

ESTECO USERS' MEETING | NORTH AMERICA

29th » 30th OCT
» PLYMOUTH, MI



Business process modeling for composite material design



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Agenda

Composite materials selection and design

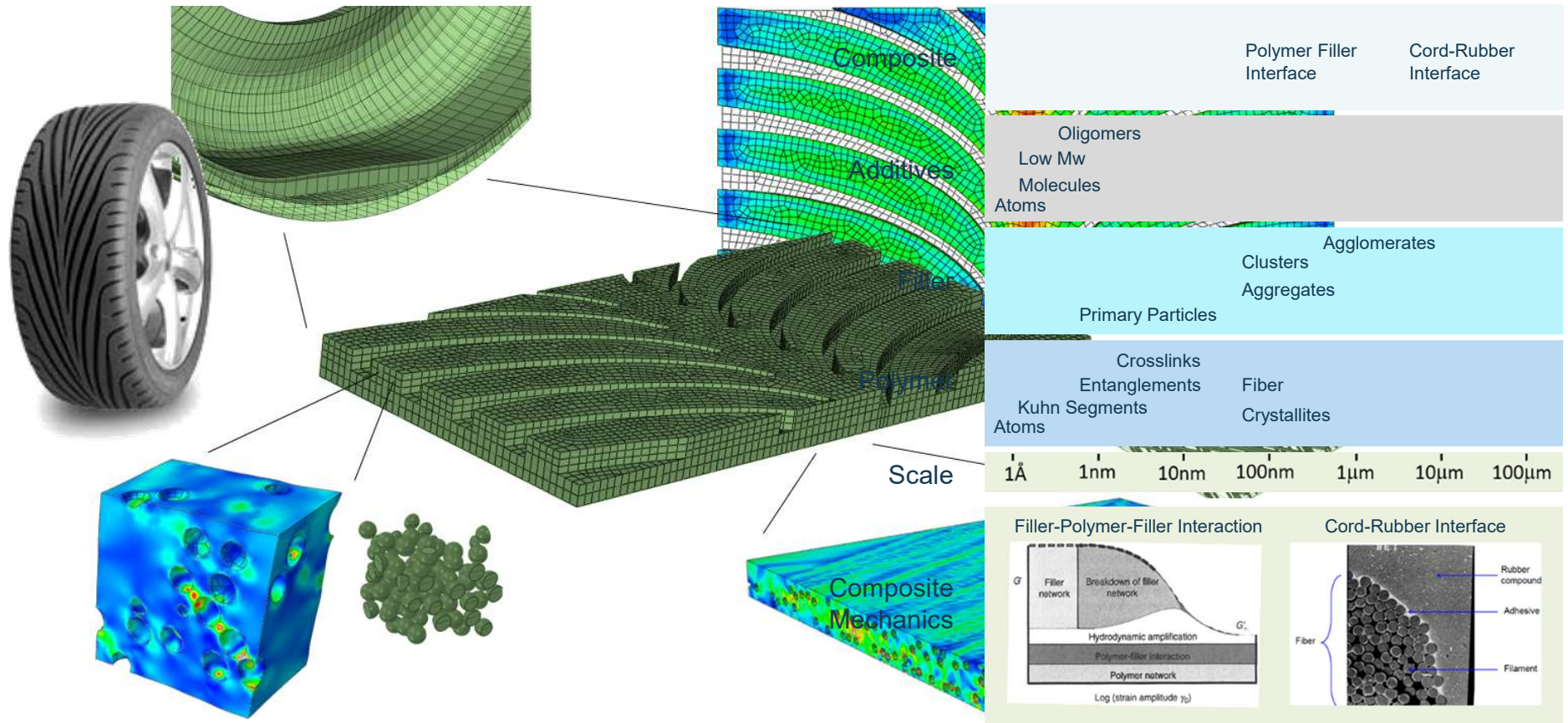
Business process and decision making standards

