Model Based Requirements Engineering (MBRE)
Webinar rules:

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- The Webinar will be recorded. A link to the recording will be sent to you in few days
Presenter’s profile

- CTO at The REUSE Company
- SE Professor at Universidad Carlos III de Madrid (Spain)
- President Elect of AEIS (INCOSE Spain)

- Member of AEIS Board
- INCOSE Ontology Working Group Chair
- Member of INCOSE Requirements Engineering WG
- Contributor to INCOSE Guide for Writing Requirements
- Certified Systems Engineering Professional (CSEP)

Dr. Juan Llorens
Juan.Llorens@reusecompany.com
Juan.Llorens@uc3m.es
Webinars 2017

- Description of The Reuse Company
- Whishes Upon a Star
- MBSE Introduction
- Model Based Requirements Engineering
- Demos and Conclusion
WEBINARS 2017

The REUSE Company in the World

Headquarters
Office
Partner
Associate Partner
We want to speak your language

https://mapchart.net/world.html
### Selected set of Customers

#### Aerospace and Defense

- AIRBUS
- AIRBUS HELICOPTERS
- EADS
- MBDA Missile Systems
- Thales
- Safran
- Safran Sagem

#### Automotive

- RENAUlT

#### Energy

- Fusion for Energy
- Iter

#### Consulting

- Indra
- Sherpa Engineering

#### Banking

- BCR
- Santander

#### Health care

- Think Surgical
- Health Net

#### Other industries

- Sage
- Siemens
- Tiran Editorial
SQA - System Quality Analyzer
  Global Quality Management

RAT - Rich Authoring Tool
  Smart text authoring

SKM - System Knowledge Manager
  Management of System Knowledge Libraries

SIM - System Interoperability Manager
  Tailorable Interoperability Platform
  - R+ Manager
    Managing requirements transformations
    Managing models transformations
  - T+ Manager
    Managing traceability
  - Reasoning Manager
    Task based environment
Whishes upon a Star

Possible Use Cases involving Requirements and MBSE
Performing Requirements Engineering BUT as part of MBSE processes

- You need to develop requirements but you know they are affected by existing models
- You know that requirements evolution and management will also affect the models
- We’d like to perform modern Requirements engineering within Models development
- But we’d also like to see requirements as humans like to see them (grouped within a story thread)
- Could I dream with automatically tracing the models (and their elements) with the requirements when they are really dependent on each other?
Would you like to “execute” a requirement by running a FMU, from inside a RMS or a Modelling tool?

- Using information from the requirement + Models
- Checking validity of the requirement or the model running an simulation of a Physical model
- Getting VALID / NOT VALID information on the fly
- Updating information of the requirement or model, gathered from the Simulation Execution
A requirements specification produces and maintains Models during its development

- You have struggled to produce a good requirements specification.
  - Why shouldn’t you automatically produce Models out of them?
  - Perhaps physical Models in Modelica?
- Could I do it the other way around?
  - Generate Requirements from my very mature models

- Could I dream with automatically tracing the models (and their elements) with the originating requirements on the fly?
- Could I dream with managing changes in both sides?
Automatic generation of Test Cases from requirements texts

- You have struggled to produce a good requirements specification.
- Why shouldn’t you automatically produce Test Cases?
  - Perhaps scripts that can run on Simulink?
  - Or Test sequences in English?
- Should it be interesting to automatically translate the test cases to Spanish?
  - Without loosing a single semantic aspect
  - To allow us the development and implement of the tests directly in Spain
- Why shouldn’t we also generate lower level requirements from the initial requirements set?
- Could I dream in automatically tracing these operations within a traceability system?
Model Based Systems Engineering

In a nutshell
“The formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases.”

INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02 September, 2007)

- Models as part of the flow information among activities and processes
- Eases traceability possibilities
- Enable computers to operate (transformations, simulations, V&V aids)
Stand-alone models related through documents. Documents are part of configuration management systems.

INCOSE MBSE Workshop, Jan 2014
MBSE: Shared system model with multiple views and connected to discipline models. Reusable model-based engineering with virtual product development and simulation capability.
We don’t want to forget Requirements

1. Gather Requirements (Elicitation)
2. Analyze Requirements
3. Manage Attributes
4. Persist Requirements
5. Produce the Final Requirements Specification Document
6. Verify and Validate Requirements
7. Allow Versioning and Baselines
8. Provide and Create Traceability Links
9. System Certification
10. System Verification & Validation
11. System Traceability
12. Public Authorities

System Analysis (Simulation)
Model Based Requirements Engineering

Kernel concepts
Multiple domains

Different types of artifacts

Need of intra-operability

Intra-domain

Need of interoperability

Inter-domain

Mats Berglund (Ericsson) http://www.ices.kth.se/upload/events/13/84404189f85d41a6a7d1caf0db4ee80.pdf
UNIVERSAL ACCESS to everything
A complete KNOWLEDGE SHARING approach

A Knowledge base is formed by whatever Knowledge

Figure 1. Vehicle model structure.
Common representation for everything

Power Control System
Demand battery low level
Battery

Power Control System
Charge System loading
Battery

Power Control System
Battery
Low battery load level

Resistor
OpAmp
Condensator

X X
Y Y
Z Z
Knowledge Centric Systems Engineering (KCSE)
Model Based Requirements Engineering

Formalizing natural language Requirements (and Models)
Necessary IT solutions that attempt to represent and formalize Requirements as Conceptual Graphs

Using Ontologies and Requirements Patterns

UR044: The A380 shall operate at a minimum temperature of -70 ° Centigrade
**Applications**

The aircraft shall operate at a minimum temperature of -70°C.

