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inspiring mobility

System Engineering for manufacturing
A product line approach

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Agenda

1. Faurecia group & Frames division of Automotive seating
2. System Engineering for manufacturing
3. Product line approach
4. Changeability management
5. Conclusion

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Faurecia group

Business Unit : Faurecia Automotive Seating

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World's sixth largest automotive supplier

including €13.7 billion of product sales

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Faurecia Automotive Seating

#1 worldwide in mechanisms & seats structure
#3 worldwide in complete seats

€7,1 billion
Value-added sales 2017

44,800
employees

74
production sites

19
R&D and D&D centers

23
countries

- Global standard frame platform leader
- Full range of high performance mechanisms
- Advanced mechatronic systems

- Full JIT services and seat component offer: covers, foams, accessories
- Personalized through Smart Comfort solutions
- Seat Electronics

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Frames division | References

VW/Audi MQB PF

Hyundai Genesis EQ

Renault CMF

BMW UKL PF

Ford FGEN2 PF

PSA HAB01 PF

PEUGEOT CITROËN OPEL HYUNDAI KIA Ford RENAULT NISSAN DACIA

CHRYSLER FIAT LANCIA Jeep ALFA ROMEO Ferrari GM CHEVROLET BUICK

Audi Nutzfahrzeuge BENTLEY SEAT ŠKODA PORSCHE BMW MINI

McLaren 车和家 Chehejia BORGWARD Great Wall

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Why System Engineeing for manufacturing?

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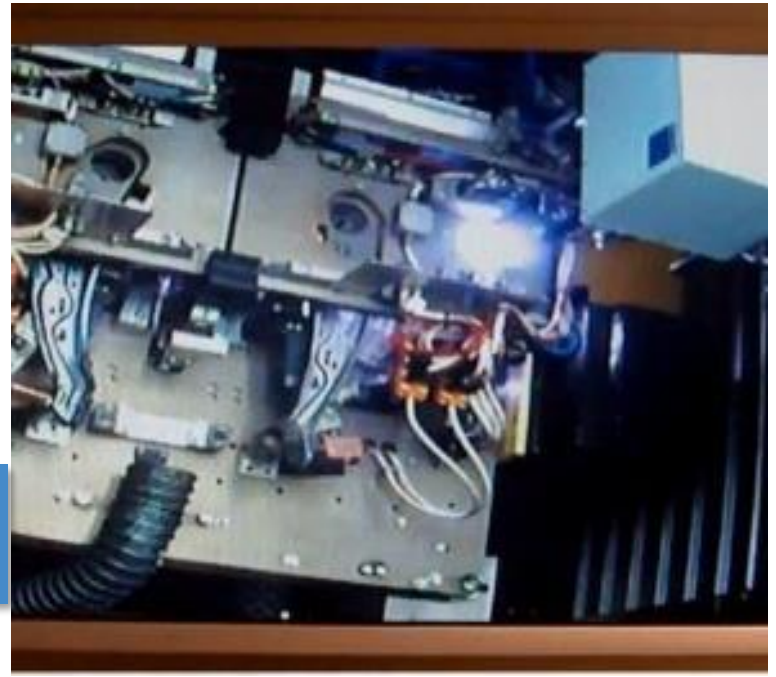
Exemples of equipements

Press cells with automatic loading and unloading



Laser welding cells

Manual assembly lines

Automatic Assembly lines

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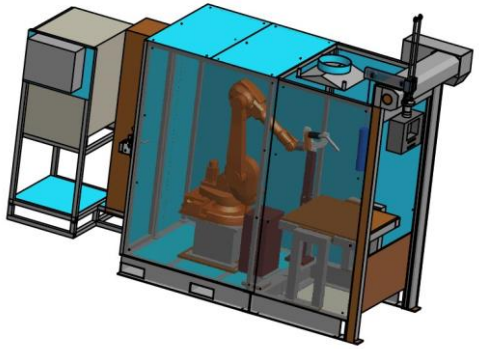
How to deal with the complexity of manufacturing systems

Definition of complexity

A complex system is composed of numerous entities with many interactions between each other, which makes impossible for an external observer to forecast the reaction and the future behavior.



