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# Agile software development: a modeling & simulation showcase in military logistics


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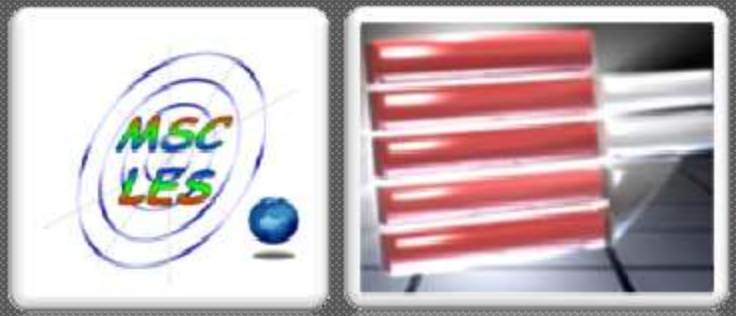


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# Outline

- Objectives and Goals
- Prognostic Military Logistics
- Why Modeling & Simulation?
- Why Agile Software Development in M&S?
- The Logistics Analysis Simulation Model (LASM)
- Modeling & Simulation and Agile Methods principles while developing LASM
- Conclusions & References

# Objectives and Goals

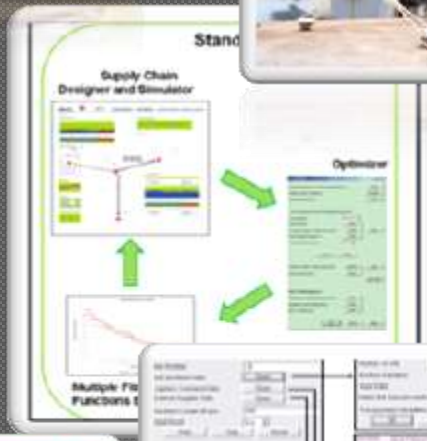
Modeling & Simulation (M&S)

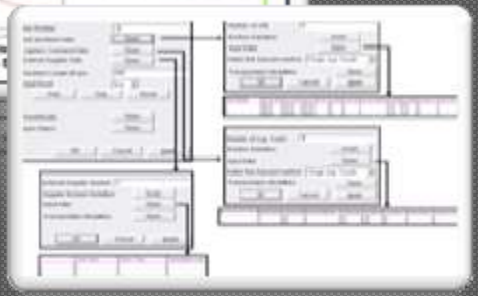
Agile Software Development (ASD)

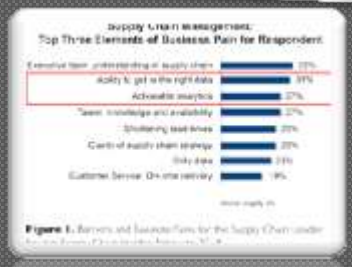
**LASM**

M&S and ASD Common Ground

Design of Prognostic Military Logistics



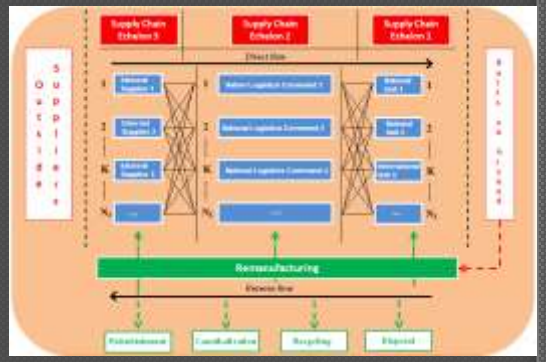



# Military Logistics

Military Logistics deals with the problem of providing the right services and supplies in the right place and at the right time

Since the very early design stages, military logistic systems are meant to support the needs of armed forces in critical contexts

Agility and modularity have to coexist with sustainability above all because the number of available assets is going to reduce, delivery routes are longer and located in hostile territory




New methods are required to support multiple supply chain configuration analysis, acquisition of new resources, evacuation operations, transportation tailored to contingent situation, dedicated maintenance management and forecasts of spare parts

