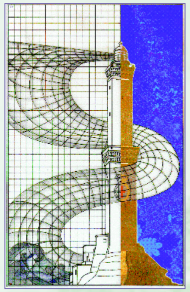
Simulation Projects Advances and Challenges



Agostino G. Bruzzone

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16145 Genova, Italy

URL www.simulationscience.org
www.liophant.org

EMAIL agostino@itim.unige.it

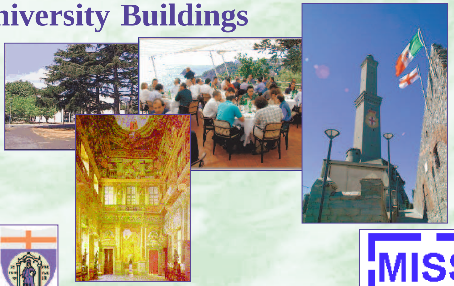
University of Genoa: an Overview

The University of Genoa is one of the oldest in Italy and in the World (founded in 1471 AD), it is located in middle of Italian Riviera.

The students are about 40,000 (about 8,000 new entries), and the engineering departments has about 7,500 students (12% in Savona Branch Departments); the University includes two major locations and the new Campus holds about 1,000 Engineering Students and is located in Savona just 25 miles west of Genoa on the coast in an old complex of barracks recently converted into new University Buildings (over an area of 200,000 m^2).

For further Information about the University of Genoa:

http://st.itim.unige.it
http://www.unige.it



DIPTEM - University of Genoa

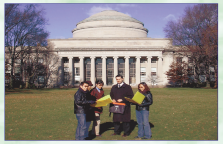
Email: secret@itim.unige.it **URL: http://st.itim.unige.it**

DIPTEM was founded in 1997 as evolution of the Institute of Technology and Industrial Management (ITIM) that was operative from '60.

DIPTEM is composed by about 65 faculty members, 15 technicians and administrative, plus several PhD Students, external Researchers and Consultants.

DIPTEM teachers are involved in Undergraduate, Postgraduate and Professional activities in Engineering, Management.

DIPTEM active in R&D Projects for major Institutions, Companies and Governmental Organisations. DIPTEM co-operates actively with major Excellence Centers World-Wide.



MISS - DIP University of Genoa

The MISS-DIP of *Genoa University* carries out many industrial simulation projects in cooperation with the large corporations and small and medium sized Enterprises; some example of recent industrial simulation project are following:

ADtranz ABB Daimler-Benz	**On-Line Simulation for Distributed Production Management of Locomotives**
Ansaldo	**Distributed Synthetic Environment for Power Plant Design**
Cetena **Fincantieri**	**Simulation & Virtual Project Management of Car Deck Construction for Fast Ferry**
COOP	**Simulation for Re-Engineering Supply Chain in a National Chain of Grocery Stores**

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

- Italian Point of Contact of ISAG (International Simulation Advisory Group)
- Associate Vice President of SCS and Chairman of Industrial Relations for Europe
- Member of NATO Industrial Advisory Group for Simulation & VV&A for Design

McLeod Institute of Simulation Science

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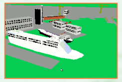
The MISS have a very long tradition in M&Simulation; the activities involve modeling, simulation in many different aspects:



- Methodologies and techniques developments
- VV&A Best Practices and Policies
- Academic and professional education
- Real Applications Projects (design, re-engineering, management, training etc.)
- Tools and Model Repository
- Standards Development

The Institute staff is in touch world-wide with the simulation community and is present actively to conferences, exhibitions and working meetings with the major Associations, Agencies and Companies.

22 MISS Centers World-Wide &
5 Satellite Centers

Liophant Simulation

www.liophant.org

info@liophant.org

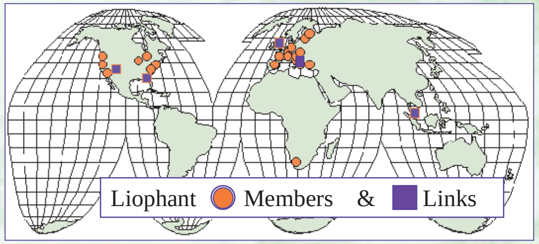
Liophant Simulation involves World-Wide over 120 Scientists and Technicians working in Companies and Academia.

The *Liophant* develops Advanced Projects for Real Industrial Applications as:

- ❖ VAED : Virtual Aided Engineering & Design (Gas Turbine Modeling)
- ❖ Safety First : Virtual Ship Handling Simulation in Harbour Environment
- ❖ Wolves: Warehouse Management & Logistics Simulation
- ❖ Health Care Survey

Liophant Simulation promotes international Cooperations and exchanges with Excellence Centers World-Wide (i.e. NCS)

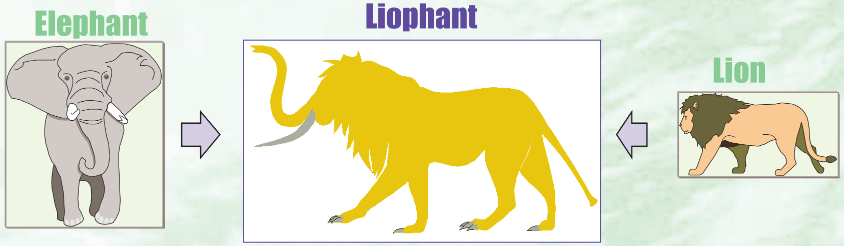
\www.liophant.org



Liophant ● Members & ■ Links

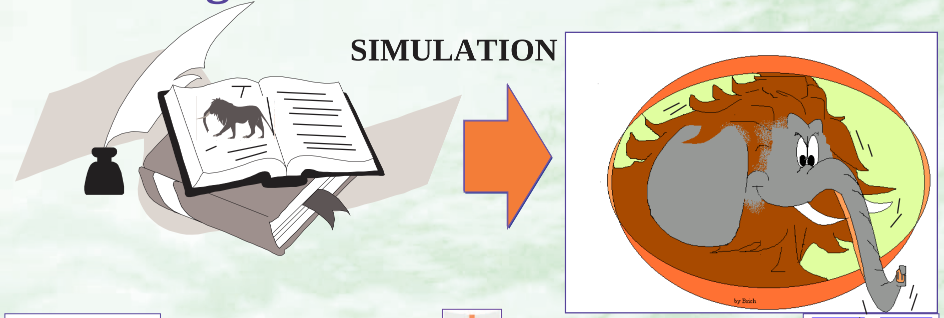
What is a Liophant ?

- It is an Animal that is a combination of an Elephant and a Lion
- It's a Mythological Creature
- He is courageous as a Lion & powerful as a Elephant



Why Liophant?

- The *Liophant* is a Mythological Being that only Simulation could bring back to life.



The International Activity of Liophant

ICAMES2004, Istanbul, May
COMADREJA & SILLA2
F.Longo, D.Carini, A.Ganapini, M.Meistro,
S.Poggi -1st Runner Award

Exchange Activity
PhD, Master, BS **2004**

Workshop I3M2004/MAS2004
Bergeggi, Oct.

SimServ, Copenhagen
September,

ST Genoa/Venice
S. Saavedra, R.Gallan,
J.Zumaglini, C.Bussi,
B.Jamel

Istituto Nacional de Atrofisica Optica Y Electronica
Universidad Popular Autonoma de Estado de Puebla
Universidad Popular Autonoma de Mexico
Istituto de Investigaciones Eletricas
Universidad Panamericana
November-December
S.Simeoni

SCSC2005
San Jose`
July, S.Simeoni

Boston College
Boston , July-August
R.Moccia

VMASC, May
R.Revetria

University of
Maryland
November
G.Prioreschi

Dupont & Darden
Alessio Carbone

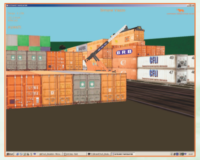
HMS2004 LAMCE
Rio De Janeiro
September
A.Nogueira, S.Viazz

SimServ
Helsinki
June
Kurri

MBA, London
Business School, G.Oran

ITEC2004, London
May, F.Longo

A Quick Overview on Hot Spots



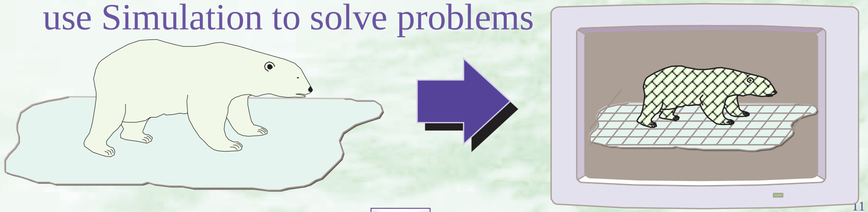
- Simulation is becoming quite popular
- New Application areas require innovation to face new Challenges
- Interoperability Challenges are still open issues
- Interdisciplinary Modeling is an emerging need
- Needs for Advances Simulation Technologies while Enabling Technologies are available
- Growth in Size & Complexity of M&S
- Need to motivate Effectiveness of M&S

What is a Simulation Project?

Simulation is the reproduction of the reality by using computer models.

The simulation allows to build up a ***Virtual Environment*** and to run dynamic scenarios in order to analyze or optimize the real system.

A simulation project is devoted to develop and use Simulation to solve problems



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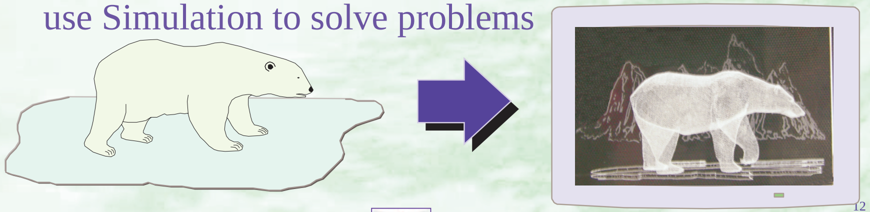

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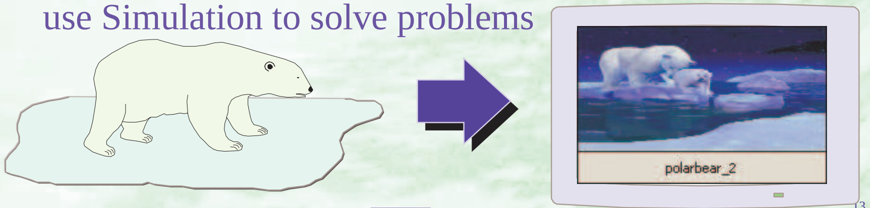


Project: PIOVRA

Polyfunctional Intelligent Operational Virtual Reality Agents

PIOVRA is developed for Italian and French MoDs in the frame of the EUCLID Program CEPA11. Project aims are:

- **To develop a new Generation of CGF able to simulate "Intelligent" behaviour, filling up the gap between user requirements and current available CGF performances**
- **To create PIOVRA intelligent CGF as effective models to be integrated in HLA Simulation for:**
  - **Training**
  - **Operation Planning**
  - **Operation Support**

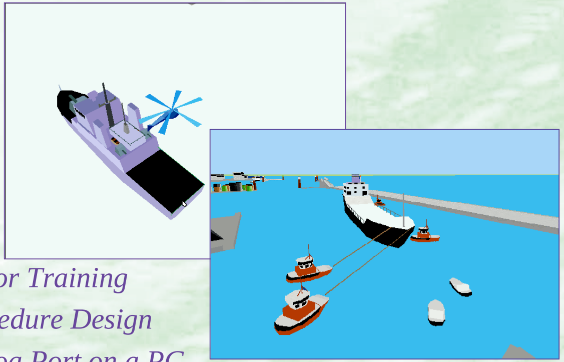
- **To guarantee the possibility to Define/Configure PIOVRA CGF using Libraries and Effective Paradigms in order to guarantee Accreditation, Effectiveness and Usability of PIOVRA developments**

Project: SAFETY FIRST

Training & Design for Ship Handling

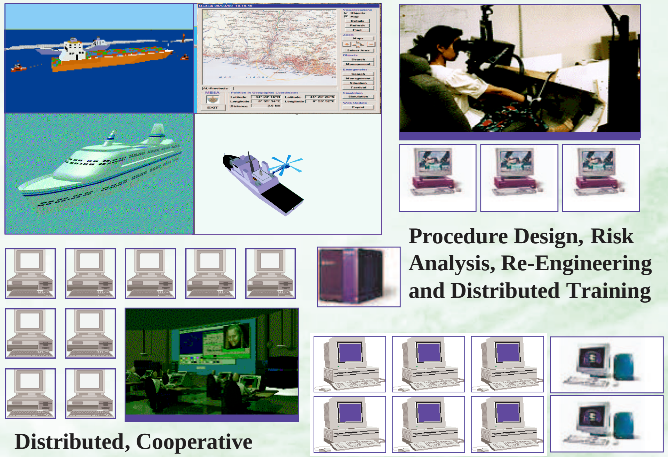
The simulator includes a complete virtual reproduction of Genoa Harbor and it's devoted to the design and training of Harbor Technical Services Operators (Pilots, Tugs & Boat Men)

This simulation system is designed in order to be portable for cooperative training on web server just using regular browser with specific plug-in.



