Towards Model-Based Adoption for Requirements Elicitation in Railway – the Role of Collaborative and Participatory Modelling

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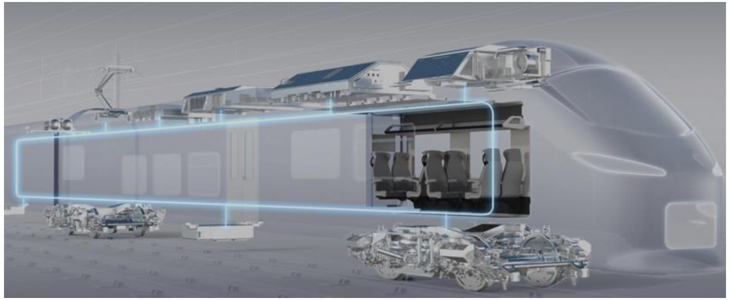
Some history...

Topic

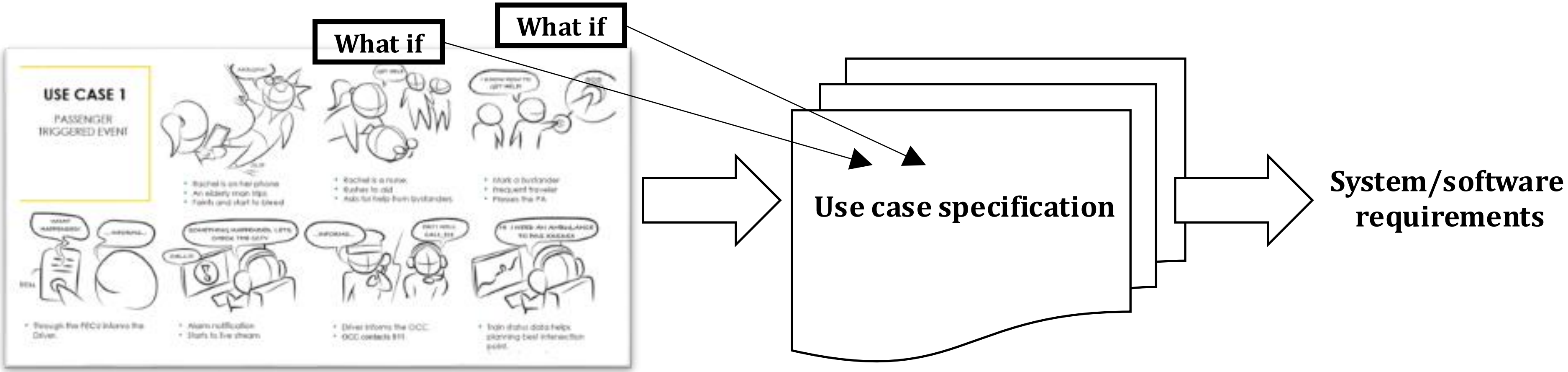
- Discuss context of potential implementation and adoption of model-based practice for managing and facilitating stakeholder collaboration and communication in systems engineering in a complex environment.
- Motivational example – requirements elicitation in railway vehicle engineering.
- Provide context for future research.

Domain

- Railway vehicles are Cyber Physical System-of-Systems (CPSoS). A railway vehicle is composed of a range of complex subsystems, many of them characterized by a high degree of electromechanics – e.g. propulsion, brake, couplers, passenger doors.
- Railway vehicle use cases characterized by a wide range of different actors.
  - E.g. London Underground: +4000 trains, +3 million passengers/day, 3500 train operators, 14 maintenance depots
- Railway vehicle control achieved by combination of conventional relay logic and distributed embedded system – architecture featuring information, operational and safety control layers.
- Railway vehicles face high demands on operability, dependability, security, environmental conditions.
- Railway vehicles operate on unique legacy infrastructure – tracks, platforms, electrification system, signalling system, maintenance depots.