Application cases for design of composite materials

A Business Decision Support System

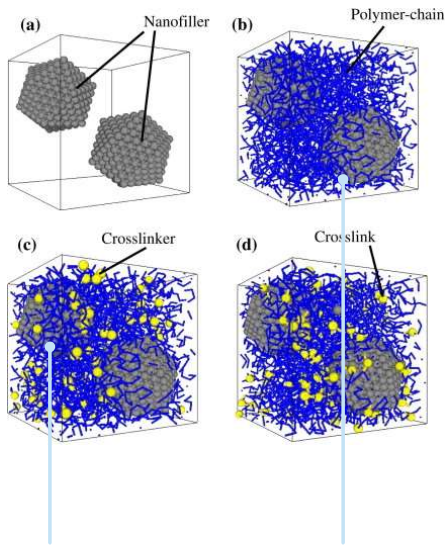
Conclusion

Selection and design of composite materials



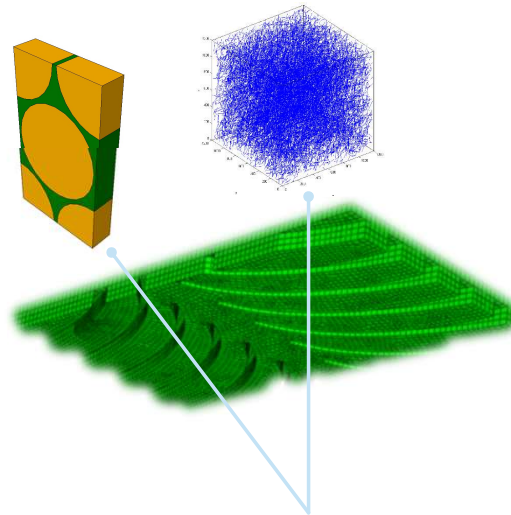
multi-scale multi-models

Multiple models in multiple scales

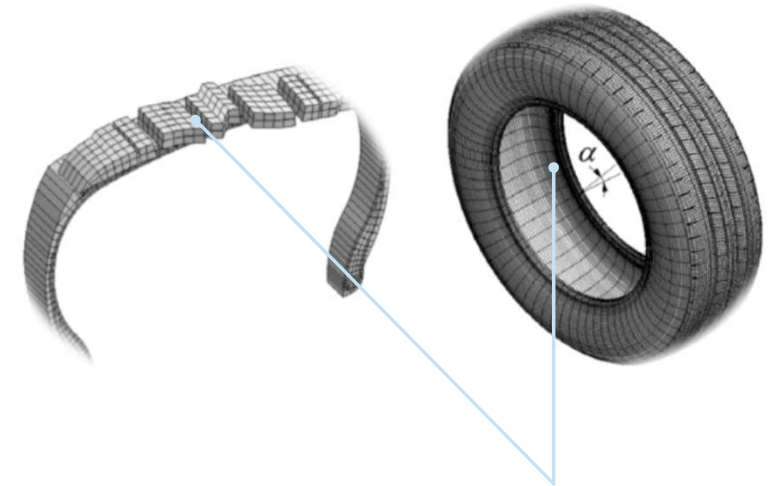


MODEL 1:
ATOMISTIC
model (MD)

MODEL 2:
MESOSCOPIC
model (DPD)



MODEL 3:
CONTINUUM
Model: Solid Mechanics
Micromechanics



MODEL 4:
CONTINUUM
Model: Solid Mechanics



Decision making in composite materials

OPERATIONAL requirements

- Low rolling resistance
- Low noise
- Resistance to wear
- Resistance to ageing
- Resistance to absorptivity
- Ability to damp unevenness
- Troublefree operation