A production cell

A complete production line

IT system in the plant

Challenges

Manage the complexity of engineering : Functional, Structural and Organizational:

- Requirements from many stakeholders
- Many engineers and experts
- Many scientific domains
- Limited budgets

How to deal with the complexity of manufacturing systems

Context:

- Machines are more complex : need to manage a high level of diversity and be more agile and adaptable
- The software part of machines is more and more important (PLCs, Robots, HMI, networks, analytics, etc.)
- With Digital transformation and Industry 4.0 the machines are considered as subsystems of the global system of the plant
- The classical methods present some weakness to deal with the high complexity

Response:

System Engineering approach and product line concept

Objectives :

- Improve engineering efficiency
- Better quality of systems: Integration, seamlessness, coherency, traceability
- Early validation
- Collaborative engineering
- Best practices & know-how capitalization
- Create a standard modules and subsystems

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System Engineering for Advanced Manufacturing

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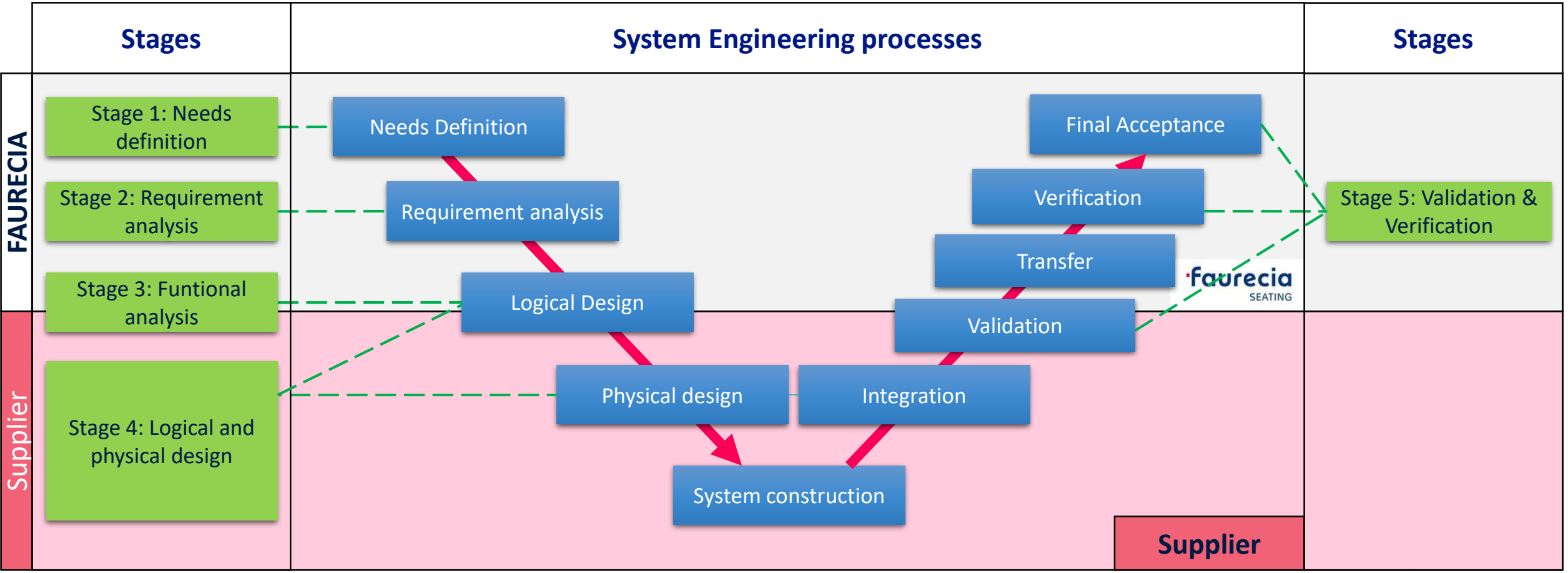
SE processes and collaboration between Faurecia and suppliers



