Simulation Team

Mixed Realty & Simulation in Marine Domain for Safety and Security & Live Demonstration

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Accidents in Ports

Seaports are critical infrastructures and have significant impact on economy and people's life. Indeed, nowadays they manage huge flows of goods and passengers, create numerous work opportunity and are essential parts of economy of countries where they are located. Unfortunately, such environments are characterized also by high risk of accidents; for instance, handled materials could be dangerous (e.g. toxic products, explosives) while heavy, huge and cumbersome equipment and ships might collide each other or with goods and port structures.

In order to identify main safety issues in seaports, it is necessary to analyze existing situation as well as past events.

Crane collapse at Jebel Ali Port, Dubai

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Port Historical Examples

Collision of ships and consequent fire caused explosion in port of Halifax (1917)

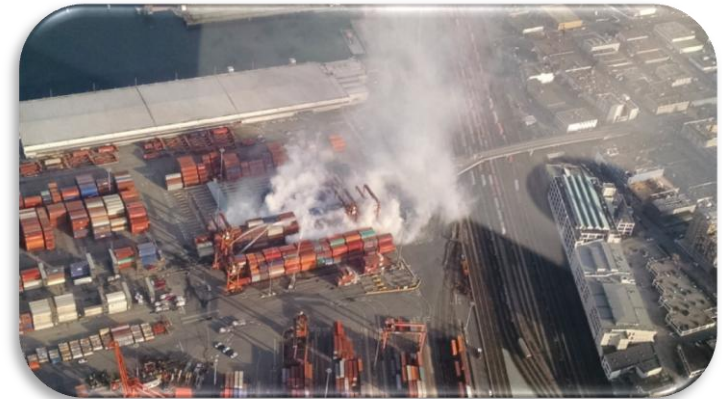Improper handling of ammuntion caused explosion in Chicago (1944)

Ammonium nitrate detonation in Galveston Bay (1947) One of largest non-nuclear explosions: 567 casualties

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Recent Cases: Fire & Leakages in Ports

Ferry collided with port crane causing fire, Barcelona (October 2018)

Fire in containers with trichloroisocyanuric acid at Port Metro Vancouver (March 2019)

*More than 120 persons hospitalized after chlorine leakage in Mumbai Port (July 2010)*

Hundreds of cars burned in Savona port during storm (October 2018)

Recent Cases: Explosions

Even modern big ports face sometime issues with planning and communication, which impact safety of persons.

For instance, in case of Tianjin port explosion (China), firefighters were not informed about presence of calcium carbide and tried to extinguish fire by water, which is considered as one of main cause of the explosion. Furthermore, distance between the storage of hazardous materials and nearby houses was less than one km, which caused additional casualties
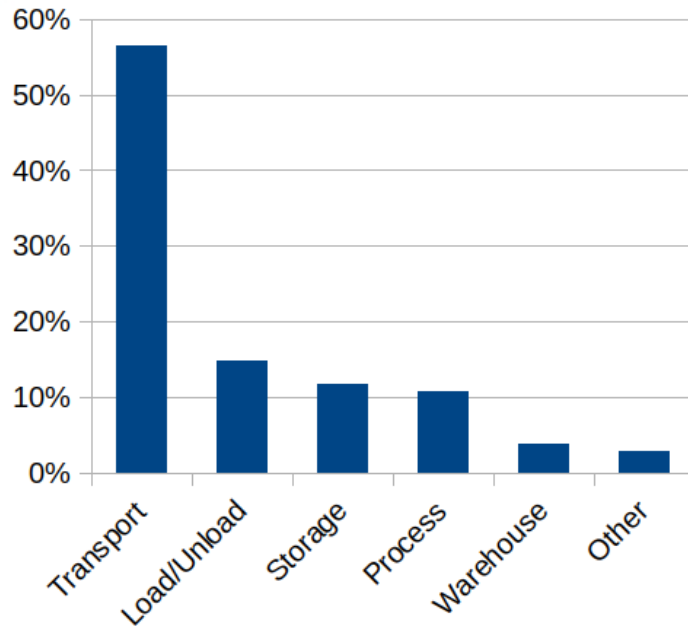

