue is a global sensation, both physical and mental, for analysis is often distinguished between muscle fatigue (physical) and nervous fatigue (mental).

Reliability = **The** ability of an element to perform a required function under given conditions during a given time interval.

Firme/Surface = Set of layers built on the esplanade that constitute the resistant structure of the roadway and that generally comprise, from the bottom up, the layers of sub-base, base and pavement. It allows the circulation in conditions of security and comfort.

Management due to the effect of the road = Traffic regulation through the implementation of measures in traffic lanes: reversal of the direction of traffic, closure of lanes or speed control. **Gloves** = According to UNE-EN 420:2004+A1, general requirements for gloves, are a personal protective equipment (PPE) that protects the hand or part of it against certain risks. In some cases it may cover part of the forearm and arm.

Glossary of terms H-Z

Passenger compartment = Part of the structure of a car intended for driving and passengers. It's all the living space of a car. (*MotorGiga*)

Kilometre marker = A vertical sign with reflective elements that is placed vertically on the margin of the road platform. It indicates the name of the road and the kilometre point from its origin to the point where it is located. It is made up of three elements: support (galvanised sheet steel); non-reflecting zone (use of paints) and retro reflecting zone (sheets of this material). Its shape and size depends on the type of line. (*FLC Dictionary*).

Primer (priming coat) = Treatment consisting of spreading a liquid binder over an uncoated layer with fine voids. The viscosity of the binder must be such that it penetrates by capillarity into the holes at the top of this layer. (*Dictionary of the World Road Association*).

Traffic incident = **An** abnormal or unforeseen situation, including accidents, with detrimental effects on the flow of traffic.

Traffic Infringement = Non-respect of laws, regulations, traffic codes.

Traffic intensity = Number of vehicles passing through a given cross section of a road in the unit of time. (IMD, Average Daily Intensity).

Manual handling of loads = Any operation of transporting or securing a load by one or more workers, such as lifting, positioning, pushing, pulling or moving, which, because of its characteristics or inadequate ergonomic conditions, involves risks, in particular lower back risks, for the workers. (*RD 487/1997, of 14 April, Manual handling of loads*).

Curative maintenance = All work that corrects defects in the constructive elements, to restore them to their normal conditions of service. (*World Road Association Dictionary*).

Road maintenance = A set of actions designed to maintain and restore the trafficability and service level of a road.

CE mark of conformity = Distinctive that, within the European Union, guarantees the conformity of a product with the regulations that affect it. (*Prevention Line.* http://www.lineaprevencion.com/)

Road markings = Marks on the pavement, horizontal signage.

Medium = Longitudinal strip between two separate platforms, not intended for circulation. (*Road Act 2015*)

Occupation = Percentage of time during which a given cross-sectional or longitudinal section of a road or highway, during a certain period of time, is occupied by some vehicle or persons, somewhere in the section. (*World Road Association Dictionary*).



Ears = Two caps covering the ears, adapted to the head by means of soft pads, generally filled with plastic foam or liquid and lined, normally, with a material capable of absorbing sound. They are joined together by a pressure band called a harness. They are more protective than earplugs and aural arches.

Stop = Immobilisation of a vehicle for less than two minutes, without the driver being able to leave the vehicle. (*Traffic Code and Road Safety*)

Platform = Area of the road intended for the use of vehicles, formed by the carriageway, shoulders and berms affirmed. (*Road Act 2015*)

Pavement = The top layer of the pavement placed on the base and in direct contact with traffic. The upper part of a road surface which must withstand the stresses produced by traffic, providing a comfortable and safe running surface. (*FLC Dictionary*).

Danger = Potential source of harm.

Perception = The process of acquiring, interpreting, selecting and organizing relevant information from the human senses.

Risk perception = **A** systematic process carried out by an organism to achieve, and maintain, a tolerable level of risk.

Conservation policy = A set of elements that define conservation, including the desired levels of services, the strategy for achieving them, the organization involved, and the monitoring of results.

Signalling gantry = Gantry located on the carriageway, the lintel of which allows signals to be placed on top of the affected rails.

Prevention of occupational risks = Set of activities or measures adopted or planned in all phases of activity of the company in order to prevent or reduce the possibility that a worker suffers damage arising from the performance of their work, whether these are accidents, diseases, pathologies or injuries.

Protection = Prevention technique that acts on the consequences of the risk, reducing or even eliminating them. These are measures that prevent harm to workers in the event of an accident. **Road network** = A set of roads within a given area.

Risk reduction = Actions taken to reduce the probability and/or consequences associated with a risk.

Reflectance = Property of a body to reflect light.

Pavement Rehabilitation = An operation to restore a satisfactory level of service and to extend the service life and duration of the pavement.

Risk = Combination of the probability of occurrence of damage and the severity of its consequences.

Occupational hazard = Possibility for a worker to suffer a certain damage resulting from work. In order to qualify a risk from the point of view of its severity, the probability of its occurrence and the severity of the damage shall be assessed together.

Protective clothing = Garments designed to cover or replace personal clothing and to protect the body or part of the body against one or more dangers of: dermal absorption of dangerous substances, thermal and chemical burns, abrasions, cuts, punctures and contact with biological agents. Workwear: raincoats, overalls, vests, aprons, etc. High-visibility clothing: parkas, bracelets, overalls, vests, etc.