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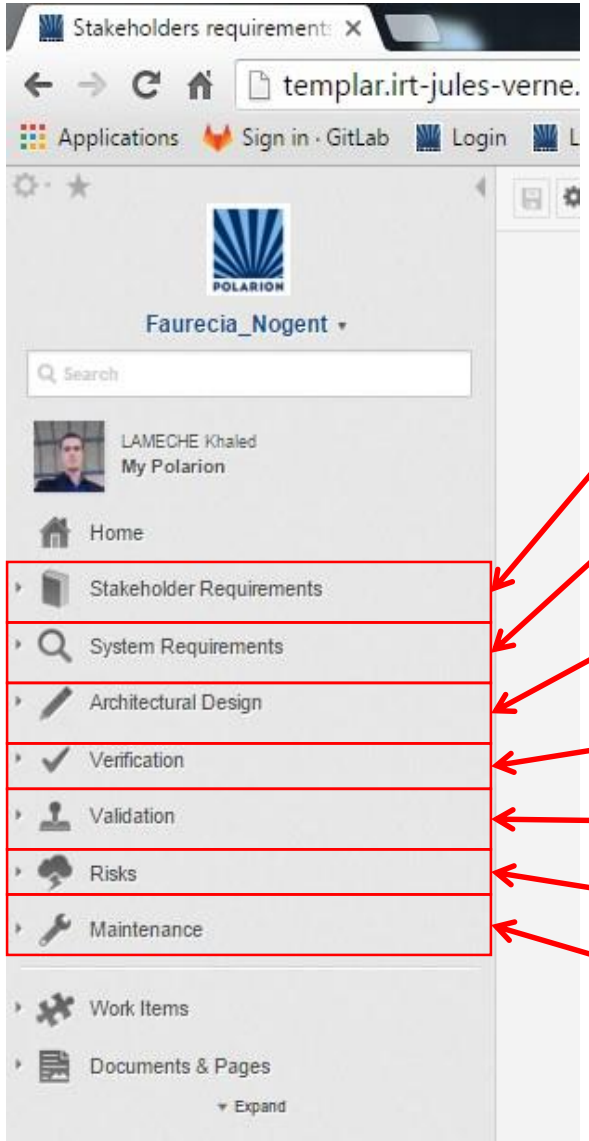
Engineering tools

- **MBSE (Model Based System Engineering) :**
  - Papyrus + Majic Draw
- **Requirements Management:**
  - ALM Polarion
- **Simulation and digital twins :**
  - Visual Components, Delmia, Process Simulate
  - Development of a library of standard components and templates of our machines and production lines
- **PLM :**
  - Build with Dassault System solutions

Implementation in the ALM

- *The ALM supports the engineering stages*
- *Creation of templates for typical development projects*



Needs definition of the stakeholders

Requirements analysis

Logical and Physical architecture and design

System Verification

System Validation

Risk analysis

Maintenance

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Product line approach
to respond to changeability requirements

Characterization of changeability

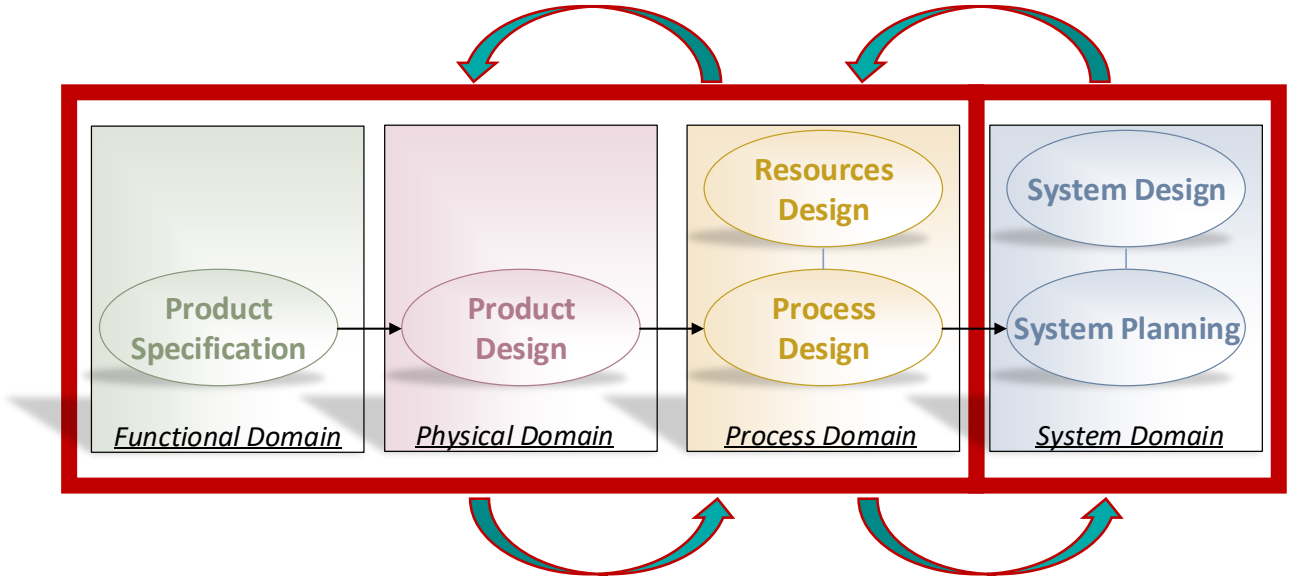
- **Capability of the system to adapt itself to changing circumstances (over time)**