Before: 25 May 2015

After: 13 August 2015
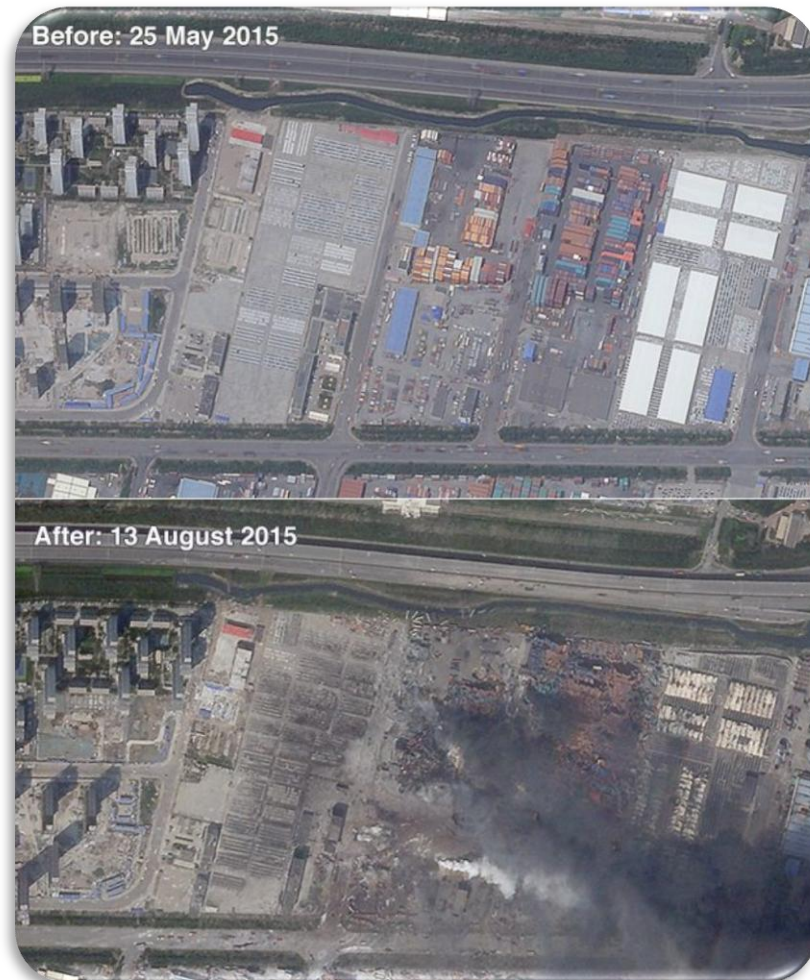
Tianjin port explosion (China)
Source: bbc.com