ECONOMIC requirements

- Low price
- Availability of materials
- Accessible production technologies

FUNCTIONAL requirements

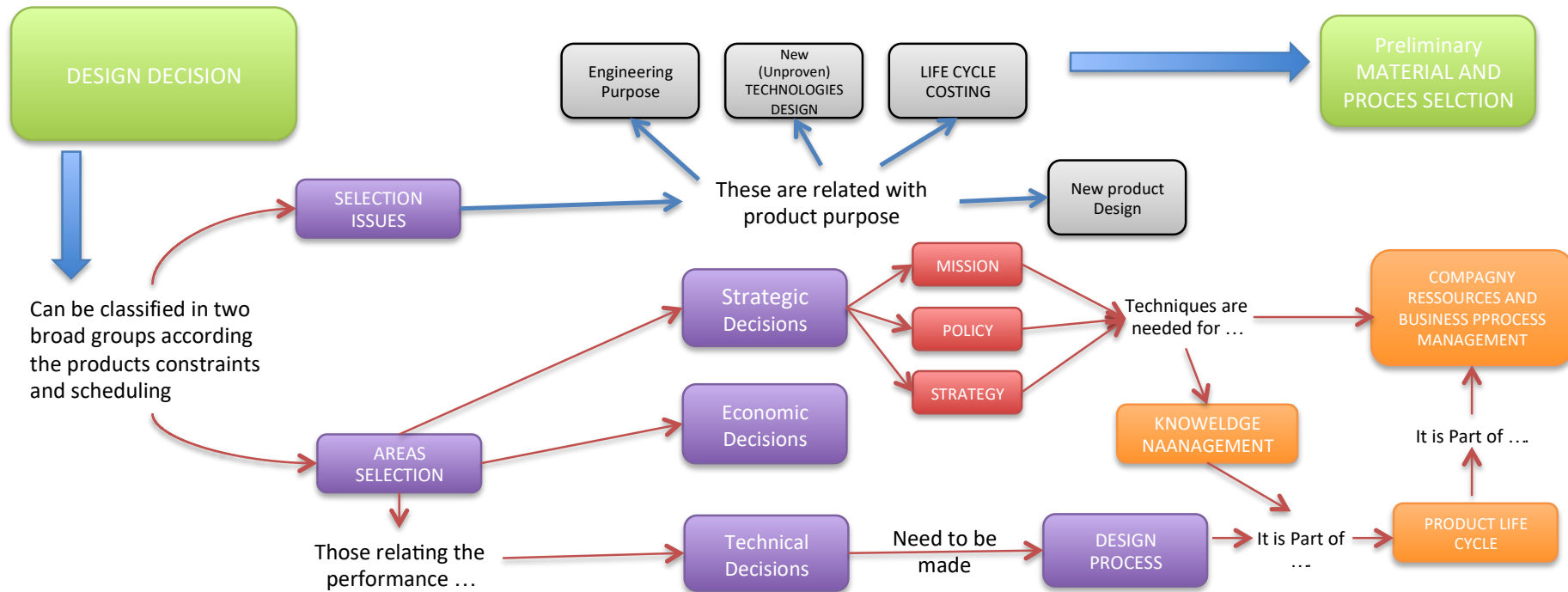
- Appropriate stress-strain characteristics
- Optimum inflating
- Prevention of aquaplaning
- Optimum adhesive properties
- Static and dynamic balance

MATERIAL requirements

- Long life
- Low mass
- Good mechanical properties
- Ability to be retreaded
- Ability to be recycled
- Resistance to weather conditions



Business decisions are complex



Business decision makers at different levels, require the accumulated knowledge to be presented in a way that is **tailored to their needs**.



Need of a paradigm shift

Decisions require workflows involving different types of models and their coupling and linking at different scales

Need of interoperability standards



The BPMN and DMN standards



Business Process Model and Notation 2.0



Decision Model and Notation 1.1



The BPMN standard

The screenshot displays the BeePMN Editor interface. On the left, a toolbar contains icons for BPMN elements: START, INTERMEDIATE, END, ACTIVITY, GATEWAY, DATA, BOUNDARY, POOL, and ARTIFACT. The main workspace shows a BPMN diagram with the following elements:

- Start Event:** Opportunity for material change found.
- Gateway:** An XOR gateway.
- Activity:** Perform part assessments.
- Activity:** Manufacture first parts.
- Activity:** Test first parts.
- Gateway:** An XOR gateway labeled "Tests passed?".
- End Event:** Global analyze and d... new...

Message flows connect the activities and gateway:

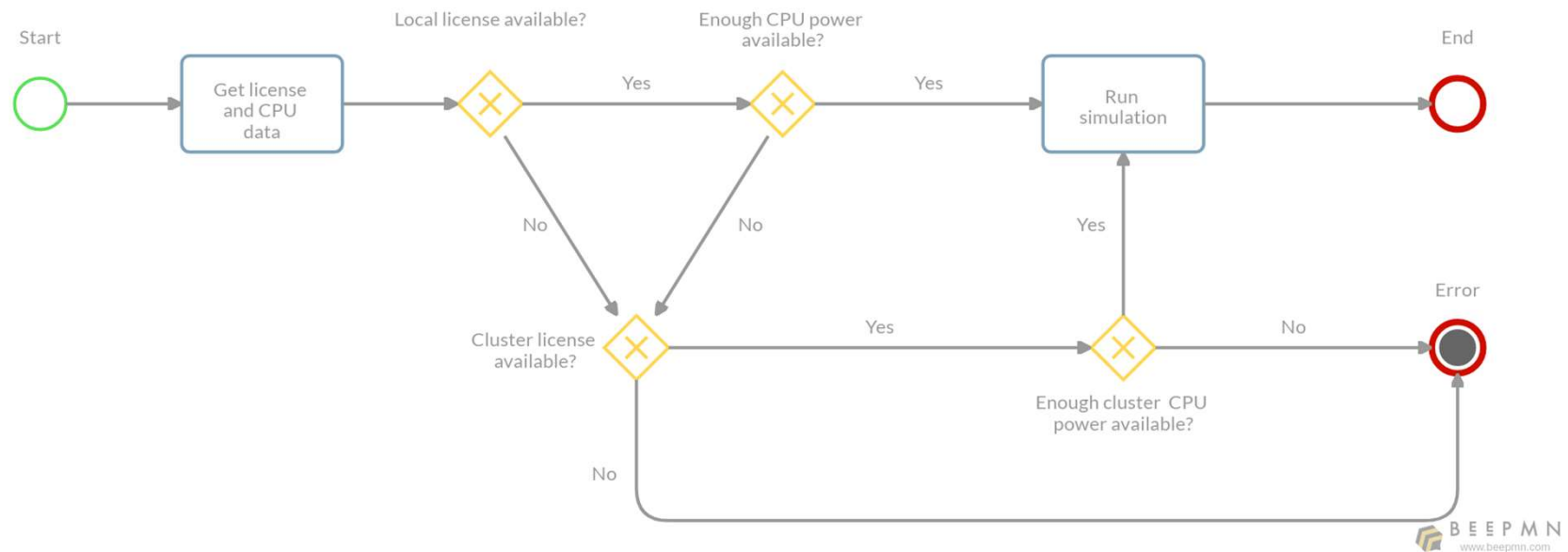
- Request information from Perform part assessments to Manufacture first parts.
- Change request from Manufacture first parts to Perform part assessments.
- Response from Perform part assessments to the "Tests passed?" gateway.
- Change response from the "Tests passed?" gateway to Perform part assessments.