- *Full Interactive Real-Time for Training*
- *Faster than Reality for Procedure Design*
- *Virtual Environment of Genoa Port on a PC*

Distributed Virtual Maritime Environment



DIS
HLA

C/C++
Java

Procedure Design, Risk Analysis, Re-Engineering and Distributed Training

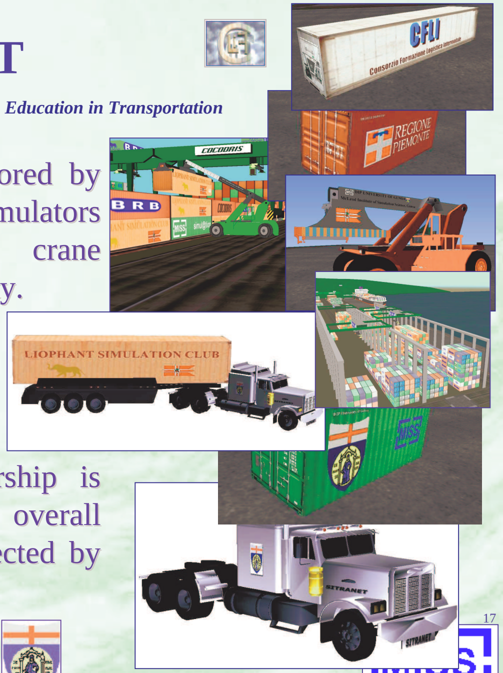
Distributed, Cooperative Planning and Management

Distributed Operation Control

A Platform Independent Distributed Environment for Maritime Applications

Project: SITRANET

SImulation for TRAiniNg & Education in Transportation



SITRANET is a project sponsored by EC, devoted to creating three simulators as training equipment for crane operators based on Virtual Reality.

The Simulators includes:

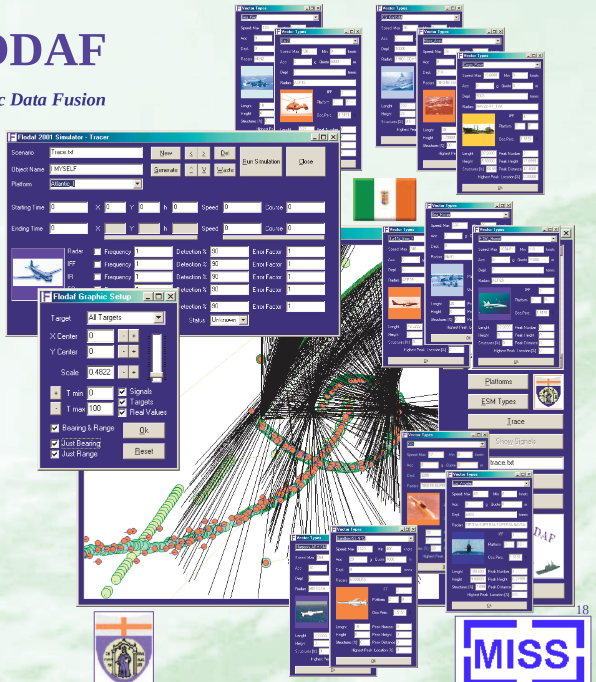
- Special Crane Simulator
- Contstacker Simulator
- Truck Simulator

The project technology leadership is assumed by DIP, while the overall coordination of courses is directed by CFLI

Project: FLODAF

Fuzzy Logic Data Fusion

FLODAF suite includes a Scenario Generator and a Simulator for analyzing the Data Fusion performances over complex Air-Naval scenarios including ships, submarines, missiles, airplanes and helicopters.

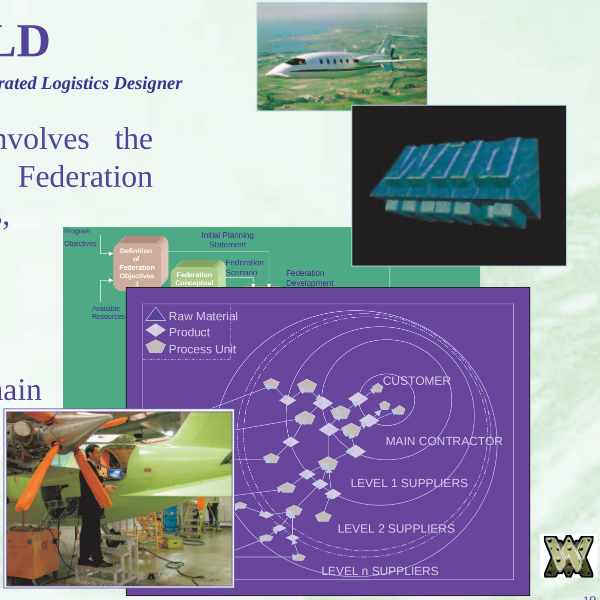


Project: WILD

Web Integrated Logistics Designer

The WILD project involves the development of a Federation composed by Simulators, Scheduling Systems and ERP.

WILD Federation reproduces the supply chain and supports on-line distributed management and control among customers, main contractors, suppliers



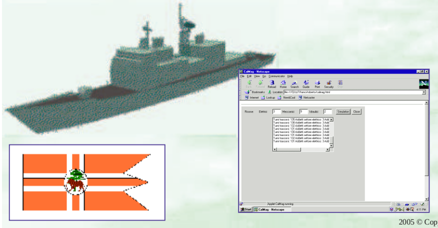
Project: WSS&S

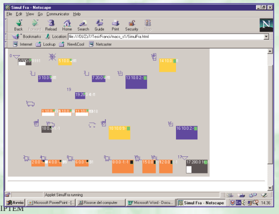
Weapon System Service & Simulation

This Simulator is devoted to re-engineer Weapon System Logistics and Service.

The Simulator is operating in Taranto Base to support the service planning of Torpedo, Missile, Rocket Launchers and Naval Gun Systems.

The simulator is a web-based stochastic simulator and supports the concurrent service management; the model is object-oriented and the implementation allows to operate directly with regular browsers without any special requirements in term of platform or plug-ins..





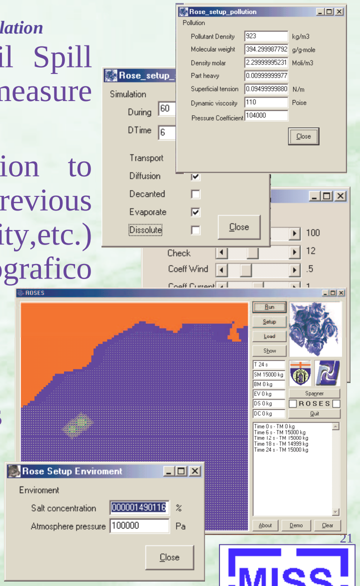
Project: ROSES

Reaction to Oil Spill Emergency and Simulation

The project is deveoted to create an Oil Spill Simulator for CETENA including countermeasure models.

The Simulator was validated in relation to historical data available from previous cooperations (i.e. MESA, Kuwait University,etc.) and existing databases (i.e. Istituto Idrografico Italian Navy) in order to guarantee the result fidelity.

Roses reproduces both the oil spill physical phenomena and the countermeasures actions in order to provide estimations about risks, policy effectiveness and standing operating procedures.


Rose_setup_pollution
Pollution
Pollutant Density 923 kg/m3
Molecular weight 394.299987792 g/g-mole
Density molar 2.29999995231 Moli/m3
Part heavy 0.00999999977
Superficial tension 0.09499999880 N/m
Dynamic viscosity 110 Poise
Pressure Coefficient 104000

Rose_setup_
Simulation
During 60
DTime 6
Transport
Diffusion ☑
Decanted ☐
Evaporate ☑
Dissolute ☐

Check 12
Coeff Wind .5

ROSES
T 24 s
SM 15000 kg
BM 0 kg
EV 0 kg
DS 0 kg
DC 0 kg

Time 0 s - TM 0 kg
Time 6 s - TM 15000 kg
Time 12 s - TM 15000 kg
Time 18 s - TM 14999 kg
Time 24 s - TM 15000 kg

Rose Setup Enviroment
Enviroment
Salt concentration 000001490116 %
Atmosphere pressure 100000 Pa

Project: POSEIDON

POrt Simulation Environment for Design of Operation and Network

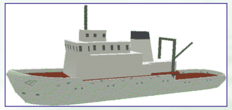
This Project involves a web based, stochastic & combined (discrete & continuous) simulator.

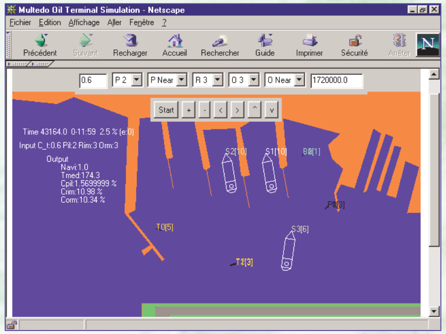
The implementation is made by using Java, the demo is available at:

http://st.itim.unige.it/liophant/projects/poseidon

Multedo Oil Terminal - Genoa

- **Vessel Traffic System**
- **Tankers**
- **Docks**
- **Pilot Boat**
- **Tugs**
- **Mooring Men Boats**




Multedo Oil Terminal Simulation - Netscape

0.6 | P 2 | P Near | R 3 | O 3 | O Near | 1720000.0

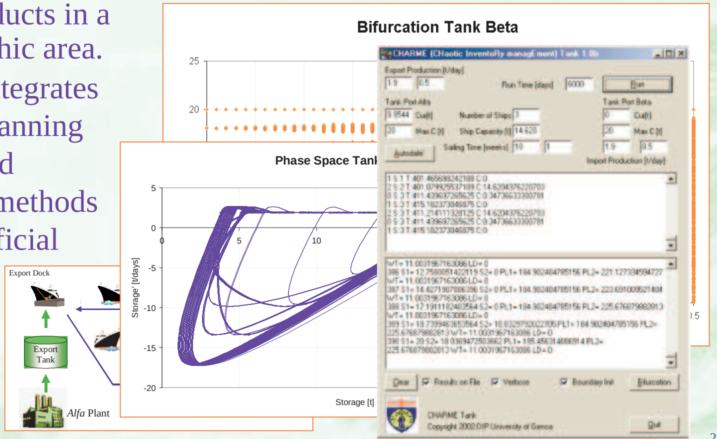
Time 43164.0 0-11:59 2.5 % (e:0)
Input C_t:0.6 Pil:2 Rim:3 Orm:3
Output
Navi:1.0
Tmed:174.3
Cpil:1.5699999 %
Crim:10.98 %
Corm:10.34 %

Project: LOGOS

Logistics Optimisation System

The project is devoted to optimize the fleet management of ships for chemical products in a wide geographic area.