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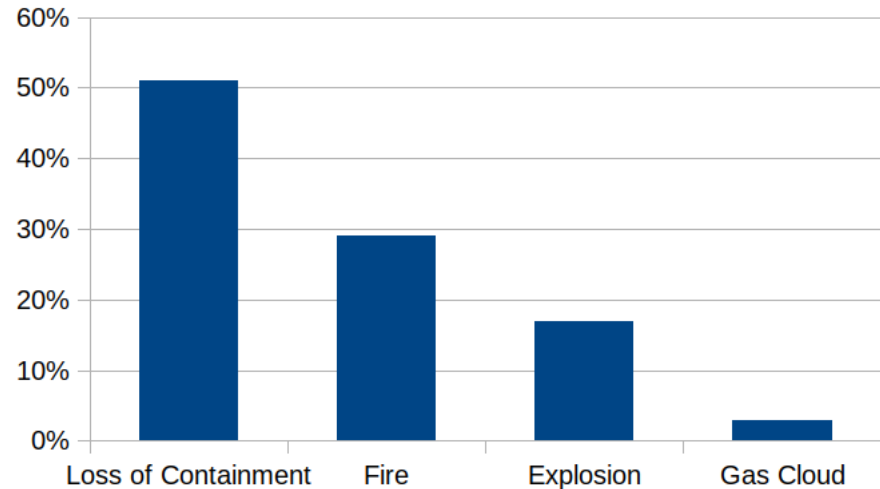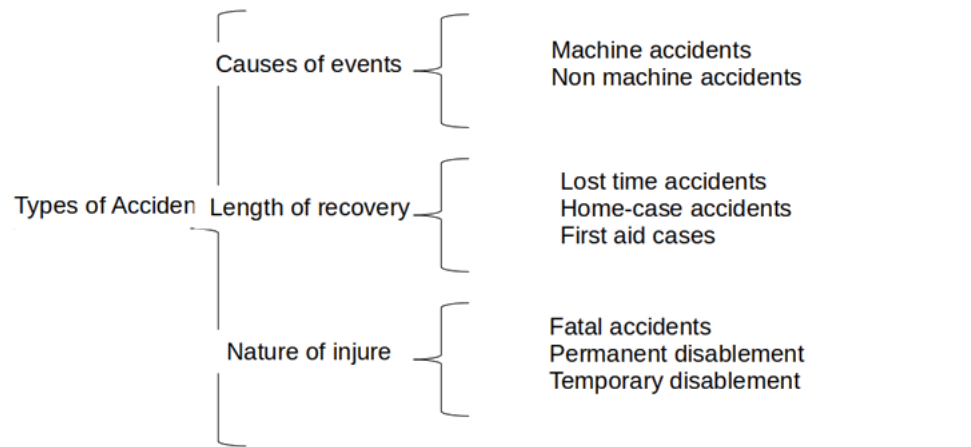
Analysis of Typical Port Problems

Place or activity in which the accident occurred:
process plant, storage, transport, load/unload,
waste, other

*Occurrence rate of accidents by type*

Classification of accidents

Causes and Effects

In general, analyzing the statistical data, it is possible to conclude that number of accidents in seaports is constantly growing despite continuous improvements in safety procedures, even due to a constant increase in flows and operations. This could be explained by continuously increasing sea traffic. In the same time, frequency of domino effect accidents is decreasing, even if their occurrence is still quite high.


Causes of accidents
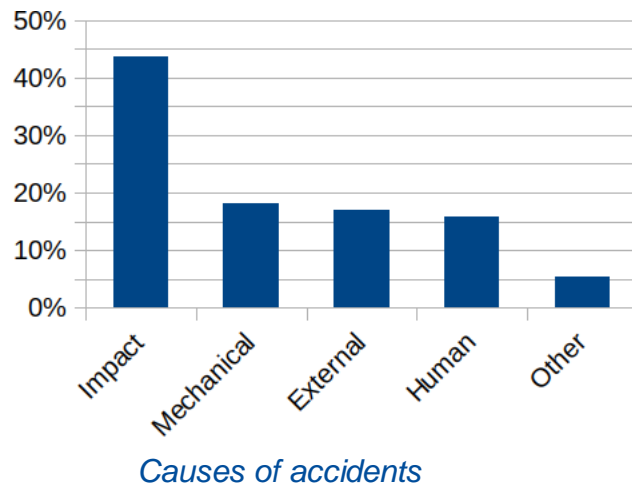
Fire and chemicals leak in Laem Chabang

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Simulation for Emergency Management

Simulation is a strategic science, capable to analyze existing or future complex systems through experimentation over models, which makes it a perfect tool to be applied to the context of emergency management.