**Terminology**

- **A380**
- **A350**
- **System**
- **Operate**
- **Temperature**
- **Environment**
- **Pressure**
- **Shall**
- **a minimum**
- **Of**
- **At**
- **Work**
- °C

**Thesaurus**

- **<<Minimum>>**
- **<<Operation>>**
- **<<Aircraft>>**
- **Environment**
  - a minimum
  - Operate
  - Work
  - A380
  - A350
  - Temperature
  - Pressure

**Patterns/Models**

- **<<Aircraft>>**
- **Shall**
- **<<Operation>>**
- **At**
- **<<Minimum>>**
  - Environment
  - Of
  - NUMBER
  - [MEASUREMENT UNIT]

**Generation Rules**

- **<<Aircraft>>**
- **Shall**
- **<<Operation>>**
- **At**
- **<<Minimum>>**
  - Environment
  - Of
  - NUMBER
  - [MEASUREMENT UNIT]

**Inference Rules**

- If **NUMBER**
  - **" Greater than (>) "**
  - +60°C
  - **" Lower than (<) "**
  - -60°C
- **" Greater than (>) "**
  - +60°C
  - **" Lower than (<) "**
  - -60°C

- **Applications**

The aircraft shall operate at a minimum temperature of -70°C.

- **Temperature**
  - **-70°C**
  - **" Greater than (>) "**
  - **°C**
Formalization of system Models

Power Control System

<<Message Sending>>
Demand battery low level

Battery

Charge System

<<Message Sending>>
Charge System loading

Power Control System

<<Message Sending>>
Low Battery load level

Battery
Model Based Requirements Engineering

Text Generation
Textual Generation uses mapping between patterns, which identify the original work-product and the automatically generated work-product.

Using patterns we make sure that the exit work-product is formed as we wish.

Original Work-product

Pattern 1

Pattern 2

Pattern 3

Pattern 4

Pattern N

When the fan is on, the green led shall turn on

Turn the fan on. Assure that the green led is on.

The green led of the fan shall be an SMD led.

Când ventilatorul este pornit, LED-ul verde trebuie să se aprindă.

Test case 1

Work-product 2

Translated work-product

Work-product N
Bring requirements to MBSE

- Stakeholder View Development
  - Requs 2 Requs
  - Translate Requs Anonymize Requs Etc.

- System Development
  - Requs 2 Models
  - Models 2 Requs

- Sub-System Development
  - Simulate Requs

- Component Development
  - Requs 2 Test Cases // Test Cases 2 Requs

- System Integration

- Component Integration

IMPLEMENTATION
Use Case Demos
Performing Requirements Engineering BUT as part of MBSE processes

Demo Scenario

- CREATING / EDITING REQUIREMENTS INSIDE RHAPSODY
- EDITING REQUIREMENTS USING FORMAL PATTERNS
- MANAGING REQUIREMENTS AS A RMS
- GENERATING MODELS FROM REQUIREMENTS IN DOORS
Would you like to “execute” a requirement by running a FMU, from inside a RMS or a Modelling tool?

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Use Case 4 – Requirements 2 Test Cases

Automatic generation of Test Cases from requirements texts

Demo Scenario
Automatic generation of Test Cases from requirements texts

- Demo Scenario
You have struggled to produce a good requirements specification.

Why shouldn’t you automatically produce Test Cases?
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Why shouldn’t we also generate lower level requirements from the initial requirements set?

Could I dream in automatically tracing these operations within a traceability system?
Automatic traceability discovery between requirements and Models

- A team in your organization has developed a good requirements specification.
- Other team in your organization has developed a good Models design.
- But no traceability work was defined neither performed.

- Would you like a system to offer suggested traceability between Requirements and Models?
- Every 4 seconds, the power control system shall send a "demand battery load level" message to the battery.
- When the voltage level is below 11.5 V, the battery shall send a "low battery load level" message to the power control system.
- If the battery is low, the power control system shall send a "show low energy level alarm" signal to the information display system.
- The user must plug in the bicycle to the electrical power.
- When the bicycle is charging, the power control system shall send a "Load battery" signal to the charge system.
- When the battery is loaded, the charge system shall send a "stop charge system Loading" message to the power control system.

- Total number of Matches = 5
- Number of Requirements with no match in the model = 1
- Number of transitions in the model with no match in requirements = 6
Every 4 seconds, the power control system shall send a "demand battery load level" message to the battery. When the voltage level is below 11.5V, the battery shall send a "low battery load level" message to the power control system. If the battery is low, the power control system shall send a "show low energy level alarm" signal to the information display system. The user must plug in the bicycle to the electrical power. When the bicycle is charging, the power control system shall send a "load battery" signal to the charge system. When the battery is loaded, the charge system shall send a "stop charge system loading" message to the Power control system.

Traceability Between Requirements and Models
Requirements engineering can be improved by merging it with MBSE and vice versa.

Requirements Engineering can be assisted if requirements are automatically managed and formalized.

It becomes possible to generate SE activities and automatically trace work-products.

Model Based Requirements Engineering is the kernel for better requirements engineering.
Questions?