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ISTITUTO NAZIONALE PER L'ASSICURAZIONE
CONTRO GLI INFORTUNI SUL LAVORO



I4 D3 A2

I mmersive	D eveloping	A reas
I ntuitive	D elivering	A ctivities
I nteractive	D angerous	
I nteroperable		

Agostino G. Bruzzone

Email: agostino@simulationteam.com

URL: www.itim.unige.it

Partnership

Simulation Team, Università di Genova



CENTRALLABS

Central Labs Università di Cagliari



MSC-LES, Università della Calabria



Immersive, Interoperable, Intuitive, Interactive virtual environment for Developing and Delivering training by simulation to operators in Dangerous Areas & Activities



I4D3A2: Objective

I4D3A2 is focused on developing intuitive solutions to experience within a digital twin a challenging environment respect Safety issues. The goal is to be able to Experiment Virtually new solutions as well as new procedures to reduce Risks. Extended Reality within the MS2G Paradigm allows to combine the benefits of Serious Games in terms of Engagement and Usability with the Fidelity of Simulation. The use of such innovative Solutions could support both Experimentation, New Procedure Design as well as Training.





I4D3A2: Initial Work

I4D3A2 first phases where devoted to conduct a state of Art and review of previous Models and Solutions that could support the development of Interactive, Immersive Interoperable and Intuitive Synthetic Frameworks for improving Safety within Dangerous Working Environments We conducted a survey on AR, VR, XR, MS & SG. We evaluated the Application to finalize the Scenario to be used in implementation & experimentation based on Budget Reduction, keeping in mind open design as opportunity to extend it to other cases in future.





Simulation Team: Who Are We?

Universities, Research Centers and Companies operating worldwide in synergy for developing Innovative Solutions with a particular focus in Modelling and Simulation



DIME
Università
di Genova



Liophant
Simulation



CentraLabs
Cagliari



CSU
Australia



CIREM
Università di Cagliari



MSC-LES



Mik
Riga TU



Universidad
de la Rioja



UNICAL



SimCenter Universitat
Autònoma de Barcelona

LOGIXTICA



Perugia
Università di Perugia



LISIS
Marseille



Rio de Janeiro
Brazil



IMS-LAPS
Univ. Bordeaux



McLeod Institute of
Technology & Interoperable
Modeling Simulation Genoa



VIRTUALLY



STRATEGOS
Genuense
Athenaeum



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Simulation Team MITIM DIME

The Simulation Team in Genoa carries out many industrial projects in cooperation with Agencies, major Corporations, Small & Medium sized Enterprises; some example of recent industrial simulation projects:



ENI Group
ANSALDO
CSC **DU PONT**
LAMCE
Petrobras
EDA
Ford Motor
LOCKHEED MARTIN

Fleet Management Planning & Scheduling
Chemical Plant Logistics Optimization
Plant Service Management and Optimization
Oil Platform Simulation and Augmented Reality
Decision Support for Country Reconstruction Activity Planning
New Production Line Design Based on Simulation



Members of MISS are appointed in several positions in simulation community such as:

- General Director M&S Net (34 M&S Centers Worldwide)
- President Simulation Team (24 Centers Worldwide)
- Chairman of Technical Chapter in SCS and Past Associate VP
- Member of NATO SAS, MSG, and NIAG, Founder for NATO STO Marine M&S





DIME - University of Genoa

Simulation Team



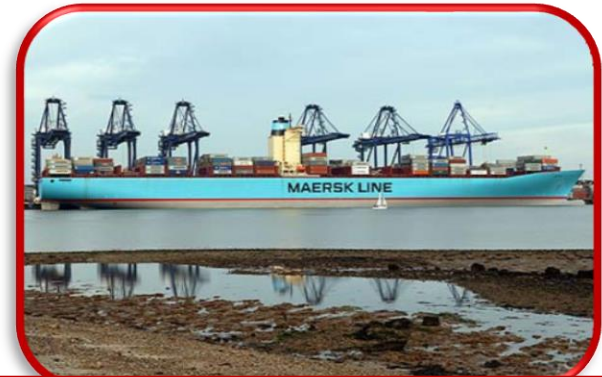
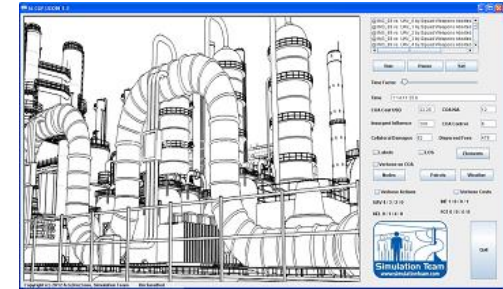
www.itim.unige.it

DIPTTEM was founded in 1997 as evolution of the *Institute of Technology and Industrial Management (ITIM)* that was operative from '60. In 2011, DIPTTEM evolved in DIME and it is currently composed by about 80 faculty members, 15 technicians and administrative, plus several PhD Students, external Researchers and Consultants. DIME teachers are involved in Undergraduate, Postgraduate and Professional activities in Engineering, Management. DIME active in R&D Projects for major Institutions, Companies and Governmental Organisations. DIME co-operates actively with major Excellence Centers in all Continents

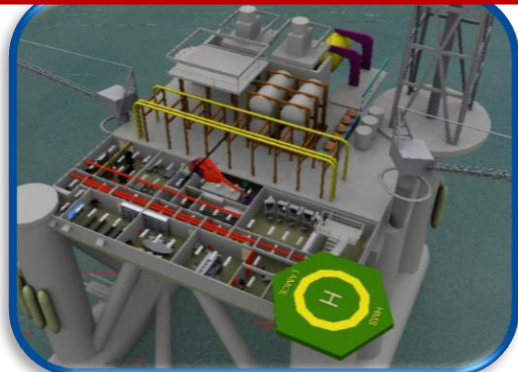




Digital Twins...