PONTUS is a city model, which simulates the entire population along with social activities and its behavior in case of critical events. It allows to calculate flooding zones caused by rain and analyze impact on population, with particular attention to the situation in the points of interest.
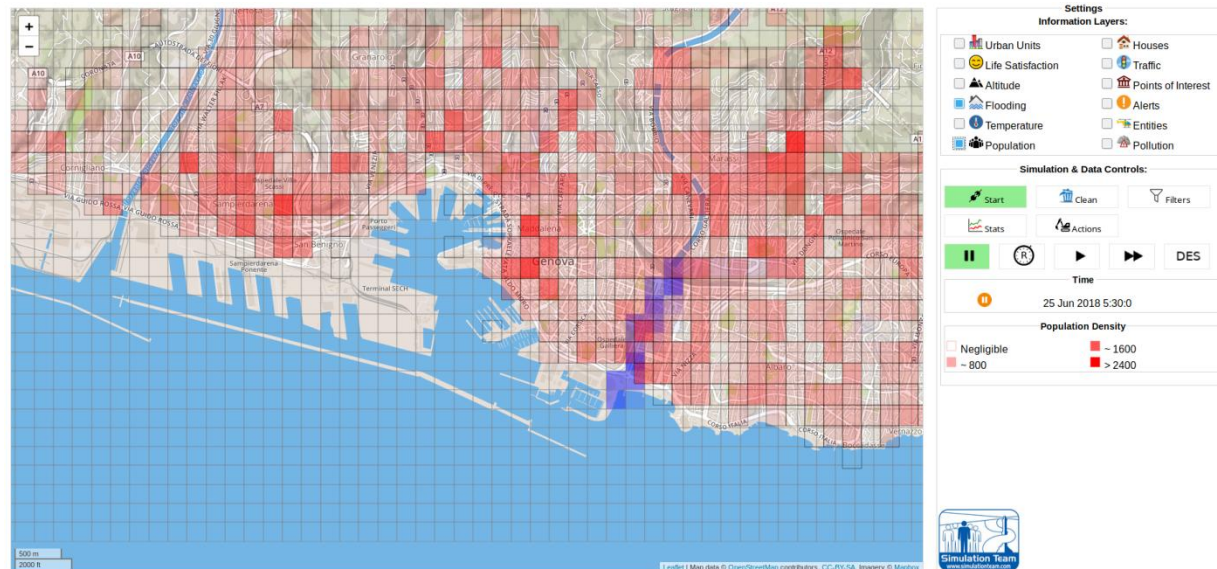

PONTUS: model of human behaviour and flooding – population density in areas at risk