# Prognostic Military Logistics – the case of Maintenance Management

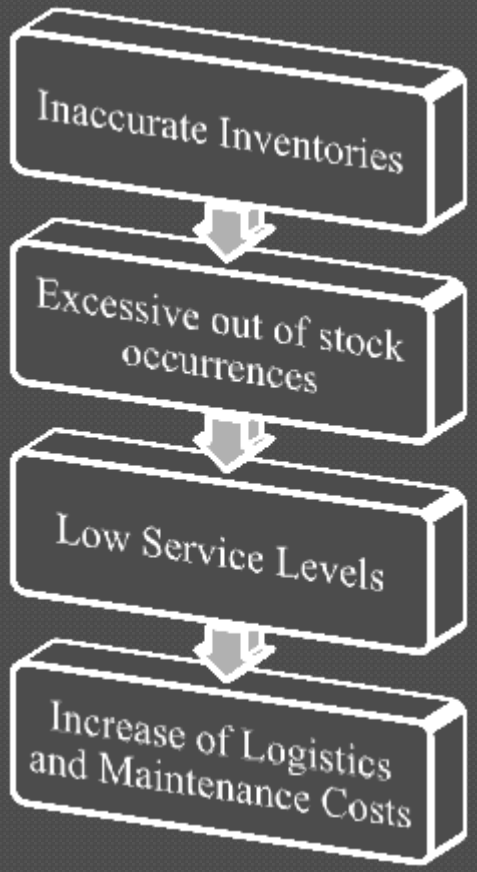
Prognostic Logistics makes use of embedded solutions to gather data from available assets real-time and continuously in order to use such data to predict the future state of the assets.

Current military supply chains are reactive supply chains or based on statistic forecasts where data are often incomplete or inaccurate

Indeed developers of Military assets (e.g. Weapon systems) have developed over a long time more sophisticated test and system specific diagnostic equipment that are no linked to the Military logistic information systems

More complex training for maintenance personnel, increase of training time and costs

Vice-versa the use of embedded diagnostic technology in the commercial sector is increasing rapidly (e.g. in the Automotive Sector, in Civil Aviation, etc.)



