NY SPIN
Software & Systems Process Improvement Network

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The use of a requirements modeling language for industrial applications

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Presented at NYSPIN OCTOBER 11, 2012

Outline of the talk

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- Introduction to Corporate Technology
- Four stories of *industrial experience* in requirements engineering or why we need the Unified Requirements Modeling Language (URML)
- Overview of the URML
- *Early feedback* regarding use of the URML on REAL projects
- A demonstration (Time Permitting)
- Questions & answers

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Siemens is organized in 4 Sectors: "Industry", "Energy", "Healthcare" and "Infrastructure & Cities"

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Siemens: Facts and Figures

Siemens Sectors

Industry

Divisions:

- Industry Automation
- Drive Technologies
- Customer Services

~€ 20 bn [1)]

Energy

Divisions:

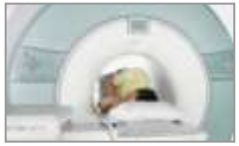
- Fossil Power Generation
- Wind Power
- Solar & Hydro
- Oil & Gas
- Energy Service
- Power Transmission

~€ 25 bn [1)]

Healthcare

Divisions:

- Imaging & Therapy Systems
- Clinical Products
- Diagnostics
- Customer Solutions



~€ 12 bn [1)]

Infrastructure & Cities

Divisions:

- Rail Systems
- Mobility & Logistics
- Low and Medium Voltage
- Smart Grid
- Building Technologies

- Osram [2)]

~€ 17 bn [1)]

Corporate functions

- Corp. Finance
- **Corp. Technology**
- Corp. Development
- …

Corporate Technology

Key figures FY 2011

- **Sales:** ~€ 74 bn
- **Locations:** in 190 countries
- **Employees:** ~402,000
- **R&D expenses:** ~€ 4 bn
- **R&D engineers:** ~28,600
- **Inventions:** ~8,600
- **Active patents:** ~53,300

1) Sales in FY 2011 estimated for the new organizational setup with 4 Sectors
2) Not included in sales figure; Siemens announced its intention to publicly list Osram

Corporate Technology has 3 missions

Corporate Technology: Mission, roles and basic principles

The source of our excellence are our **people.** We attract and develop **creative talents** for Siemens. We foster **talent exchange** with the Business Units.

We develop Siemens' **technology and innovation strategy** on **corporate level.** We ensure **seamless technology and innovation processes** between Corporate and Business Unit levels.

We foster a **culture of innovativeness and high performance** and our **visibility** to all internal and external stakeholders

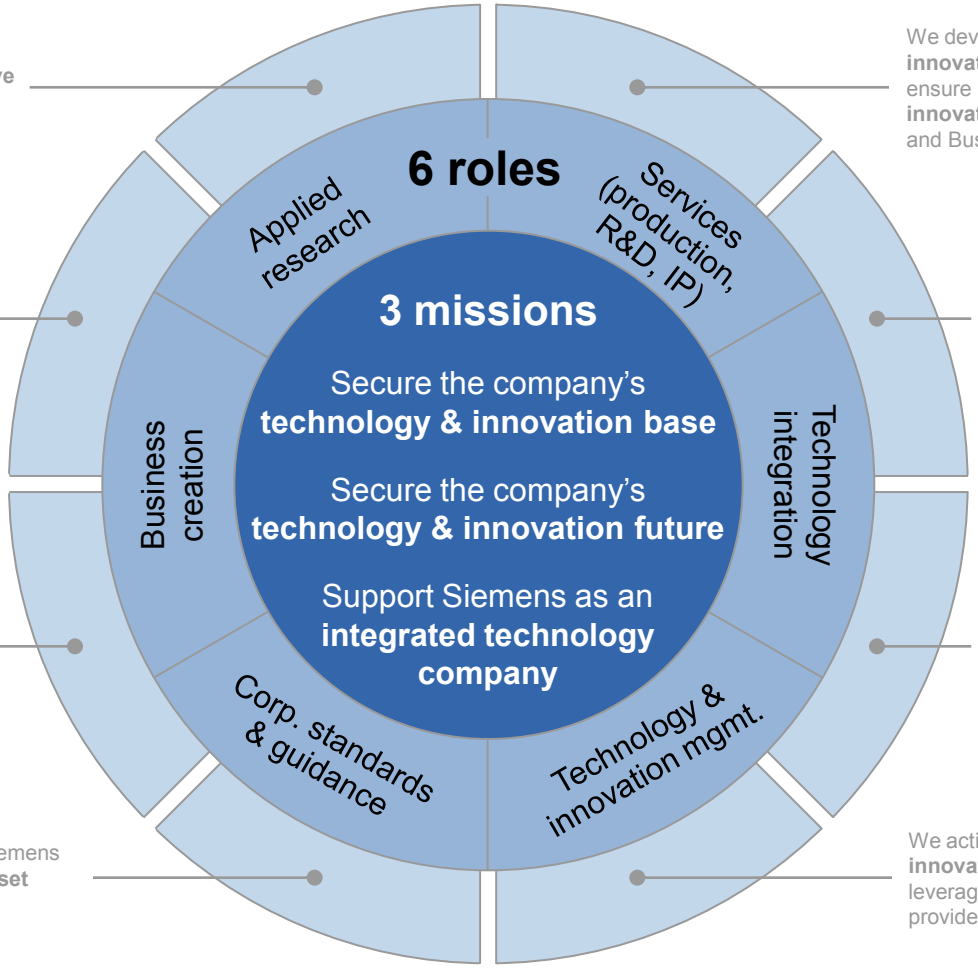
We deliver services for the businesses as a **strategic partner** and integral part of their **value chain**

We take a **focused approach** (e.g., in regional setup, technology focus) to achieve high performance

We regularly develop **high-impact technologies and innovations** for Siemens with a **clear focus on results.** The business responsibility for implementing innovations lies with the Business Units.

We primarily serve **internal** Siemens customers with a **global mindset and setup**

We actively manage our **technology and innovation portfolio.** We systematically leverage **external competence networks** to provide the best know-how for Siemens.



CT Research and Technology Center: ~1,650 experts in 13 technology fields

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CT Research and Technology Center (RTC)

- Software quality
- Architectural design

HQ: Munich
RGs: 7

- SW / System integration
- Middleware, cloud
- Enterprise IT

HQ: Munich
RGs: 10

- Security architecture & lifecycle
- CERT services
- Access control

HQ: Munich
RGs: 8

- Decision support
- Knowledge discovery
- Condition monitoring

HQ: Munich
RGs: 8

- Control systems
- Engineering
- Simulation & Optimization

HQ: Princeton, US
RGs: 10

- Wireless & industrial networks
- Internet of things

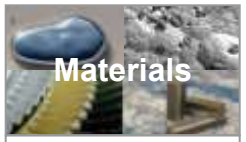
HQ: Munich
RGs: 6

- User Interface Design
- PLM process support
- Systems Engineering

HQ: Munich
RGs: 11

- Computer vision
- Image proces-sing & analytics

HQ: Princeton, US
RGs: 12



- Materials development & processing
- Analytics

HQ: Berlin
RGs: 8

- Electronic design & manufacturing processes
- Assembly & test

HQ: Munich
RGs: 8

- Sensor devices & system integration
- Inspection & test

HQ: Erlangen
RGs: 9

- Power electronics & management
- Mechatronic systems
- Mechanical assembly

HQ: Erlangen
RGs: 9

- Energy conversion & storage
- Environmental technologies
- Oil & gas

HQ: Erlangen
RGs: 9

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Industrial Experience Stories

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1. Oh, you have a *PRODUCT LINE!*
2. Why is this feature in the product? What are we really trying to accomplish??? And where are the requirements?
3. Hazard analysis (and threat modeling) early on
4. “I can’t tell the processes from the use cases”

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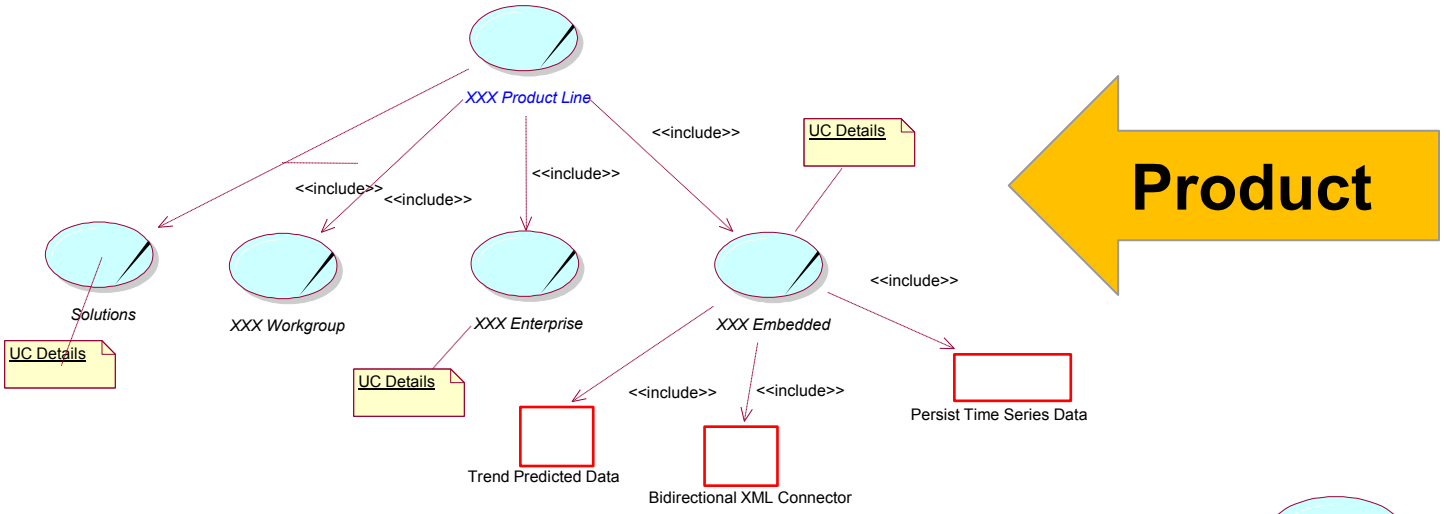
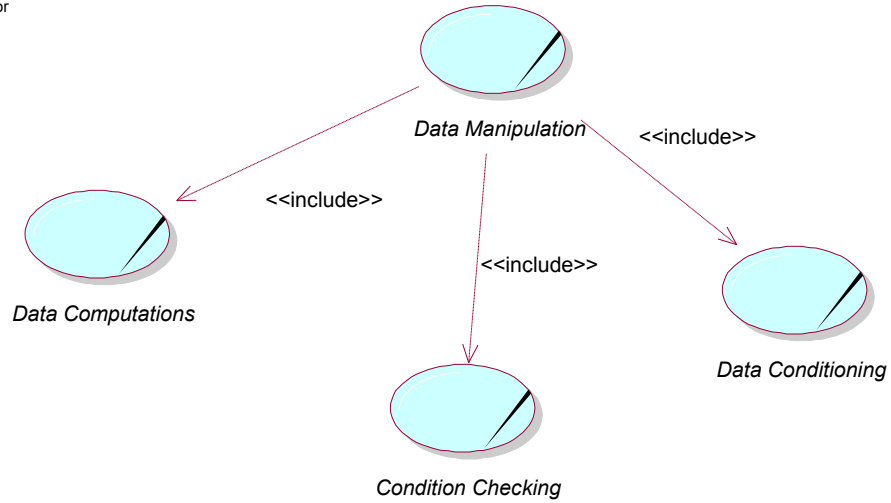
What they got in a modeling session