Virtual Lab for Ports

In virtual laboratory it is possible to test the effectiveness of new technological and infrastructural solutions to reduce vulnerability, mitigate damage and prevent emergencies. The simulation techniques adopt the new MS2G paradigm (Modeling, interoperable Simulation and Serious Games) to combine different
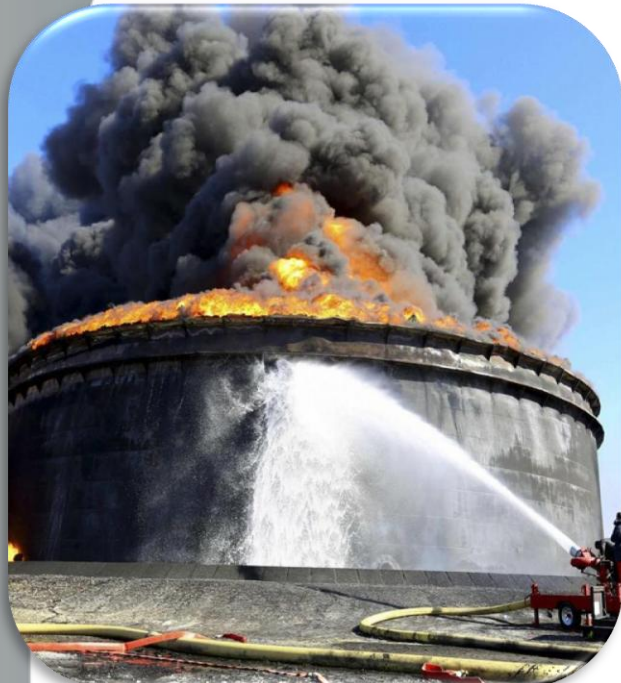
Libya Es Sider port oil tank fire (2014)
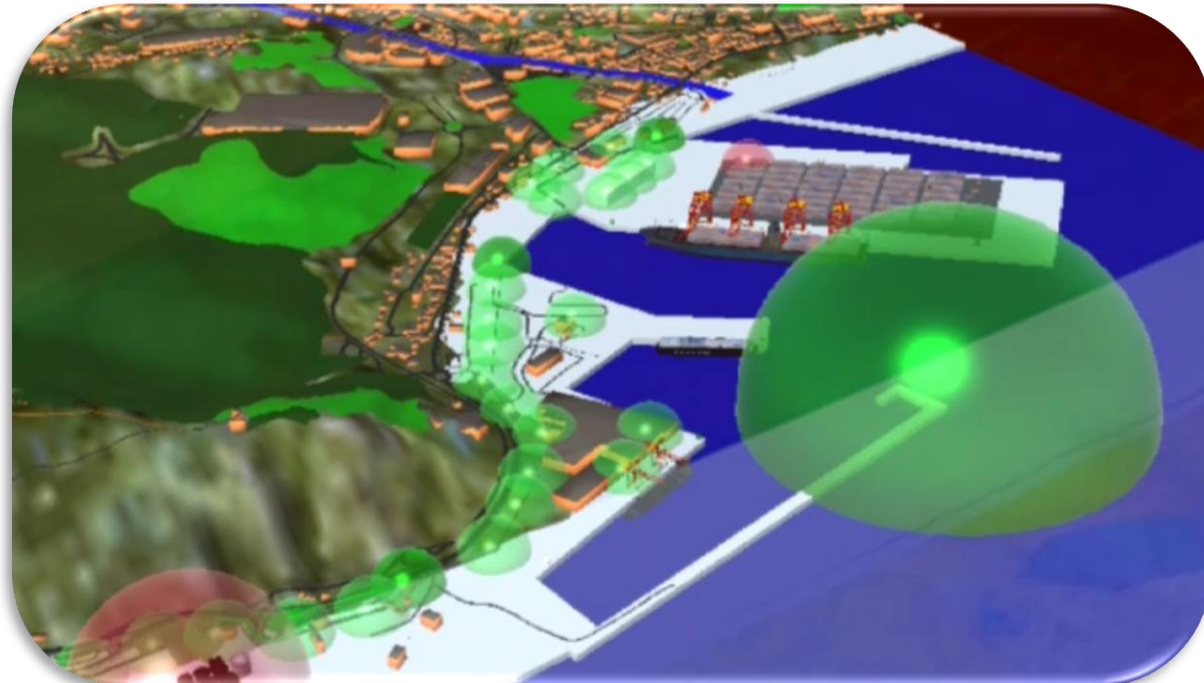
Virtual Port in Mixed Reality by Simulation Team with Risk Areas

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AI & IA

Artificial Intelligence (AI) is based on techniques designed to reproduce intelligent processes. The M&S and AI are strongly connected because simulation often has to incorporate intelligence to control assets, virtual human beings, virtual organizations, planning activities.

Intelligent Agents (IA) represent a crucial element for coupling complex scenarios with many entities that interact in a complex way. AI generally represent people, groups or units and reproduce the corresponding desired behaviors.

IAs allow an object to react to situation changes based on his perception. The use of AI-driven simulations reproducing the behavior human (HBM) is fundamental to recreate complex and extended scenarios which include the reactions of people and the population.