The project integrates simulation, planning scheduling and optimization methods based on Artificial Intelligence Techniques.

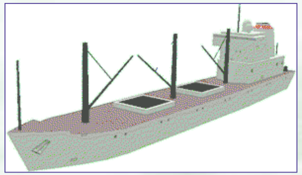

CHARME (CHaotic InventoRy managEment) Tank 1.0b
Export Production [t/day] 1.9 0.5
Run Time [days] 6000
Tank Port Alfa: Cu[t] 9.9544; Max C [t] 20
Number of Ships 3
Ship Capacity [t] 14.620
Sailing Time [weeks] 10 1
Tank Port Beta: Cu[t] 0; Max C [t] 20
Import Production [t/day] 1.9 0.5
☑ Results on File ☑ Verbose ☑ Boundary Init
CHARME Tank
Copyright 2002 DIP University of Genoa

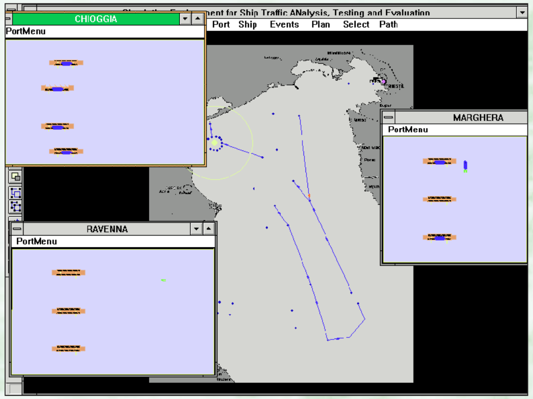
Project: SESTANTE

Simulation Environment for Ship Traffic Analysis, Testing & Evaluation

The project supports the simulation of Maritime traffic in a wide area (i.e. Mediterranean Sea) by using Object Oriented Models.

SESTANTE allows to compute the flows and delays related to strategic investments over ports or maritime lines.

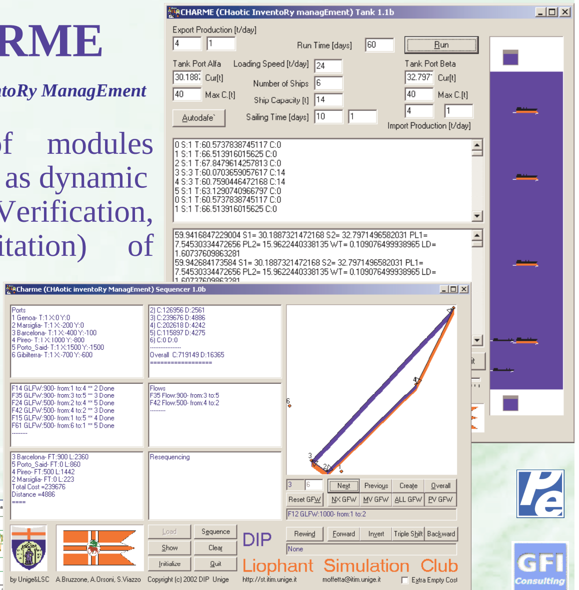




Project: CHARME

CHAotic inventoRy ManagEment

CHARME is a set of modules developed by DIP/Liophant as dynamic reference for VV&A (Verification, Validation and Accreditation) of LOGOS Decision Support System for Fleet Management (Planning, Scheduling & Simulation) in large chemical industries. CHARME uses chaos theory approach in application to real stochastic logistics networks.


CHARME (CHaotic InventoRy managEment) Tank 1.1b

Export Production [t/day] 4 1
Run Time [days] 60
Tank Port Alfa: 30.188 Cur[t]; 40 Max C.[t]
Loading Speed [t/day] 24
Number of Ships 6
Ship Capacity [t] 14
Sailing Time [days] 10 1
Tank Port Beta: 32.797 Cur[t]; 40 Max C.[t]; 4 1
Import Production [t/day]

```
0 S:1 T:60.5737838745117 C:0
1 S:1 T:66.513916015625 C:0
2 S:1 T:67.8479614257813 C:0
3 S:3 T:60.0703659057617 C:14
4 S:3 T:60.7590446472168 C:14
5 S:1 T:63.1290740966797 C:0
0 S:1 T:60.5737838745117 C:0
1 S:1 T:66.513916015625 C:0
```

```
59.9416847229004 S1= 30.1887321472168 S2= 32.7971496582031 PL1=
7.54530334472656 PL2= 15.9622440338135 WT= 0.109076499938965 LD=
1.60737609863281
59.942684173584 S1= 30.1887321472168 S2= 32.7971496582031 PL1=
7.54530334472656 PL2= 15.9622440338135 WT= 0.109076499938965 LD=
```

Charme (CHAotic inventoRy ManagEment) Sequencer 1.0b

```
Ports
1 Genoa- T:1 X:0 Y:0
2 Marsiglia- T:1 X:-200 Y:0
3 Barcelona- T:1 X:-400 Y:-100
4 Pireo- T:1 X:1000 Y:-800
5 Porto_Said- T:1 X:1500 Y:-1500
6 Gibilterra- T:1 X:-700 Y:-600
```

```
2) C:126956 D:2561
3) C:239676 D:4886
4) C:202618 D:4242
5) C:115897 D:4275
6) C:0 D:0
-----------------
Overall  C:719149 D:16365
==================
```

```
F14 GLFW:900- from:1 to:4 ** 2 Done
F35 GLFW:900- from:3 to:5 ** 3 Done
F24 GLFW:500- from:2 to:4 ** 5 Done
F42 GLFW:500- from:4 to:2 ** 3 Done
F15 GLFW:900- from:1 to:5 ** 4 Done
F61 GLFW:500- from:6 to:1 ** 5 Done
--------
```

```
Flows
F35 Flow:900- from:3 to:5
F42 Flow:500- from:4 to:2
--------
```

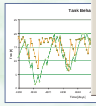
```
3 Barcelona- FT:900 L:2360
5 Porto_Said- FT:0 L:860
4 Pireo- FT:500 L:1442
2 Marsiglia- FT:0 L:223
Total Cost =239676
Distance =4886
====
```

Resequencing

F12 GLFW:1000- from:1 to:2

None

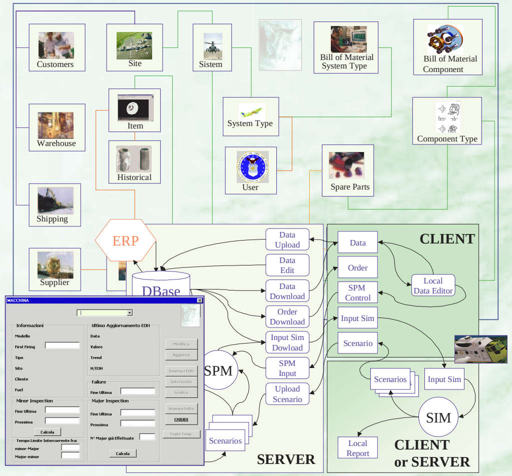
by Unige&LSC A.Bruzzone, A.Orsoni, S.Viazzo Copyright (c) 2002 DIP Unige http://st.itim.unige.it moffetta@itim.unige.it



Project: COUGAR

Controller & Organizer for Ultimate Government of Availability and Reliability

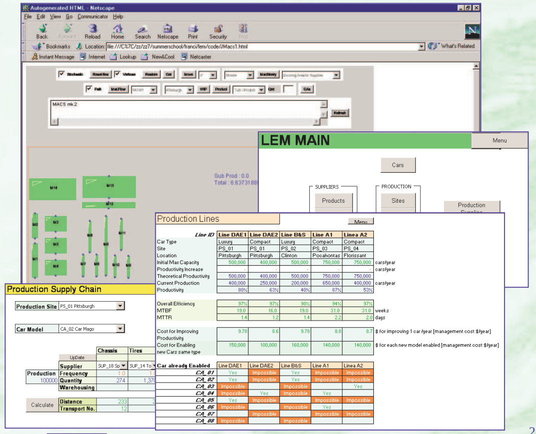
COUGAR is the innovative system for the Service and Maintenance of complex systems (i.e. Helicopters). The system is designed to satisfy the requirements connected with the maintenance management of helicopters taking care of both pre-planned and emergency actions.



Project: LEM

Logistics Evaluation Model

LEM Project is a joint venture among Ford, Boston College, LSC & Genoa University for Developing a Web Based Support System for Supply Chain management.



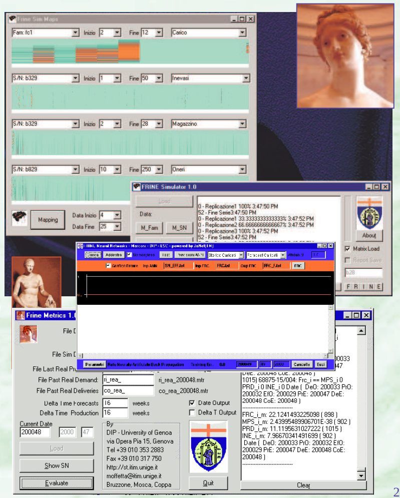
Tests using LEM beta_modules have been carried out successfully on over 70 logistics centers.

Project: Frine

Forecasts Robust INtelligent Evaluator

FRINE is a modular approach for supporting inventory management, purchasing and outsourcing planning in telecommunication production industry.

FRINE includes: Frine Sim a detailed simulator for evaluating different scenarios, Frine ANN an intelligent forecast system based on Artificial Neural Networks and Commercial Data Fusion and a Frine Metrics for on-line performances measuring and controlling.



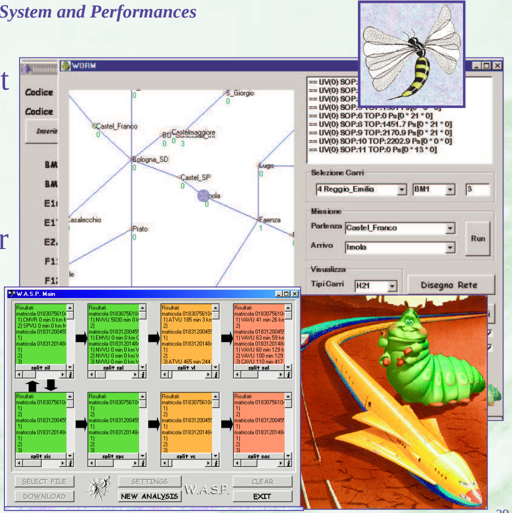
Project: WORM & WASP

Work Organization for Railways cargo Management
Wide Analysis of rail System and Performances

WORM is a simulator of freight rail operations for estimating service quality and costs.

WASP is a data mining system and smart performance analyzer directly integrated in railways information system.

WASP & WORM are integrated to operate as DSS for ASA Logistics Div. in Italian Railways



```
== UV(0) SOP:6 TOP:0 Ps[0 * 21 * 0]
== UV(0) SOP:8 TOP:1451.7 Ps[0 * 21 * 0]
== UV(0) SOP:9 TOP:2170.9 Ps[0 * 21 * 0]
== UV(0) SOP:10 TOP:2202.9 Ps[0 * 0 * 0]
== UV(0) SOP:11 TOP:0 Ps[0 * 13 * 0]
```

Project: MASC & DICO-SAP

Modeling & Analysis for Satisfaction of Customers
DIP-COOP SAP

MASC is a system for Statistical Analysis, Modeling & Simulation applied to big-distribution chains.