Product

Features



Analysis of Story 1

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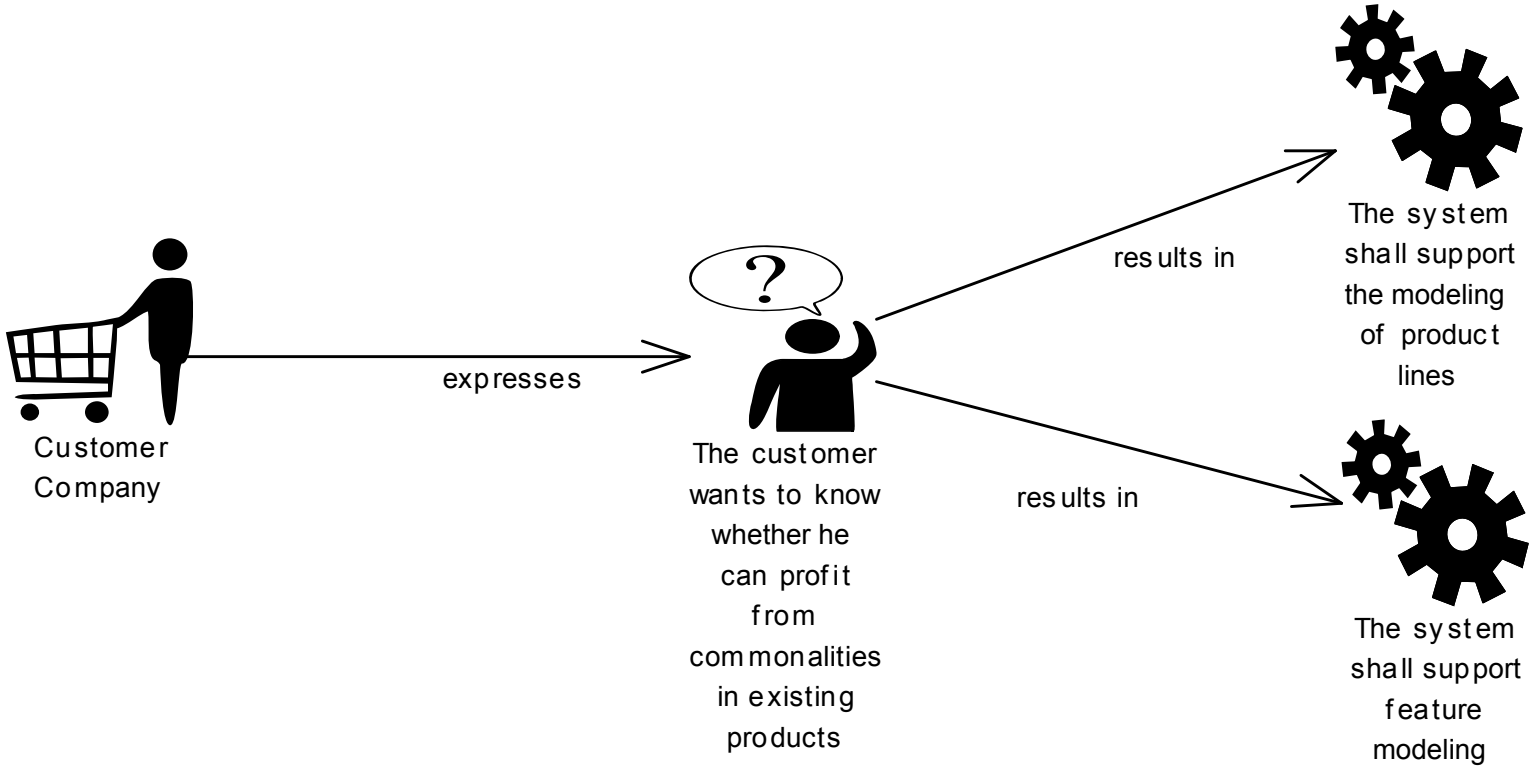
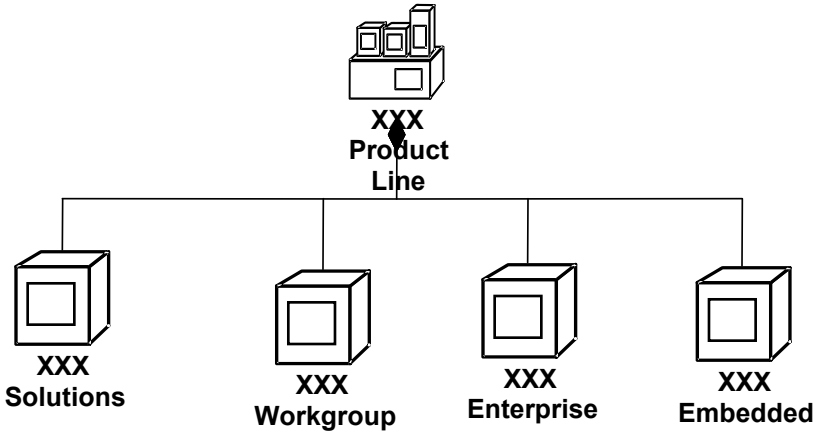
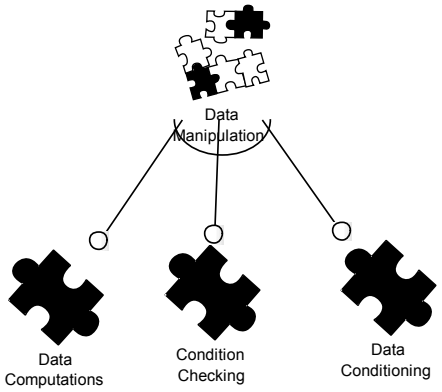


What they needed



Products

Features



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Story two – stakeholder goals

What they had from the transcript of a meeting

Joe:
We need high market share
We need lower lifecycle costs than today

Mary:
We really need a competitive feature set
And it has to cost less than $150K per unit
And we need a reduction in complexity

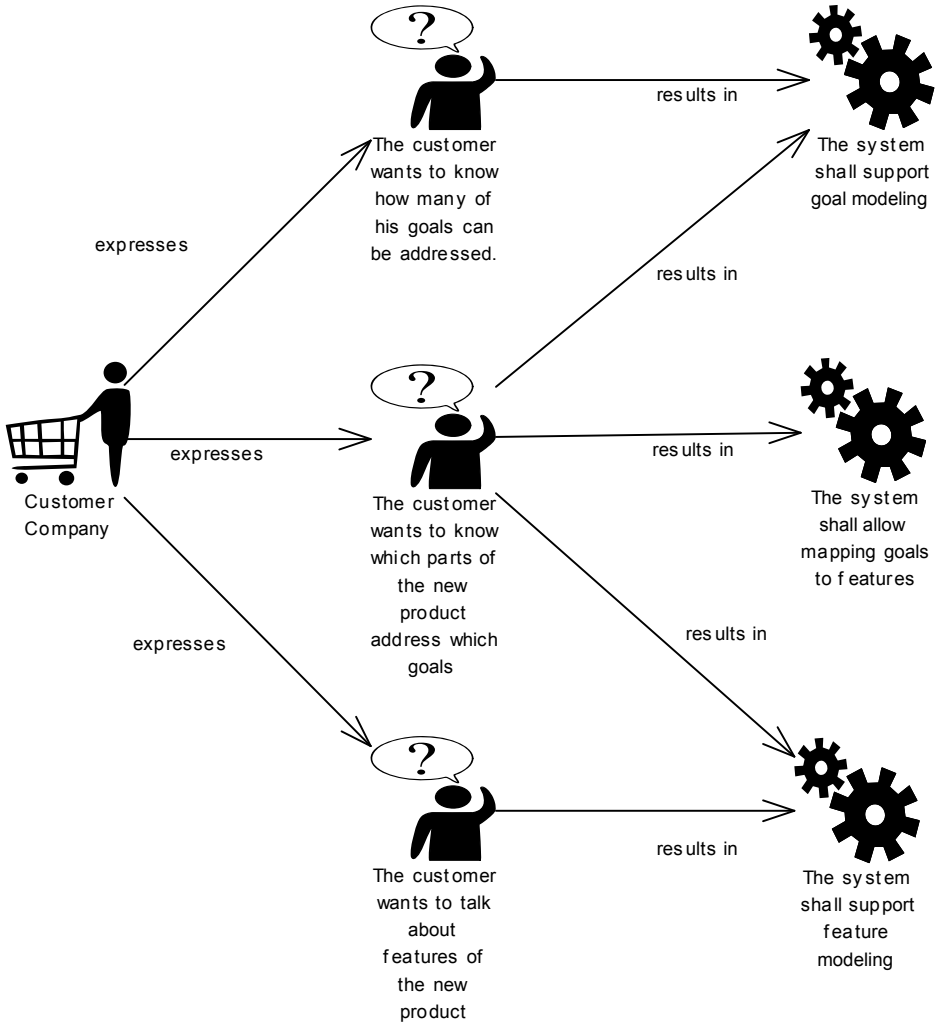
John:
Yes, but we need packaged options and high reliability

Tom
Maybe we want a reduction in complexity compared to the current unit

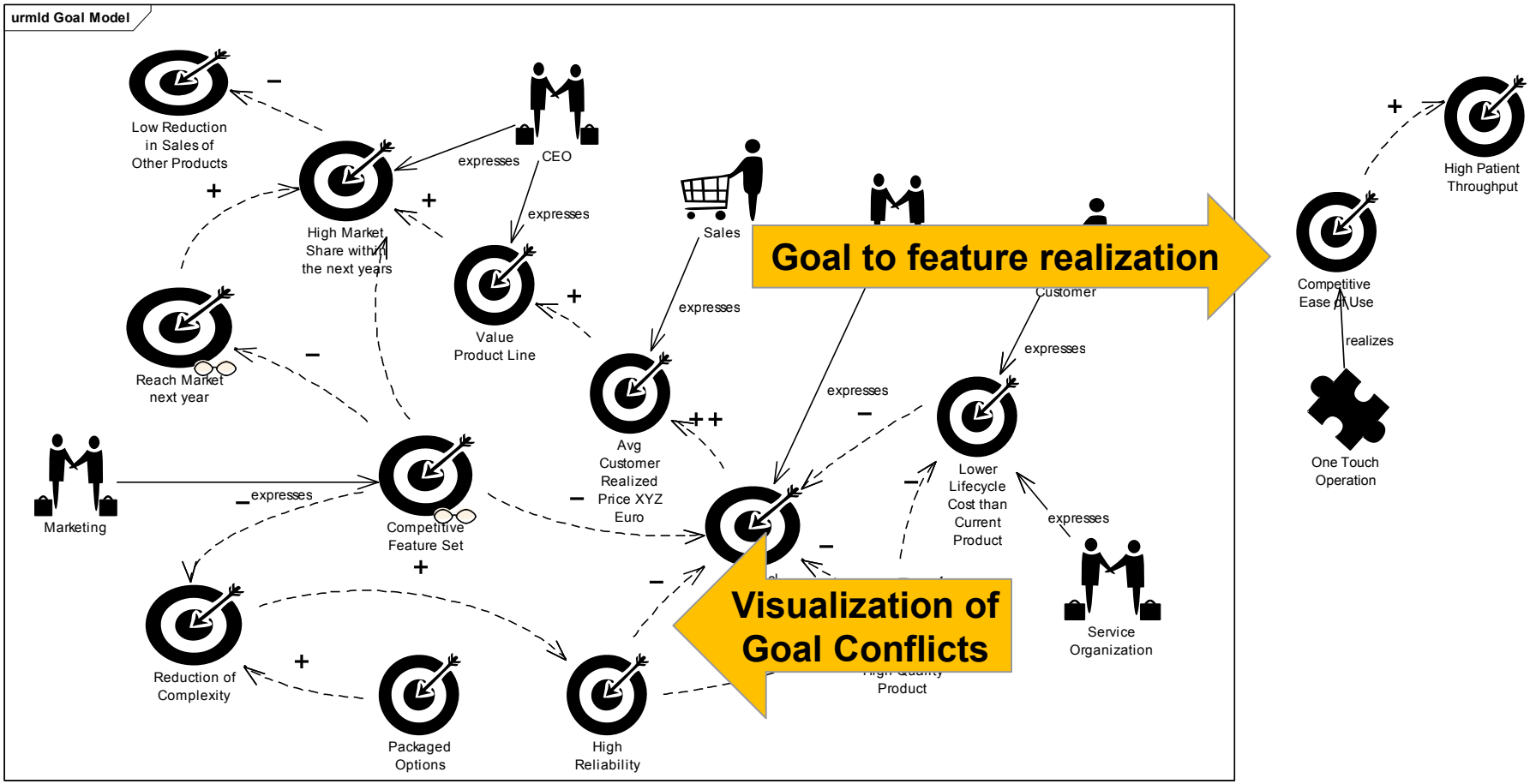
Marketing Manager:
These are all great ideas. let's go with them.

Engineering: Huh???

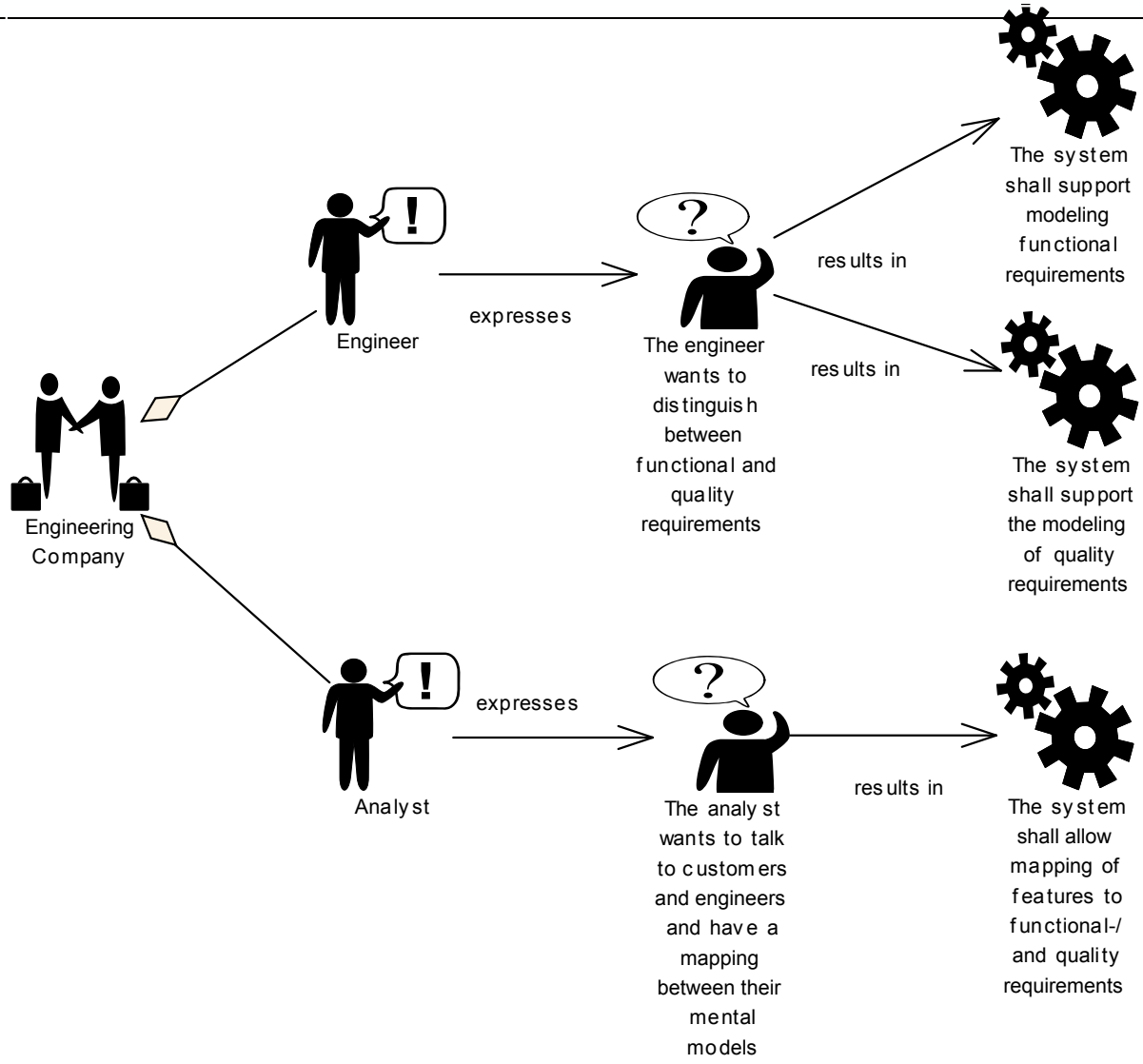
Analysis of Story 2



What they needed!