# Prognostic Military Logistics - Main issues

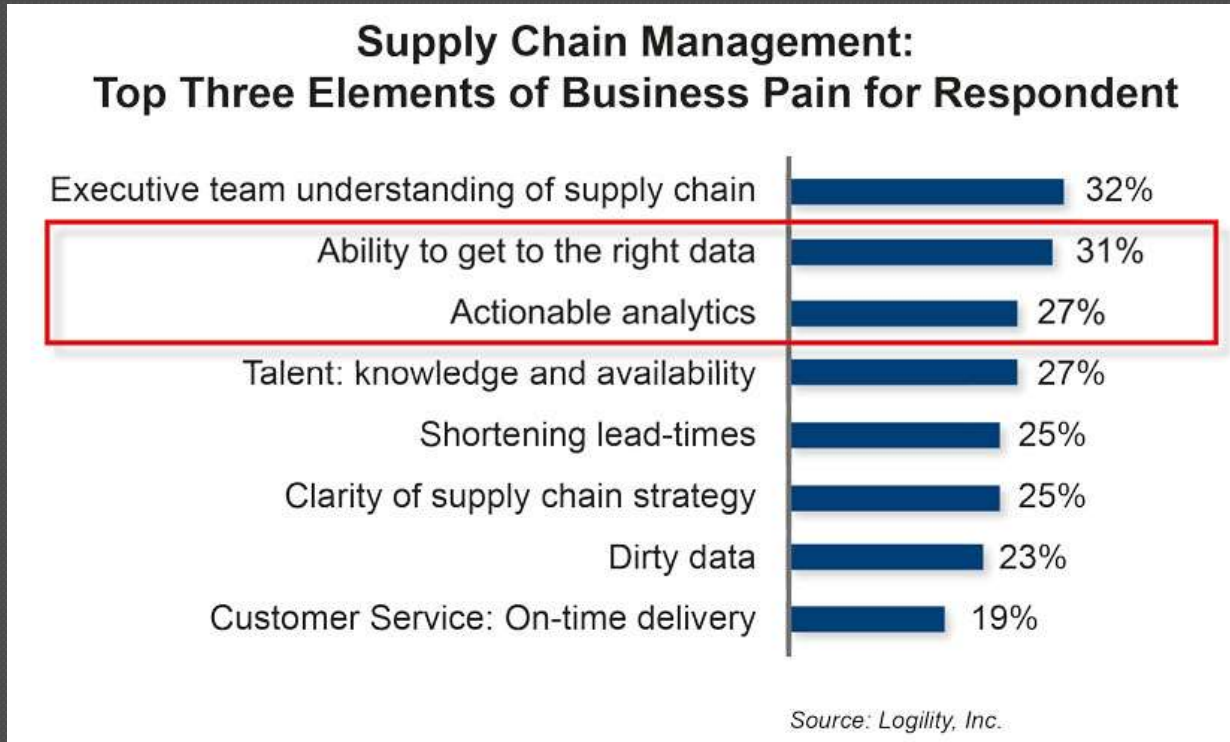



**Figure 1.** Barriers and Business Pains for the Supply Chain Leader
Source: Supply Chain Insights February 2014

# Prognostic Military Logistics – a Proactive Supply Chain

Real Assets

Prediction of Maintenance and Logistic Needs

Right Time and Place for Services and Supplies

Embedded Diagnostic

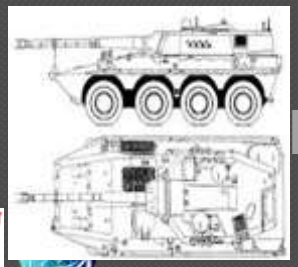
Commander Information and Logistics System

Anticipate Failure and Repairs

Distributed Communication systems

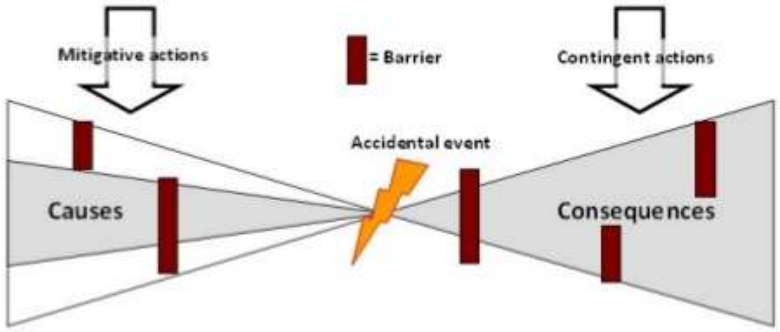
Dedicated Information Systems

Pro-Active Logistics



# Military Logistics
# ProActive Vs Reactive

## Proactive versus Reactive




Mitigative actions address risk sources.
Contingent actions address risk consequences.


Asbjørnslett, B E and Rausand, M (1997) ***Assess the vulnerability of your production system***. Report NTNU 97018. Norwegian University of Science and Technology NTNU, Department of Production and Quality Engineering, Trondheim, Norway.

Tomlin, B. (2006) ***On the Value of Mitigation and Contingency Strategies for Managing Supply Chain Disruption Risks***. Management Science, Vol. 52, No. 5, pp. 639-657

Ritchie, B. and Brindley, C. (2004) ***Risk Characteristics of the Supply Chain – A Contingency Framework***. In: Supply Chain Risk. Ed. Brindley, C. , Ashgate Publishing, pp. 28-42,197-202