- **Capability of the system to be installed in different contexts (different places)**

  - Two types of capabilities:
    - Flexibility : pre-planned capability to respond to a scope of needs with a relatively short change-over phase
    - Reconfigurability : structural capability to undergo to physical changes, in adding, removing, modifying modules. The system can go through successive reconfiguration phases

Context: Design domain activities

- Product specification
- Product design
- Process design with resource selection/design
- System design and system planning



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What kind of design to support for changeability ?

REVIEW OF SOME DESIGN STRATEGIES

- Product variety management strategies:

  product family, product platform, modularity and commonality in product architecture

- Design process for reuse:

  product line engineering

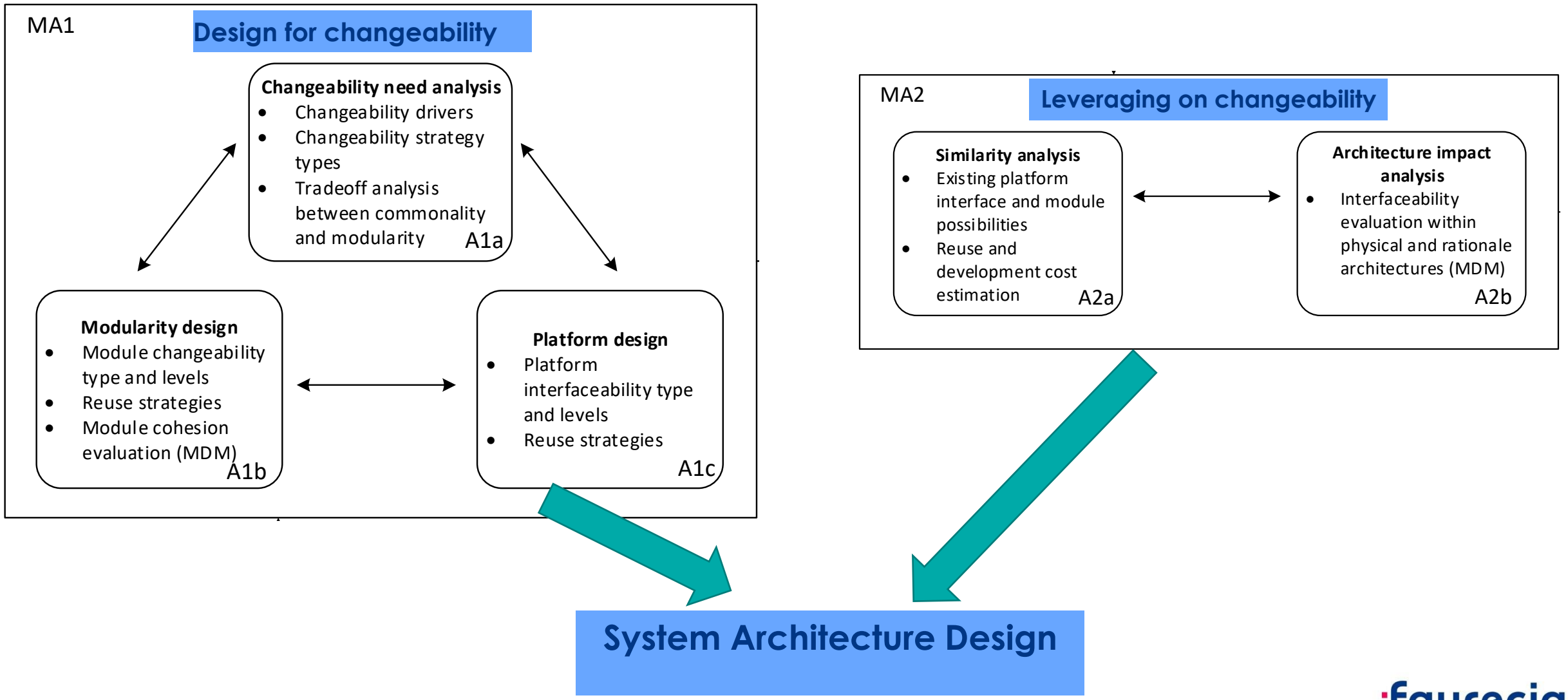
- Enablers for changeability :

  Modular, interfaceable, mobile subsystems, software configuration

CHALLENCE

How to actively support design for changeability during the whole system design process, beginning with conceptual design ?