The Project is carried out in cooperation with the major Italian company in this area

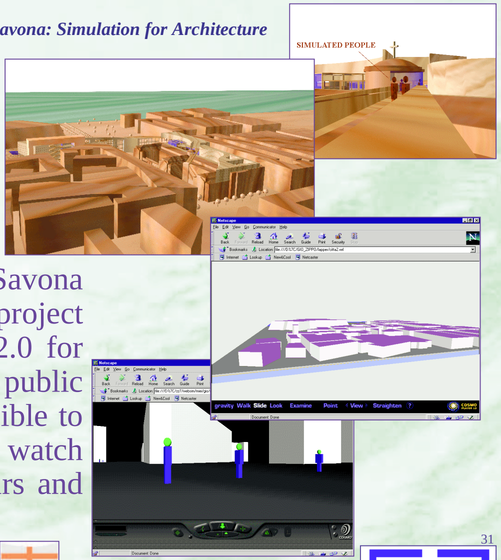
The final target is to improve the customer satisfaction acting on policies, operating procedures, resources & equipment; the system is fully integrated with company ERP (SAP R/3) and benefits of similar experiences carried out other companies (i.e. Genoa Mass Transportation Company).

Project: San Paolo 2000

San Paolo Hospital in Savona: Simulation for Architecture

San Paolo 2000 is the integration of simulation with architectural techniques for functional design and analysis of urban areas and buildings.

The system reproduce the Savona Downtown with the restoring project of this building using VRML 2.0 for exploitation of the results in the public community by WWW; it's possible to navigate in the scenario and to watch the interactions of simulated cars and people



Project: EFESTO

Liguria

Elaborazione Flussi Economato Sistemi, Tecniche & Organizzazione

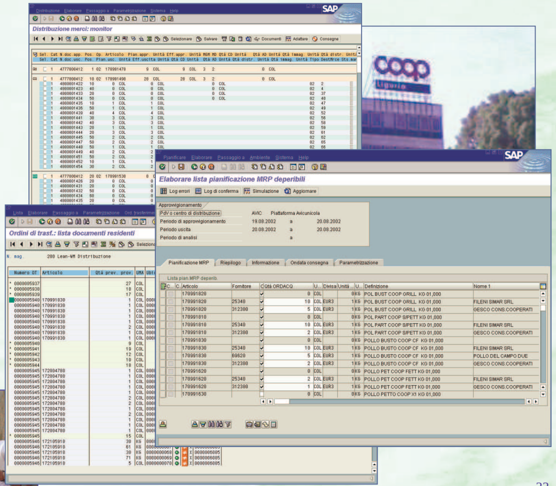
The EFESTO project is focusing on the creation of models for Business Process Re-Engineering integrating simulation techniques.

The system allows to integrate PowerPoint^{tm}, Access^{tm} and Excel^{tm} with simulation and to distributed the results directly in HTML format in Intranet managing hierarchical process structure.

Project: AVICUNICOLO

Project for Logistic Platform devoted to White Meat Fresh Products

The project is devoted to the architecture definition, system development and testing for a new logistics platform integrated in a large supermarket supply chain. The system was implemented in SAP R/3 Retail 4.6tm



Project: HOSSIAN

Hospital Simulation Analyzer

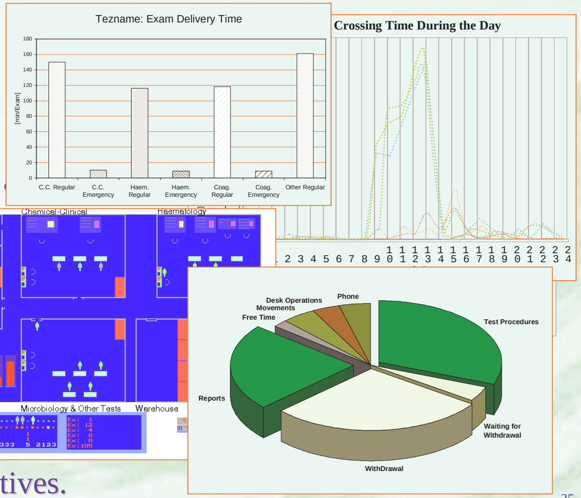
HOSSIAN is a tool developed to support resource planning in Hospital by integrating simulation and AI (Artificial Intelligence). The system has been successfully applied to the personnel and equipment scheduling in a Surgery Division composed by 6 operative rooms.

Project: TEZNAME

Tactics Evaluation & optimiZatioN for Analysis in Medical Environment

TEZNAME is a tool for analyzing Hospital Departments Management considering the detail of each resource, individual procedure.

The system has been successfully applied to Laboratory Re-engineering to compare different investments and policy/organization alternatives.



Modelling & Simulation for Transportation & Logistics

The use of M&S in considering the impact of security components on logistics/industrial facilities is more than justified by the need to analyze complex interactions among numerous factors.

Security equipment and procedures related to logistics facilities can usually be grouped into two major classes:

- Internal: Security control of logistics flow
- External: Security control of external components

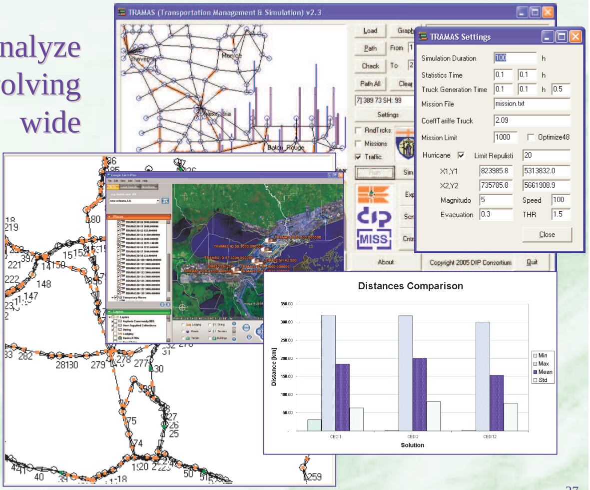
Project: TRAMAS

Transportation Management & Simulation

Tramas is devoted to analyze complex scenarios involving transportation over a wide geographic area.

The simulator consider Costs, Times, Constraints, as well as all the major factors:

- Traffic
- Weather
- Road Saturation
- Logistics Flows



TRAMAS Settings

Simulation Duration: 100 h
Statistics Time: 0.1 0.1 h
Truck Generation Time: 0.1 0.1 h 0.5
Mission File: mission.txt
CoeffTariffe Truck: 2.09
Mission Limit: 1000 ☐ Optimize48
Hurricane ☑ Limit Repulisti: 20
X1,Y1: 823985.8 5313832.0
X2,Y2: 735785.8 5661908.9
Magnitudo: 5 Speed: 100
Evacuation: 0.3 THR: 1.5

Large Area Transportation vs. Crisis

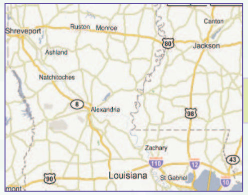
Transportation Systems:
- Roads
- Railway
- Maritime Lines
- River Traffic
- Airlines

Infrastructures:
- Towns
- Country Side
- Stations
- Ports
- Airports

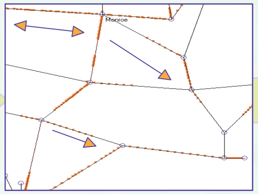
Critical Event: Hurricane
- Position & Characteristics
- Dynamics
- Protection Infrastructures
- Impact Algorithms

Flows:
- Regular People Traffic
- Good Flows
- Distribution Policies
- Special Flows (i.e.Evacuation)

A Case Study: Hurricane on a State



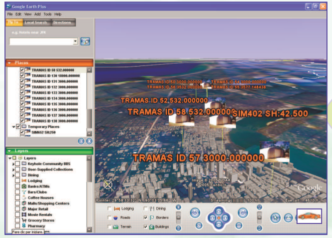
Infrastructure DBases



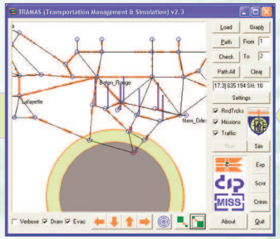
Regular Activities & Transportation

Hurricane Simulation

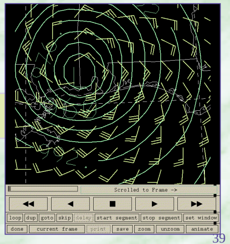
GIS Integration



Overall Simulation

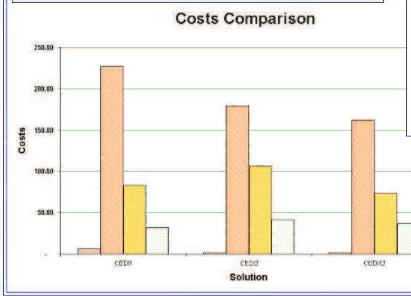


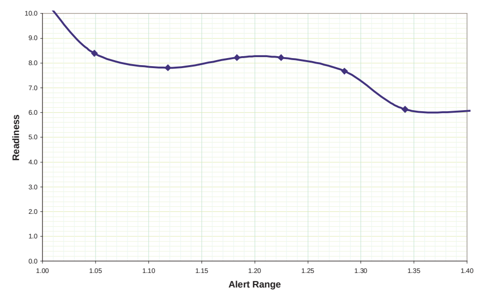
Evacuation P&P



Evaluating Quality and Costs in Realistic Scenarios

It Becomes possible to estimate operation costs within different solutions in term of location of the resources and support bases





It is possible to identify the best risk range in order to alert population for evacuation procedures

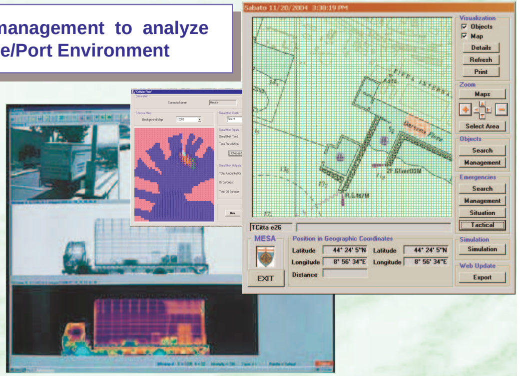
MESA Maritime Environment for Security Analysis

Simulation support to access risk of different events (security infrastructures and procedures)

Reuse Support Systems for Emergency management to analyze safety and security scenarios within Maritime/Port Environment

Use of Tool to analyse Port and Terminal security and safety issues in relation to complex operations and procedures, considering both regular processes and external threads

MESA allows to evaluate impact of threads in case of occurrence and to quantify damages, casualties and actions to be done.

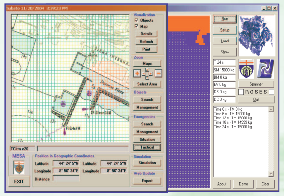


Scenario Evaluation by Interoperable Simulation

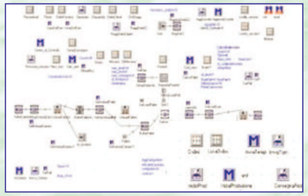
The simulation estimates the effects of Security Procedures in Operation as well as the impact of an Emergency on other objects, identifying the entities hit by the event and its impact, the interactions as well as the countermeasure effectiveness.

Today there are Simulators available for analyzing the different aspects related with several possible scenarios.


