



A new paradigm for early systems engineering

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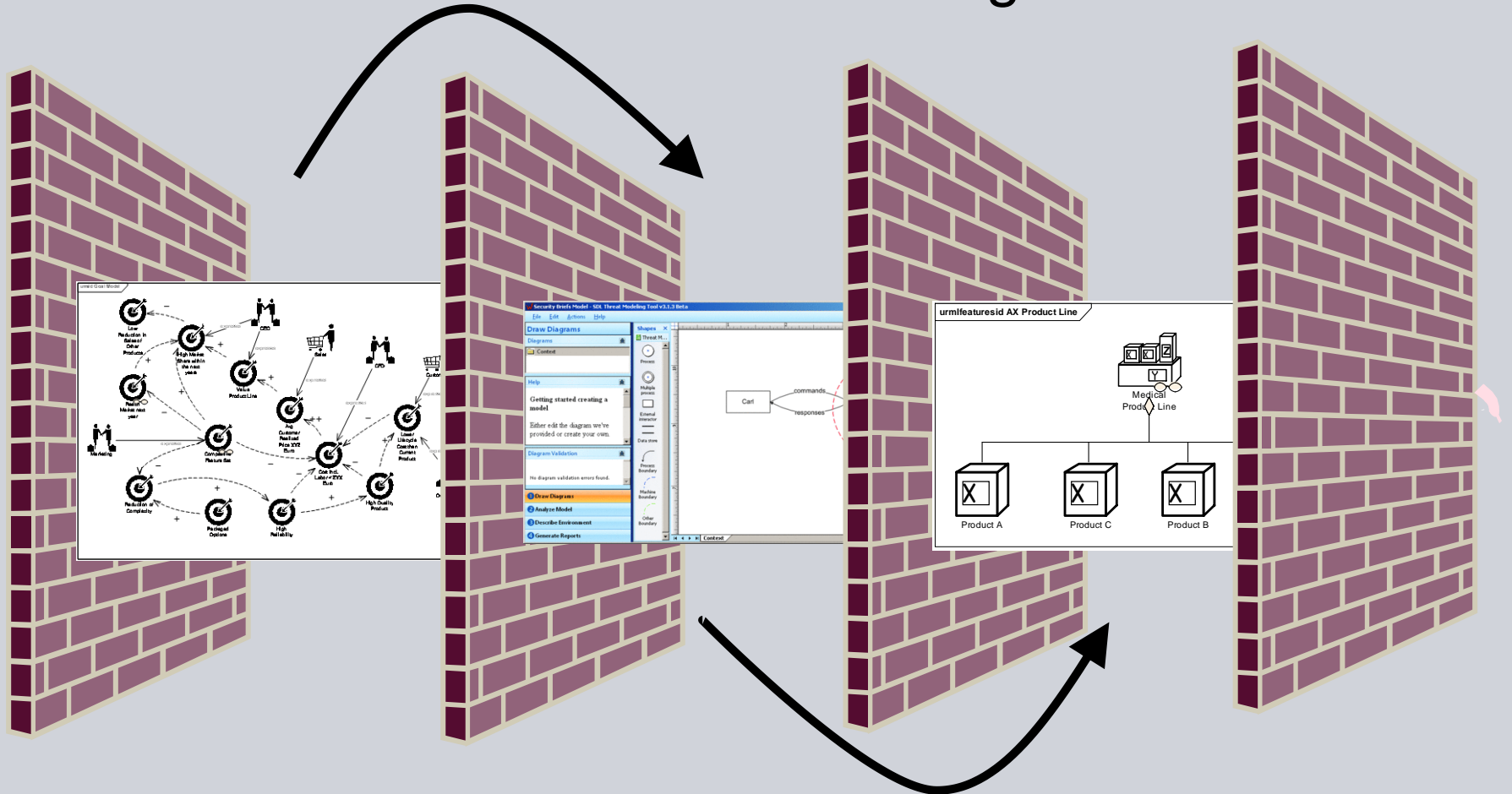
Problem Statement 1