Framework for changeability



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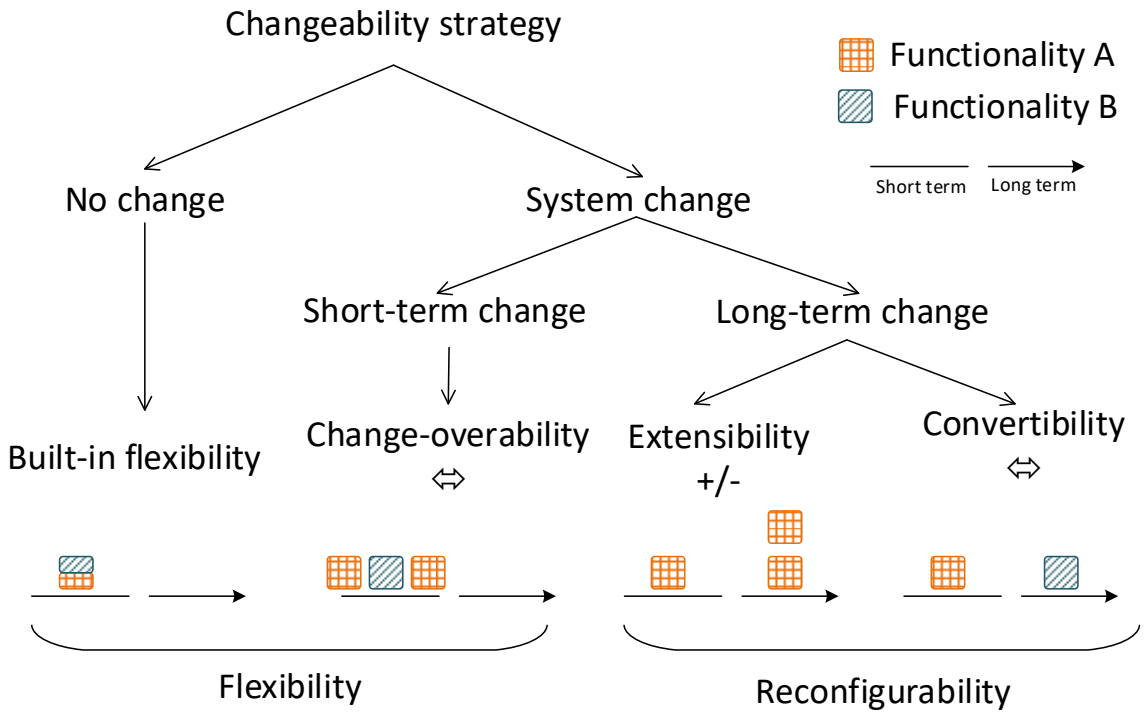
Design for changeability

1. Requirement stereotypes for changeability :

<Product family change stereotype>
<Product variant change stereotype>
<Product volumes change stereotype>
<Layout change stereotype>
<Manufacturing process change>
<Logistic process change stereotype>
<Standard change stereotype>