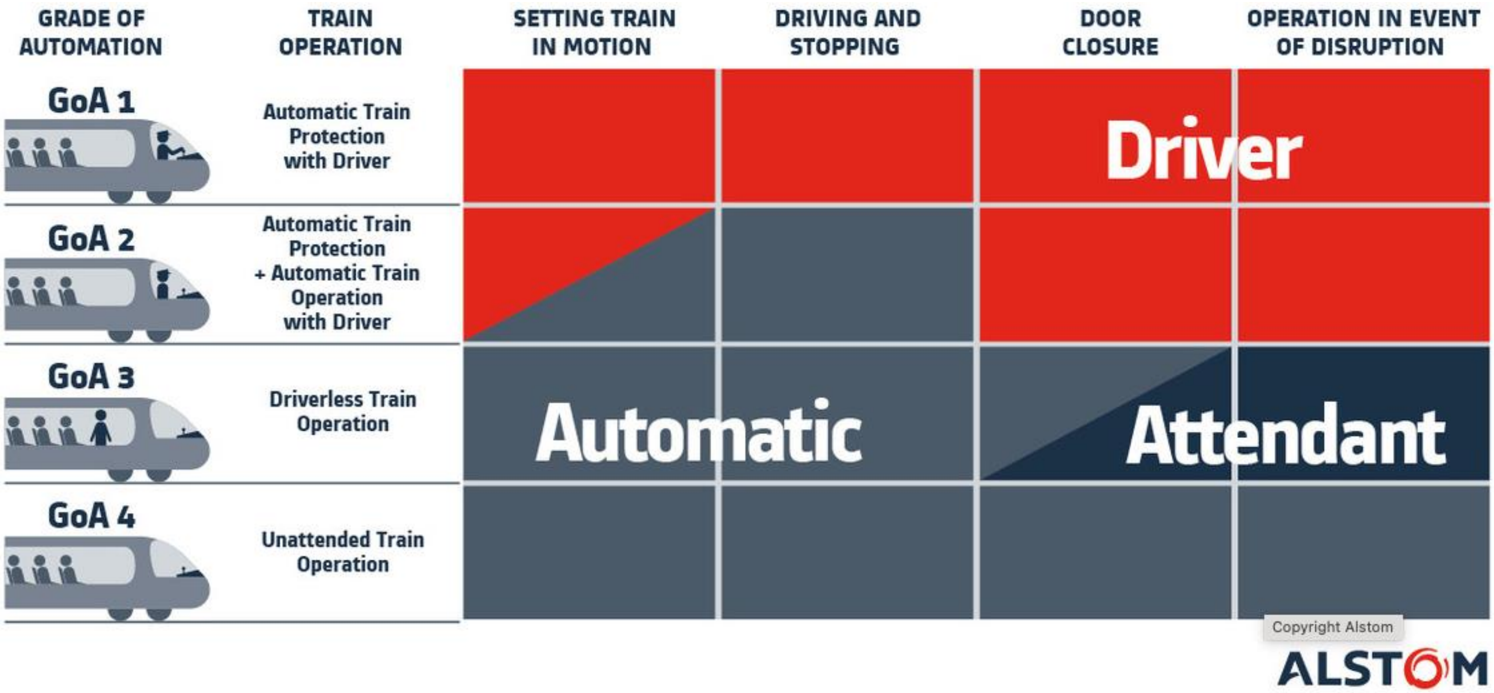


Base scenarios + what-if scenarios → use case specifications → derived requirements

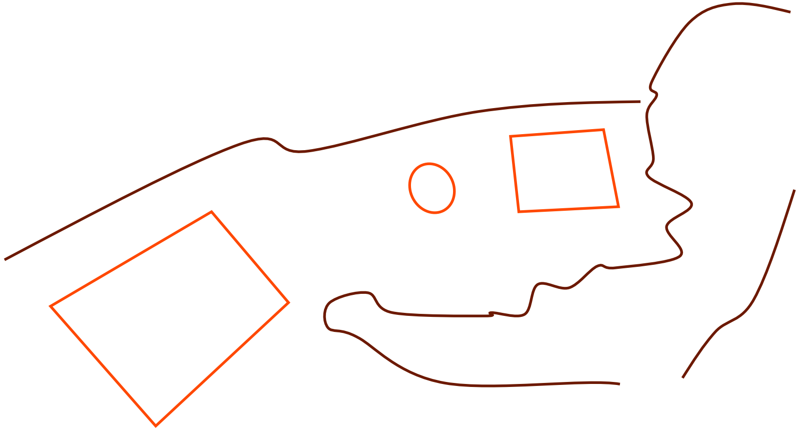


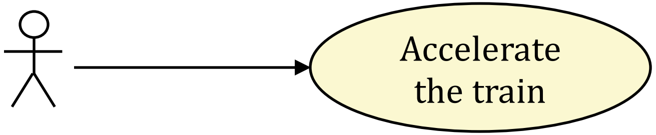
Use cases in operation, goals and actor classes