Analysis of Story 2 Where are the requirements?



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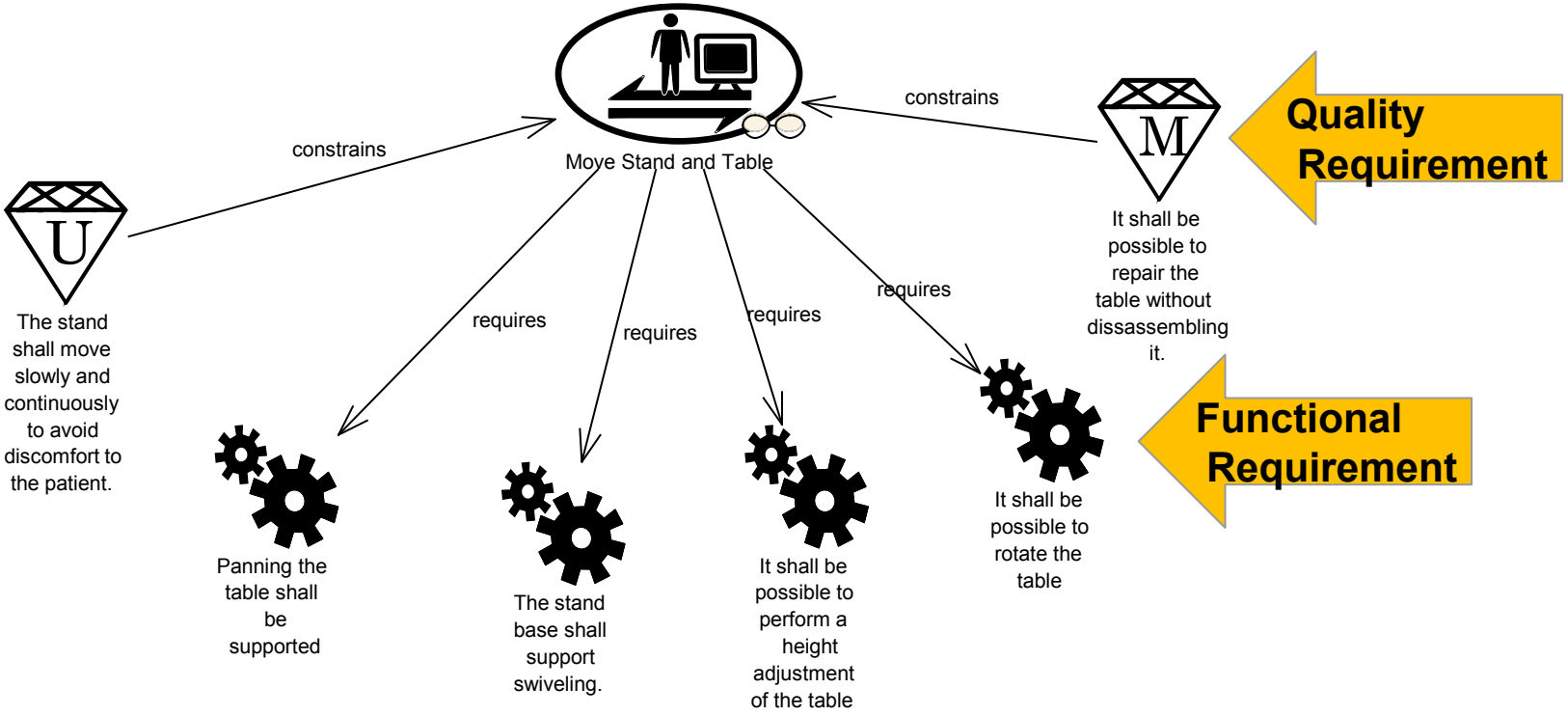
What the designers wanted to see



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Story 3 – Identification of hazards and threats

Phlebotomy - ORDER OF DRAW
Blood collection tubes must be drawn in a specific order to avoid cross-contamination of additives between tubes. The recommended order of draw for plastic vacutainer tubes is:

First - blood culture bottle or tube (yellow or yellow-black top)

Second - coagulation tube (light blue top). If just a routine coagulation assay is the only test ordered, then a single light blue top tube may be drawn. If there is a concern regarding contamination by tissue fluids or thromboplastins, then one may draw a non-additive tube first, and then the light blue top tube.

Third - non-additive tube (red top)

Last draw - additive tubes in this order:

SST (red-gray or gold top). Contains a gel separator and clot activator.

Sodium heparin (dark green top)

PST (light green top). Contains lithium heparin anticoagulant and a gel separator.

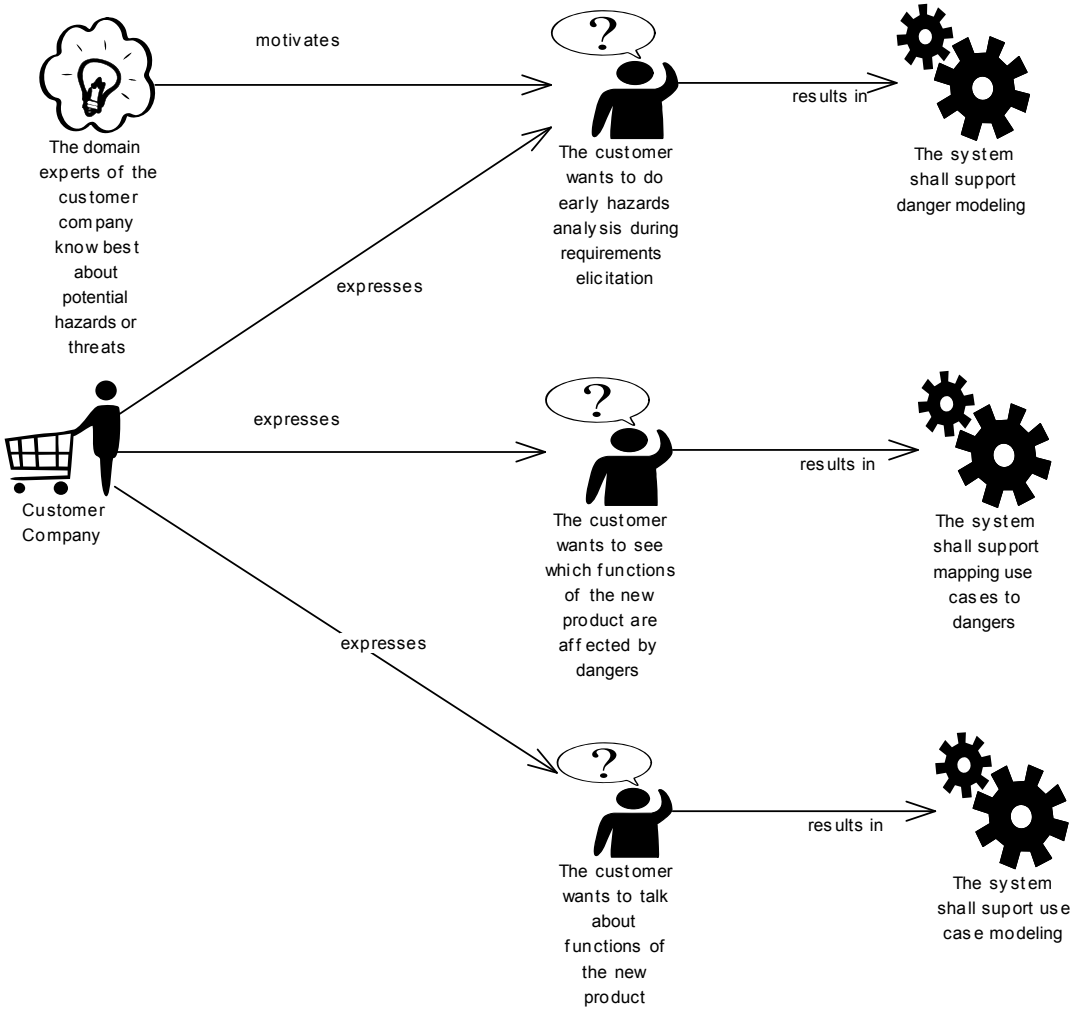
EDTA (lavender top)

ACDA or ACDB (pale yellow top). Contains acid citrate dextrose.

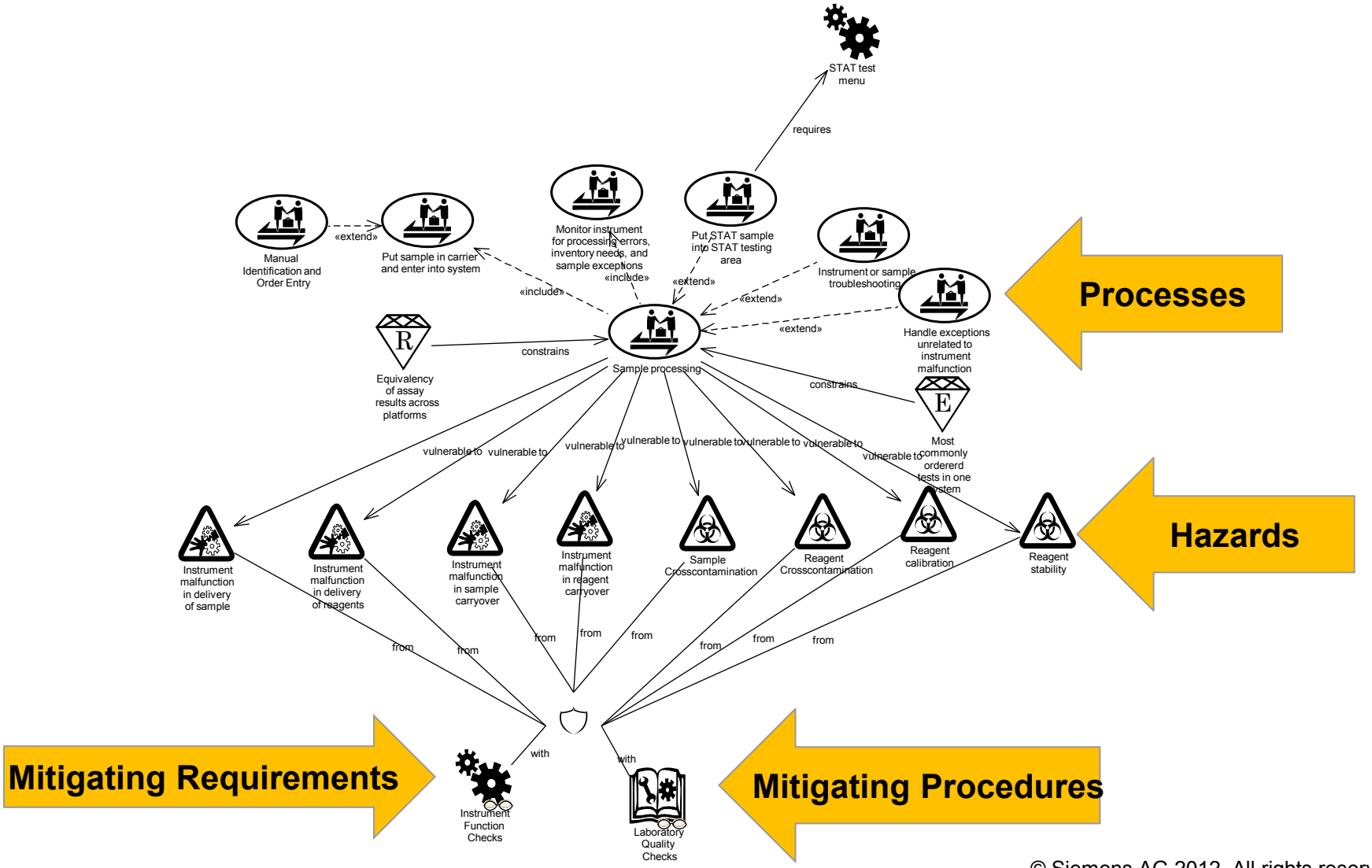
Oxalate/fluoride (light gray top)

NOTE:Tubes with additives must be thoroughly mixed. Erroneous test results may be obtained when the blood is not thoroughly mixed with the additive