We need a better/faster/easier way of capturing information upstream of design including:

- Capturing Ideas (Innovation)
- Goals & Goal Conflict Resolution
- Feature, Product & Product Line Definition
- Hazard & Thread Identification & Mitigation
- Distinction between Use Cases and Business Processes

Problem Statement 2

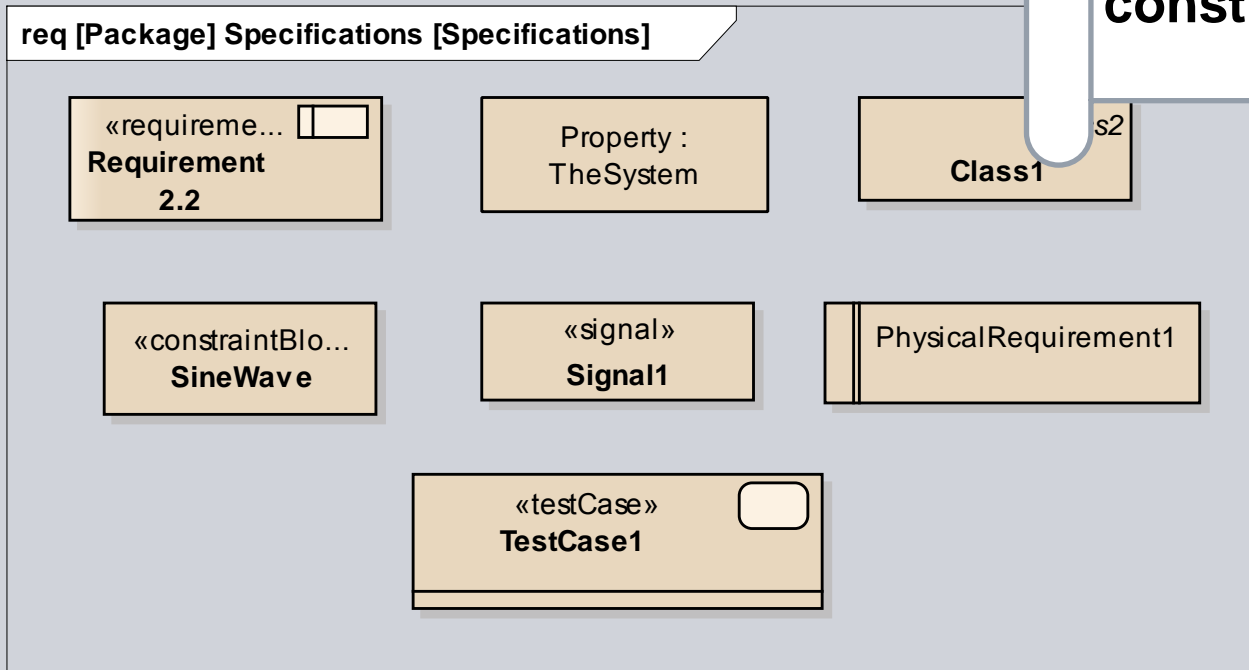
We need intrinsic End-to-End Tracing



Problem Statement 3

We Need Semiotic Clarity

Principle of Semiotic Clarity: There should be a 1:1 correspondence between semantic constructs and graphical symbols*