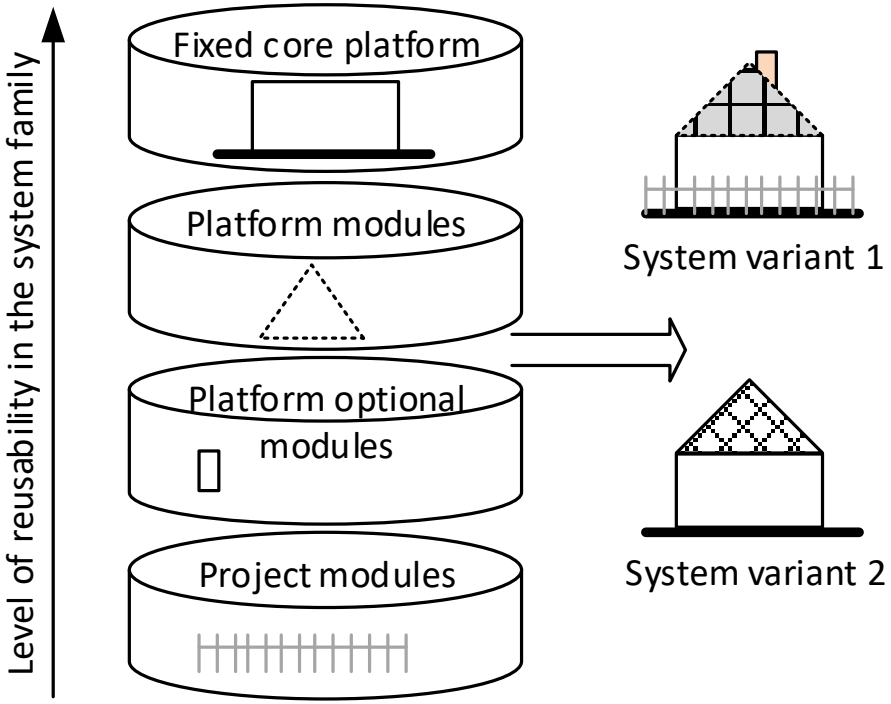
2. Changeability strategies:



Design for changeability

- Modularity design and platform design
  3. Planned reuse strategy

Fixed core platform	Common core elements within any system variant of a system family
Platform modules	Modules that must be instantiated (or parameterized) in any system variant.
Platform optional modules	Available modules that can be used in any system variant without being common to all variants
Project specific modules	Specific to a custom solution, but pointed out as being reusable in any project.



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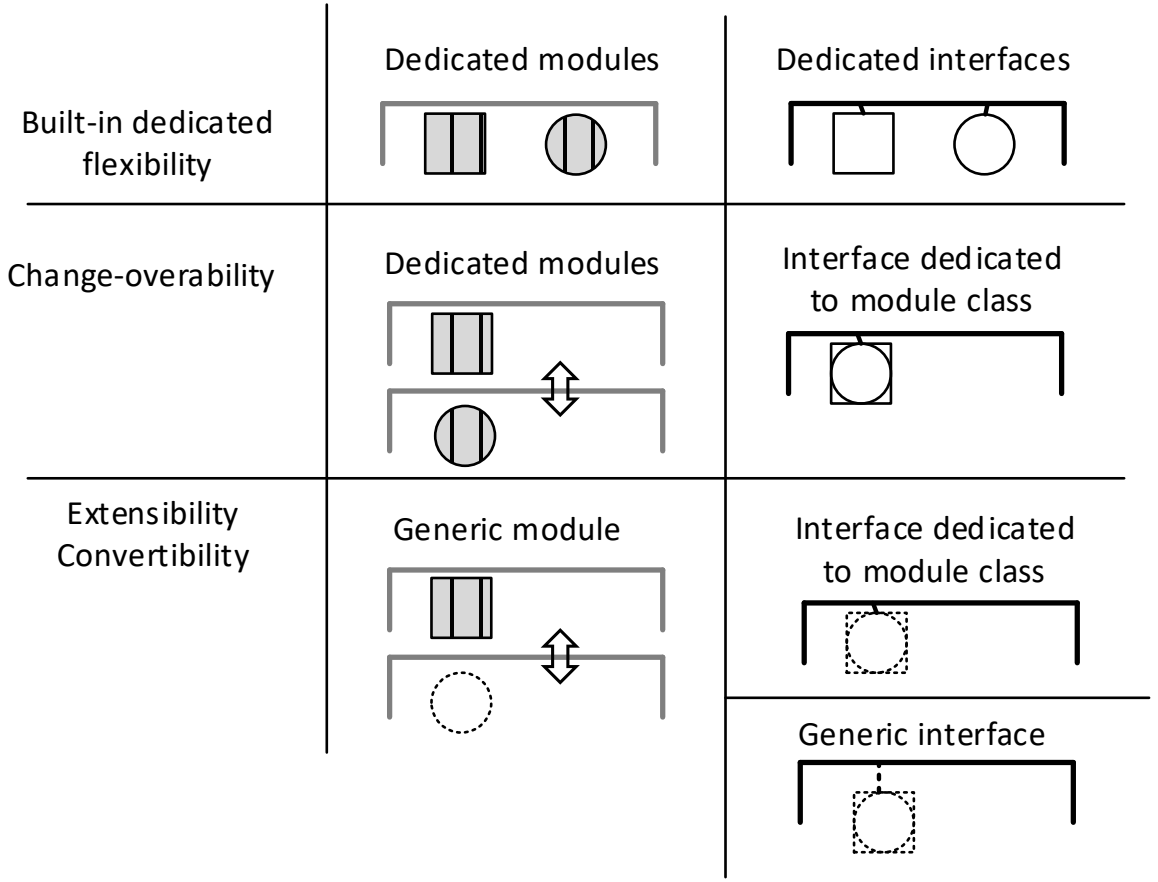
Design for changeability