Port Protection

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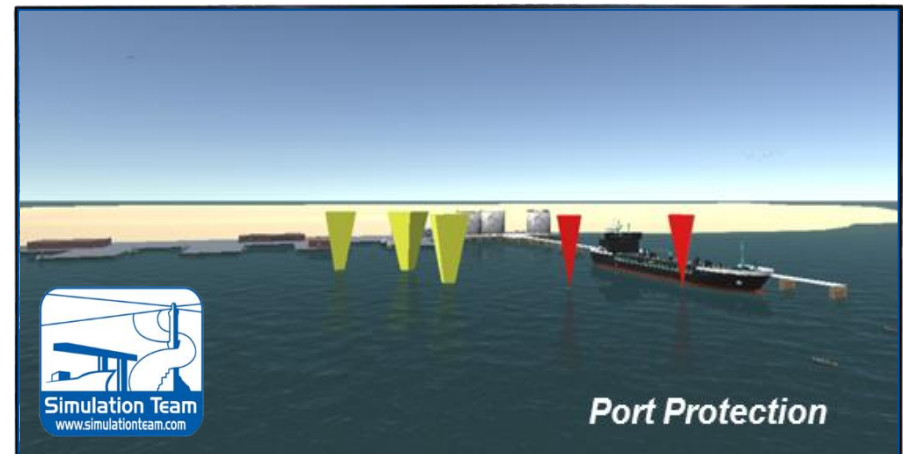
AR & VR Solutions

Augmented Reality allows the 3D terrain and port infrastructure to be overlapped with the real nautical map of the zone of interest; such technology allows to extend information provided by "hardcopy" map. In this example, it adds information regarding hazardous materials, security systems and adjacent zones