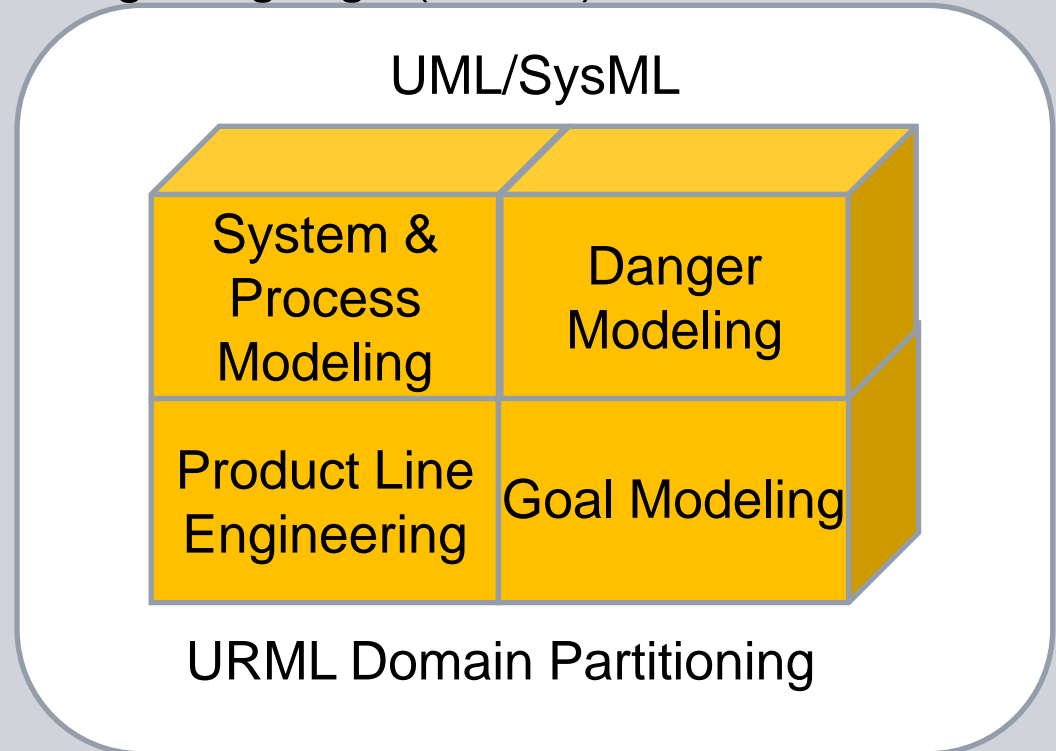


*Goodman, N., *Languages of Art: An Approach to a Theory of Symbols*. 1968, Indianapolis: Bobbs-Merrill Co.

Proposed Solution

The Unified Requirements Modeling Language (URML)