On the right, the XML code for the diagram is displayed, starting with:

```
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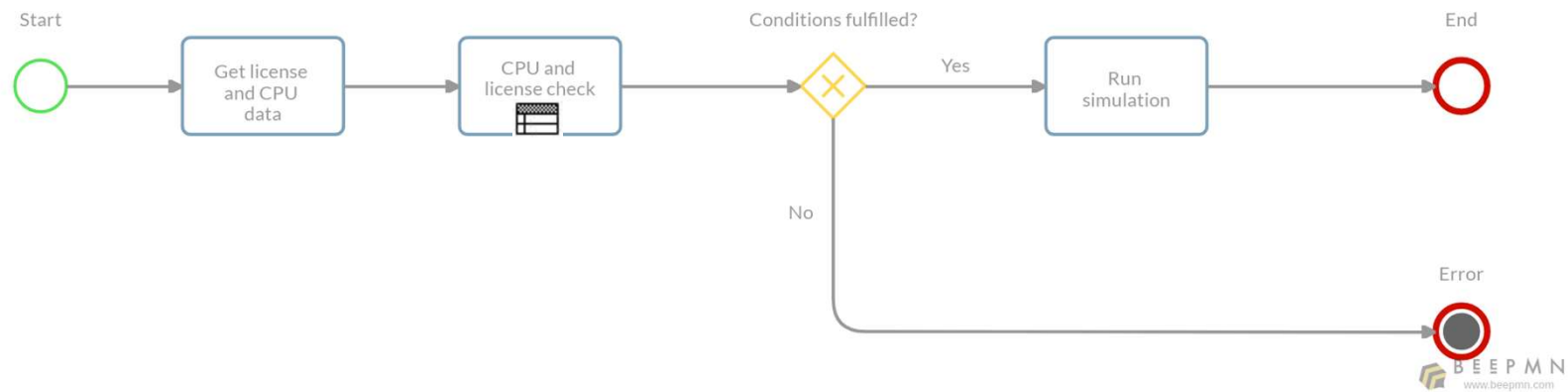
The DMN standard



Example of a business process where **decision logic** is modeled with **process flow elements**



The DMN standard

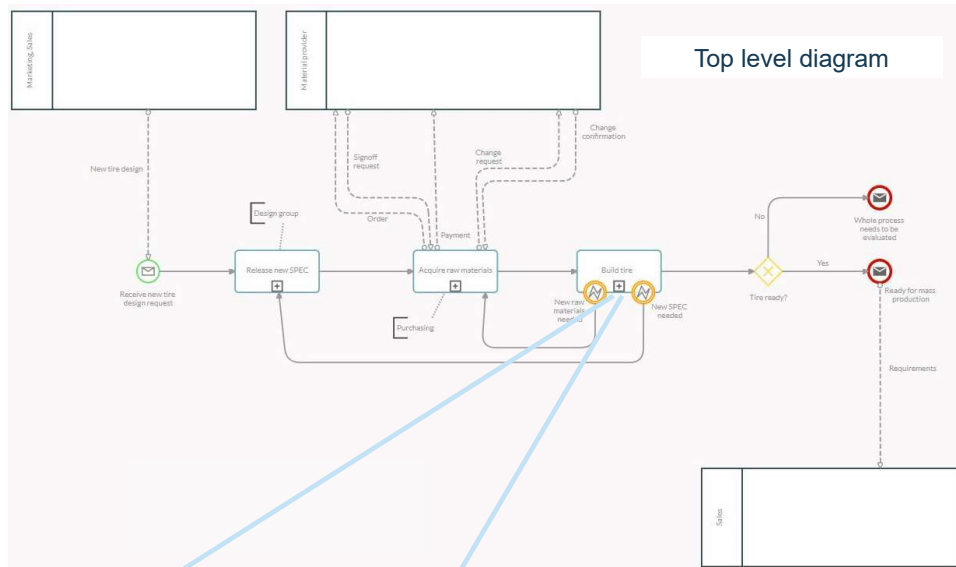


| DMN decision table for execution | | | | | | |
|----------------------------------|--------------|----------------|----------------|------------------|---------------|-------------------|
| F | Input | | | | Output | |
| | localLicense | clusterLicense | localResources | clusterResources | canBeExecuted | executionLocation |
| | boolean | boolean | boolean | boolean | boolean | string |
| 1 | true | - | true | - | true | local |
| 2 | - | true | - | true | true | cluster |
| 3 | - | - | - | - | false | nowhere |

Example of a business process where **decision logic** is modeled with a **decision table**



How to aim to decision making using BPMN and DMN