- Grade of Automation 1– 4

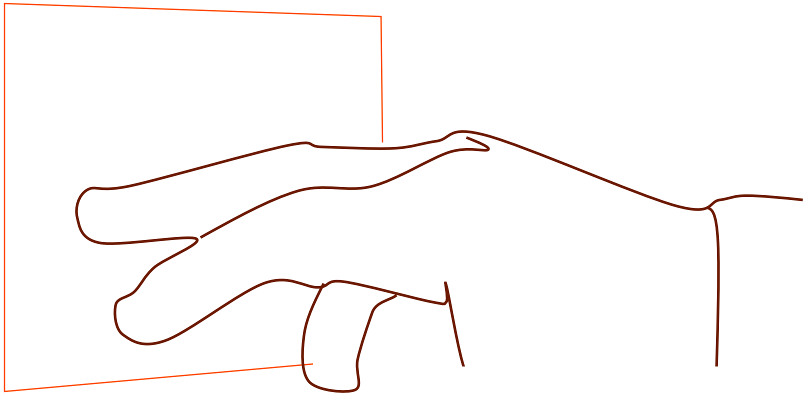


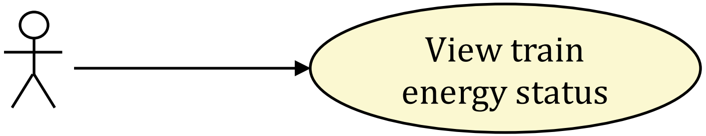
Scenario examples – Accelerate the train



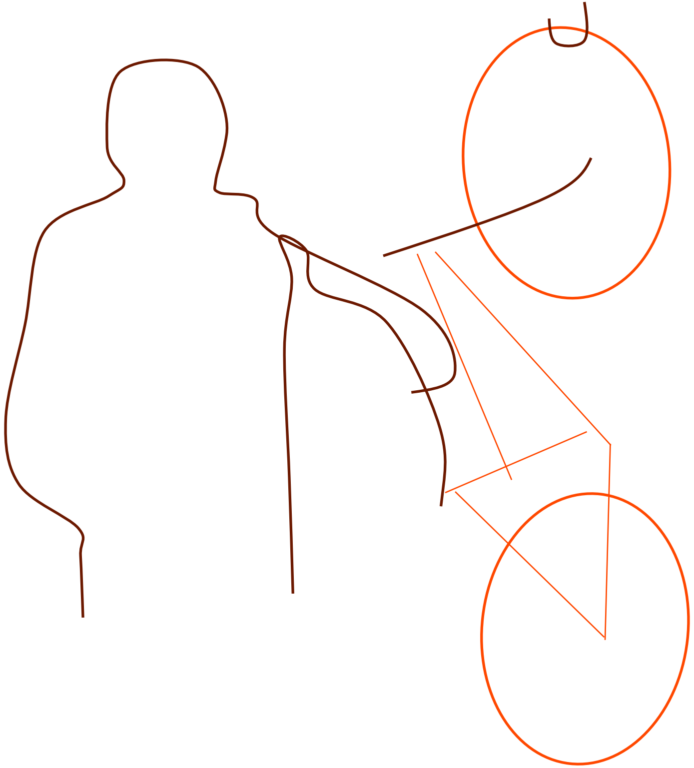


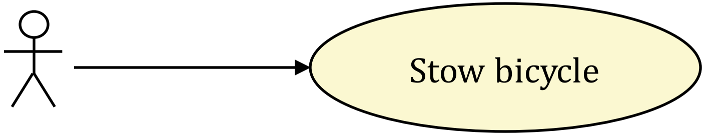
Scenario examples – View train energy status