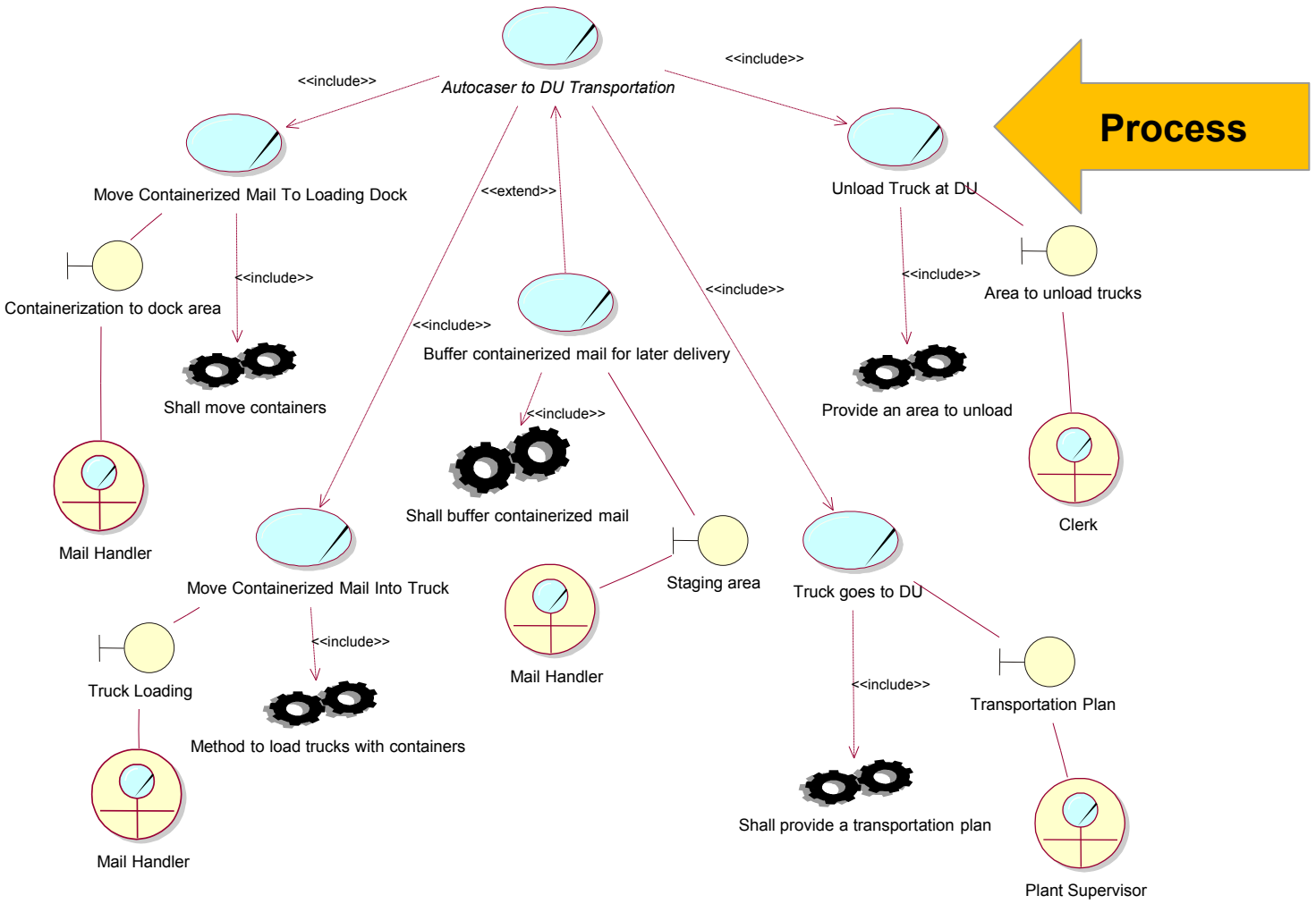
Analysis of Story 3



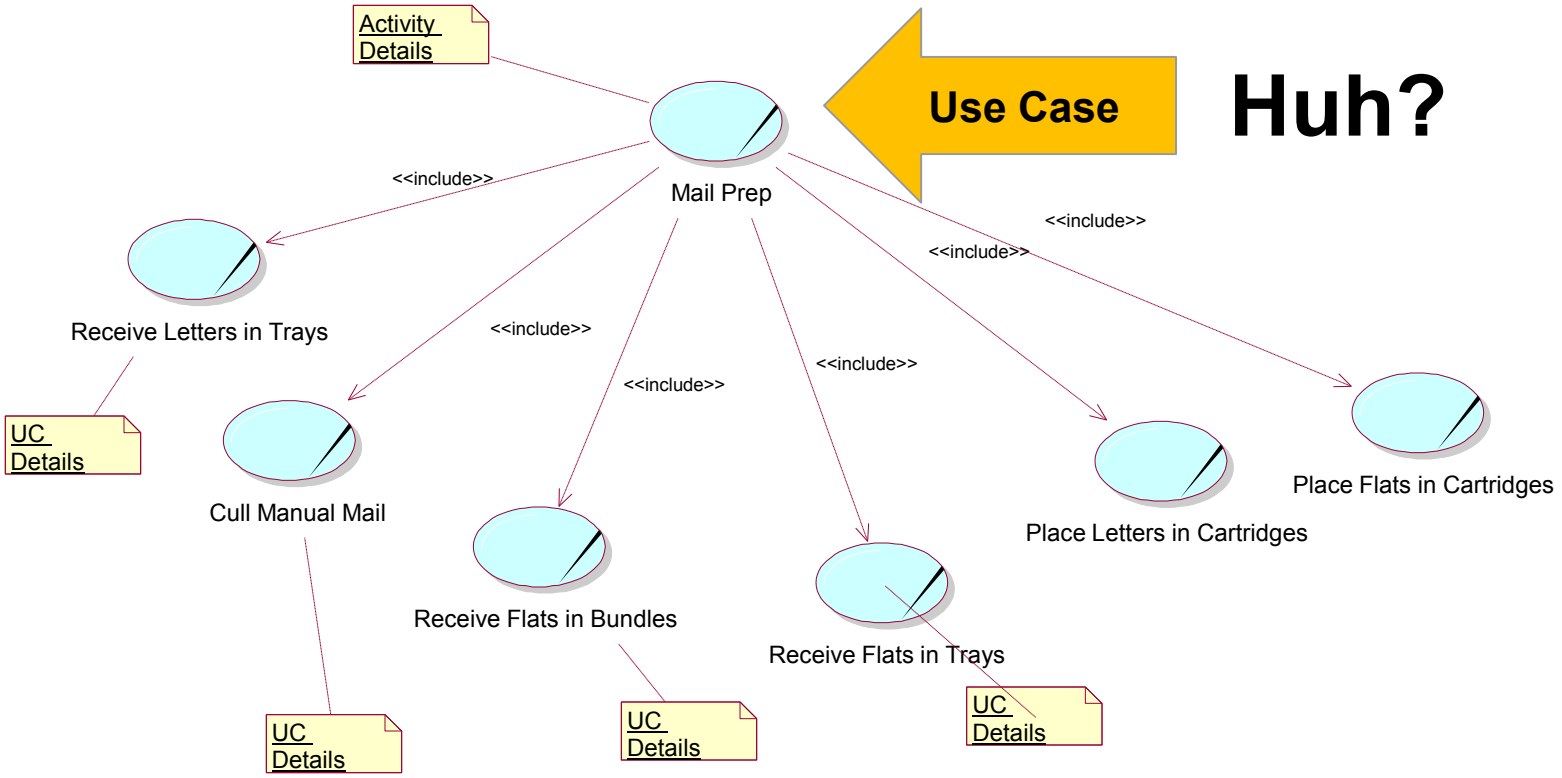
What the designers wanted to see



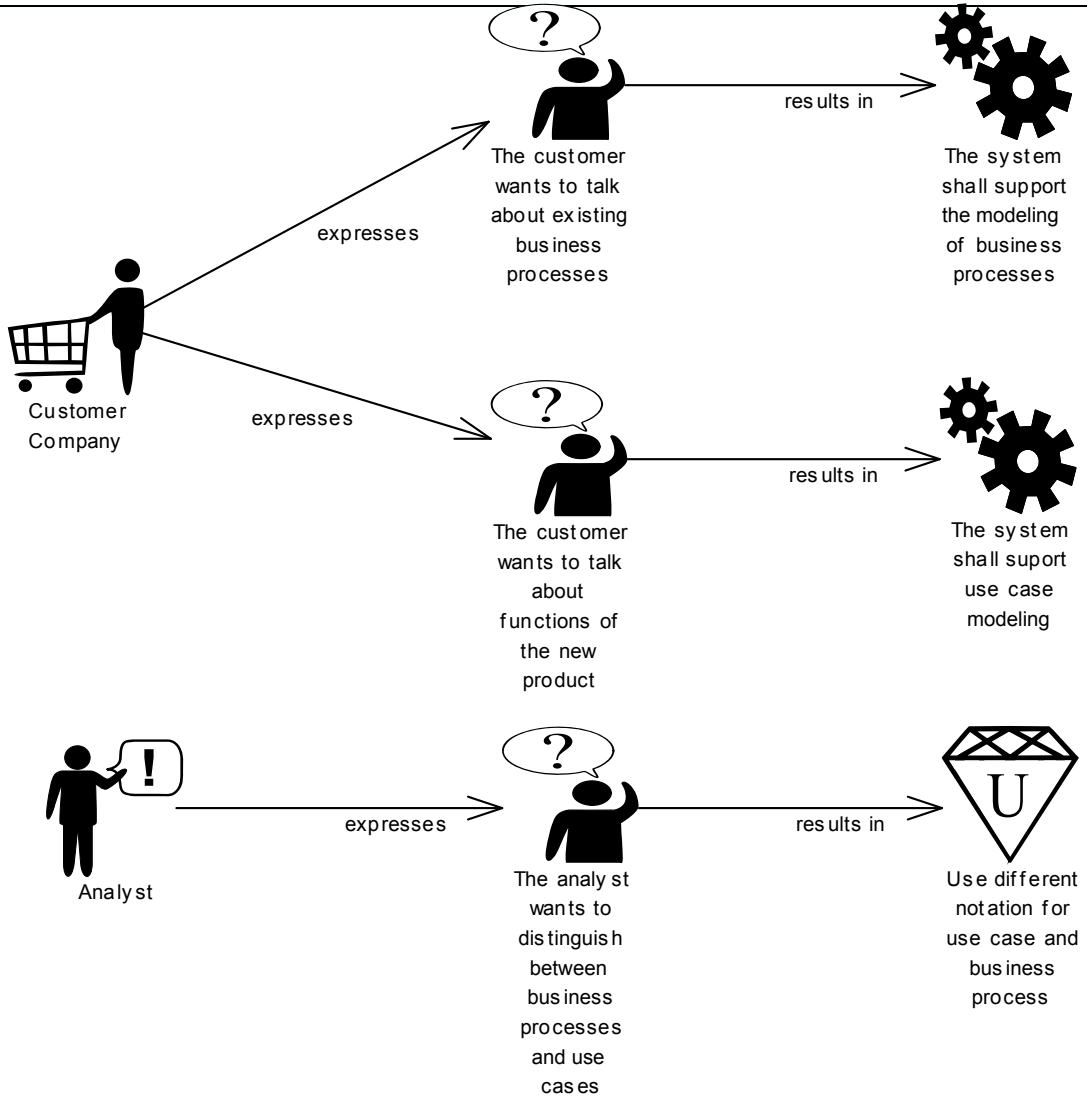
Use Case vs. Process



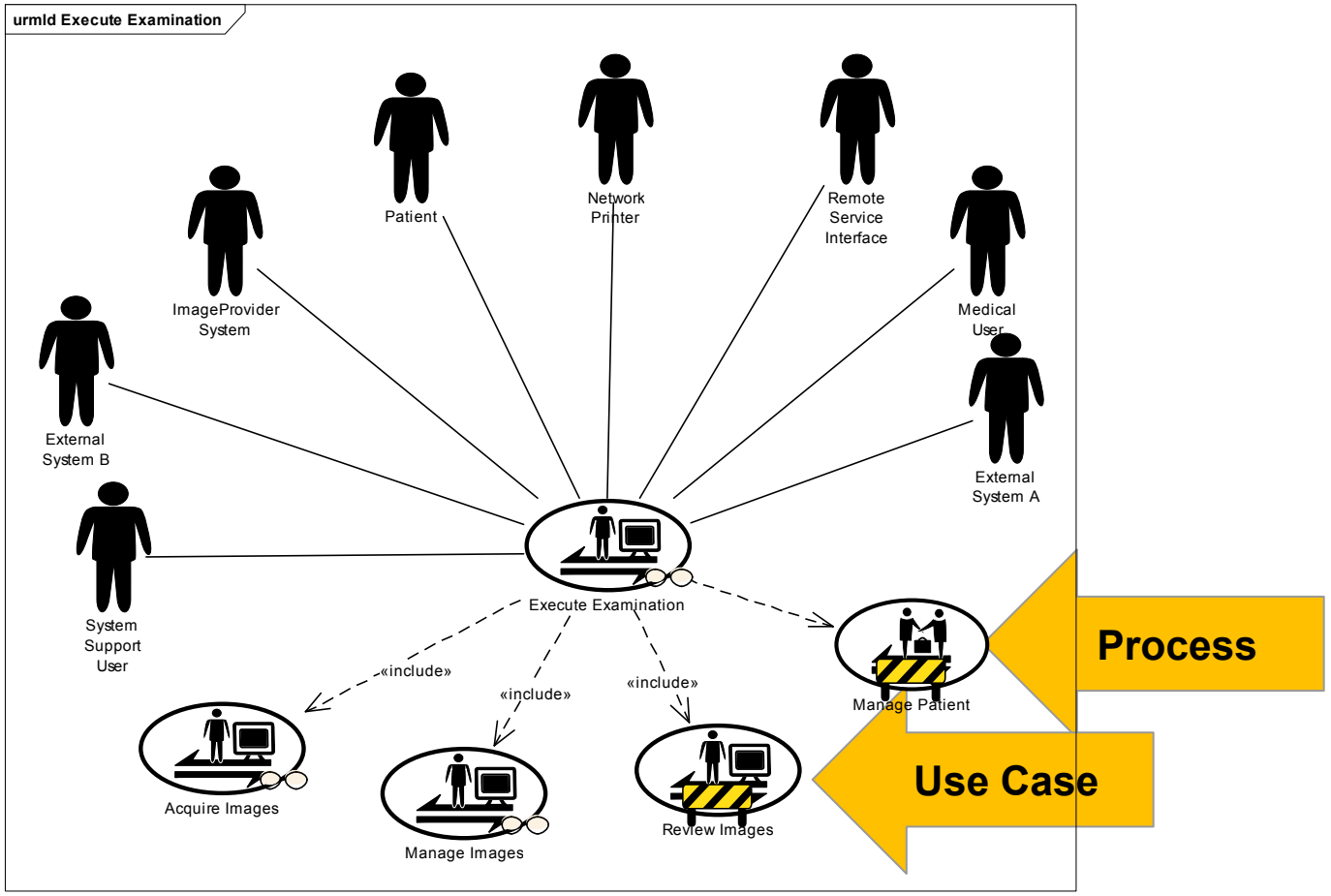
Use Case vs. Process

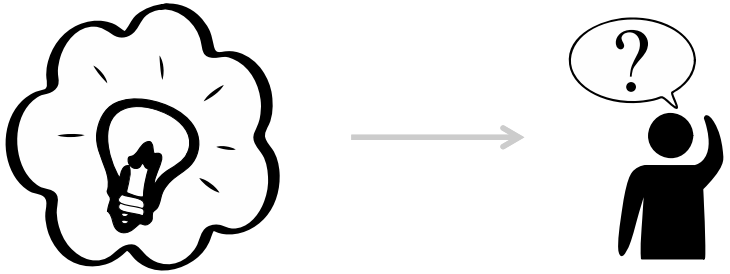


Analysis of Story 4



Maybe this?





Why not address all these requirements in one graphical language?