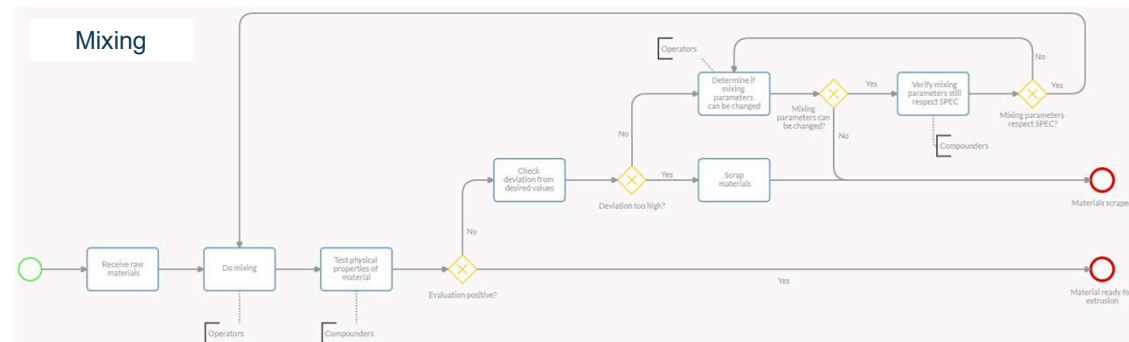
Decision making workflow

Indicates

- Process elements
- Key players (actors)
- Complexity
- Potential improvement area

Tire building

- ...
- Mixing
- Extrusion
- Tire assembly



Composite leaf spring



Design a leaf spring using carbon reinforced polymers in parallel with glass-reinforced polymers.

Production rate: 72000 parts/year

50% weight saving versus steel

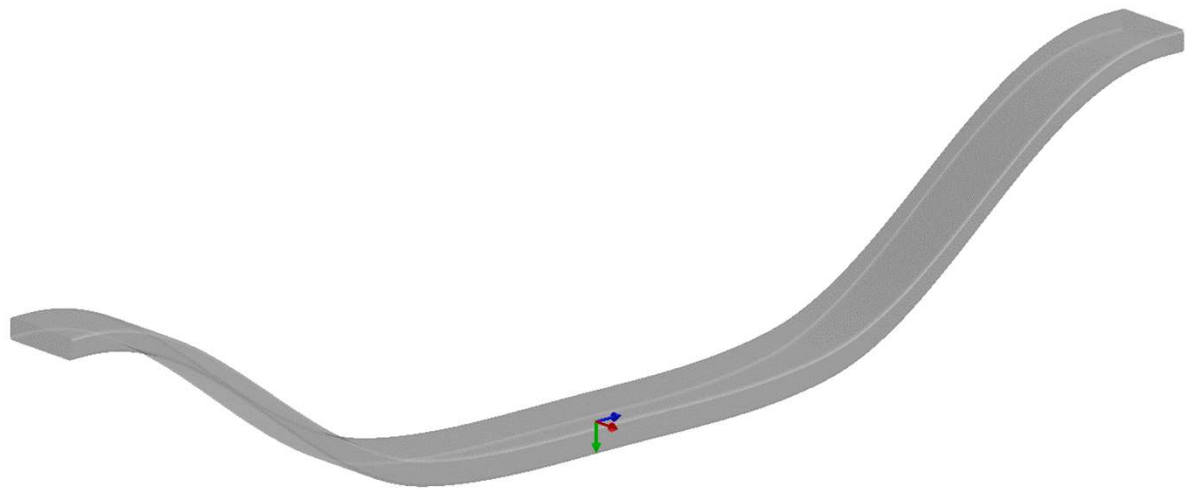
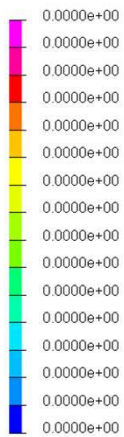


Technological solution bases on polymer matrix reinforced composites

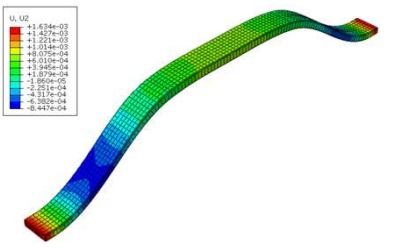
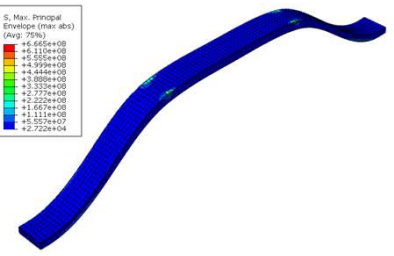
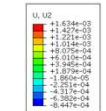
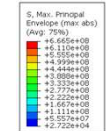
isothermal central injection

COMPOSELECTOR\LeafSpring_RTM_RESULT.erth5

NODE : FILLING_FACTOR
Min = 0 at Node 102540
Max = 0 at Node 102540



1 / 0.000000



Business process analysis with BPMN and DMN



Set of requirements for part of system

KPIs

Translator