Simulation of Operations in Detail


Emergency Simulation


Terminal Activities Simulation

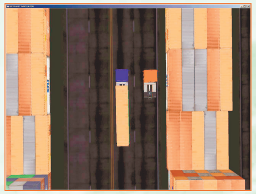

Modeling Security Procedures

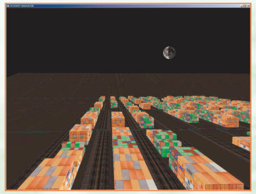
HLA Integration for Interoperability

HLA integration allows to create interactive real time simulation across a network

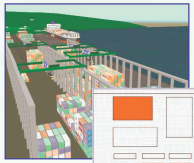
Virtual Containers in the Yard

The Container Area allows to reproduce the interactions among trucks and cranes with different weather conditions

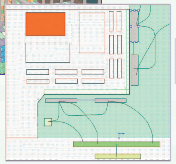




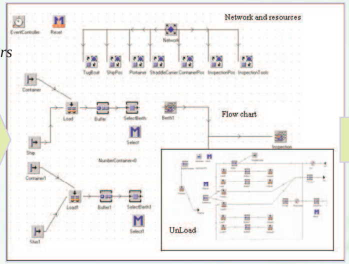
A Case Study: Container Operations



- 1MTEU/year
- *9 Portainers*
- *32 Van Carriers*

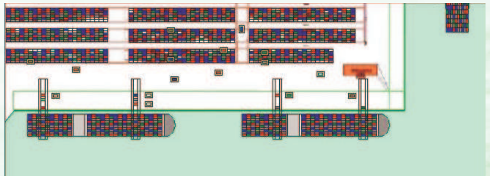


Scenario Definition



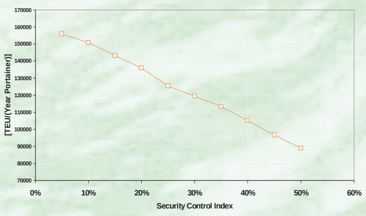
Security Operation Simulator

Emergency Simulator

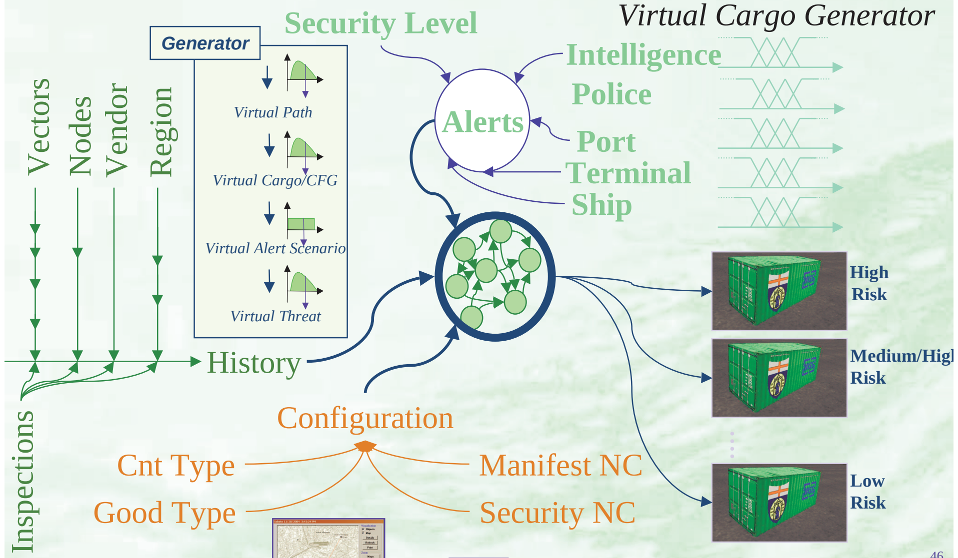


Terminal Operation Simulator

Security vs. Performances in Container Terminal



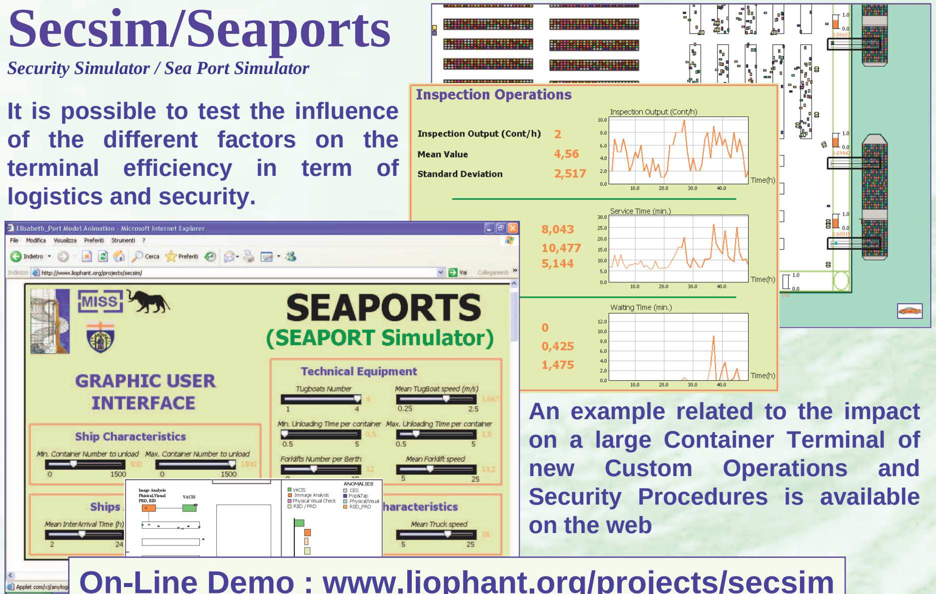
Container Risk Evaluation



Secsim/Seaports

Security Simulator / Sea Port Simulator

It is possible to test the influence of the different factors on the terminal efficiency in term of logistics and security.



Inspection Operations

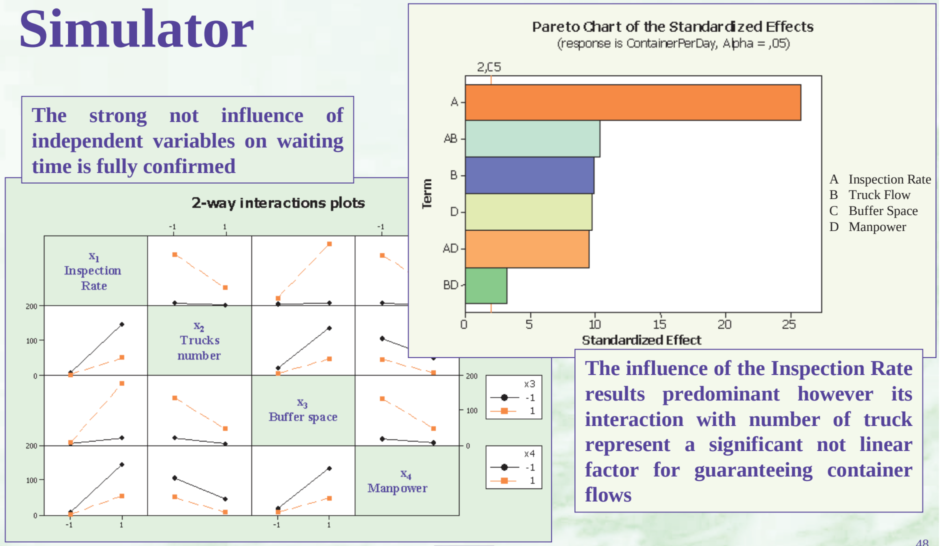
Inspection Output (Cont/h)	2	
Mean Value	4,56	
Standard Deviation	2,517	
	8,043	Service Time (min.)
	10,477	
	5,144	
	0	Waiting Time (min.)
	0,425	
	1,475	

An example related to the impact on a large Container Terminal of new Custom Operations and Security Procedures is available on the web

On-Line Demo : www.liophant.org/projects/secsim

System Knowledge by DOE on the Simulator

The strong not influence of independent variables on waiting time is fully confirmed

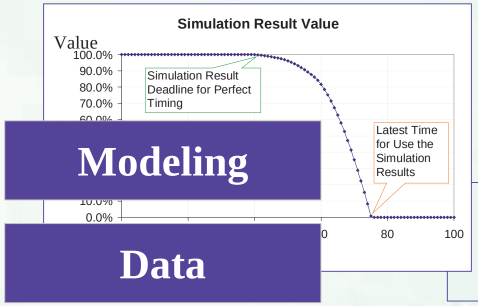


The influence of the Inspection Rate results predominant however its interaction with number of truck represent a significant not linear factor for guaranteeing container flows

Simulation Project Nature

- Simulation Projects are different from SW Projects because needs to face strong VV&A versus real Systems
- Simulation Projects deadlines and requirements are often related to other on-going Projects
- Simulation Knowledge needs to be used for Model Development as strong background for Implementation phase

Simulator Development



Simulation Result Deadline for Perfect Timing

Latest Time for Use the Simulation Results

Modeling

Data

Implementation

Validation

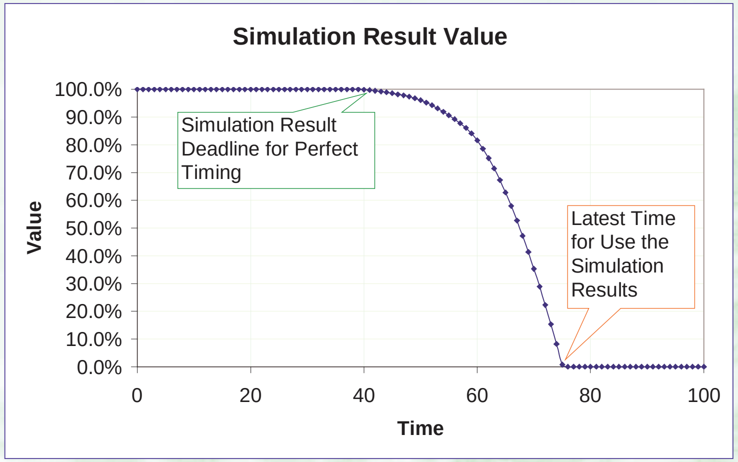
Budget Planning Limitation

Length of Development Cycle

Communication during Development Cycle

Development Process

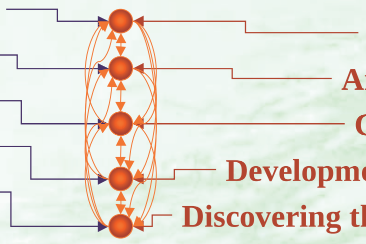
Just in Time on Simulator Deliverables



Simulation Result Deadline for Perfect Timing

Latest Time for Use the Simulation Results

Open Issues in M&S Projects



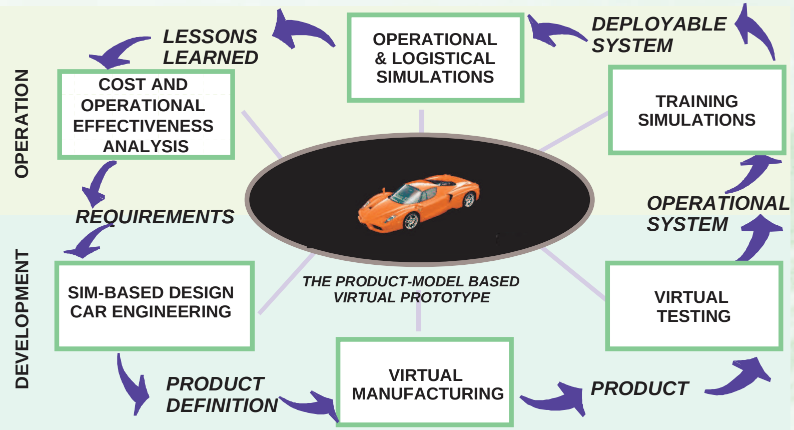
Problem Playground

Multidisciplinary Teams
Distributed Teams
Scenario Definition
Skills & Experiences
Legacy Dreaming

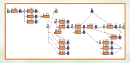
Large Projects
Ambitious Goals
Complex RAM
Development Bottlenecks
Discovering the Real Models

Life Cycle: How many Models?