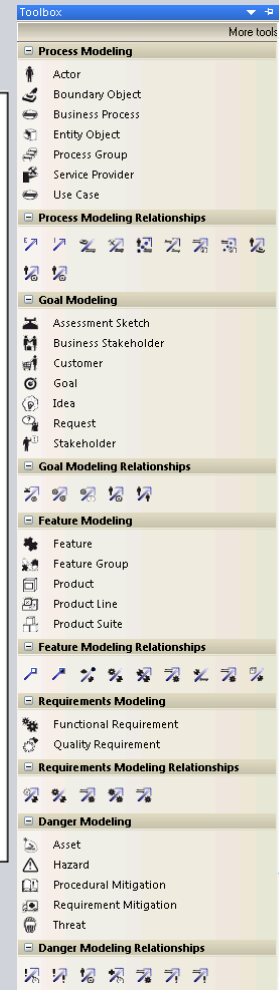
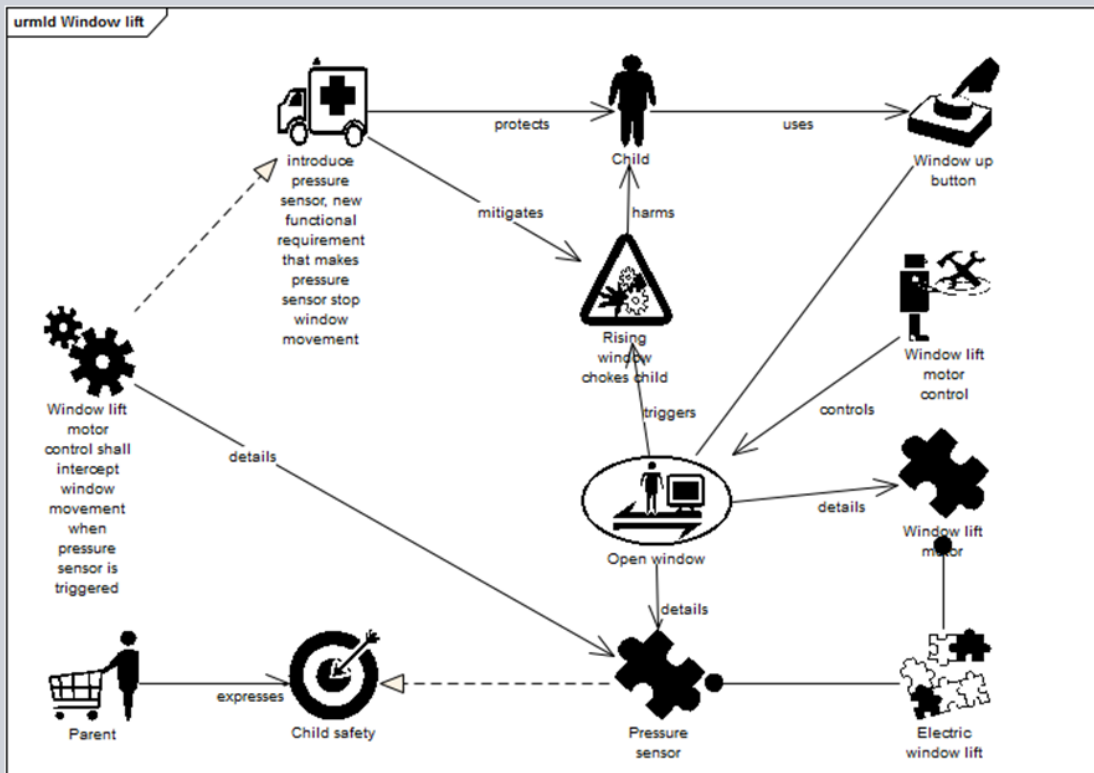
- ✓ Has an abstract syntax
- ✓ and a concrete syntax
- ✓ and semantics^{1,2}
- ✓ Partial Integration with UML/SysML