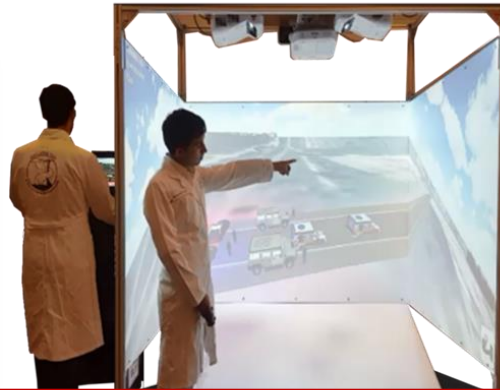
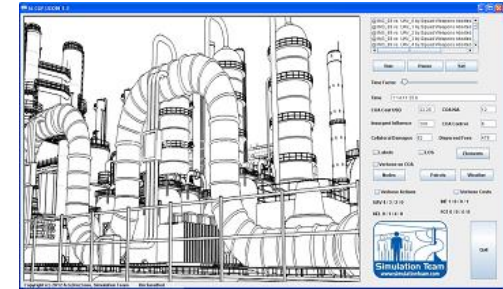


... exist, therefore we have to look inside to see their characteristics and usability





Keep in Mind...



... XR could be supported by very innovative as well as consolidated supports

XR eXtended Reality as combination of Virtual and Augmented Reality (VR & AR)





...the Potential of new Solutions



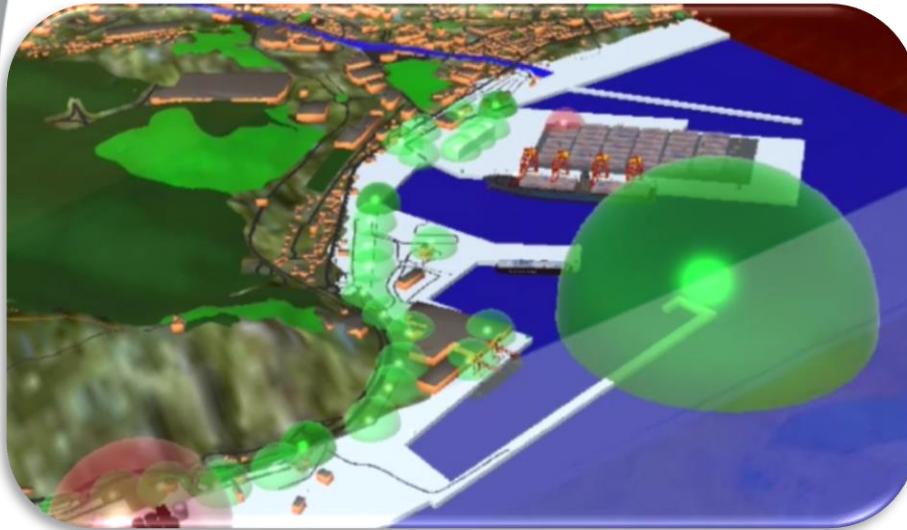
Simulation Team conducted many experiments on different solutions, devices & platforms to improve safety in ports & industrial plants. For instance, we tested scalable solutions from tablets & smartphones to CAVE





Example: Smartphone Demo App for Virtual Port

Smartphone Demo developed were able to operate on smart phones with Android 8.0 (or more recent) and gyroscopic systems and allows to be immersed within a 3D environment including a port with cruise, Cargo and Commercial Activities as well Containers, presenting them by Augmented Information on Safety & Security eventually using an Headset





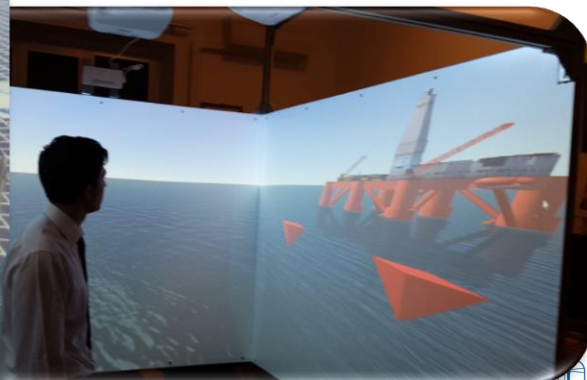
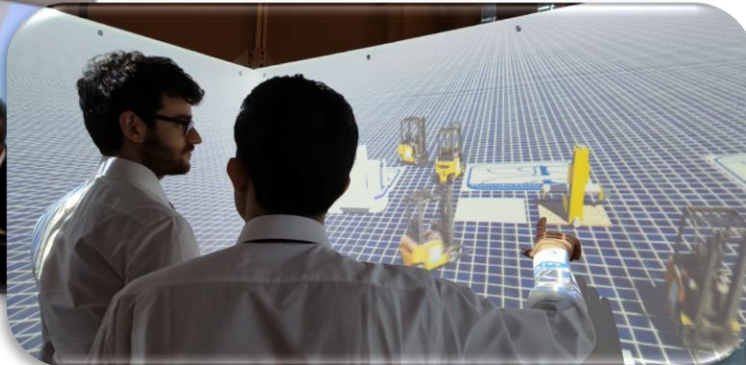
SPIDER

Simulation Practical Immersive Dynamic Environment for Reengineering



The SPIDER (Simulation Practical Immersive Dynamic Environment for Reengineering) is an innovative Interactive and Interoperable CAVE (Cave Automatic Virtual Environment) developed by Simulation Team. The basic configuration is compact (just 2m x 2m x 2.6m) and could be embedded within a standard Container and integrated in any interoperable simulator.

The SPIDER is interactive through touch screen technologies.



The SPIDER is fully Immersive including sound and motion.





Digital Twins: XR & M&S

A Digital Twin is a digital replica of a physical asset, which is often considered as the next step in simulation after the simulation-based system design. Digital Twins allow Optimization & Configuration of real



Systems prior to their construction, anticipate and mitigate Problems during operations, reflect state of the Real Asset in its Virtual Representation.