Scenario examples – Stow bicycle



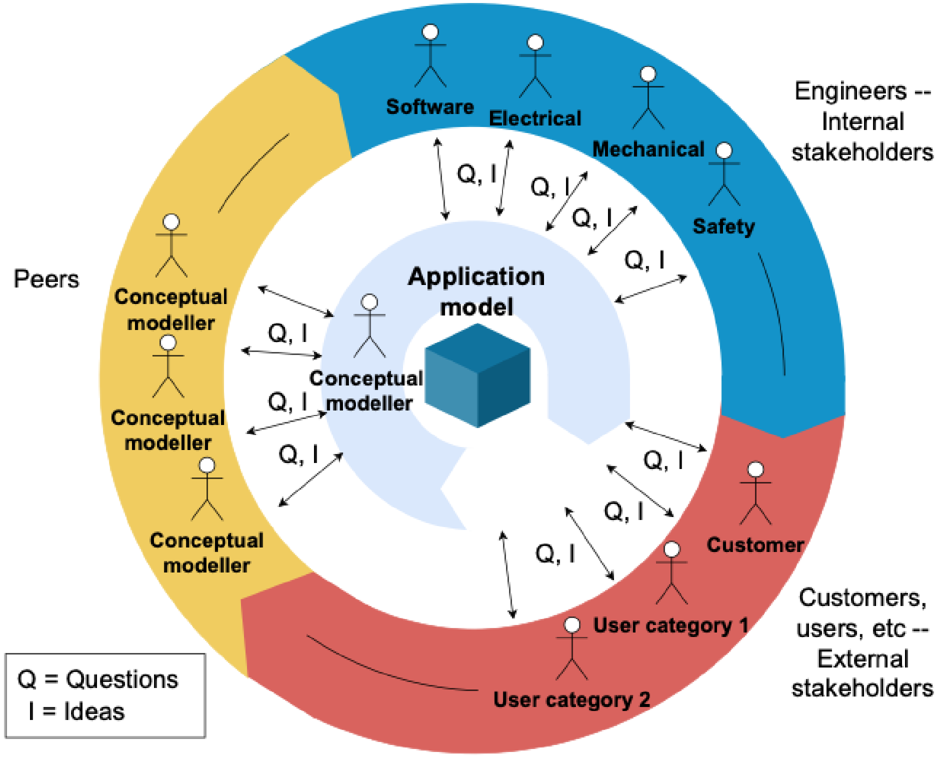


Organization

- Categories of collaborating participants involved in modelling:
  - Internal stakeholders
  - External stakeholders
  - Peers
- Global distribution of collaborating participants.
- The decomposition of the model reflects the organization of the modelling core team.