# Prognostic Military Logistics and Integrated Logistics Support (ILS)

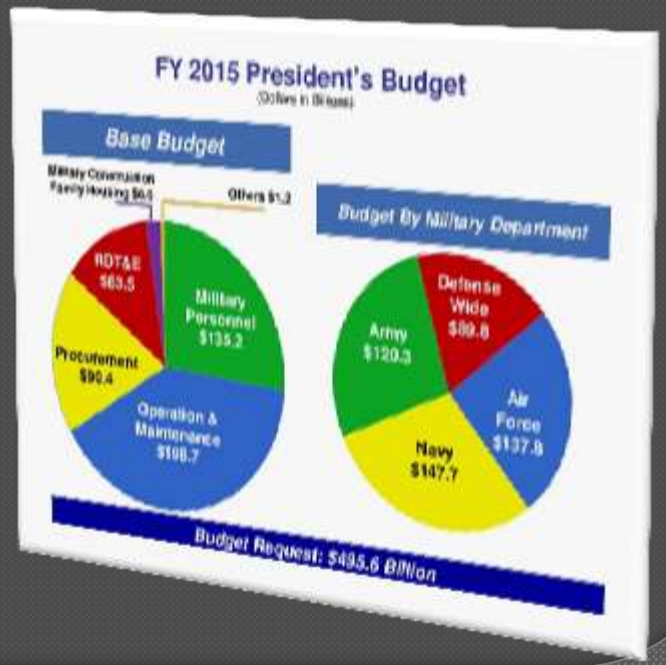
The Prognostic Military Logistics idea fully support the Integrated Logistics Support (ILS) concept where the main goal is to increase the life cycle of military assets requiring less support and reducing costs as consequence.

An Example of Operations and Maintenance Costs from the U.S. DoD Budget for 2015

*The Main Interest for Prognostic Military Logistics and ILS is the potential for costs reduction*

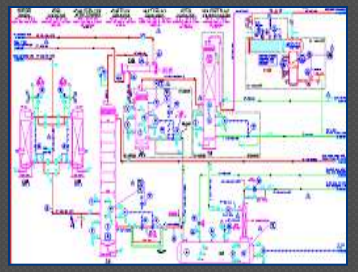
| *$ in Thousands* **Base Budget** | FY 2014 Enacted | FY 2015 Request | Delta FY14 - FY15 |
|---|---|---|---|
| Military Personnel | 135,024,091 | 135,158,605 | 134,514 |
| Operation and Maintenance | 192,822,692 | 198,726,096 | 5,903,404 |
| Procurement | 92,439,558 | 90,358,540 | -2,081,018 |
| RDT&E | 62,805,956 | 63,533,947 | 727,991 |
| Revolving and Management Funds | 2,222,427 | 1,234,468 | -987,959 |
| **Defense Bill** | **486,215,434** | **489,046,736** | **2,831,302** |
| Military Construction | 8,392,244 | 5,366,912 | -3,025,332 |
| Family Housing | 1,415,764 | 1,190,535 | -225,229 |
| **Military Construction Bill** | **9,808,008** | **6,557,447** | **-3,250,561** |
| **Total** | **496,023,442** | **495,604,183** | **-419,259** |

SOURCE: UNITED STATES DEPARTMENT OF DEFENSE FISCAL YEAR 2015 BUDGET REQUEST - OVERVIEW



# Design Prognostic Military Logistics by Modeling & Simulation and Agile Software Development

## Why Modeling & Simulation?



Internal Complexity → Complex Behaviors

↓

Not Linear Systems
Not valid Simplification Hypotheses
Boundary Conditions are Critical
No Generalization