1. B. Selic, "The Theory and Practice of Modeling Language Design for Model-Based Software Engineering---A Personal Perspective,"
2. A. Kleppe, *Software Language Engineering: Creating Domain-Specific Languages Using Metamodels*,

Focus of the URML

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



← System & Process Modeling

← Goal Modeling

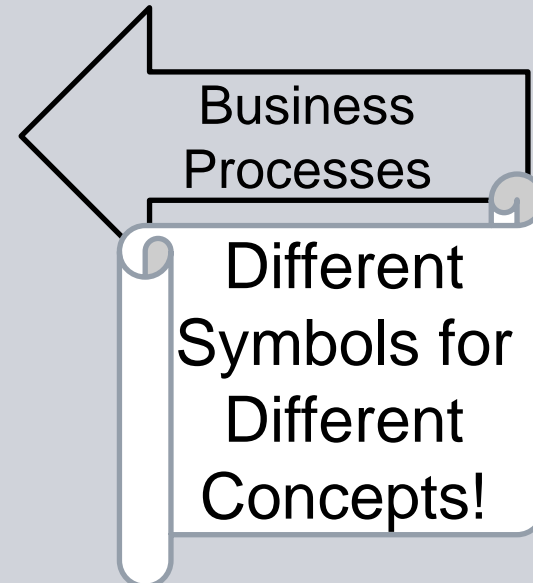
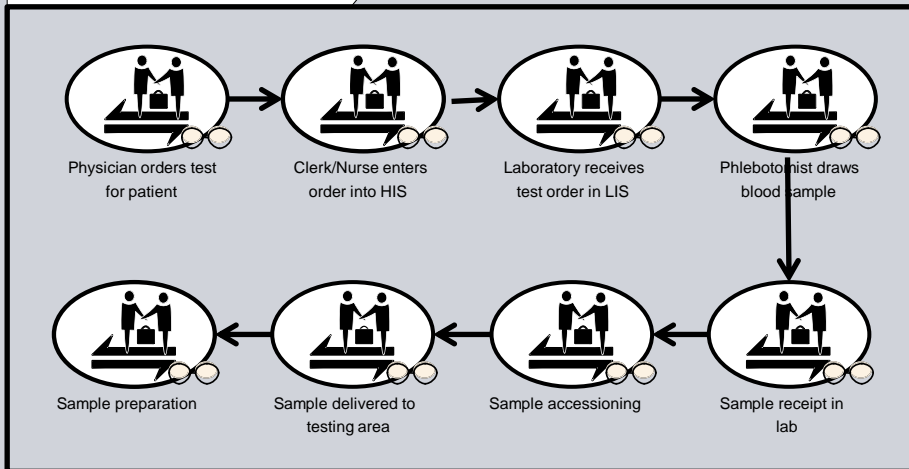
← Product Line Engineering