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Unified Requirements Modeling Language (URML)

- ✓Abstract Syntax
- ✓Incorporation of concepts
- ✓Well-formedness rules (in progress)
- ✓Concrete Syntax
- ✓Icon-based
- ✓Semantics
- ✓Informal (as in the UML).

Abstract Syntax Meta-Model

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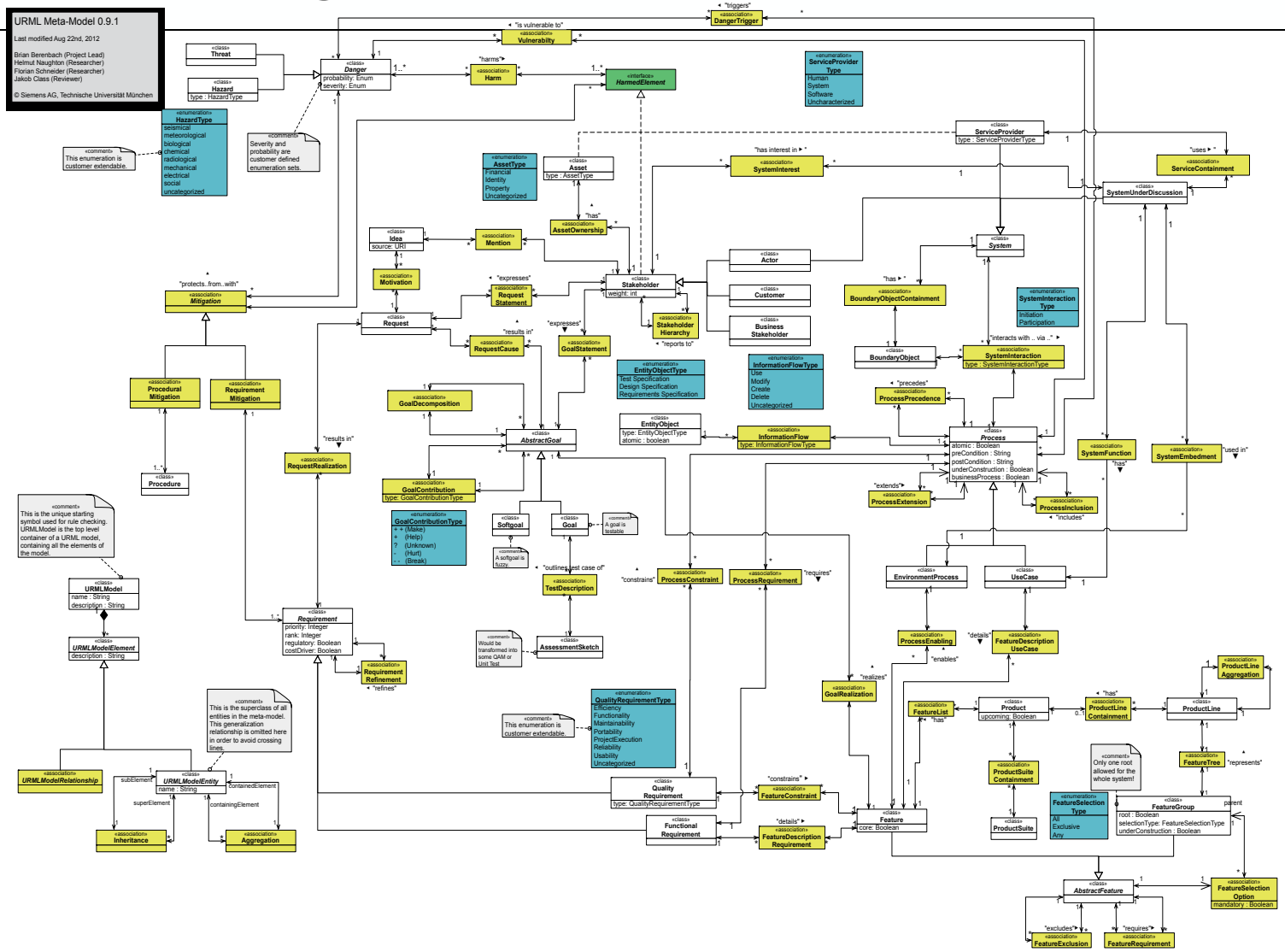

Abstract Syntax Meta-Model

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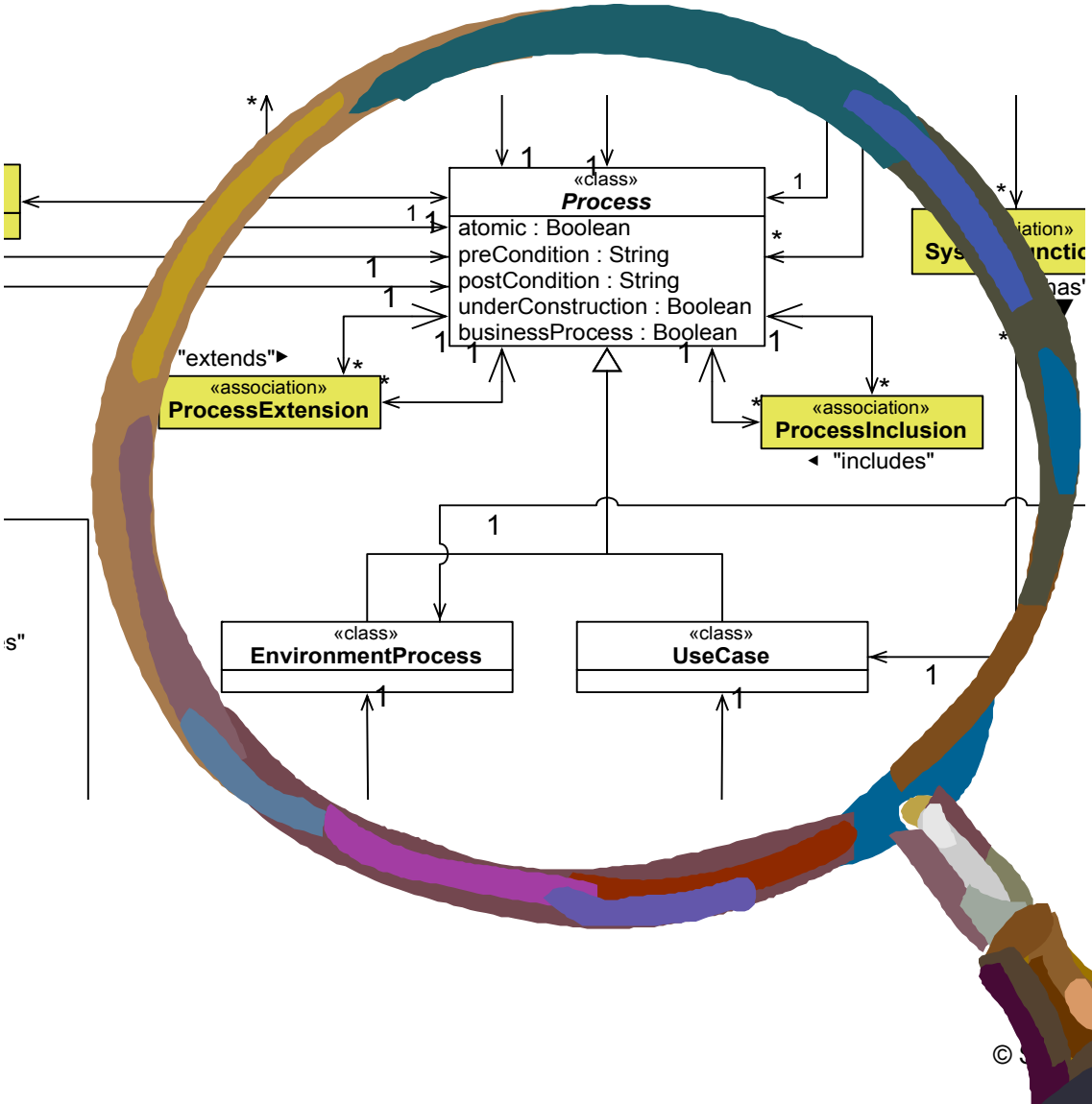

Abstract Syntax Meta-Model

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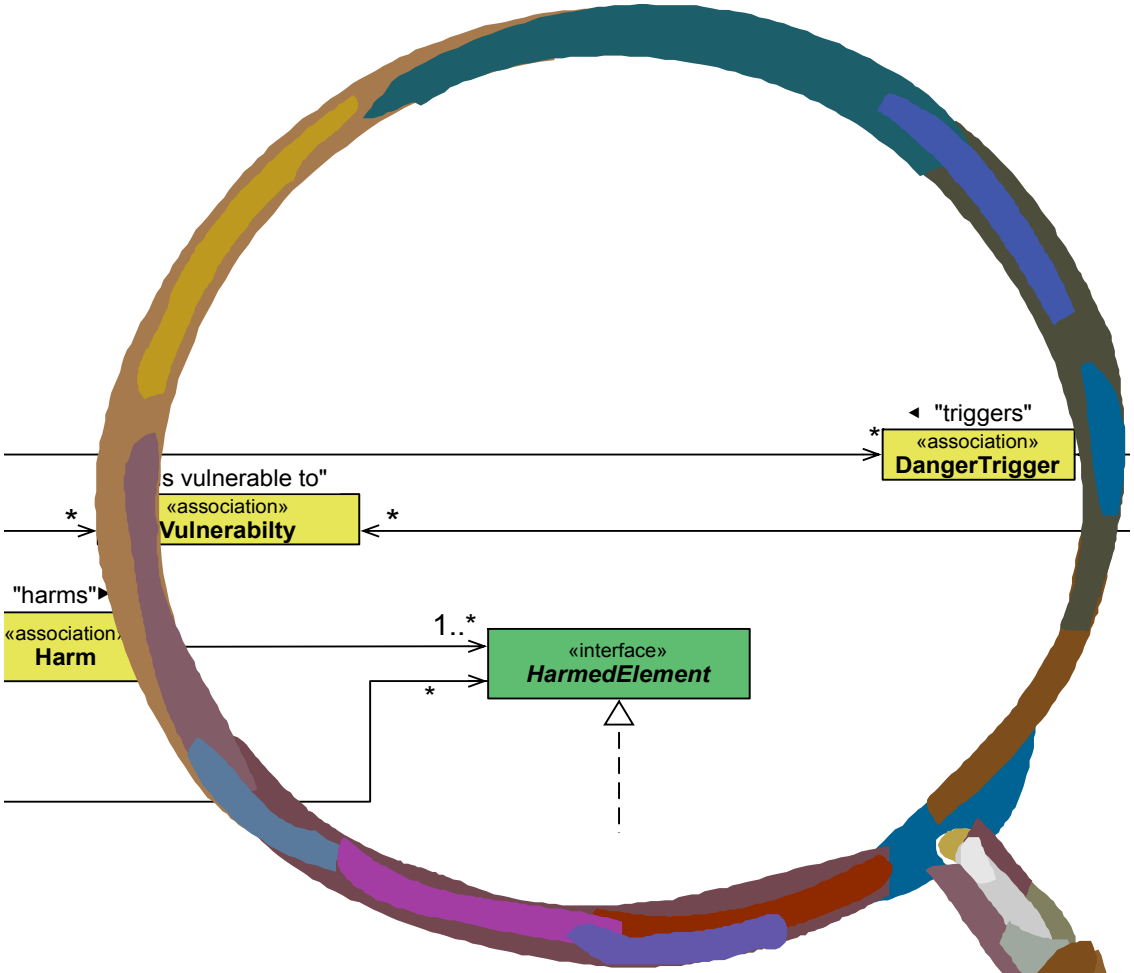

Abstract Syntax Meta-Model

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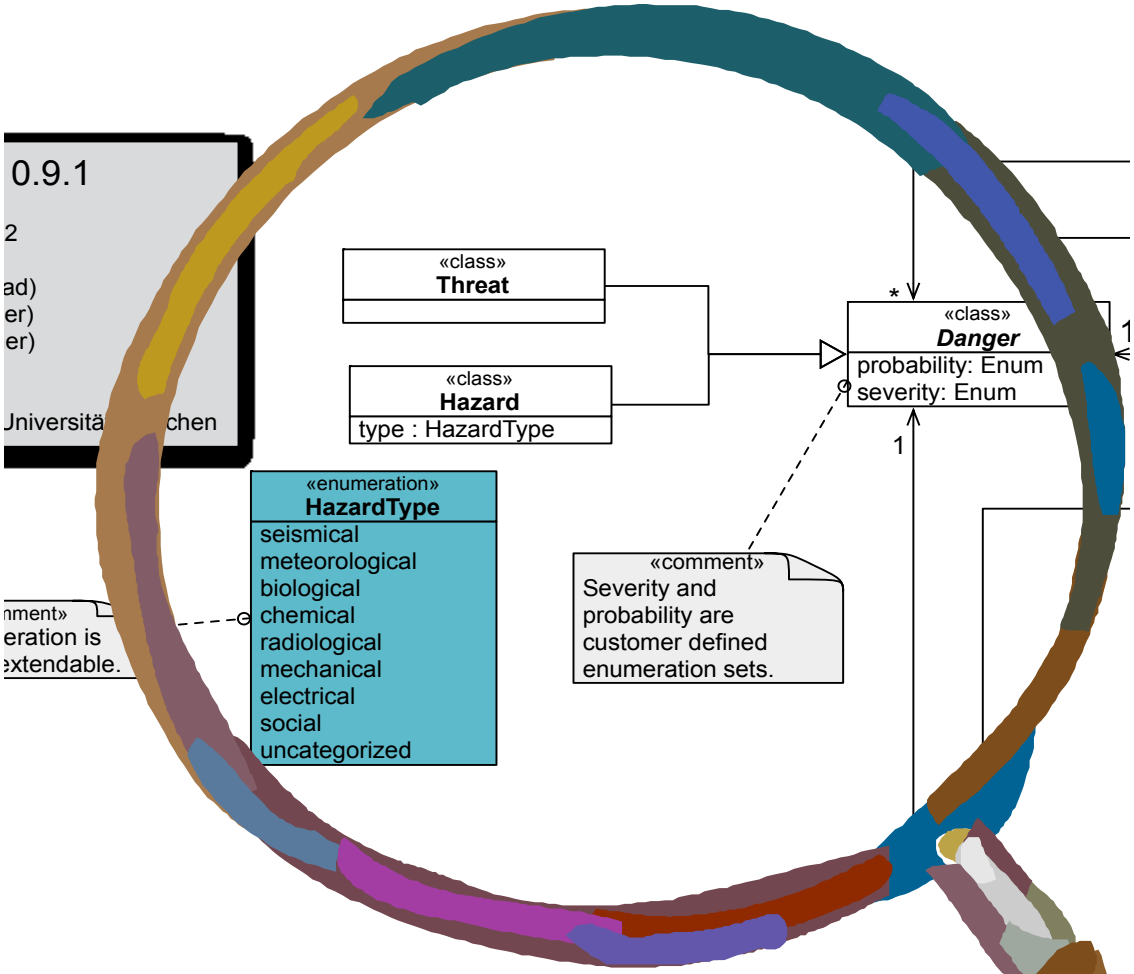