The Virtual Product Life Cycle

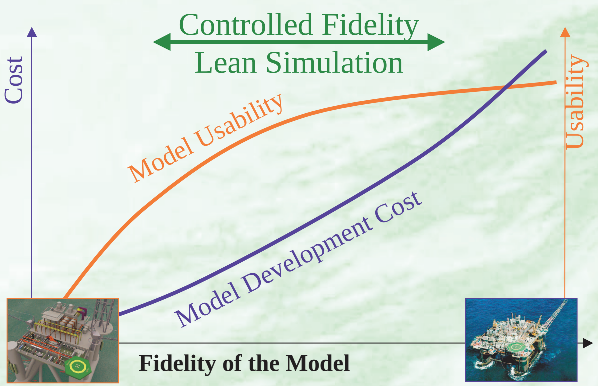


GOAL: CONCEIVE, DESIGN, BUILD, TEST, TRAIN, AND OPERATE A NEW PRODUCT IN A COMPUTER BEFORE CUTTING METAL



Usability vs. Fidelity in M&S

A model Output could be considered in relation to a credibility level. If correctness grows, development cost of the model grows; meanwhile usability of the model increases, but with a non-linear, tipically decreasing, rate.



SMEs ESE: Needs for New Paradigms

Small & Medium Size Enterprises
Early Stage Evaluation

What is Lean Simulation?

- Lean Simulation is an innovative approach devoted to guarantee development of M&S (Modeling and Simulation) projects with reduced resources and in quick time by fast track procedures.
- The key point of this approach is to be able to relax fidelity requirements and ancillary activities keeping under control the model confidence respect to the application requirements.

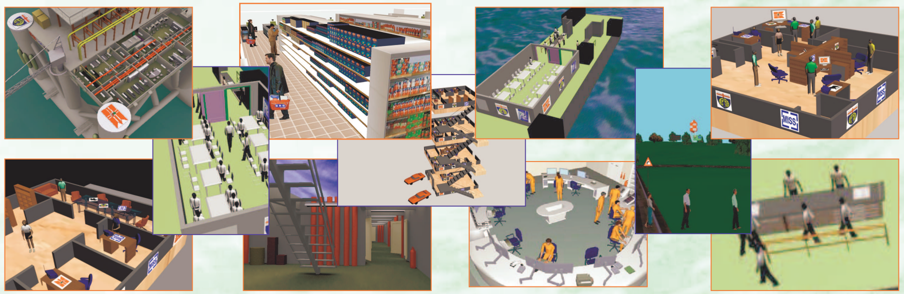
Lean Simulation key points could be summarized as follows:

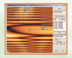
- **Essential Statement of Work for Simulation Success**
- **Minimal Fidelity for Satisfy Project Requirements**
- **Quantitative Control on Model Confidence**
- **Tailored Protocols and Procedures per Application Categories**
- **Compact Simulation Unit**

Human Behaviour & Simulation

The data flows, business processes are usual in use in current simulation.

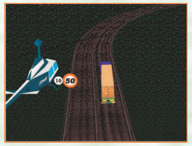
The human beahviour involving in these aspects have a strong impact and becomes more and more important to properly faces this aspect.





Human Modeling Challenges

- •RATIONAL DECISION MAKING
  - •Intelligent Behaviour
  - •Organisation & Hierarchy
- •EMOTIONS & PERSONAL ATTRIBUTES
- •CROWD CONTROL

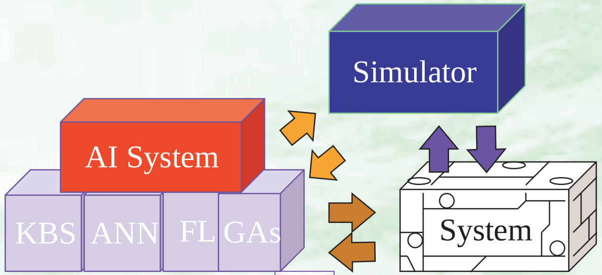


Simulation and Integration with Other Advanced Techniques

AI Techniques	Advanced Techniques
Knowledge Based Systems	Simulation
Artificial Neural Networks	Chaos Theory
Fuzzy Logic	Metamodels & DOE
Genetic Algorithms	Optimization Techniques

Integration as Additional Challenge

- The square stone to success in the application of new methodologies is the integration of different techniques and on multibody analysis by using different skills:

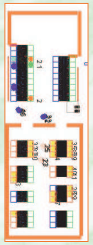


Simulator

AI System

KBS ANN FL GAs

System



New Initiatives in M&S

Simulation Projects involving HLA and new architectures are moving back the infrastructure development to general purpose Language.

Developers from Academia are investing in developing new formalism and architectures devoted to support Model Development (i.e. XMSF)

Critical Issues in M&S Project Cost Estimation

Resource Cost

Development & Integration Costs

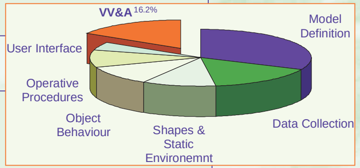
Issues

- **Situation of Available Resources**
- **Specific Training & Expertise**
- **Proprietary Issues** !?
- **Life Cycle Issues** !?
- **Maintainability**
- **Portability**
- **Value of Deliverables versus Planning**
- **VV&A Responsibility Assignments** !?
- **……**
- **Miscellaneous**

Estimation of VV&A Costs

The estimation of total costs can't be generalized.

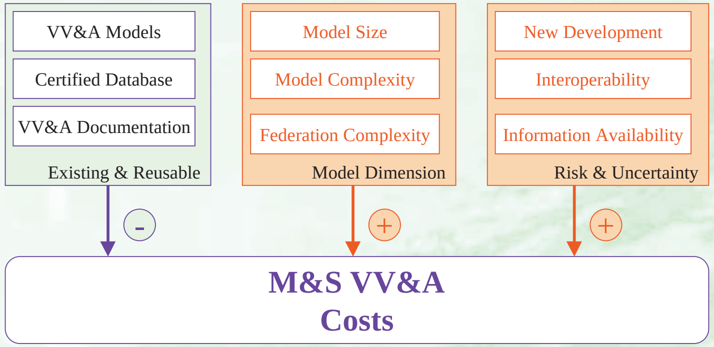
It is possible to outline a set of examples reporting about the resources, scheduling and costs related to the VV&A.



Example Elements:

- ***Outline Boundaries***
- ***Describe Expert Selection and Use***
- ***Describe responsibility***
- ***Report on time and costs***

General Cost Drivers

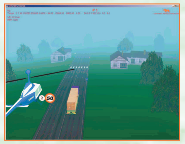


Existing & Reusable (-):
- VV&A Models
- Certified Database
- VV&A Documentation

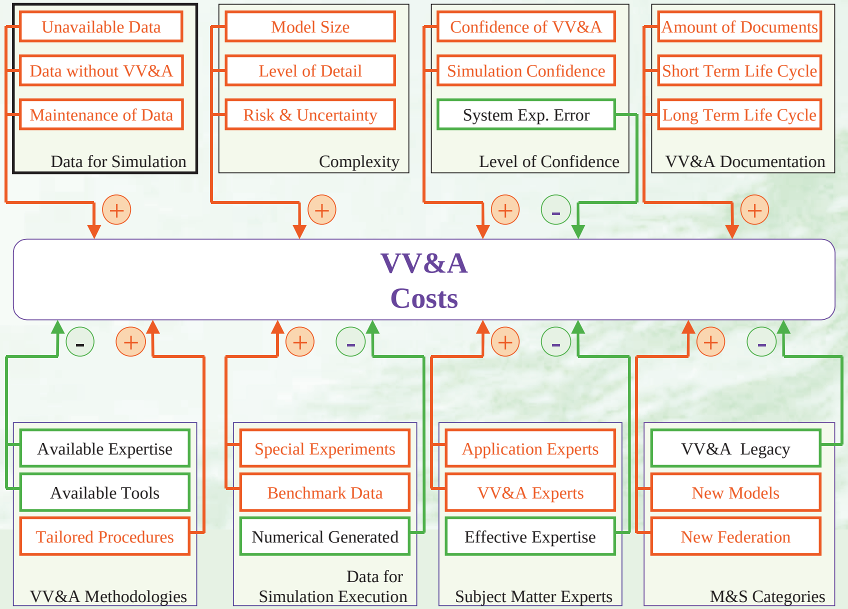
Model Dimension (+):
- Model Size
- Model Complexity
- Federation Complexity

Risk & Uncertainty (+):
- New Development
- Interoperability
- Information Availability

M&S VV&A Costs



Cost Driver Overview



Data for Simulation:
- Unavailable Data
- Data without VV&A
- Maintenance of Data

Complexity:
- Model Size
- Level of Detail
- Risk & Uncertainty

Level of Confidence:
- Confidence of VV&A
- Simulation Confidence
- System Exp. Error

VV&A Documentation:
- Amount of Documents
- Short Term Life Cycle
- Long Term Life Cycle

VV&A Costs

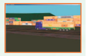
VV&A Methodologies:
- Available Expertise
- Available Tools
- Tailored Procedures

Data for Simulation Execution:
- Special Experiments
- Benchmark Data
- Numerical Generated

Subject Matter Experts:
- Application Experts
- VV&A Experts
- Effective Expertise

M&S Categories:
- VV&A Legacy
- New Models
- New Federation

VV&A Military Vs. Industrial Applications



MILITARY	INDUSTRY
Projects are medium- long term and have larger budgets	Projects are short - medium term length, budget is critical
Deadline is fixed	Profit drives the deadline
Requirements are very precise even in terms of procedures to be used and documents to be produced	Companies do not have precise requirements on which methods are to be used to solve the problem
Operative people are the final users	Managers are final customers, and need to be supported after the delivery of products

VV&A Military Vs. Industrial: Different Targets

MILITARY	INDUSTRY
Military projects define precisely simulation requirements.	Companies have usually problems to be solved and they don't care if it's used simulation or whatever else
Users will run themselves the simulator to find solutions, while experts complete just demonstration phase	Managers need a support to continuous use of simulation analysis for applying results to real cases
Simulation developers are requested for delivering products	Simulation developers are requested for applicative results

Current Situation in Project Management for M&S

Project Management Issues in M&S are related to:

Identify the Critical Issues in PM applied to Distributed Simulation

Propose Solutions for Distributed Simulation Project Management

Construct the Bridge to Overpass PM Problems on distributed Simulation

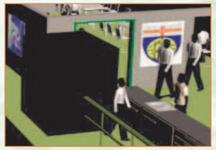
Applying Project Management Methods in M&S

Using PM Methodologies could strongly benefit the Projects:

•Project Time Control

•Project Cost Control

•Project Team Management

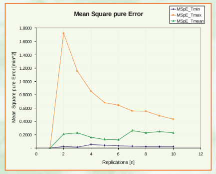


In New Large Projects involving geographically distributed teams these aspects are stressed

M&S Standard & Tool Dreaming

Project Teams are often expecting to find M&S Project Solution in new tools acquisitions while this needs to face with:

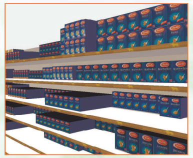
- **Proper Tool Acquisition based on Alternative Overview**
- **Training and Knowledge Acquisition Issues**
- **Conceptual Model Proper Fundamentals**



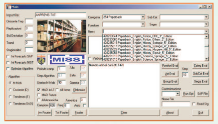
Providers & Vendors

The COTS Simulation Tools are currently very directed to:

- **User Internal Market & *Afficionados***
- **No Attention to Distributed Development Issues**
- **Small Attention to Distributed Simulation**
- **Development of *Compliant* instead of *Compatible***
- **Investments in New Release versus New Features**



Legacy Systems & Simulation Projects



Legacy Systems are generating Dreams in Final Users in term of expectation about:

- **Reusability**
- **Fidelity**
- **VV&A Saving**

Reusability of the Model is important until the Model is Consistent considering new requirements

Fidelity of a Model used for a Different Purpose could change Drastically

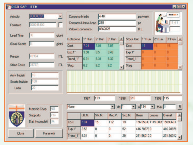
VV&A of new Developments is strongly based on the new configuration

---

Critical Issues Overview

The four basic phases of a simulation project include:

- **Modeling**
- **Data and Knowledge**
- **Implementation**
- **Validation**



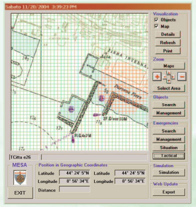
The critical issues associated with those phases determine the effectiveness of the simulation.