Adjacent zones

3D terrain

Storage of dangerous materials

CCTV covered zone
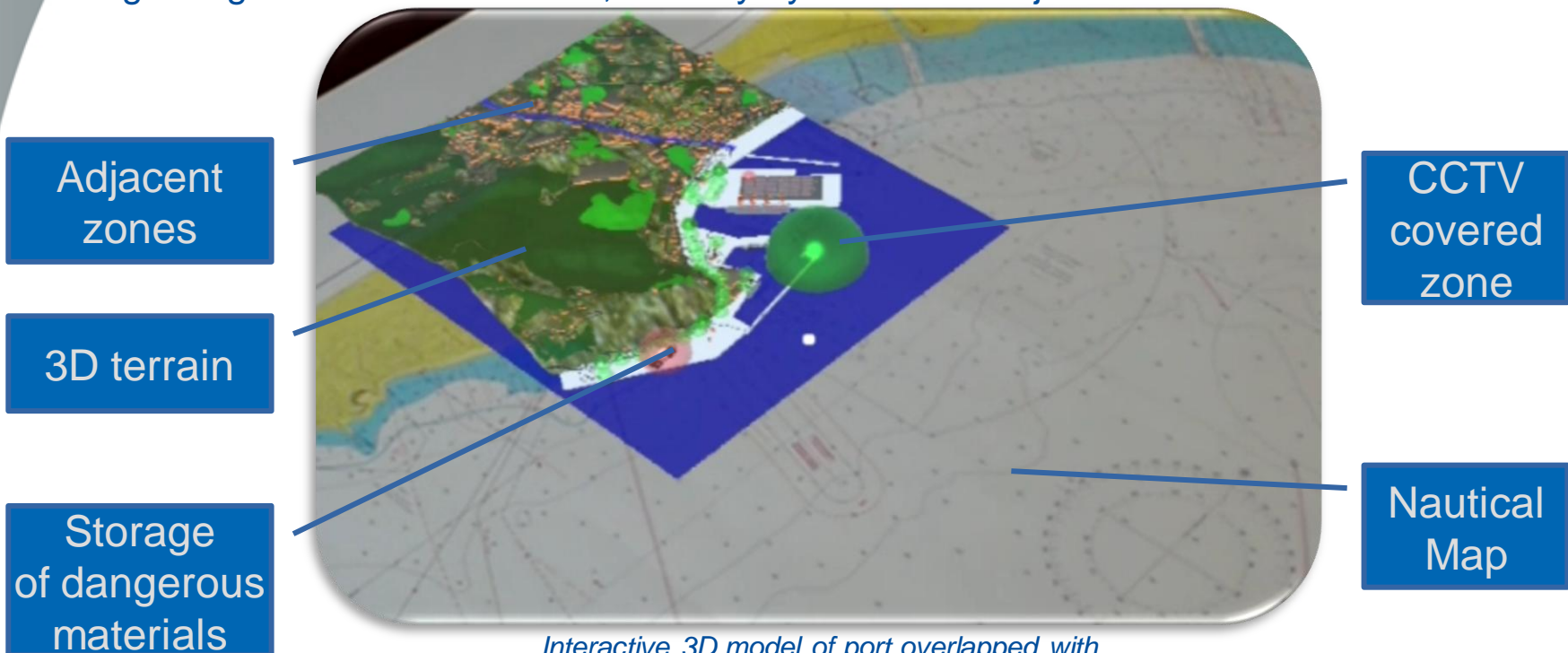
Nautical Map

Interactive 3D model of port overlapped with nautical map, view from Hololens

AR & VR Live Demonstration

Thanks to **Augmented & Virtual Reality** it becomes possible to recreate the emergency scenario using immersive virtual reality technologies, allowing the operators to take actions and simulate their work in environment that reproduces the real emergency conditions and that guarantee to be involved in the crisis.
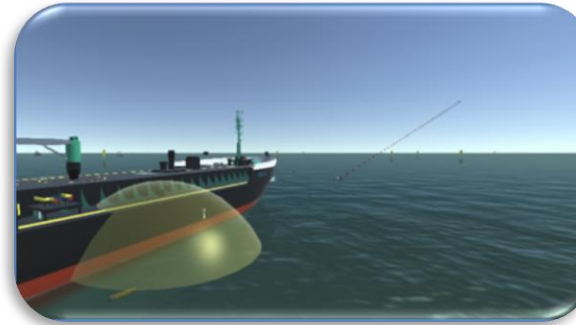

Cyber space simulation in SPIDER CAVE

Using Oculus Rift in maritime frmework
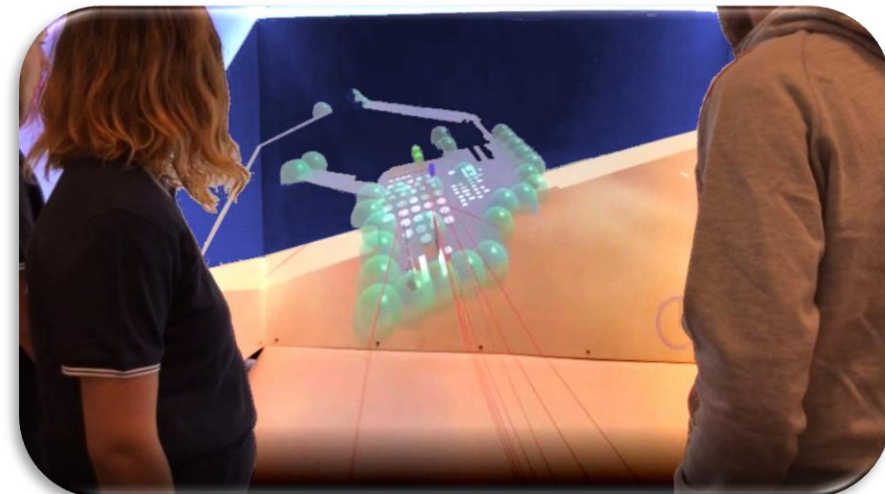
T-REX simulator in SPIDER CAVE

ALACRES2

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the ALACRES2 laboratory investigates and analyzes the behavioral procedures & protocols for:
- Vertices of the chain of command and / or operating centers of management, or those who are deputies to manage an emergency condition lasting over time (widespread and prolonged fire, spill in uncontrolled water, evolving toxic cloud, etc.)
- Operational subjects in charge of the first intervention activities aimed at curbing the emergency and / or reducing the causes that generated the indicator (fire brigade, emergency workers, etc.)