Abstract Syntax Meta-Model

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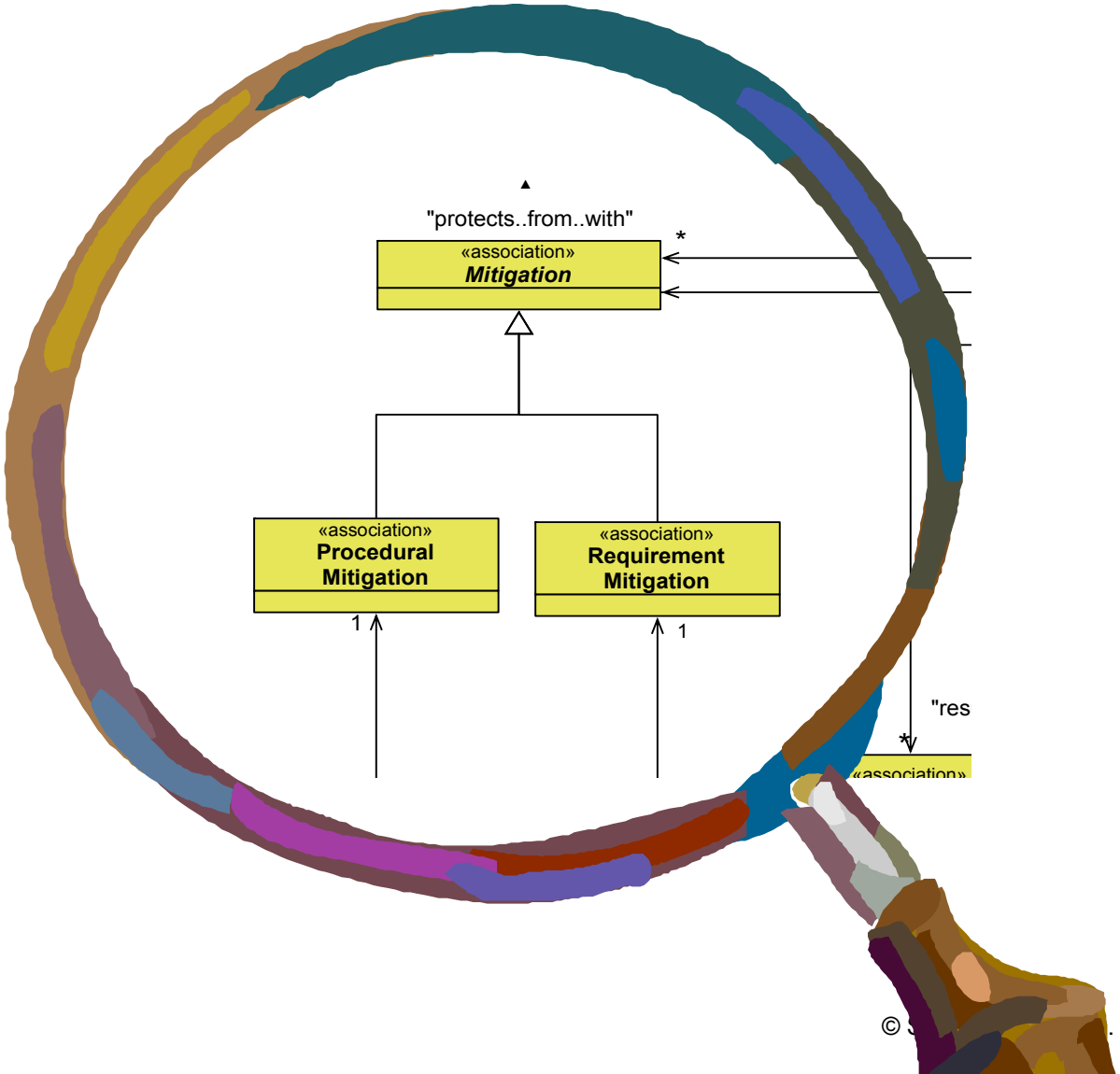

Abstract Syntax Meta-Model

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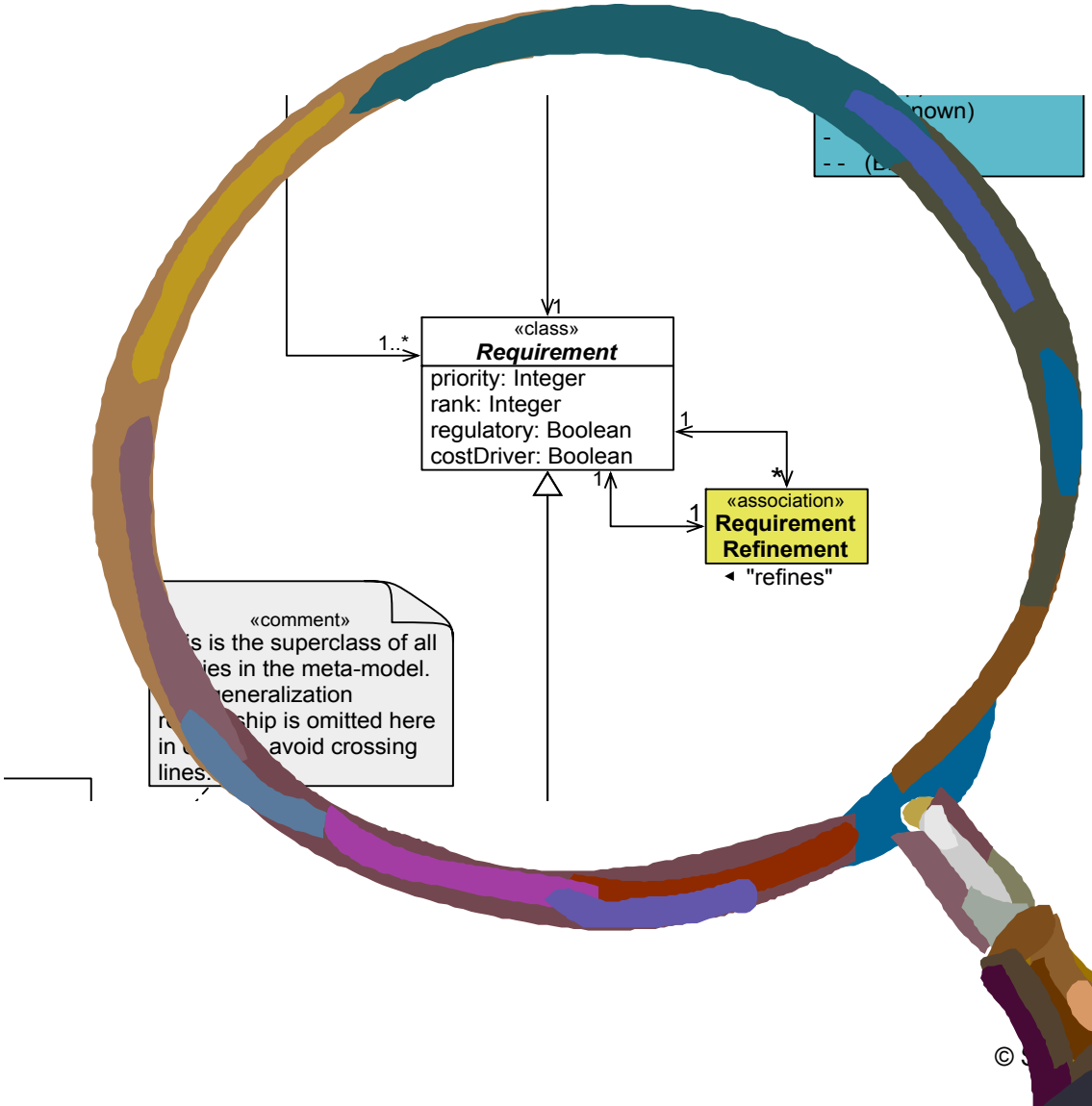

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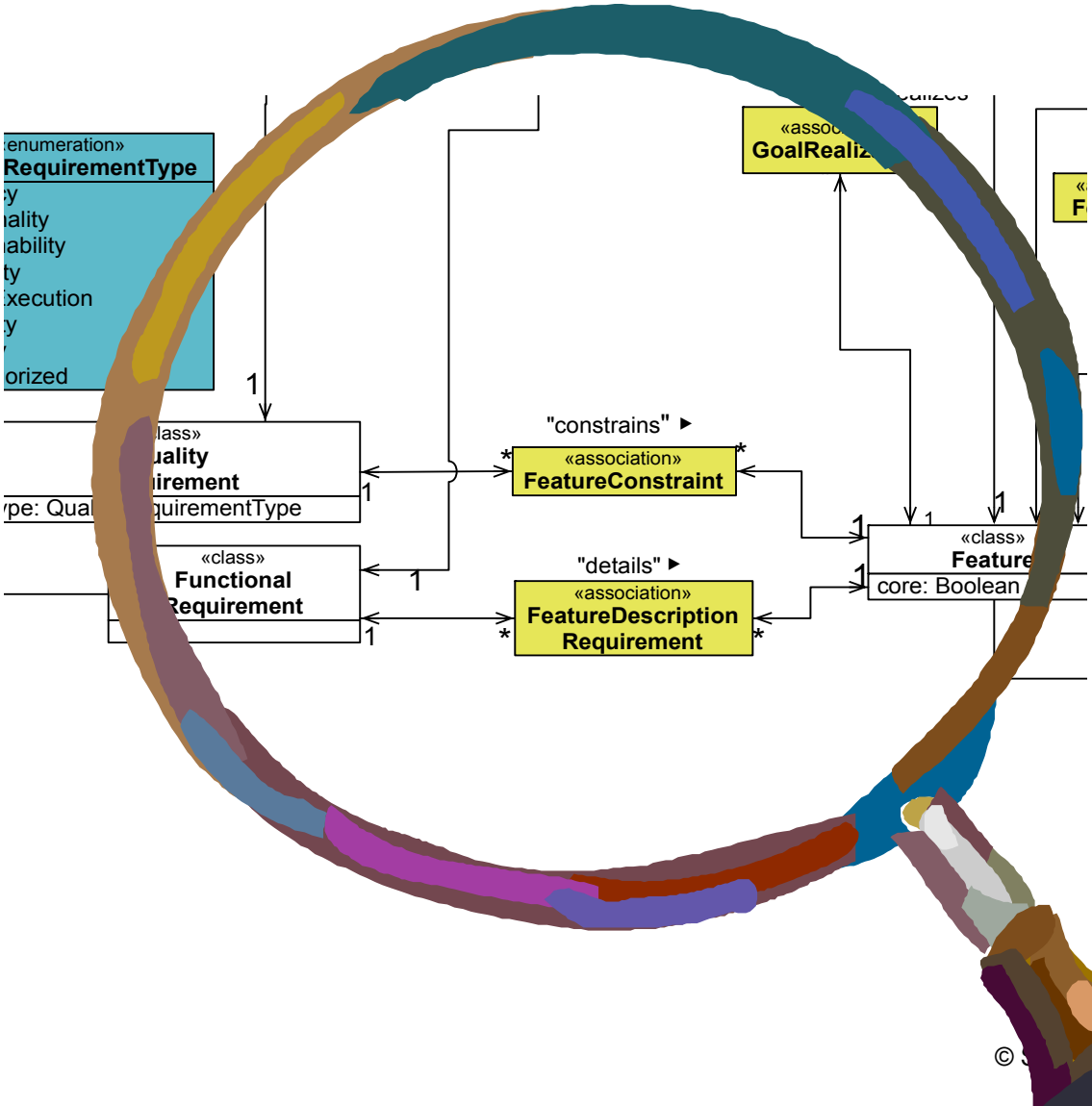