This presentation addresses the factors that contribute to those issues that may result in decreased effectiveness or invalidate the simulation. Suggestions are offered to assist in the early identification of potential for difficulties, thus leading to simulation that can achieve the objectives successfully

The Simulation Development Process

- Establish Requirement
- Budget Planning Limitations
- The Length of the Development Cycle
- Communications during the Development Cycle

Simulation Framework

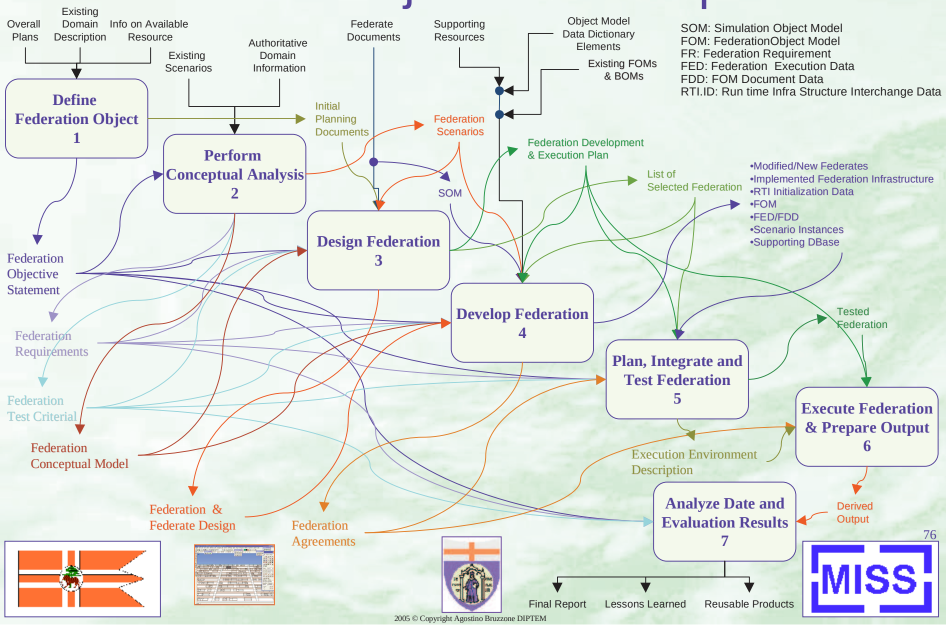


- Simulation Level
  - **•Components**
  - **•Sub-Systems**
  - **•Systems**
  - **•Multi-Systems**
- Simulation Applications
  - **•Conceptual Design and Feasibility Studies**
  - **•Design**
  - **•Fabrication**
  - **•Test**
  - **•Evaluation**
  - **•Training**
  - **•Logistics**

Overview – the Fundamental Steps in Simulation Projects

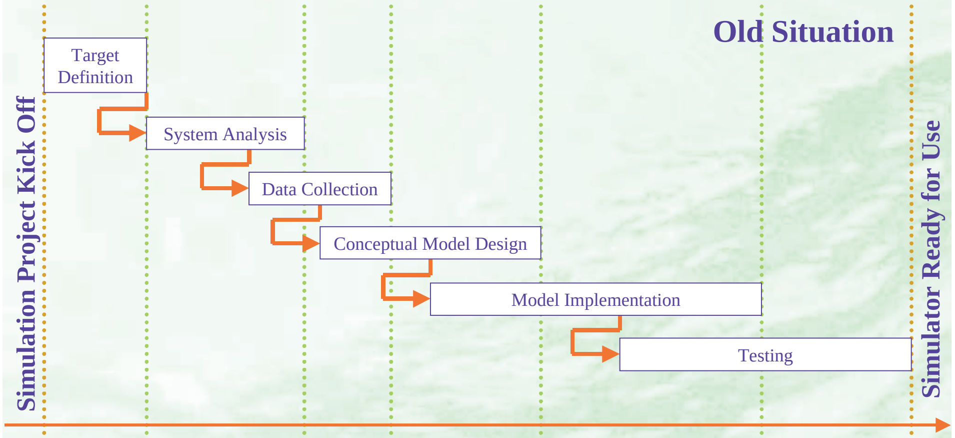
- **Formulate problem**
- **Set objectives and project plan**
- **Conceptualize model**
- **Collect data**
- **Model build**
- **Model verification**
- **Model validation**
- **Experimental design**
- **Production runs and analysis**
- **Documentation and reporting**
- **Decision Implementation**

Simulation Projects vs.Fedep

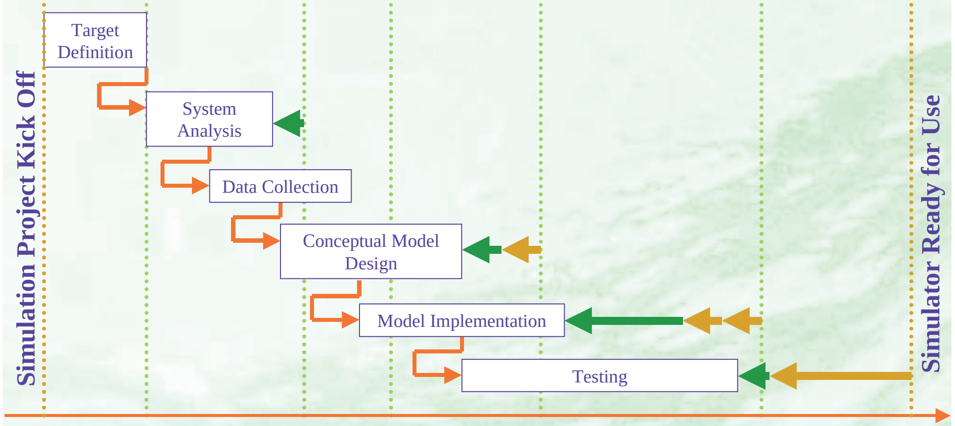


SOM: Simulation Object Model
FOM: FederationObject Model
FR: Federation Requirement
FED: Federation Execution Data
FDD: FOM Document Data
RTI.ID: Run time Infra Structure Interchange Data

Development Time: Traditional

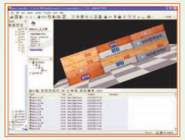


Development Time: Now



New Situation

Critical Issues: Modelling



Modelling Classification

Components ***Systems*** ***SubSystems*** ***MultiSystem***

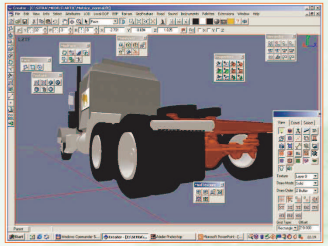
Updating Models Changes

Model Applications

Model Confidence

Model Reusability

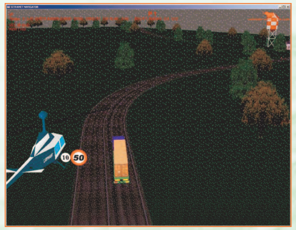
Critical issues in Modeling



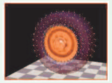
- Model Classification
  - **Component Models**
  - **Sub-Systems Models**
  - **System Models**
  - **Multi-System Models**
- Model Applications
  - **Conceptual Design**
  - **Design**
  - **Production**
  - **Test**
  - **Evaluation**
- Updating Models for Changes
- Model Confidence
- Model Reusability

Examples of Modeling Issues

- Incorrect Models
- Range of Variables
- Rigorous Models
- Incomplete Models
- Correct Models
- Complex Models
- Model Simplification



Modelling Problems & Solutions



<u>Complex Models</u>. Environmental models are very complex are very dependent on conditions at a given time. It is not common to include unusual environmental conditions in the model. When severe down drafts were encountered that caused accidents in commercial airline operations, the simulators had to be modified to add that particular environmental effect into the simulation.

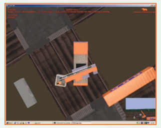
<u>Incomplete Models</u>. The surface ship dynamic models must include the forces that produce ship motion such as: wind, current, mooring lines, and tugs in addition to the internal ship controls. The modeling of these external forces is relatively complex. It took many years to develop effective models for docking.

<u>Incorrect Range of Variables</u>. A visual system developed for commercial airline application was installed on a Marine Corps Fighter. The aircraft roll rates for the fighter were much higher that those of for commercial airline simulators and as a result the visual scene could not follow the fighter aircraft roll rates. The visual system had to be modified to accept the higher roll rates.

<u>Correct Models</u>. When the correct model is use the results are very gratifying Here is one example. In many facilities the material handling (from pallets in a production department to ammunitions inside a carrier) is a typical problem where simulation can improve efficiency and avoid operative problems. Obviously the model definition is critical for the successful application. In ATA, a corporation involved in environmental treatment, the use of proper simulation models improved the efficiency of transportation systems by 40%, just by re-engineering the management policy.

<u>Simplifying Complex Models</u>. How many simplifications are made to the model to accommodate available data or to facilitate programming. Do these models truly represent the behavior of the systems? Is some randomness introduced into the models in order to replicate the operational counterparts? These model issues also relate to degraded systems performance and the introduction of emergencies. Probably one of the most classical cases of debate over models is in the simulation of the main rotor of a helicopter. The model normally used, because of its relative simplicity, is the vectored thrust model. A much more detailed model is called the Blade Element model. That model requires an enormous amount of computing power.

Critical Issues:
Data & Knowledge



Data & Knowledge Connection

System Data Evolution

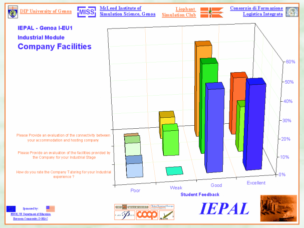
Complex Environmental Databases

Knowledge Data

Human Behavior Data

Critical Issues in Data and Knowledge

- Obtaining data and Knowledge for Models
- Systems Data
- Environmental Data
- Knowledge data
- Human Behaviour Data



Data: Problems & Solutions

Incorrect Aircraft Data Relating to Aircraft Model Changes A decision was made to use the simulation models and data from an earlier version of the aircraft on a new model of the same aircraft. When the simulator went into the test phase it came obvious that the results did not represent the new aircraft model. The entire simulation had to be redesigned. The program was delayed by about 2 years.

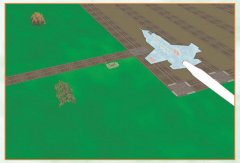
Incorrect Data. A firm never achieved the car production target for few years. The analysts was complying with the low motivation, personnel skills, etc. for the area. The model was developed based on such productivity hypothesis. After a period of operation, an analysis, based on field collected data, demonstrated that the hypothesis for the initial design was based on a wrong market scenario. With the real market scenarios and with the optimal personnel efficiency at the production site included in the model, the painting tools and equipment parts were identified as the critical bottleneck in the process

Incomplete Data. An automated filling line for mineral oil was developed by a leading company in that field. The site commissioning was successful and the target of 10,000 box/day was reached. However the real daily production never surpassed a 7,000 box/day threshold until a simulation study demonstrated that an elevator malfunctions was affecting the overall performance due to interactions with the automation control system. As a result of the simulation study, the firm was able to re-engineer the facility and achieve the design goal with reduced investments.