Digital Twins allow to fully benefit from Extended Reality (XR), combining Virtual and Augmented Reality (VR & AR) by introducing in digital environments high fidelity replicas of real industrial plants and systems. Hence, it is possible to train personnel and perform experimentation on virtual but “real” plants by using Modeling and Simulation (M&S)



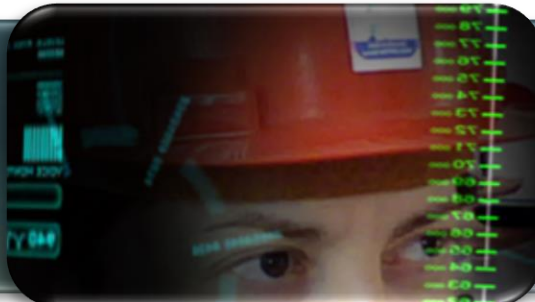
Simulation Team Defense as Country Defense! Port Traffic... new Issues...

Top 10



5					593.3	575.8
6					543.6	519.9
7					510.0	500.0
8					579.0	540.0
9	Tianjin	China	508.0	501.0	551.0	541.0
10	Rotterdam	The Netherlands	469.0	467.4	461.2	466.4

10% more than first European Port





... and Safety and Security

Top 1

Town, Port and **Industry growth** created a intensive **dangerous Area**



Just a Huge Accident caused by the Dangerous Materials present in the Port & Errors

Tianjin Explosion
August 12th, 2015

800 tons Ammonium Nitrate, 336 tons of TNT explosion equivalent
173 casualties, 2km range, 9bUSD Insurance Damages





Impact could be Disruptive! ... yesterday and today

Top 1



Beirut Explosion
August 4th, 2020

2'700 tons Ammonium Nitrate, 1.1 ktons of TNT explosion equivalent
200 casualties, 300'000 homeless, 15bUSD Damages





Logistics as Complex Systems

Strategic Engineering, M&S, and XR are very well addressing issues related to Logistics that are usually affected by the well know & critical VUCA factors (Volatility, uncertainty, complexity and ambiguity). Its use could provide a very Strategic Advantage





STRATEGOS

Strategic Engineering allows to combine many different sources of data and to clean, elaborate and fuse them together using AI and Data Analytics to extract information

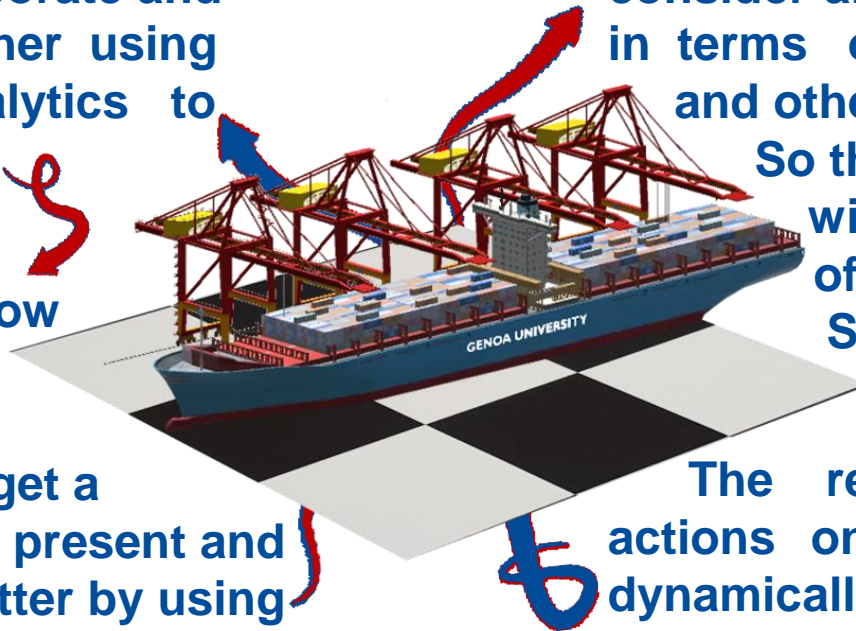
This allow us to know what happen in the past and what is happening now to get a good picture of the present and to understand it better by using our up-to-date Models & AI

AI Artificial Intelligence

The Models are used to simulate the situation and the impact of our decisions but also to consider all possible alternatives in terms of situation changes and other players moves.

So the Decisions are made with benefits of Results of Simulation & Smart Systems based on AI

The real impacts of our actions on the field allows to dynamically refine our models & simulators by using advanced Machine Learning Techniques





Ports are very Challenging by themselves, holding many Risks



Sailors know at Sea there are Major Challenges

These Challenges could come from many Sides and outside



Italian Coast, August 2013: UTEXAS compromised GPS of a 80M\$Yacht by spoofing using a 2k\$ device...

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



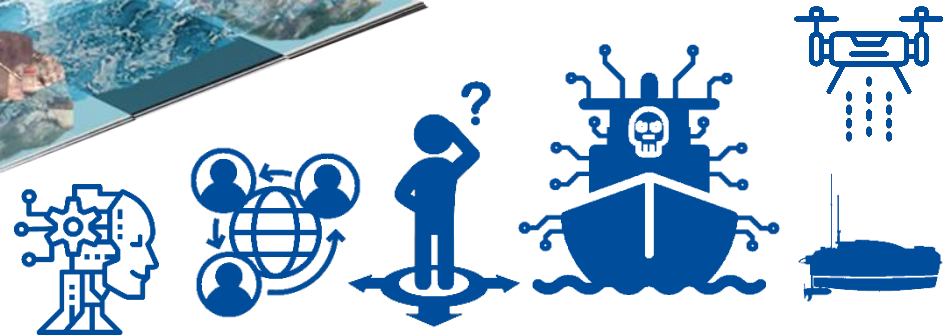
Ferry collided with port crane causing fire, Barcelona (October 2018)



Over 120 persons hospitalized after chlorine leakage in Mumbai (July 2010)



Hundreds cars burned in Savona during storm (October 2018)