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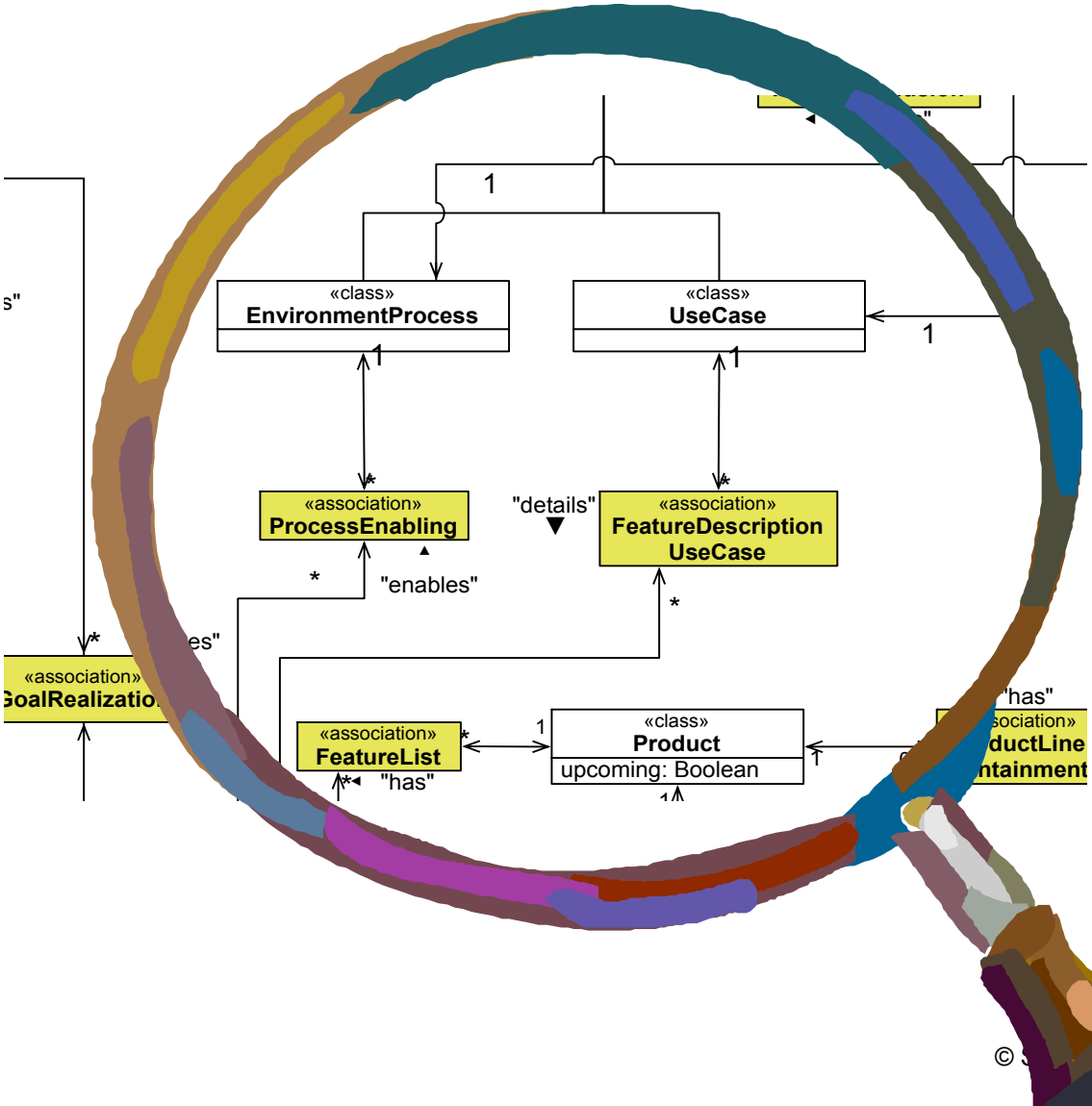

Abstract Syntax Meta-Model

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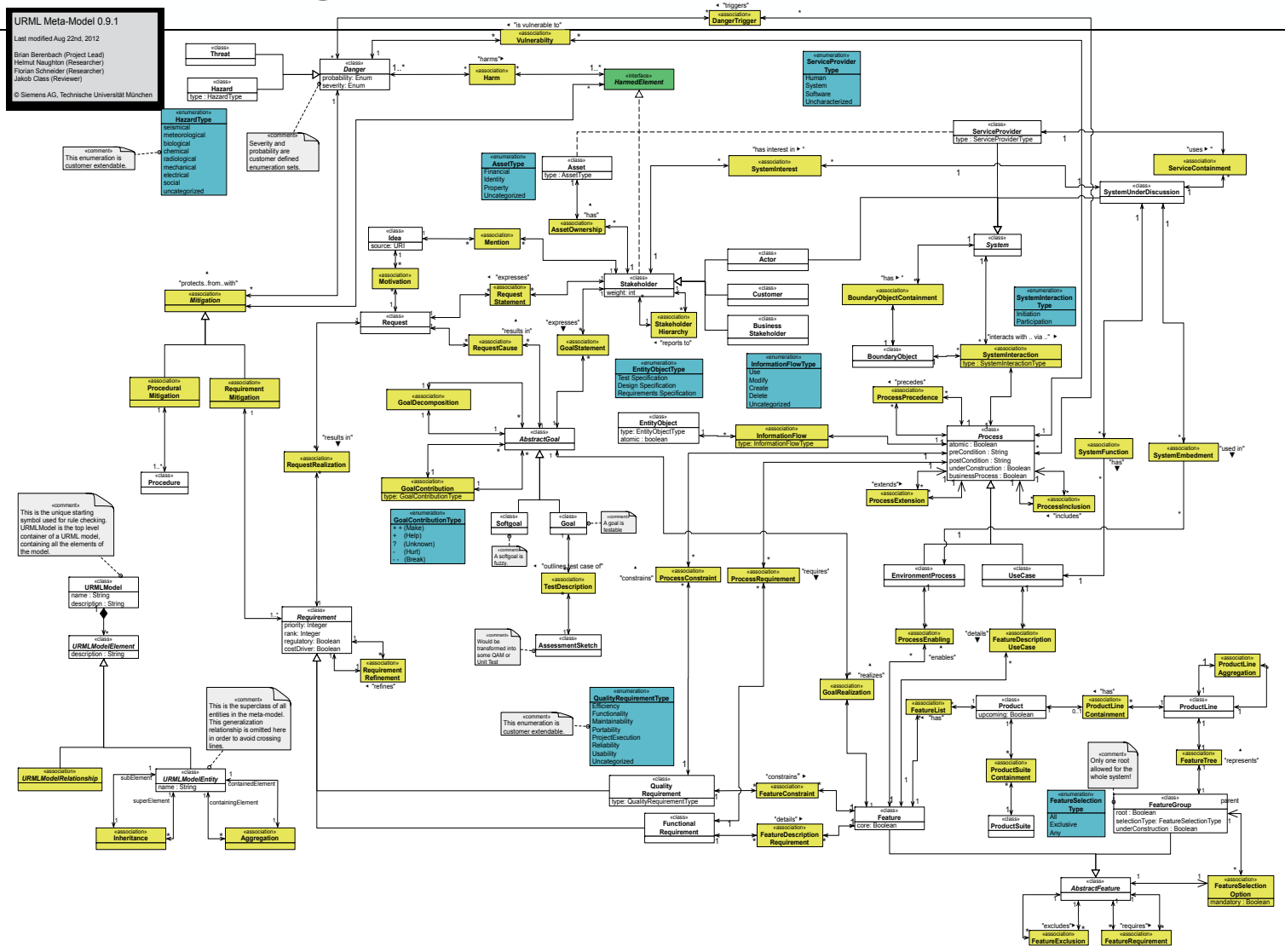

Simplified Abstract Syntax Meta-Model

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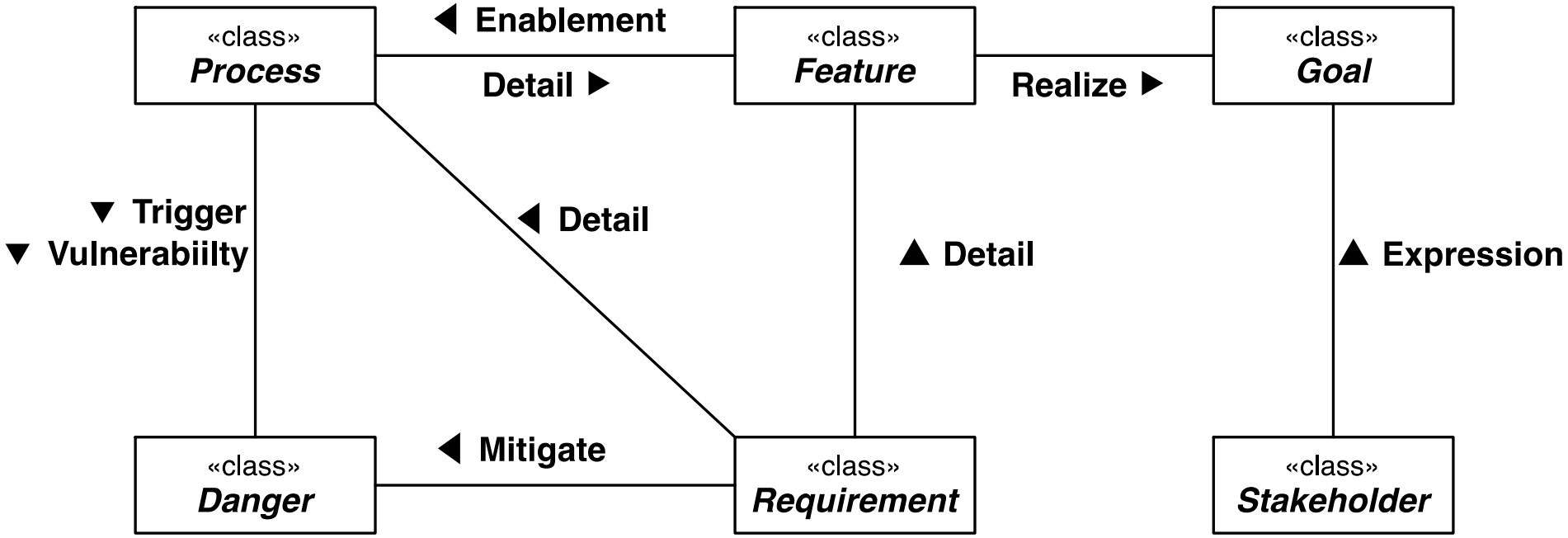
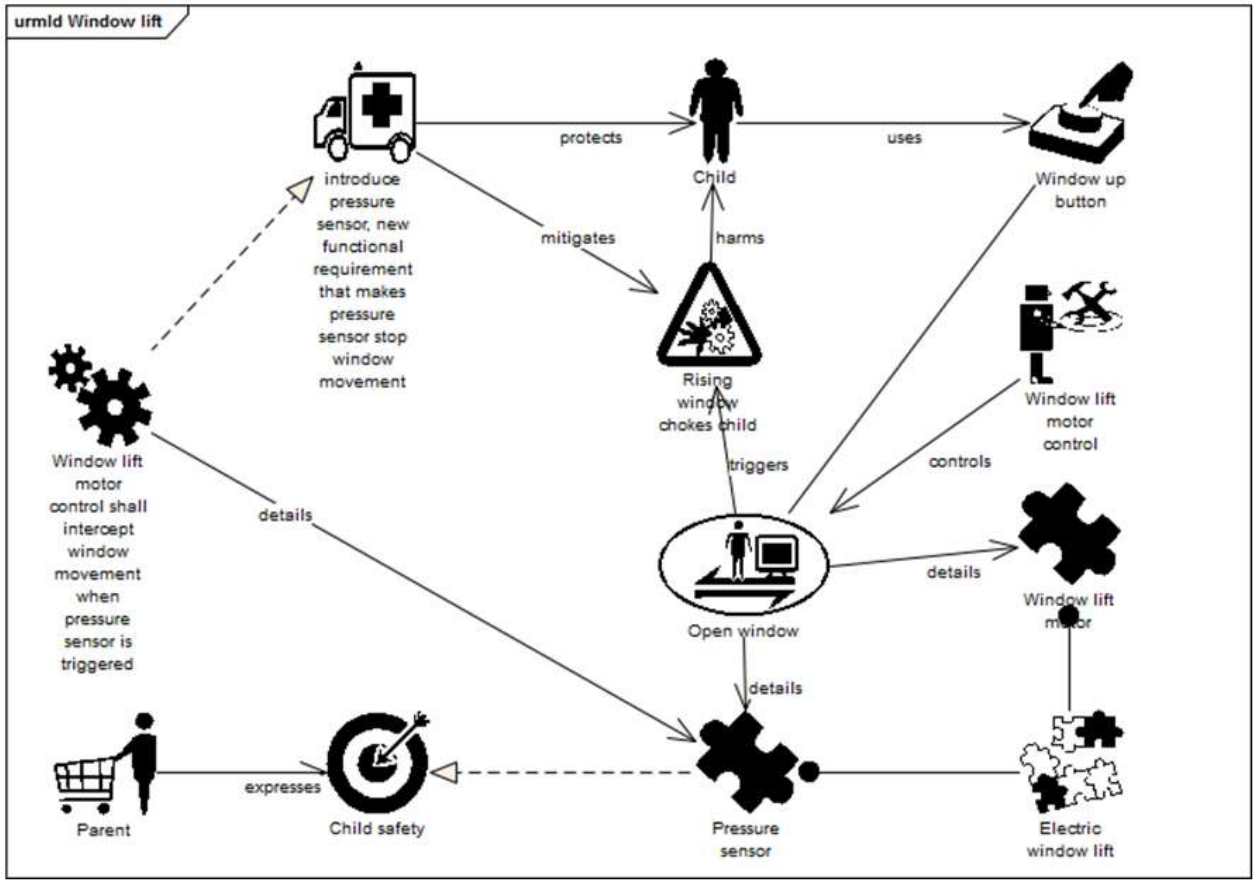


Focus of the URML

The Unified Requirements Modeling Language permits a unified, holistic view of systems