**Simulation:**
*More Efforts*
*More Capabilities*
*Reusable Model*

←

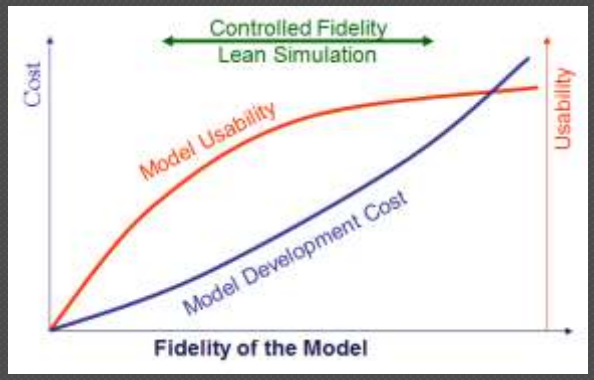
↑

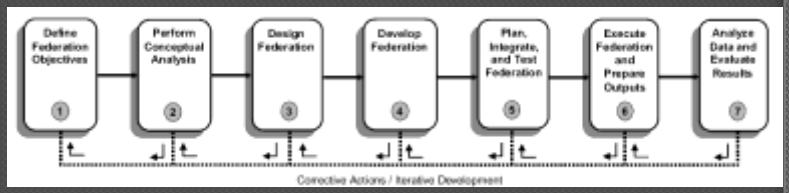
External Complexity → Many Interactions

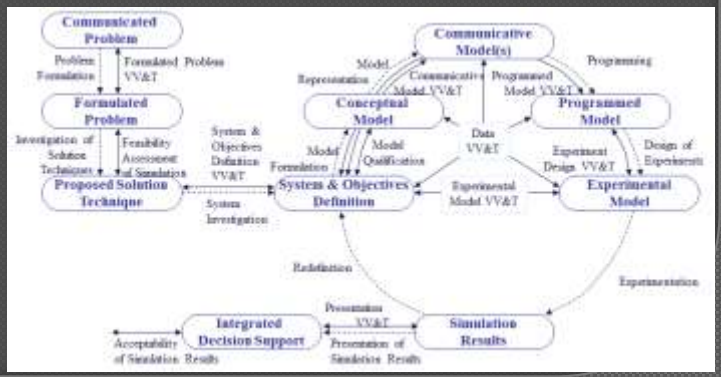
# Design Prognostic Military Logistics by Modeling & Simulation and Agile Software Development

## Why Modeling & Simulation?

- ✓ Choose correctly among different Logistics scenarios
- ✓ Compress and expand time
- ✓ Understand why
- ✓ Explore possibilities in terms of maintenance, replenishment and inventory policies
- ✓ Diagnose problems and criticalities
- ✓ Identify constraints (mobility, environmental conditions, etc.)
- ✓ Develop understanding
- ✓ Visualize the plan
- ✓ Build consensus around new procedures
- ✓ Prepare for change toward prognostic Logistics
- ✓ Invest wisely and reduce costs
- ✓ Train the team to new standards and procedures
- ✓ Specify requirements



# Design Prognostic Military Logistics by Modeling & Simulation and Agile Software Development

## Why Agile Software Development (ASD)?

### What M&S is used for?

- ✓ Software Blocks
- ✓ Needs for strong VV&A
- ✓ Used to recreate complex system behavior
- ✓ Start from Simple
- ✓ It is used to support real decision making and training
- ✓ Interoperability, Reusability and Composability
- ✓ Invest Wisely
- ✓ Specify Requirements
- ✓ Simulation Models work for you

SOURCE: Handbook of Simulation, J. Banks, 1998

### ASD Main Principles

- ✓ Satisfy the Customer
- ✓ Welcome changing Requirements
- ✓ Deliver working Software Frequently
- ✓ Business and developers work together
- ✓ Face to Face conversation
- ✓ Working software is the primary measure of progress
- ✓ Sustainable Development

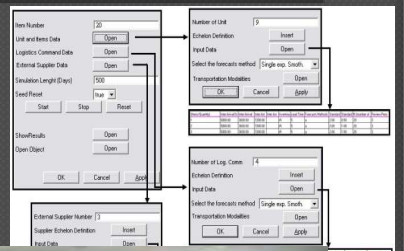
SOURC; ASD Manifesto

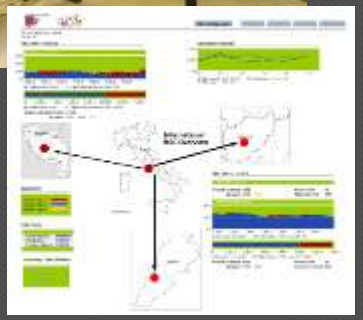
### M&S and ASD Common Ground

- ➢ Customers and SMEs involvement
- ➢ Add complexity if needed
- ➢ Ability to Remodel
- ➢ Communicate Openly
- ➢ Start off on the right foot
- ➢ Working on the right problem
- ➢ Manage Customer's expectations
- ➢ Question Customer Skillfully
- ➢ Take Calculated Risks

# LASM – Logistic Analysis Simulation Model

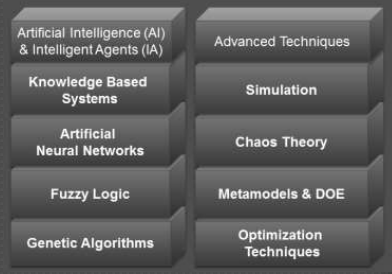
LASM simulation model has been developed according to M&S and ASD principles as a decision support tool for the design of proactive military logistics