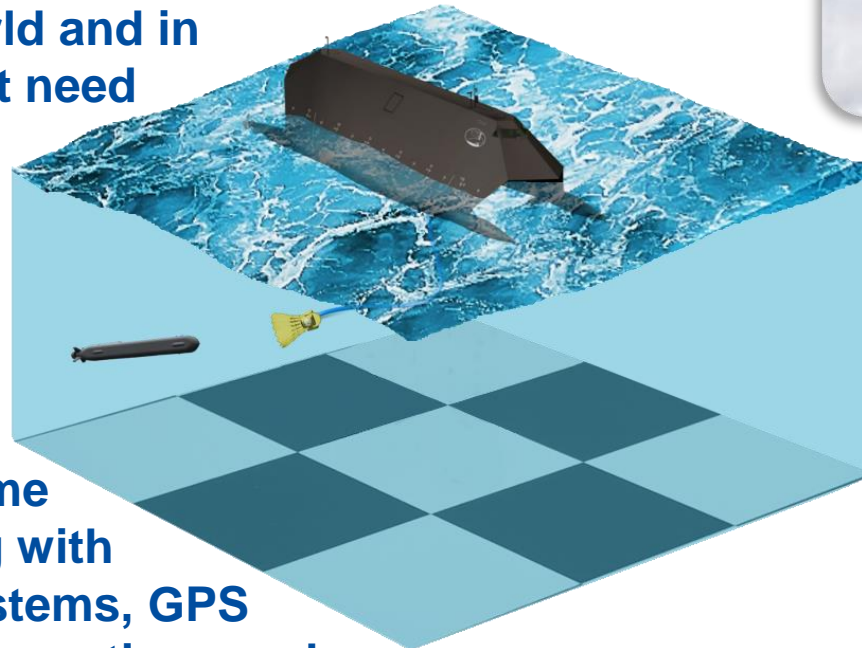


New Threats... & New Assets Real... and... Virtual



Nowadays, there are new Threats in Physical World and in Cyber Space that need to be considered

At the same time New Solutions Exists to improve Safety & Security in Extended Maritime Framework dealing with Cyber Physical Systems, GPS Spoofing, Hybrid Operations and Media or Cyber Attacks to Critical Infrastructures





I4D3A2: Strongholds

Critical Issues:

- Intuitive**
- Interactive**
- Lean**
- Stochastic**
- Open**
- Interactive**
- Interoperable**



Intuitive, Immersive, Interactive & Interoperable





Simulation, VR & AR: eXtended Reality (XR)

Simulation, AR/VR and Serious Games Reality are crucial elements for developing new solutions:

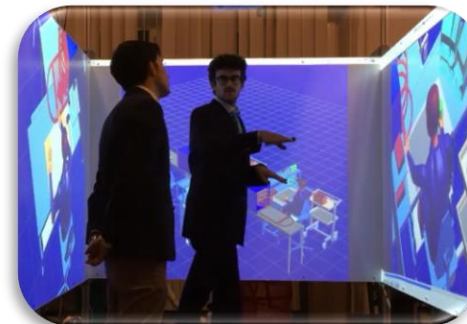
During Process Development

- Identify & Quantify Risks & Critical Issues
- Support Design & Engineering
- Defining Procedures
- Development of new Education & Training
- Involve Users in Processes Development
- Testing and Evaluating new Solutions
- Improve Safety & Security



During Operations

- Evaluate Impact of Changes
- Develop Training Programs
- Support Decision Making
- Checking Effectiveness of Decision & Actions
- Speeding Up reaction Time
- Support in Crisis & Dangerous Situations
- Accident Causes Identification



XR eXtended Reality

MR Mixed Reality

VR Virtual Reality

AR Augmented Reality



A new Approach to Enhance Education and Training

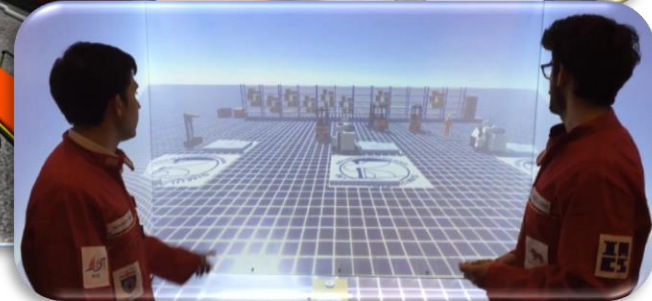
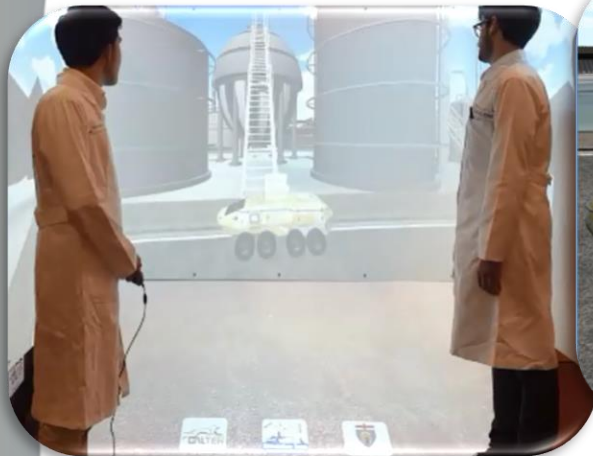
Integrated Solutions for E&T that combines Simulation, AR & VR are able today, especially for new Young Generation, to enhance Efficiency and Effectiveness of Education Programs. In particular it becomes possible to Engage and Motivate in new ways the Trainees as well as to provide them a Realistic Virtual Labs where to Test and Experience the studied theories and procedures, as well as to Exercise on Complex Simulated Scenarios. MR is further reinforcing these concepts. It is evident the necessity to tailor and integrate these technologies in the whole E&T process.