Receive and assess requirements

Assess in-capabilities

Technology route options ready?

Develop techno routes

Technology routes ready for evaluation?

Select techno routes

Technology route selected

Technology route

Process aborted

Technology routes Ready

Technology routes Ready for evaluation

No

No

No

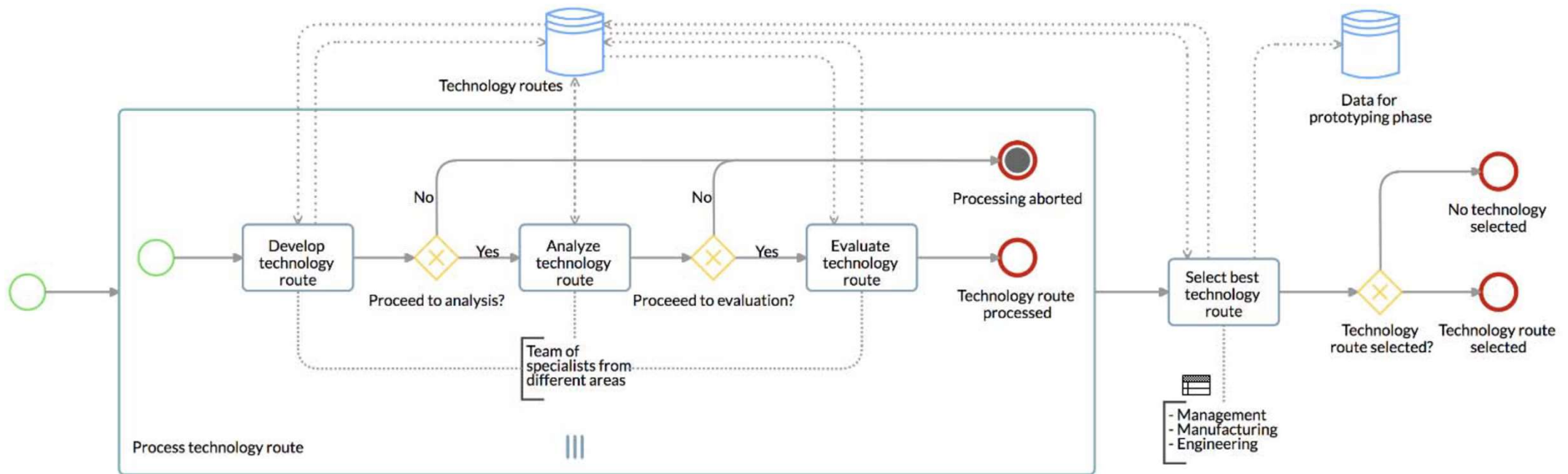
Yes

Yes

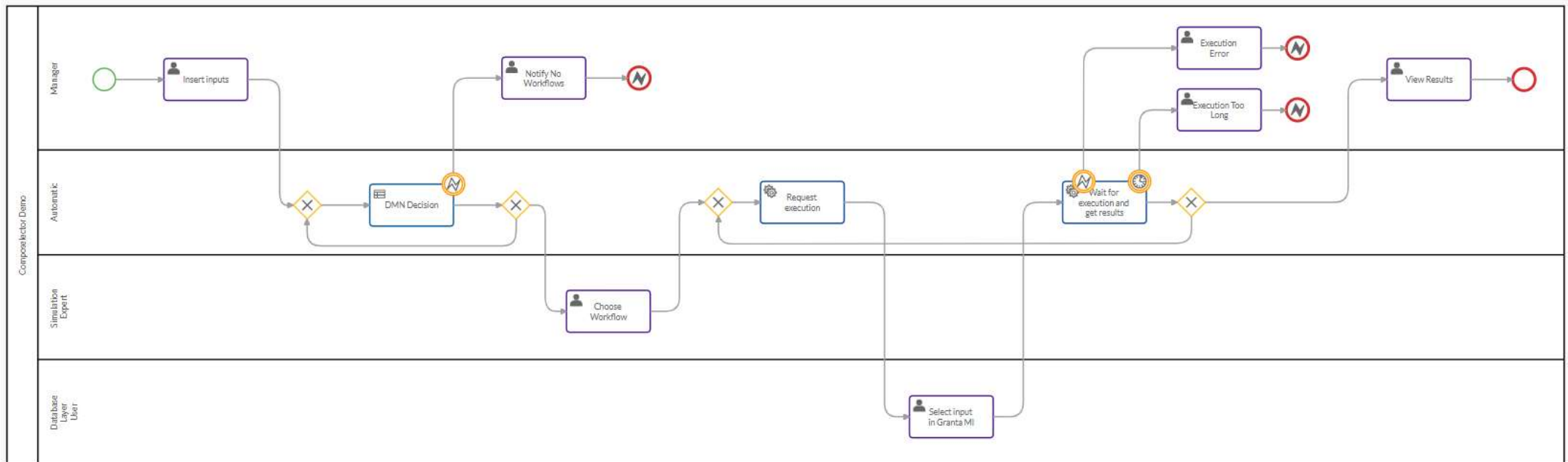
Yes



The selection of technological routes



The Business Decision Support System: an example



Conclusions

Integrated workflow

covering all scales and process stages supporting interoperability for modelling physical phenomena in the composite material design and selection

Standard solution

solution based on the two well-defined standards BPMN and DMN for business processes and decisions respectively.

Decision support

Both automatic and human-based decisions are supported

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Thank you!

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