For usability purposes LASM is equipped with user-friendly interfaces that provide an easy access to simulation set-up, execution and post-processing. Therefore front-end interfaces are meant to ensure LASM fully deployment even among non-specialists users that can avail of such interfaces to:

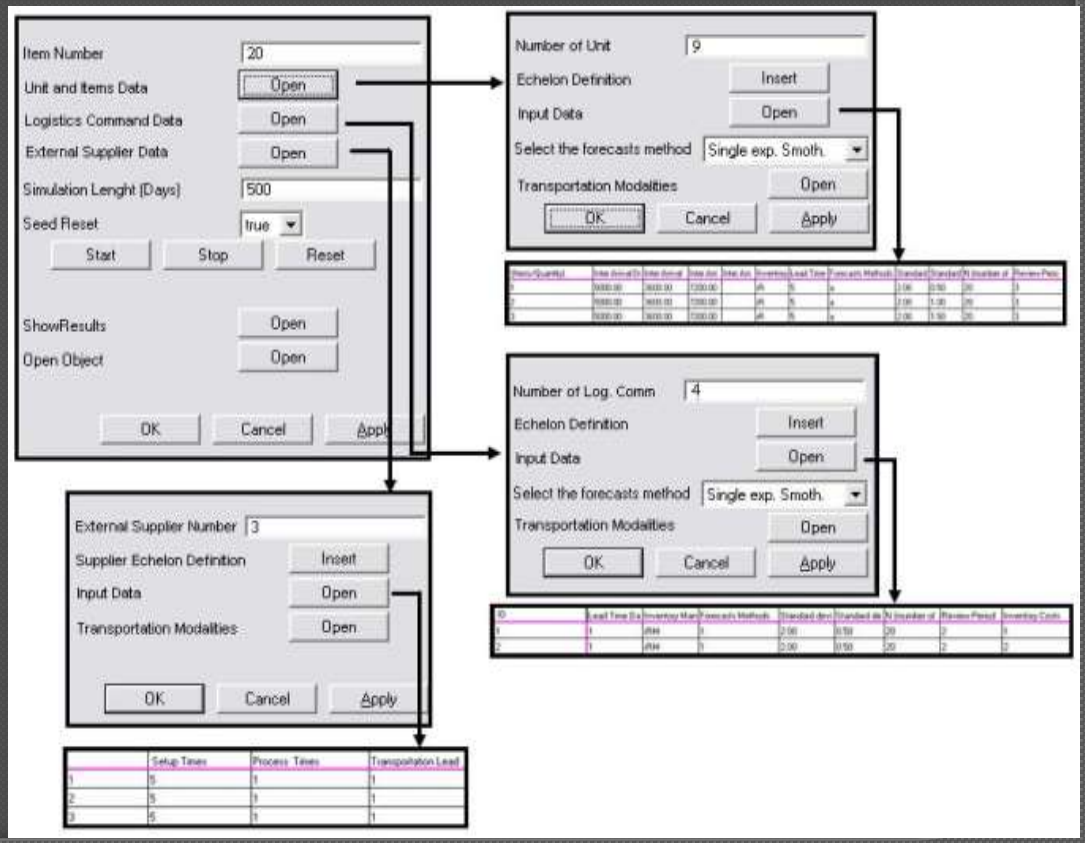
- configure the supply chain and logistic scenario;
- run the simulation;
- observe, analyze and export simulation results