MS2G Paradigm as new Enabler

The innovative concept of MS2G (Modeling, interoperable Simulation and Serious Games) allows to develop interoperable scalable and reusable simulators with benefits of new Immersive Solutions. MS2G is very flexible and enable use from different platforms: regular laptops, computers, CAVE (Computer Automatic Virtual Environment) large enough to immerse 4-5 people in the Virtual World, HDM, HoloLens as well as Smartphones and Tablets

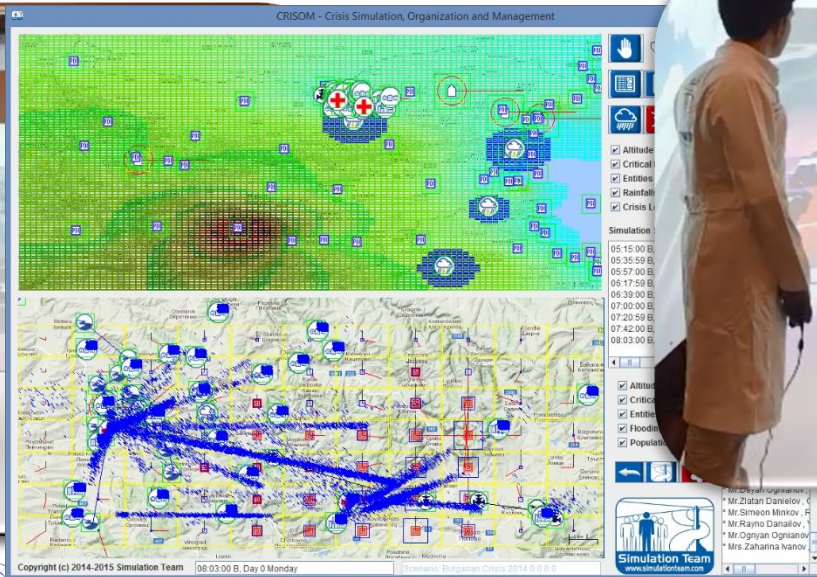




MS2G and IA-CGF



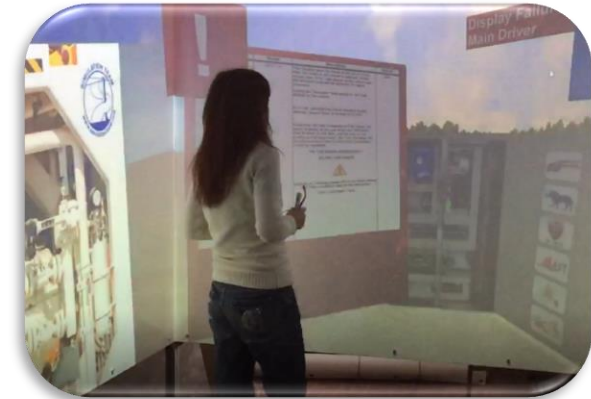
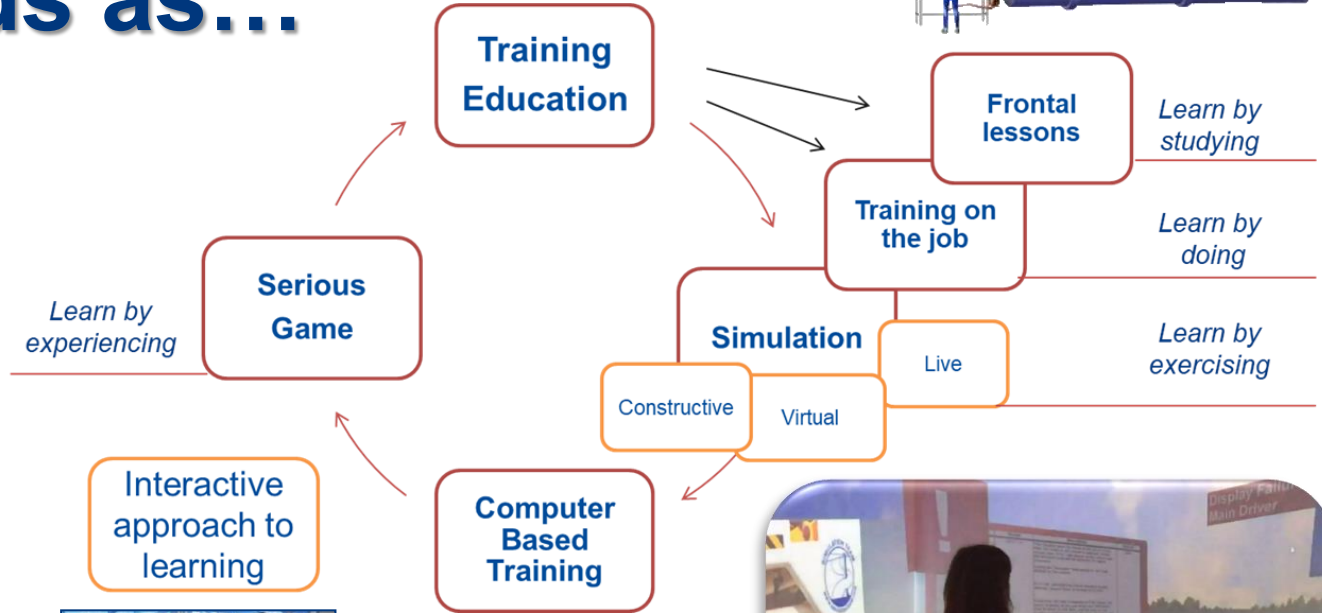
The MS2G (Modeling, interoperable Simulation and Serious Games) could be combined with use of IA (Intelligent Agent such as IA-CGF by Simulation Team). The AIs (Artificial Intelligences) drive concurrently many actors, people and related actions enabling to recreate and study very complex scenarios to improve simulation capabilities & Training Efficiency



IA-CGF Intelligent Agents Computer Generated Forces



Education & Training Aids as...