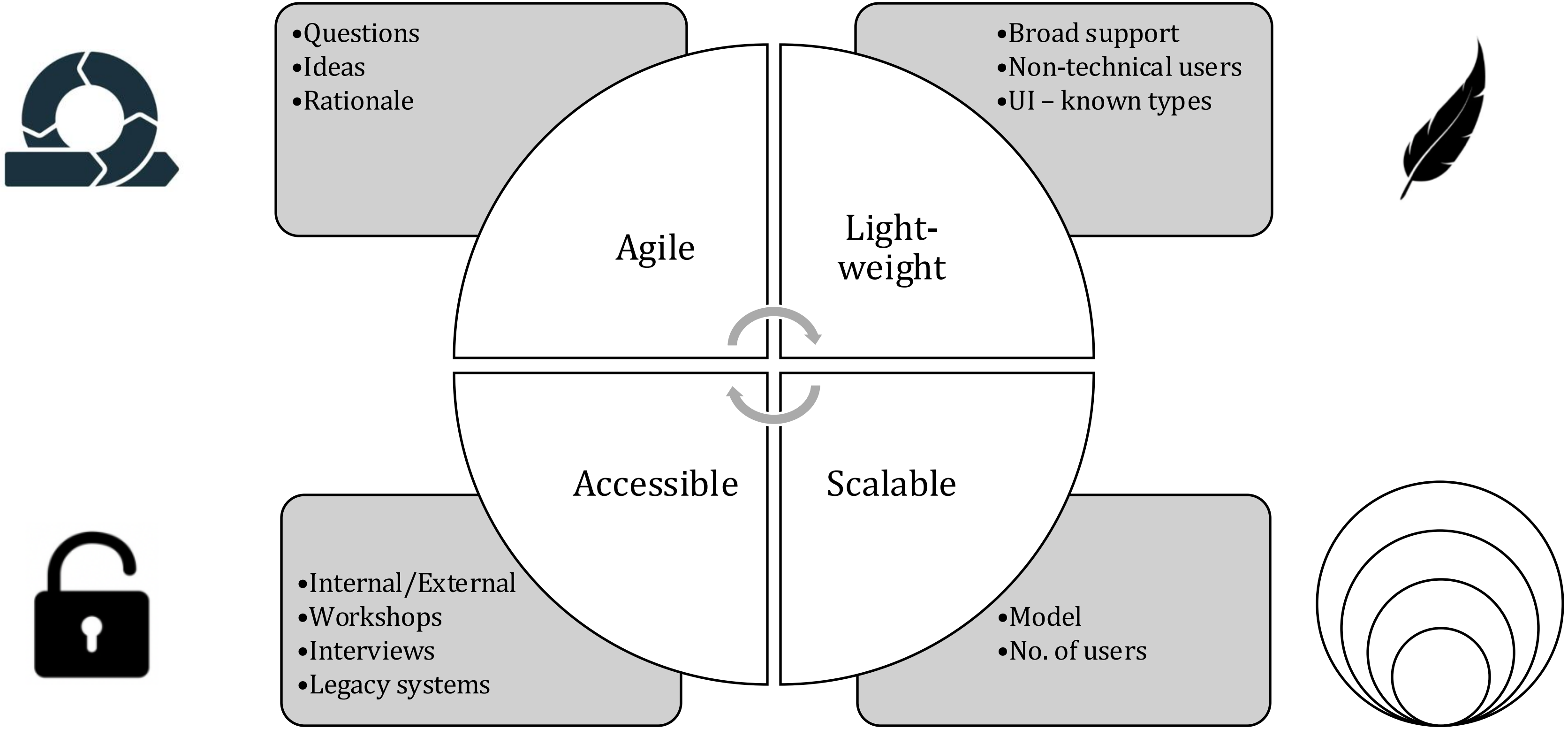
Modelling process

- Iterative and incremental.
- Hybrid approach:
  - Plan-based
  - Agile elements
- Global distribution of the participants – virtual/hybrid meetings are necessary in all process stages.
- Negotiation of stakeholder needs
- Capture and record **questions (Q)** and **ideas (I)** during the process.
- Final output: Model including **Rationale.**



Collaborative/participatory modelling approach – required characteristics

- *Accessible, agile, light-weight, scalable.*



Process

Plan-based
Agile elements
Questions, Ideas, Rationale

Agile elements, e.g.
- Kanban
- Scrum
- Feature-driven development – FDD
- Behavior-driven development – BDD
- Lean development
- Adaptive software development – ASD
- Crystal methods
- Extreme programming – XP
- Dynamic systems development method – DSDM

Work Breakdown Structure – WBS

Model organization has impact

Use Case Model organization
- Lifecycle-oriented
- Actor-oriented
- Goal-oriented

- Location-oriented
- Event-oriented
- State-oriented
- Pattern-oriented

User Interface

Meetings Virtual/ hybrid	**Meetings** Physical
”Style” elements •MS 365 •Forms ---------------- Tactile: •Pen (pad) •Touch (pad)	**”Style” elements** •MS 365 •Forms --------------- Tactile: •Pen (pad) •Touch (pad) •Whiteboard •Paper figures (e.g. SAP Scenes™)

Reuse of Patterns

Modelling with patterns in use case sequences

Patterns (examples)
- Success pattern
- Detour pattern
- Termination
- Activation/Feedback pattern
- Deactivation/Feedback pattern
- Redundancy patterns
  - Cold standby
  - Warm standby
  - Hot standby
- Plausibility checking pattern
- Trigger[guard]/action pattern

Discussion

- Powerful modelling language is attractive but must be balanced against the need to involve every participant.
- Due to the diversity of needs, it is valuable to seek to engage experts from other disciplines. E.g. cognitive behavior experts, organization experts

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Conclusion

- We discussed the perspective of modelling in early requirements engineering stage in a complex environment.
- We illustrated needs and challenges with a motivational example – railway vehicle systems engineering.
- We argue that the modelling environment should be accessible, agile, light-weight, and scalable.
- We have provided content for future research on collaborative and participatory modelling in complex, global context.

Future work

- Define and study solutions for efficient collaborative and participatory modelling in requirements elicitation.
- We welcome collaboration with CoPaMo community.

Thankyou!

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Q & A