← Traditional Requirements

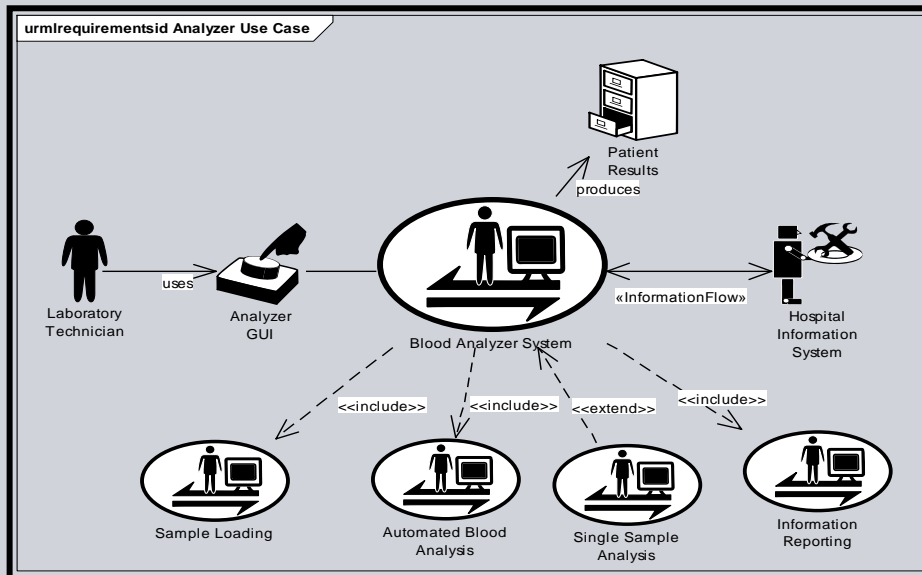
← Danger Modeling

Capture of System and Process Behaviour

urmlrequirementsid Pre-Analytical Phase



urmlrequirementsid Analyzer Use Case



Early Sketching of Product Lines and Variability

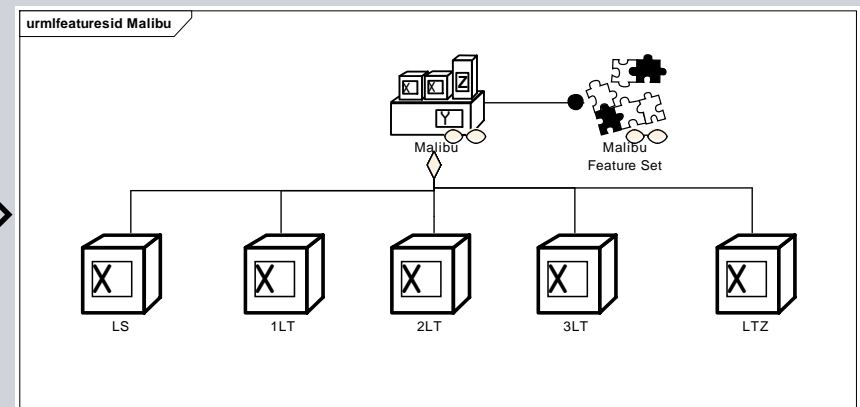
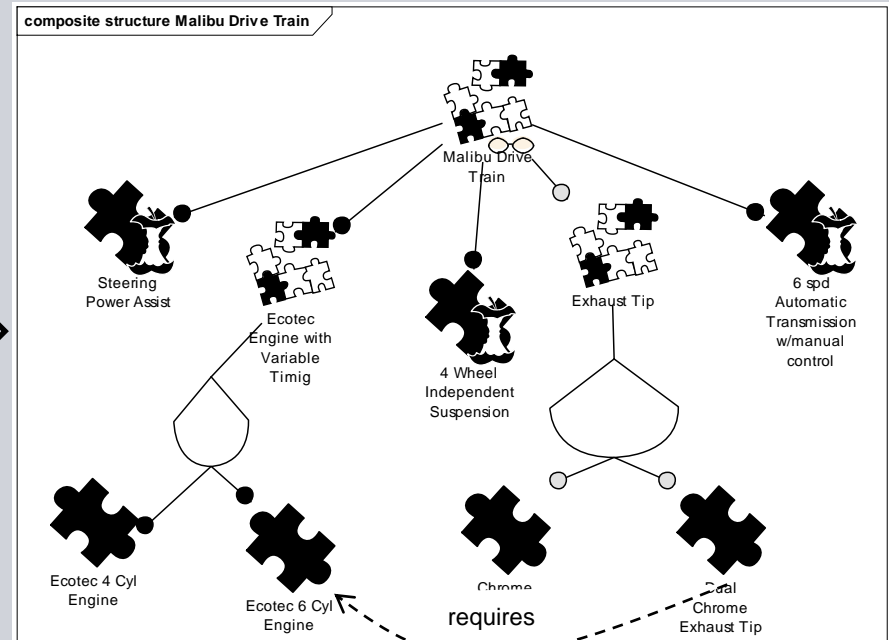
Source: Chevrolet Malibu Cars
Target: Model

Product Map	1LT	2LT	3LT	LS	LTX
4 Wheel Independent ...	↑	↑	↑	↑	↑
6 spd Automatic Tran...	↑	↑	↑	↑	↑
Air Bags - Front and Si...	↑	↑	↑	↑	↑
Brakes-4 Wheel AntiLo...	↑	↑	↑	↑	↑
Car Colored Molding	↑	↑	↑		
Chrome Exhaust Tip		↑	↑		↑
Door Handles-Car Col...				↑	
Door Handles-Chrome	↑	↑	↑		↑
Door locks: Power-pr...	↑	↑	↑	↑	↑
Dual Chrome Exhaust...		↑	↑		↑
Ecotec 4 Cyl Engine	↑			↑	
Ecotec 6 Cyl Engine		↑	↑		↑
Fog Lamps					↑
Glass Acoustic Laminat...	↑	↑	↑	↑	↑
Grille-Black	↑	↑	↑	↑	
Grille-Chrome					↑
Halogen Headlamps	↑	↑	↑	↑	↑
Lamps-Daytime Runni...	↑	↑	↑	↑	↑
Mirrors-Black				↑	