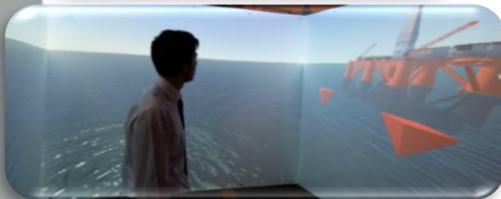


“Tell me and I will forget. Teach me and I will remember. Involve me and I will learn”,

Confucius



... Serious Games Evolve into Simulation Team Roadmap



Training on the Job



Simulation for Training

Experimenting on the Simulator

Many Installations
Many More Users



Serious Games for Training

New Education Modes
New Utilization Modes

Playing while Learning

Experimenting on Games

[Nuclear War]
..a strange game the only winning move is not to play
Joshua in War Games Movie



Interoperable Virtual Simulators & Models



The new generation Simulators represent crucial supports for Industry 4.0 in terms of Engineering, Management and Training. The Virtual Simulators are aids for Operative Resources, Technical Staff & Decision Makers. The Interoperability of our simulators is based on most advanced standards (i.e. HLA High Level Architecture, MS2G, Modeling, Interoperable Simulation & Serious Games). These Solutions enable stand-alone and Federated Simulation of Operations, Activities and Processes. Simulation Team have very long experience in Project with Industries and major International Players (e.g. NASA, NATO, EDA, EC).

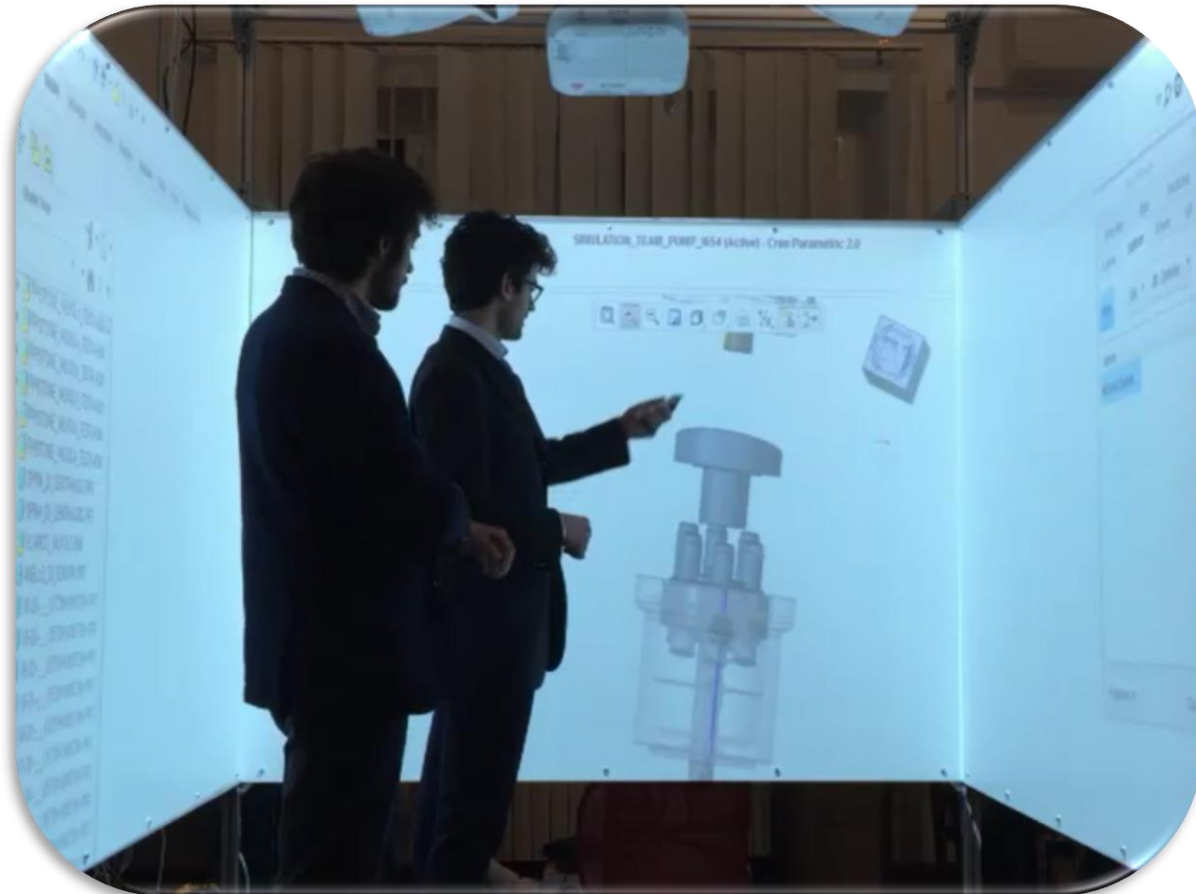




Collaborative Remote Supervision & Service



The Central Subject Matter Experts (SMEs) become available to check remotely the Status of Different Distributed Assets. So, it becomes possible to create new remote services as well as to conduct Supervised Service Operations. This could be applied to maintenance, problem solving, commissioning





Addressing Multiple Issues...

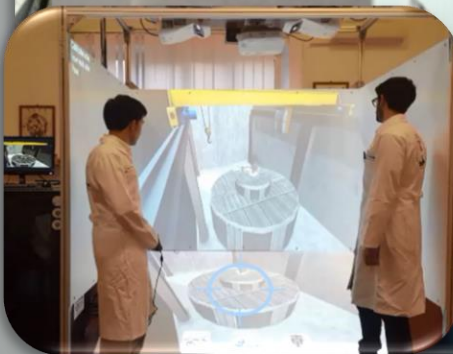
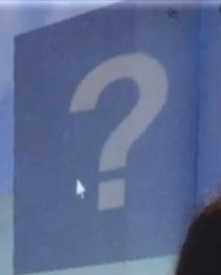


In general the XR could be scalable on different supports to be reusable to address many different goals:

- **Education and Training**: answering dynamically and interactively to questions of the trainees as well as providing examples of sequences and action points
- **Planning**: Support Decision Makers and Planners in optimizing the plan, anticipating problems and getting opportunities
- **Operational Support**: directly interacting with the operator or supporting it by IA and/or remote supervision for guarantee a safe and efficient remote supervision

In addition to lean supports, such as Glasses and Tables, new CAVEs such this SPIDER could be effectively used for training and for remote supervision

Multiple Issues addressed



SPIDER is a Virtual Immersive, Interactive, Interoperable cube 2x2x2.6m recreating and simulating Plants, Skids and Machineries



Many Different Solutions: Glasses & Goggles



In facts there are many solutions available to be adopted as support for VR and AR implementations.