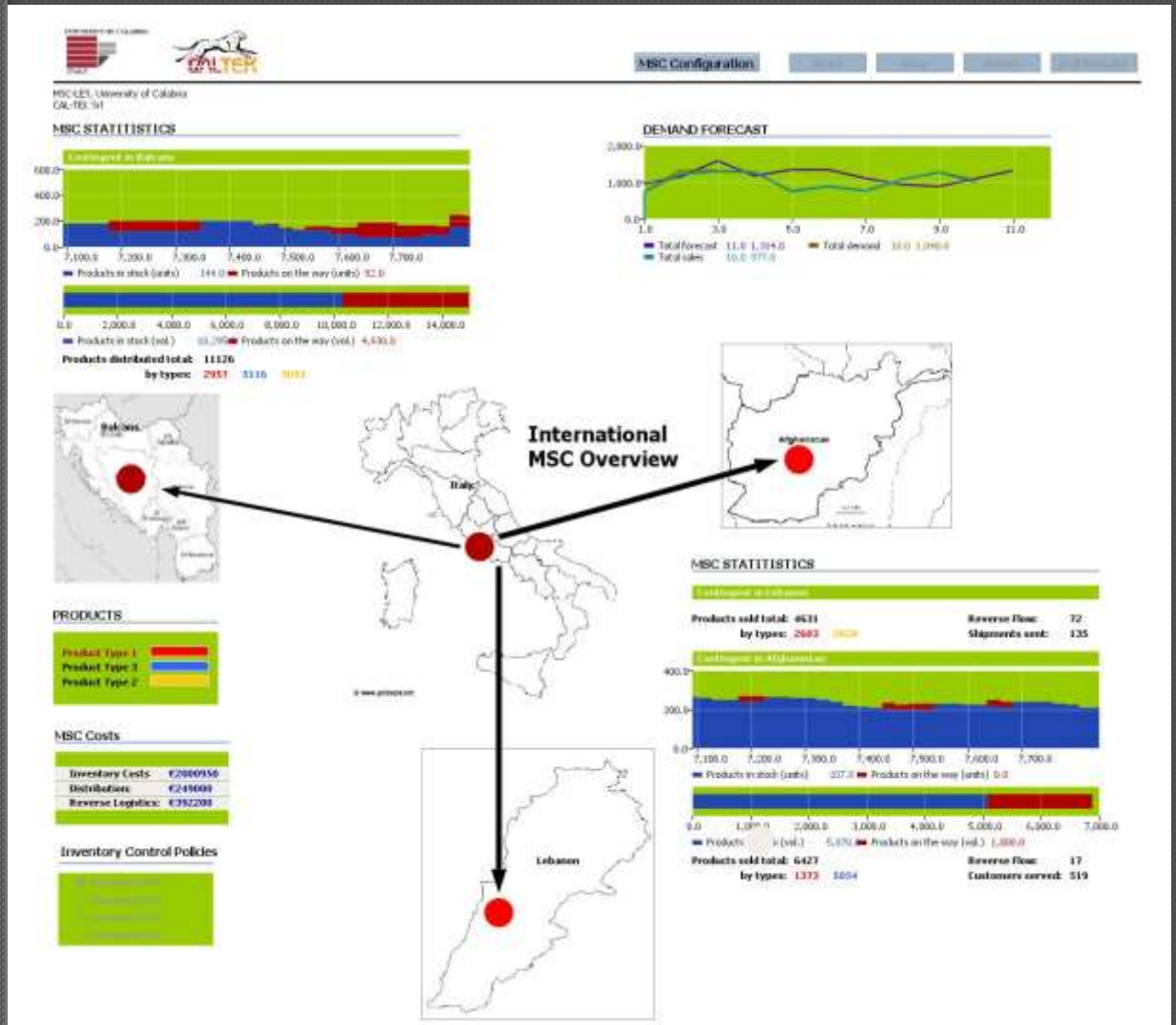
# LASM – Logistic Analysis Simulation Model
# Graphic User Interface

LASM simulation model has been developed according to M&S and ASD principles as a decision support tool for the design of proactive military logistics

- ✓ Scenario parameters setting: number and type of resources, number of supply chain echelons, number of nodes and position, maintenance policies, inventory management policies, demand forecasting methodologies, transportation strategies etc..).
- ✓ Simulation parameters setting: start, restart, shutdown and running