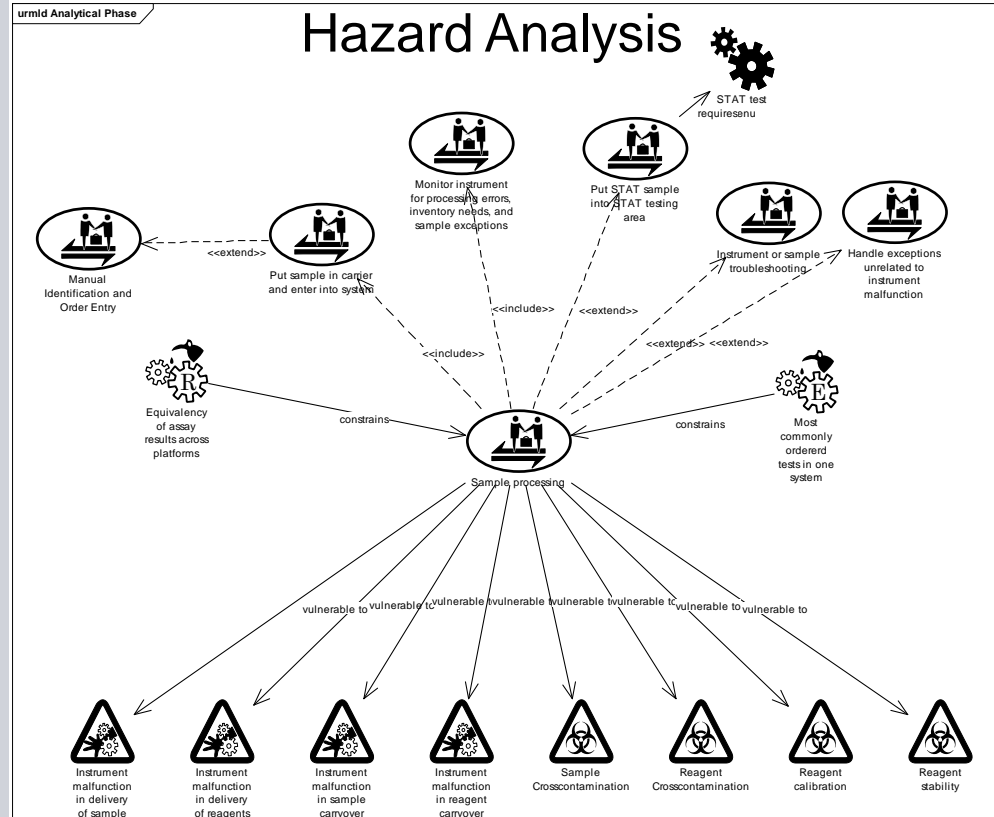
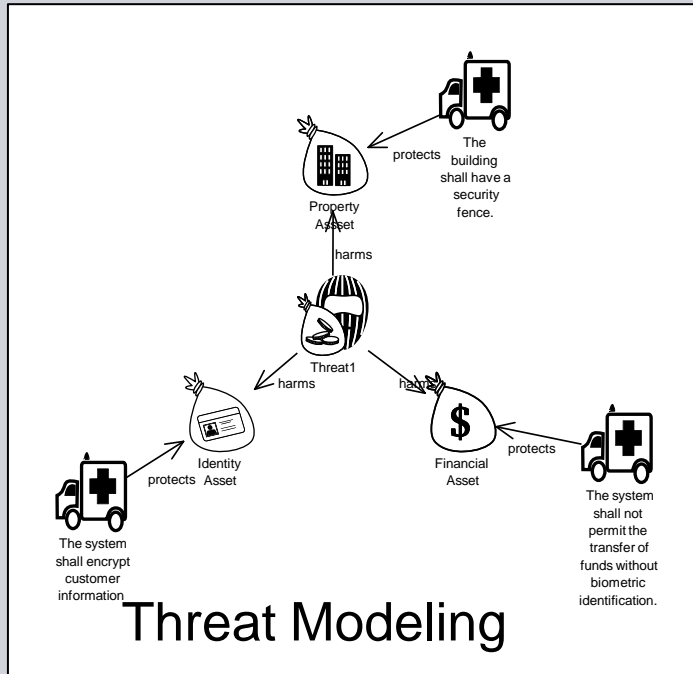
Features

Product-Feature Relationships

Products



Early Capture of Hazards & Threats



- ❑ Mix hazards, threats & requirements
- ❑ Special symbols for mitigations
- ❑ Early identification of potential issues.