New CAVE could support cooperative supervision.

Other ones are more useful for Training, as Head Mounted Displays.

The Oculus Rift is a basic and valuable commercial example of VR while the Hololens represents a new product for MR





Tablets & Smart Phones as Intuitive Approaches



Indeed sometime it is more effective to use basic Hardware solutions that result reliable and intuitive for potential users. From this point of view the tablets provide an interesting Man Machine Interface for supporting Service and Maintenance of Equipment and being operated by basic Operators.





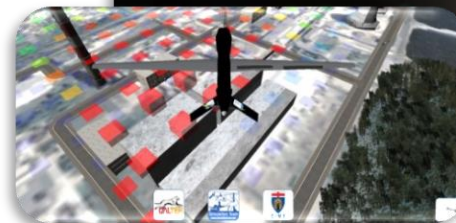
Modern Uses of Innovative Interfaces



The new architectures are designed to combine present & future technologies for continuous development.

This R&D addresses especially:

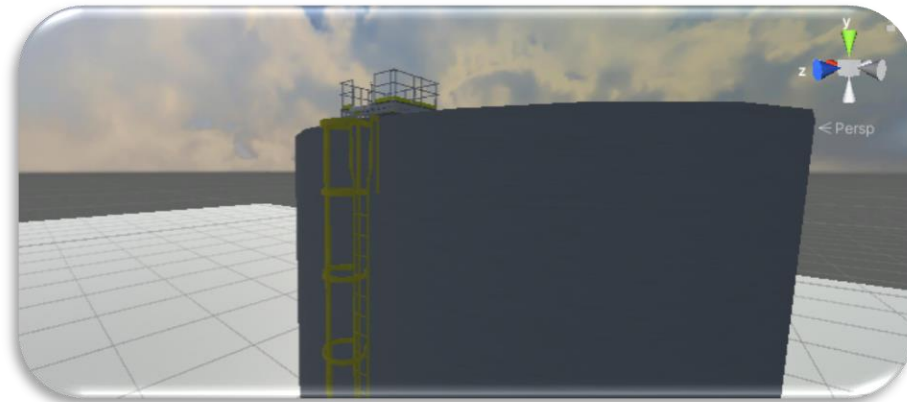
- Improvement to Safety
- Reduction of Vulnerabilities
- Monitoring & Tracking
- Remote Test & Troubleshooting
- Supervision
- Remote Service Support
- Mobile Service Support
- Availability Improvements



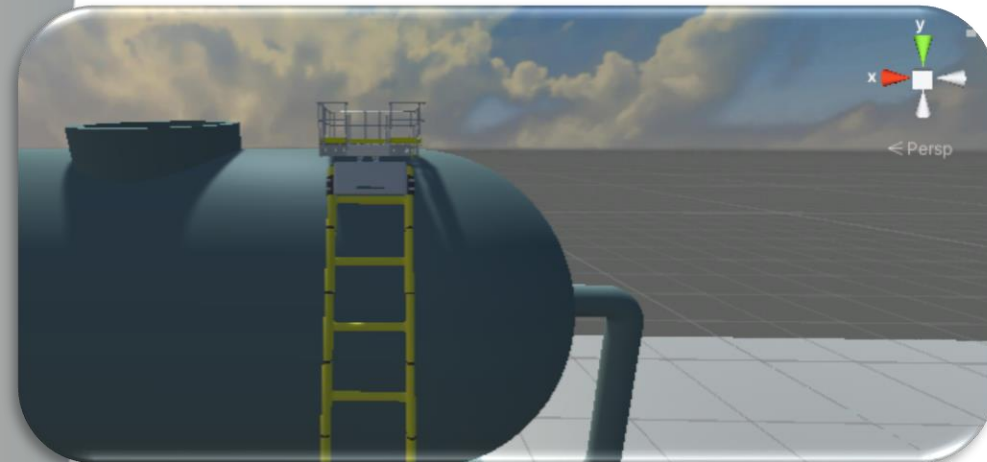


I4D3A2: Critical Working Environments

Some operational Frameworks are very challenging for humans and could require to improve awareness and reactivity as well as to develop intuitive perception and rational reaction during crises



Tanks represent an example of *Confined Space* very common and characterized by criticalities where there is an high level of risk due to many aspects including toxicity, combustion, fire, explosions as well as very limited perception capabilities