# LASM – Logistic Analysis Simulation Model MainFrame



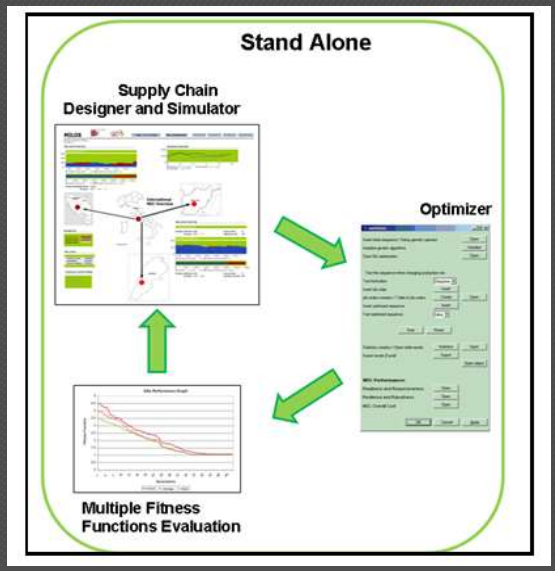

The Simulation model is able to recreate the real-time flow of data that are expected in a prognostic supply chain

Possibility to monitor multiple performance measures:

- Overall costs
- Service levels
- Inventory levels
- Supply Chain readiness
- Supply Chain resilience

# LASM – Logistic Analysis Simulation Model Optimizer

- ✓ An optimization tools that has been integrated into the LASM simulation framework
- ✓ The optimization module implements several algorithms (e.g. Ants Colony Optimization, Genetic Algorithms, Tabu search, etc)
- ✓ Possibility to optimize multiple performance measures (e.g. late deliveries, systems breakdowns, orders cancellations, increased inventories, additional capacities or unnecessary slack time).
- ✓ The simulation environment can be used as a test bed for evaluating how optimized solutions impact over the whole Military Logistics, minimize unexpected consequences or externalities that could prevent military operations from being successful




# LASM – Logistic Analysis Simulation Model Additional Capabilities

Additional capabilities include the possibility to include as part of LASM, various repair patterns, to name a few:

- ✓ RMA (Reliability and Maintainability Analysis)
- ✓ Analysis of the system operational requirements
- ✓ Analysis of training requirements and instructional staff
- ✓ RCM (Reliability Centered Maintenance)
- ✓ LCCA (Life Cycle Cost Analysis)
- ✓ MTA (Maintenance Task Analysis)
- ✓ FMECA / FMEA ( Failure Mode and Effect Analysis, i.e. the evaluation of the possible failure modes)
- ✓ SO (Spare Optimization, analysis of parts and sizing of stocks)
- ✓ LORA (Level of Repair Analysis)
- ✓ Operator Task Analysis
- ✓ Infrastructure and tools analysis
- ✓ RAMS (Analysis of Reliability, Availability, Maintainability and Safety)

# Agile Software Development for LASM Development (1)

- ✓ The LASM development process has highly benefited from a multidisciplinary and cohesive team where much attention has been paid on cross-domain interactions, knowledge exchange and effective communications
- ✓ ASD has driven toward an iterative and adaptive development process during conceptual model definition, conceptual model translation and VV&A fully supporting principles such as welcome changing requirements and deliver working software frequently
- ✓ A Milestones approach for LASM development was an opportunity for frequent and recurring testing that became a natural part of the simulation project lifecycle
- ✓ Extreme Programming (XP) has been applied getting good results in terms of software reliability, shorter testing and debugging times

# Agile Software Development for LASM Development (2)

- ✓ The simulation model implementation has highly benefited from pair programming, unit testing and refactoring that are XP key components
- ✓ Unit testing and refactoring have fed into simulation verification processes making the simulation model extremely robust and error-free
- ✓ Further benefits, achieved thanks to ASD include improving on the capability of making changes and modifications and of integrating effectively all the software components that build the simulation model up
- ✓ ADS and XP has gained the development team approval owing to the positive effect over some software properties such as reusability and extendibility
- ✓ The whole team has recognized an improved capability of meeting the above requirements

# Conclusions

- ✓ Military Logistics is a complex area where many changes are on going with the aim of transforming the current reactive supply chain in a proactive and prognostic supply chain
- ✓ Modeling & Simulation is recognized as a very efficient tool in order to support the military logistics design and management
- ✓ A simulation model consists of a set of software components well integrated each other, therefore there is much in terms of Common Ground between M&S and ASD
- ✓ The LASM simulation model has been presented together with its main functionalities
- ✓ The Development of the LASM simulation model clearly shows the Common Ground between M&S and ASD and how Agile Methods and principles positively impact the simulation model development process

# References

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