System & Process Modeling

Goal Modeling

Product Line Engineering

Danger Modeling

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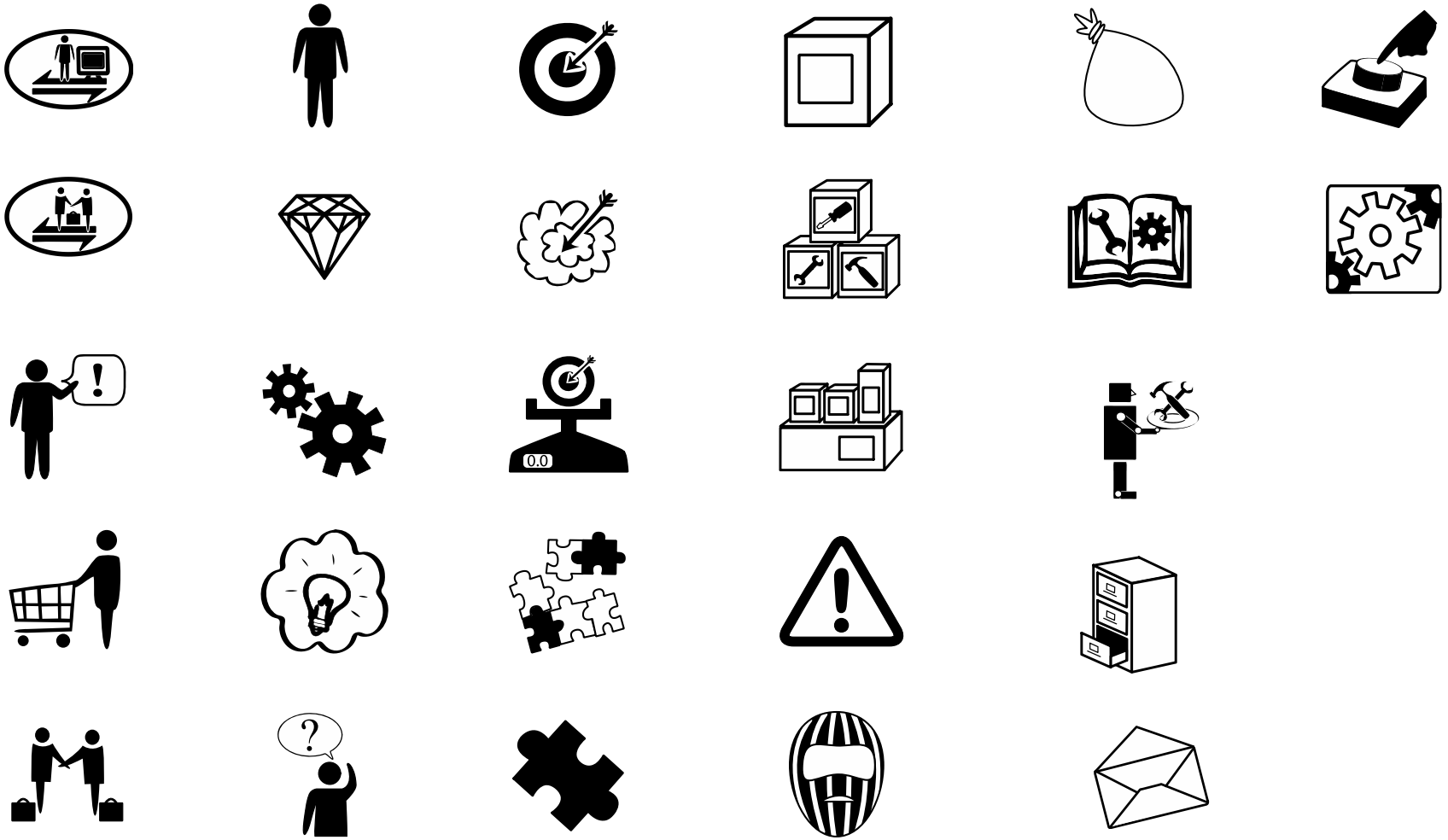
Visual Notation (Excerpt)



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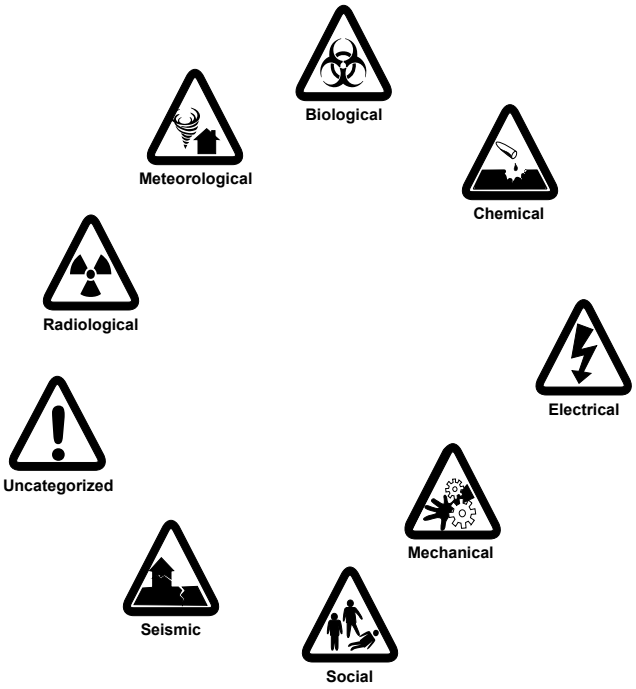
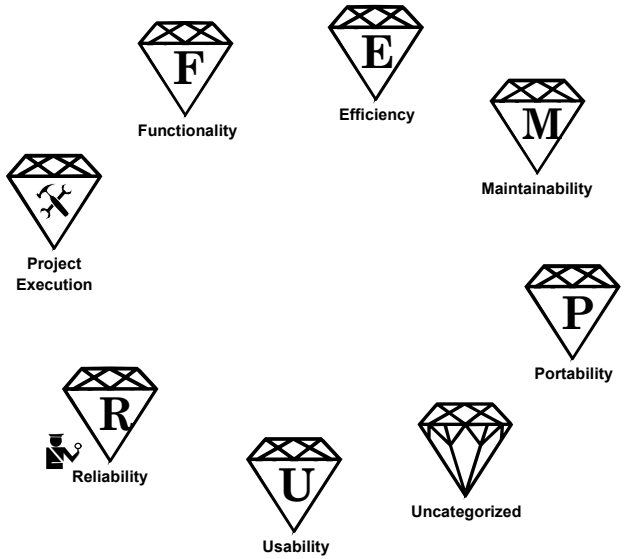
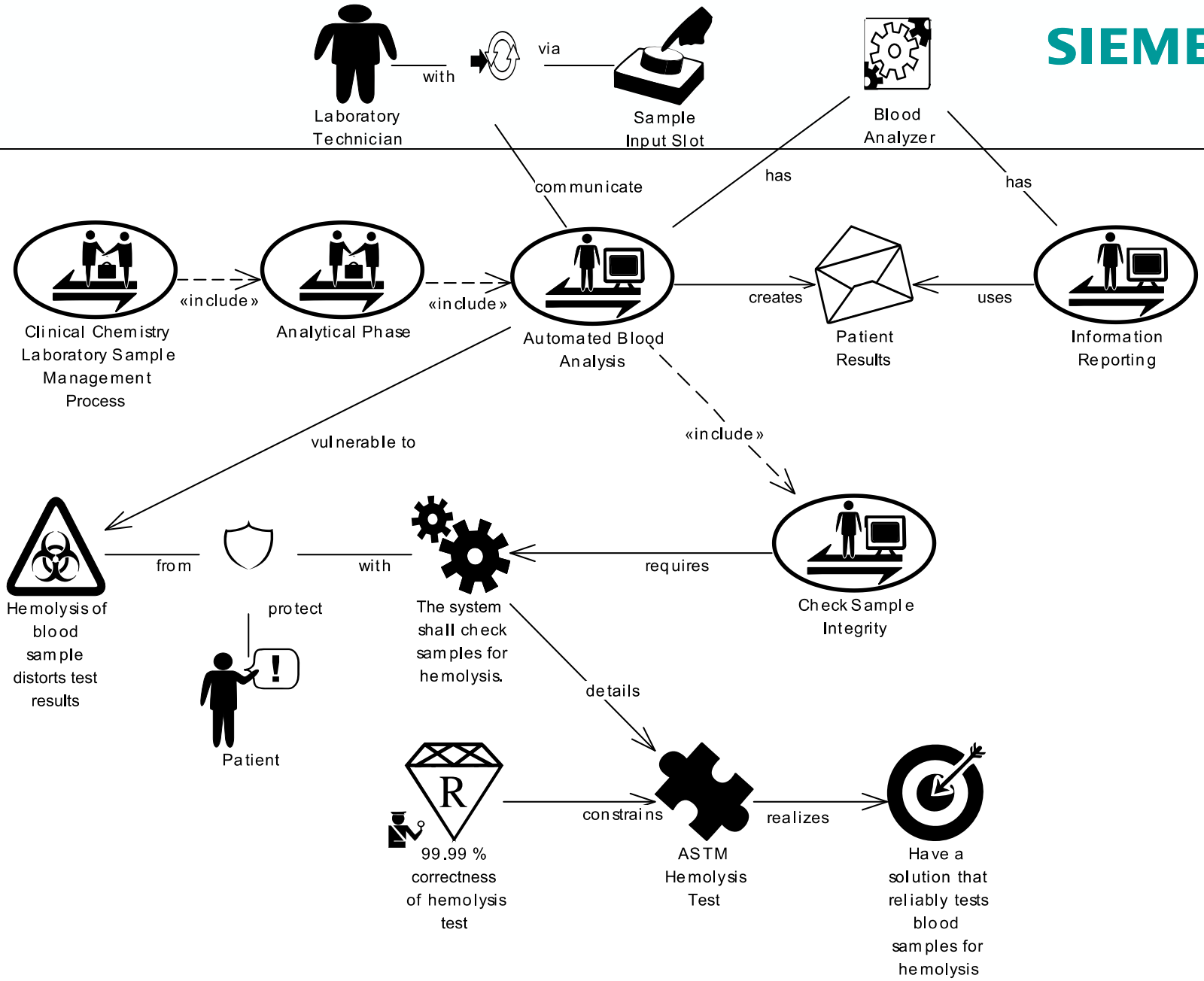
Variants of Hazard + Quality Requirement Icons

The visual notation has two kinds of overlays:

1) **A type-specific overlay (e.g. Efficiency Quality Requirement)**
2) **Attribute-specific overlay (e.g. Requirement that is a regulatory requirement)**







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Evaluation Results

✓Positive Feedback
– Goals, features, and requirements in the the same tool
  • Design tradeoffs
– Product Lines, Features, and requirements in the same tool
  • Product map with requirements traceability
– Processes and dangers in the same tool
  • Process-related danger
✓Issues
– Bugs in meta-model in general (fixed now)
– Clear guidelines missing for an interface between the URML and design-oriented languages (UML, SysML)
– Implementation UML Profile-based (with deficiencies of the UML)

"For the first time I can see where there are so many issues with this step of the process!" – a comment by a medical practitioner on seeing the hazards associated with the process step.

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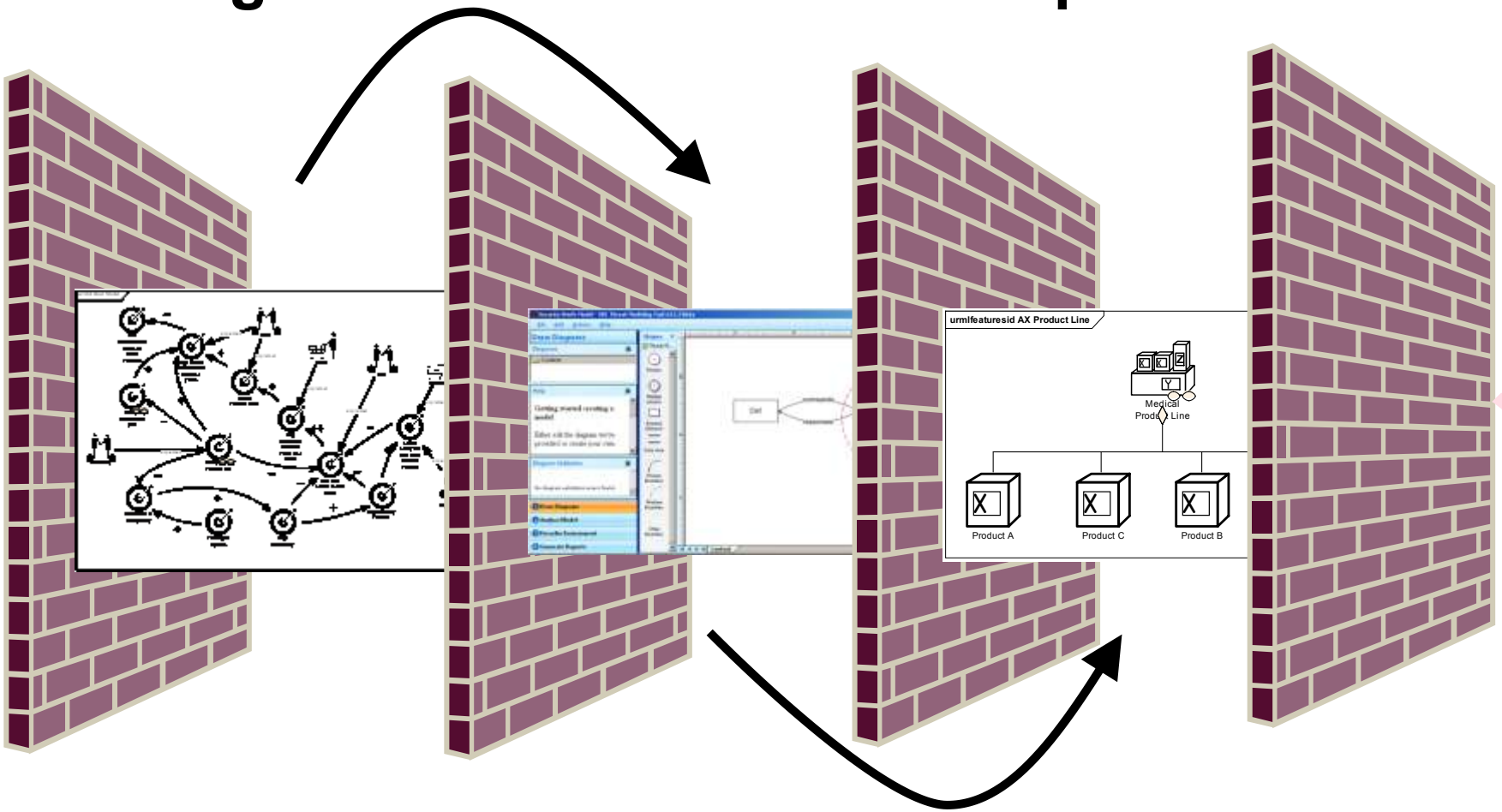
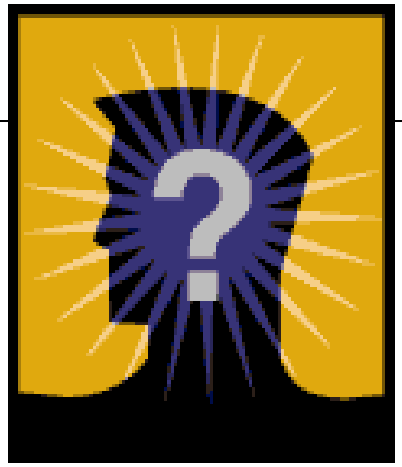
Solves the tracing problem

Tracing can be difficult with multiple tools



Conclusion

1. It Works
2. So why isn't everyone using it?



Questions?