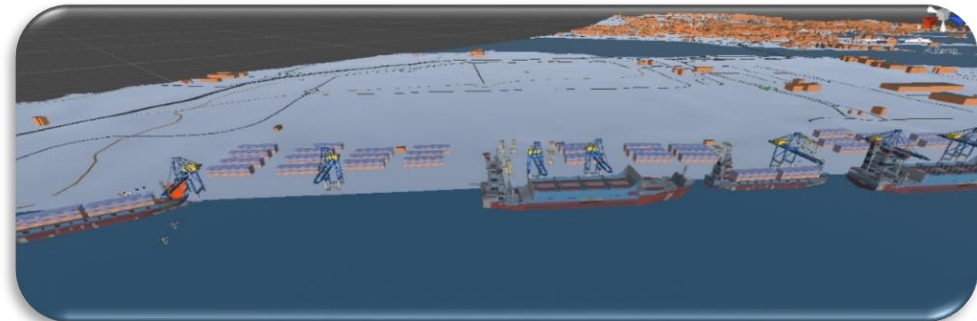
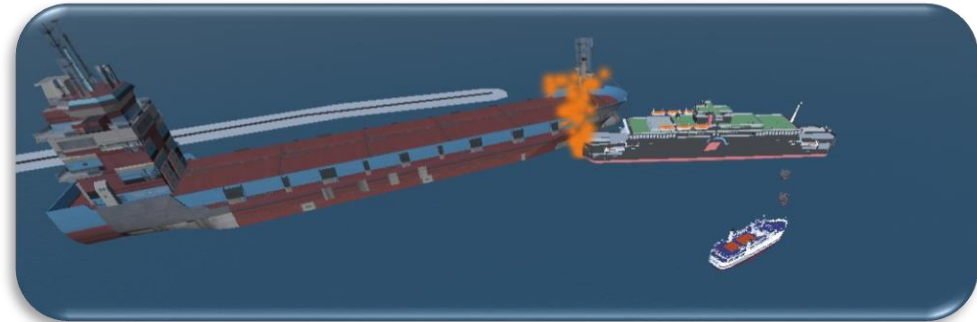
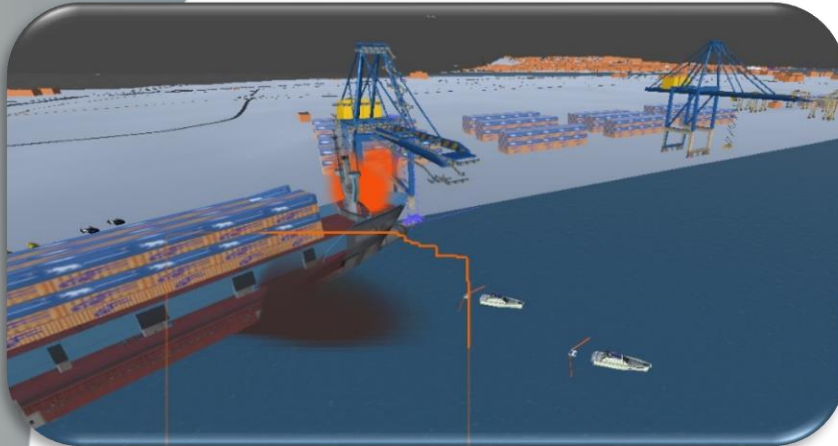




I4D3A2: Identification of crucial Roles

The research focused on:

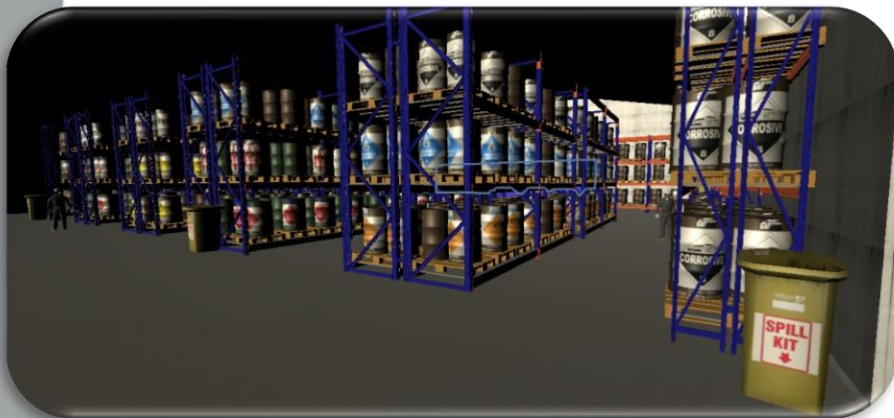
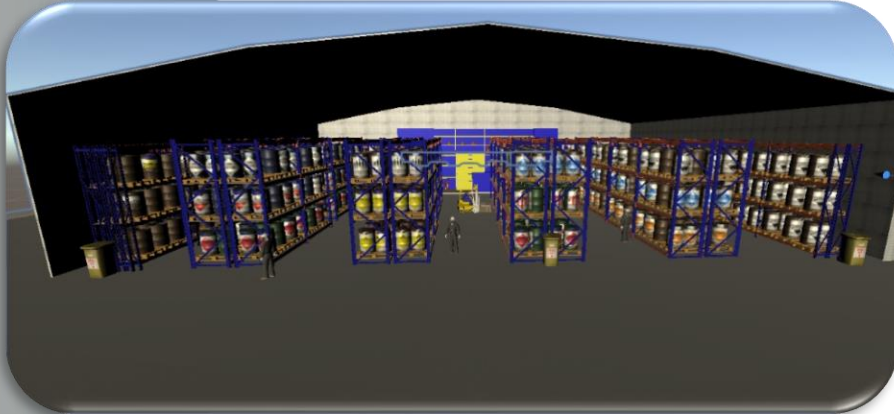
- ❖ State of Art
- ❖ Analysis of Critical Roles
- ❖ Creating Basic Virtual Worlds





I4D3A2: Dangerous Material Handling

Intensive storage of Hazardous Material is a common problem and generates multiple challenging issues for Operators and Managers in addressing Safety and identify best solutions to prevent, mitigate and manage accidents





I4D3A2: Roadmap

I4D3A2, during first months, has shown the big potential of developing Solutions based on MS2G for addressing Dangerous Working Environments. Next steps for the Team Include among the others:

- Definition of the **I4D3A2** Experimental Scenario & related Variables
- Definitions for **I4D3A2** Simulation of *Measures of Merit* (MoM) as well as Safety *Key Performance Indicators* (KPI)
- Design of the whole **I4D3A2** Architecture
- Development of the **I4D3A2** Models
- Implementation of the **I4D3A2** Simulator





Summarizing



I4D3A2 results to be very promising based on available researches carried out by the working Team, even considering their Links and Connections with users and operators. From this point of view promising contacts are existing with major Port Terminals in Genoa, Cagliari, PSA and also in other realities and it could be possible to carry out networking to identify user priorities and combine them with the INAIL Expectations & Objectives to maximize the impact of the Research. In this phase, Virtual Worlds are in development to have a framework where to check feasibility of different opportunities for the Project.





References



www.itim.unige.it/strategos



DIME



Simulation Team, MITIM
DIME Genoa University
via Opera Pia 15
16145 Genova, Italy
www.itim.unige.it
Agostino G. BRUZZONE
agostino@itim.unige.it