4. Level of definition of modules and interfaces (generic or detailed)



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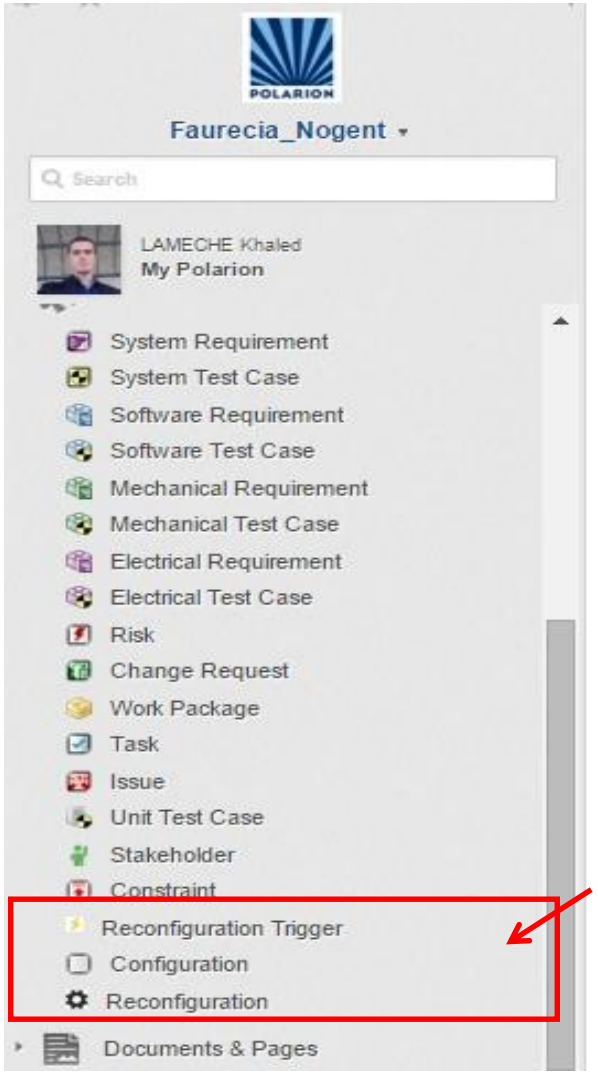
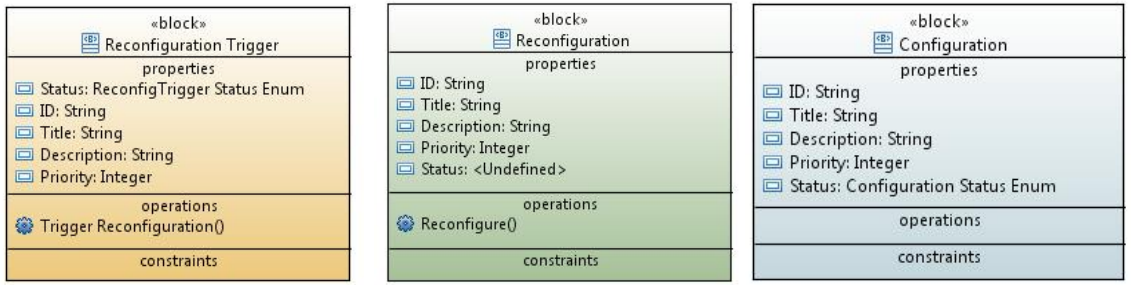
Creation of specific work items for changeability in the ALM



New work items to manage changeability requirements, implemented in the ALM



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Conclusion

- **Integration of System Engineering approach and the changeability management to define the product line for manufacturing**
- **Definition of a framework to support product line design**
- **Customization of SE engineering tools to support the methodology : ALM for Requirements Management and MBSE**
- **Applied successfully to different standard machines:**
  - Presses
  - Welding cells
  - Assembly lines

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Thank you

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