Data for Simulating Digital Computers. When digital computers began to be incorporated into operational systems the first approach was to simulate the functions of the digital computer. An immediate problem arose because of the unavailability of the program data for that computer. Thus, where the onboard computer was simulated, the simulator was unable to keep up with the changes in the operational software. There are examples in aircraft simulators, submarine simulators and various sensor simulators. This situation has also occurred in the nuclear power plant simulators.

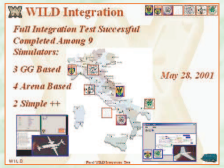
Examples Illustrating Issues with Data

- **Incorrect Aircraft Data Relating to Aircraft Model Change**
- **Data Availability and Changes**
- **Incorrect Data**
- **Incomplete Data**



Critical Issues in Implementation

- **Computational Systems**
  - *Non-Real Time Systems*
  - *Real-Time Computational Systems*
- **Examples of Issues with Computational System Implementation**
  - *Computer Capacity*
  - *Iteration Rates*
  - *Transport Delays*



WILD Integration

Full Integration Test Successful Completed Among 9 Simulators:

3 GG Based

4 Arena Based

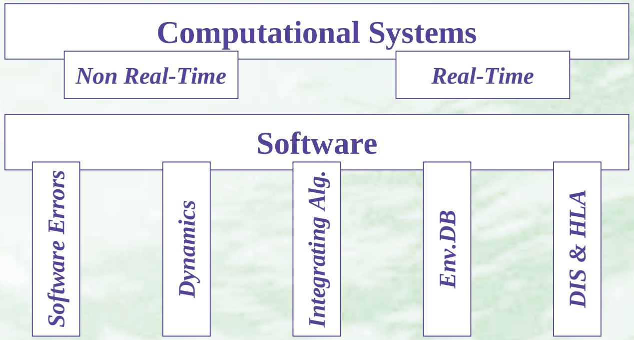
2 Simple ++

May 28, 2001

WILD

Final WILD Integration Test

Critical Issues: Implementation



Computational Systems

Non Real-Time

Real-Time

Software

Software Errors

Dynamics

Integrating Alg.

Env.DB

DIS & HLA

Critical Errors during Implementation

- **Software**
  - *Software Errors*
  - *Vehicle Dynamic*
  - *Integrating Algorithms*
  - *Environmental Databases*
  - *Distributed Interactive Simulation (DIS) and High Level Architecture (HLA)*
- **Examples of Issues with Software Implementation**
  - *Software Design Erorrs*

Implementation Examples

Computer Capacity The computer capacity was seriously underestimated for a system that included one of the first radar land mass simulators. There were also problems with estimating the complexity of the aircraft model itself. When system tests began it was determined that the computer capability had to be doubled. That resulted in major delays in delivery of the simulator.

Iteration Rates Cockpit control inputs to a computer were implemented through digital encoders on the controls. The computer was not able to accommodate the step inputs and the system failed. Prior control input technology as utilized to resolve the problem. In order to accommodate direct inputs an iteration rate of about 1500 Hz. is required instead of the 16 Hz. iteration rate of the flight equations.

Transport Delays One of the first Computer Generated Visual Systems ran into serious problems. The time delays in scene generation in response to pilot input were excessive . Human Factors studies were conducted to determine the cause of the problem and solution that would be necessary to make the system acceptable. This study concluded that the time delay should not greater than 80 to 90 milliseconds. This criteria placed a burden on the computational system because of the faster iteration rates that were required. This led to the 30 Hz. or 60 Hz. iteration rates currently used for visual systems. These rates are also consistent with television frame rates.

Software Design Errors A number of years ago there was a project that involved a major computer hardware and software development effort. The project started out with an estimate 10,000 instructions and ended up with over 80,000 instructions, small by today's standards but a major task in its time. The only way to test the software was to subject it to a major independent validation on a large mainframe computer. When test were started the error rate was about 10%. The software debugging process took about six months. After testing was completed the error rate was reduced to about .5%. The simulator could operate without experiencing any interruptions. But the entire hardware and software testing process took over 2 year on what was to have been an 18 month program.

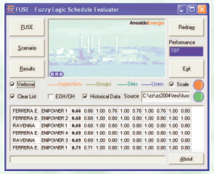
Critical Issues: Validation

Validation of Data & Models

Validation of the Implementation

Testing

Testing to the Design ***Testing to the Work Statement***



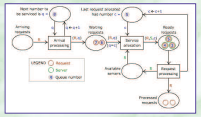
☑ Verbose ☑ Scale

☑ Clear List ☐ EOH/OH ☑ Historical Data Source C:\zz\zz2004\tesi\fuse

FERRERA E.	ENIPOWER 1	**0.66**	0.66	1.00	0.76	1.00	0.76	1.00	0.76	1.00	0.80
FERRERA E.	ENIPOWER 2	**0.68**	0.68	1.00	0.80	1.00	0.80	1.00	0.80	1.00	1.00
RAVENNA	ENIPOWER 1	**0.68**	0.68	1.00	0.80	1.00	0.80	1.00	0.80	1.00	0.80
FERRERA E.	ENIPOWER 4	**0.69**	0.69	1.00	0.80	1.00	0.80	1.00	0.80	1.00	1.00
RAVENNA	ENIPOWER 3	**0.69**	0.69	1.00	0.80	1.00	0.80	1.00	0.80	1.00	0.80
FERRERA E.	ENIPOWER 1	**0.71**	0.71	1.00	0.80	1.00	0.80	1.00	0.80	1.00	0.80

Critical Issues in Validation

- **Validation of the Models and Data**
  - *Validation of the Implementation*
  - *Testing the Simulation*
  - *Testing to the Design*
  - *Testing to the Work Statement*
  - *Validating the Simulation*
- **Examples of Issues with Validation**
  - *Correct Validation Criteria*
  - *Invalidated Simulations*



Validation Issues

Incorrect Validation Criteria. Simulators of military aircraft require much more comprehensive testing to determine if the simulator does in fact represent the performance and flying qualities of the simulated aircraft. Obtaining aircraft test data that are required for the validation testing is difficult. The application of FAA commercial aircraft standards will not cover the operating envelope of the military aircraft.

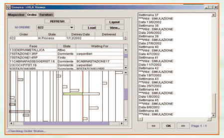
Invalidated Simulations Sometime process re-engineering is performed based on qualitative analysis or untested simulations. The development of a new large automatic warehouse was assigned to a major automation company. The designer decided to use simulation to support their analysis. They developed a model that did not consider forklift interference based on the a-priori hypothesis that this phenomena didn't have any influence. After the implementation no validation test was performed. The new warehouse design resulted in a 40% loss in productivity. The resulting claim was analyzed by third party experts using a new simulator that accounted for the mutual interference in the aisles. The results identified errors in the original automation policies the increased interference and generated deadlocks. The simulator supported the automation company's correction identification of the problem.

Problem Formulation

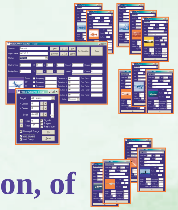
- "The goal is to model system X"
- Proper formulation of problem
- Questions to ask clients or managers
  - what decisions involving economic risk are to be made?
  - what information is needed?
  - questions should have numeric answers
- We should know when we have finished

Set Objectives and Project Plan

- Specify alternative systems or variations of the system to be considered (avoid studying "forbidden territory")
- Confirm that simulation is the proper method
- Know what resources of people, resources, money, and time will be available
- Specify project milestones with dates



Model Conceptualization



- Is the "art" portion, not the "science" portion, of simulation work
- Abstract the essential features of a problem
- Understand basic tacit assumptions concerning the system (they shouldn't remain tacit)
- Start simple; add detail if and when needed
- Involve the client (model user)

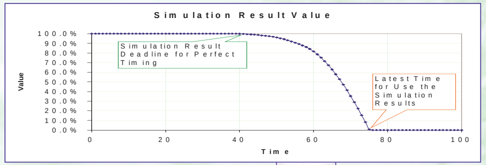
Avoid!

Management decision date to be based on Simulation Results

Project start date

Model built, ready for verification date

Time



Data Collection

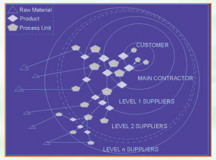
- No data at all
- Hidden data (“It’s mine!”)
- Wrong type of data (for example, delivery data needed, sales data available)
- Unfiltered data (severe example – “machine blocked” recorded as “machine down”)
- Data overanalyzed relative to its precision
- Use analogy, estimation, and sensitivity analysis
- Enlist support of higher management
- Derive needed data from available data
- Train and supervise data observers
- Use basic approximations (for example, a triangular distribution instead of a Weibull)

Model Building

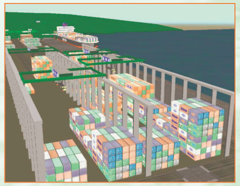
- Choose the correct tool, or combination of tools
- Use the tool(s) correctly
- Simulation languages (more powerful, more flexible, more time-consuming, animation more difficult) versus special-purpose software
- The best practical choice may be a blend of both

Model Verification

- Fundamental question: Is the model built correctly?
- Use others’ eyes and ears (walkthroughs)
- Follow model logic for each event type
- Examine output for reasonableness (for example, does the clock ever go backward?)
- Examine the animation
- Examine traces, and “current” & “total” counts



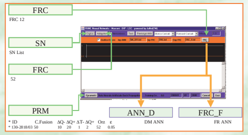
Model Validation



- Credibility, as well as validity, necessary
- Involve the user!
- Achieve face validity
- Use sensitivity analysis
- Validate model assumptions
- Replicate the past using “set-aside” data
- Undertake Turing tests

Execution and Experimental Design

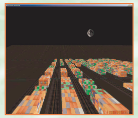
- Determine the alternatives to be simulated
  - Include only those which are organizationally and administratively feasible or permissible
- Decide length of initialization period (0 if terminating system), length of simulation runs, and number of replications per run (be generous)
- Choose a DOE (except for only 2 alternatives, avoid paired *t*-tests – prefer factorial, fractional factorial, nested, or (Greco)-Latin designs)



Documentation and Reporting

- This task should now be a consolidation process, not a major writing project!
- Place as much documentation as possible *inside* the model
- Document all assumptions made
- Document failed alternatives, lest your successors investigate them over again
- Ask the archetype scientist’s question: “Can others later reconstruct our thoughts and work?”

Decision Implementation



- If the model has achieved validity and credibility, the client will now willingly implement its recommendations
- Modeler: “stand by” for follow-up questions and experimental investigations
- All worthy scientists and engineers know that successful inquiry begets additional questions (consider the legacies of Galileo Galilei in dynamics, mechanics, and astronomy)

Genoa, Italian Riviera October

Calgary July

See you Soon in SCSC2006, MAS2006, ESS2006, HMS 2006, I3M2006 AMS2006

Barcelona, Spain October

Buzios, Brazil March

References

Development of Innovative Projects Consortium

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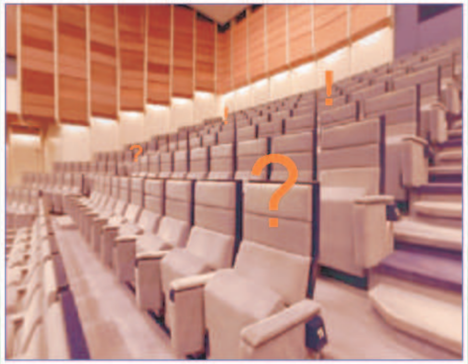
Time to Play Questions



Summary

Present Critical Issues, which can impact of Simulation:

- **Simulations have wide application in government, business and industry.**
- **Examples indicate what can occur if one or more of the critical issues avoid identification until the end of the project.**
- **The critical issues are interrelated and their interdependency should be recognized. The human element associated with communication and interpretation also plays an important roll.**
- **Simulations are very successful in performing a variety of functions if the proper design and validation procedures are followed. Their applications save lives and improve the efficiency and cost effectiveness of a wide variety of governmental, industrial and commercial systems**