Unique symbols for common hazard types

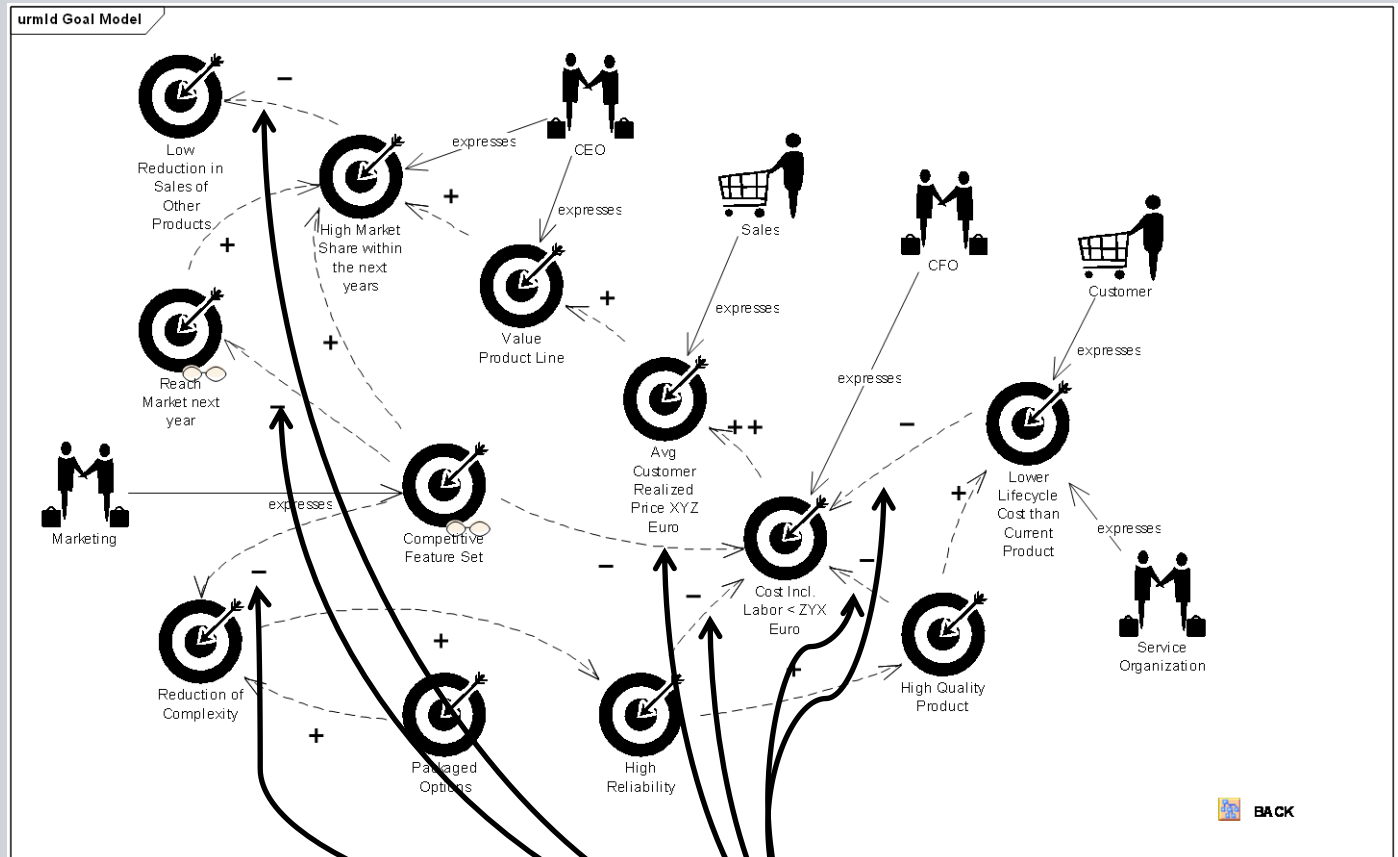
Goal Modeling & Innovation (Ideas)

Goal Modeling

- Assessment Sketch
- Business Stakeholder
- Customer
- Goal
- Idea
- Request
- Stakeholder

Goal Modeling Relationships

- Relationship icons: double-headed arrow, arrow, arrow with plus, arrow with minus, arrow with double plus, arrow with double minus.



Identification of Conflicts

Summary & Conclusions

- ❑ The URML is a work in progress
- ❑ It still needs construction heuristics
- ❑ An as-yet unexplored area is the relationship of URML concepts to SysML design concepts
- ❑ It has been tested on several internal Siemens projects with a few “gotchas”, but basically – It Works!
- ❑ This coming year, our research team is focusing on completing the meta-model, defining construction and relationship semantics, and Beta testing.



Questions?