ALACRES2 is based on simulation techniques of operational and decisional behaviors aimed at training the different subjects to perform their respective tasks in conditions of mental and physical stress and work overload, in order to evaluate incorrect processes, incorrect methods of sending and / or information management, decisions that do not comply with external conditions, etc.

The simulation makes it possible to reproduce the evolution of the crisis and the impact on structures, systems, people and goods, considering the physical aspects and the domino effect in its dynamism.

ALACRES2 is able to evaluate new solutions to reduce vulnerability, mitigate damage and prevent emergencies. The MS2G paradigm will be adopted (Modeling, interoperable Simulation and Serious Games) to be able to combine different models and guarantee a high level of fidelity and at the same time the simplicity of use, the intuitiveness and the immersive capabilities

Case Studies & Expected Results

After problem identification, it is possible to perform preliminary risk assessment and identify potential scenarios of interest, to be used for developing a simulation-based solution. In this case, it should be considered possibility of multiple types of accidents (e.g. fire with subsequent explosion) and causes. In the same time, the model should take into account the external conditions, such as presence of personnel, proximity of residential areas, meteorological conditions and configuration of the port.

As an example, possible scenario could include leakage of toxic material from tanks in the port while ferries are docked in proximity. In such case, analysis of the possible outcomes should include such factors as weather conditions (e.g. wind, fog, temperature, even time of the day) passengers' behavior (e.g. organized evacuation, panic) logic and actions of personnel and first responders, impact on port structures and nearby urban zones (domino effect, evacuation of urban areas).

Screenshot T-REX

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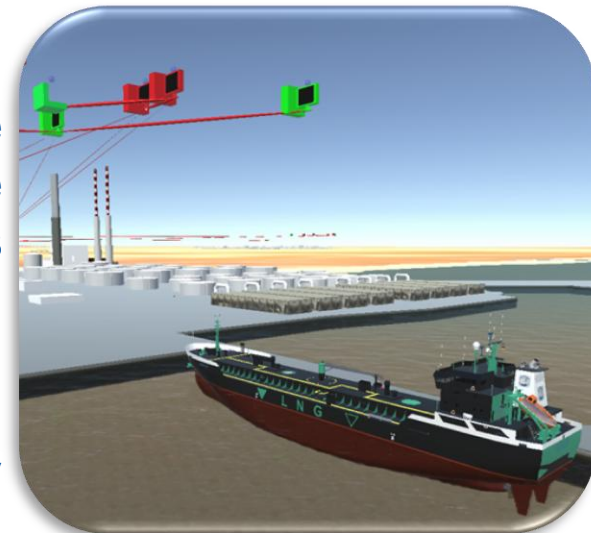
Conclusions

The objective of the presented project is to create a permanent laboratory capable to identify, test and validate procedures for emergency management in the event of crises or significant accidents with particular attention to procedures of loading and unloading of goods and hazardous material in port areas.

The project is at early stage and the alternative models to be used, paradigm to be adopted and general architecture are currently identified, while the survey on accidents and critical issues is finalizing scenario definition.

Fires
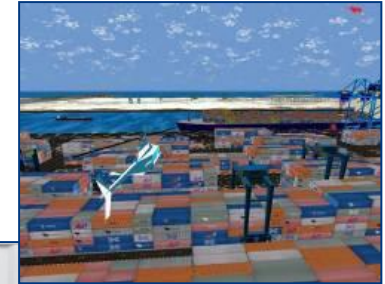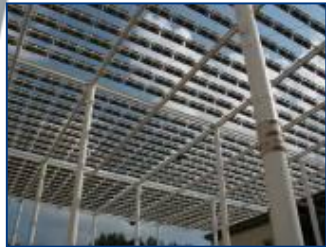*in New York South Street Seaport*

Explosion
In Tianjin

Fire and Chemicals Leaks
in Laem Chabang

References

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