Health = **A** state of complete physical, mental, and social well-being, and not merely the absence of harm or disease. (*World Health Organization*)

Safety = Absence of unacceptable risks.



Road safety = Prevention of traffic accidents with the aim of protecting people's health and lives.

Safety and health at work = Also called Safety and health at work is aimed at the implementation of measures and development of activities necessary for the prevention of risks arising from work.

Hazard Warning Signs = Elements intended to warn people that they are in a hazardous area and should avoid it, or take appropriate precautions and protections. When they indicate a work zone on the road, they have a yellow background. (*Wikipedia*)

Signs of end of prohibition = Have circular shape. Most have a white background and several black lines diagonally above the pictogram indicating what is no longer forbidden. For example, the end of overtaking signal has diagonal lines on a pictogram of two vehicles in parallel.

Mandatory signs = Impose an action on the driver. They have a circular shape, a white border and a blue background. The pictogram is also blank. For example, the obligatory direction sign is a white arrow in the direction in which cars must circulate, on a blue background. (*Wikipedia*) **Priority signs** = These are those that force other vehicles to give way in various situations.

Prohibition Signs = Signs that prohibit behaviour likely to cause a danger.

Prohibition signs = These are all signs that restrict access. Almost all of them have a circular shape, a red border and pictograms in black on a white background.

Signal in the form of a panel = A signal that, by combining a geometric shape, colours and a symbol or pictogram, provides certain information, the visibility of which is ensured by sufficient illumination.

Portable Signal = Signal designed to be easily moved from one place to another.

Signalling = A set of signals used to inform road users, ensure their safety and facilitate traffic. Examples of traffic signs include traffic lights and traffic signs (vertical signage), and road markings (horizontal signage).

Overexertion = Excessive exertion that can cause injury or trauma. Although there are other situations in which the worker may suffer an injury due to overexertion, the handling of loads is the task in which they occur most commonly, causing injuries in the lower back area.

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Speed retarder system = layout of the road (reduction of lanes, narrowing) or physical device (central islet, rounded transverse protrusion or flattening) intended to reduce the speed of vehicles on the road.

Occurrence = Occurrence, or change, of a specific set of circumstances.

Reaction time = Time taken by the driver to perform a reasoned action as a consequence of an external stimulus. (*MotorGiga*)

Permanent works = those that have a continuity in time, that by their characteristics, affect the normal circulation of the road or that by their duration, need several days of work to complete them, affecting the circulation even after the working day, needing a signalling device of the work during all the duration of the same.

Temporary jobs = like those that do not have a continuity in time. Those which, due to their characteristics, do not seriously interfere with the normal circulation of the road or which, due to their duration, can be completed during the working day, without affecting circulation once the work has been completed.

Section = Length of track or road between two cross sections of its layout.



Transitability = Functional quality of the way perceived directly by the users. This quality is generally characterised by the ability of the road to allow fluid traffic under safe conditions and at a speed appropriate to its category.

Musculoskeletal disorders = Health problems affecting the muscles, tendons, ligaments, cartilage, vascular or nervous system or other soft tissues and joints of the musculoskeletal system. They are associated with repetitive and strenuous work. They range from mild discomfort or minor aches and pains to more severe conditions that can lead to permanent disability. (OSH Wiki)

Urgency = An unexpected and sudden event requiring immediate action due to damage to human health, things or the environment.

Use of work equipment = Any activity related to work equipment, such as starting or stopping, using, transporting, repairing, transforming, maintaining and preserving, including, in particular, cleaning. (Technical Guide for the Evaluation and Prevention of Risks relating to the Use of Work Equipment. INSHT)

Vehicle = Apparatus suitable for driving on public roads or lands (both urban and interurban), and roads and lands that are of common use, and private roads and lands that are used by an indeterminate group of users (Legislative RD 6/2015, of 30 October, approving the revised text of the Law on Traffic, Circulation of Motor Vehicles and Road Safety).

Articulated vehicle = Motorised vehicle coupled to a semi-trailer (Legislative RD 6/2015 approving the rewritten text of the Law on Traffic, Circulation of Motor Vehicles and Road Safety). **Motor vehicle** = Any vehicle equipped with a propulsion engine and running on a track by its own means. Mopeds, trams and vehicles for persons with reduced mobility are excluded from this definition. (Legislative RD 6/2015)

Vehicle of transport = Means used by the workers for the transfer of place, so much of them as of the elements of signaling and beaconing necessary for the cut of lane.

Speed = Distance traveled in a unit of time.

Service road = A road significantly parallel to a road, in respect of which it has a secondary character, connected to it only at certain points, and serving adjoining properties or buildings. It can have one or two directions of circulation. (Road Act 2015)

Traffic monitoring = Observation of traffic to detect illegal or dangerous behaviour.

Visibility = Quality of visible. The greater or lesser the distance at which objects can be recognized or seen, depending on atmospheric conditions.

Traffic volume = Number of vehicles or persons passing through a given cross section of a road over a given period of time.

Stopping zone = Area fitted out in the vicinity of the roadway, which allows a small number of vehicles to be stopped or parked outside the traffic lanes.

Pedestrian zone = Part of the road, elevated or otherwise delimited, reserved for pedestrian traffic. This definition includes the sidewalk, the platform and the promenade. (Traffic Code and Road Safety).





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