Probabilistic Risk Assessment: Some Challenges

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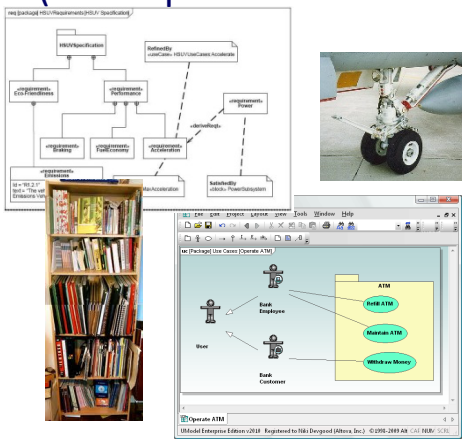
Context

- Increasing complexity of systems (systems of systems)
- Evolution of the market: from products to capabilities
- Ubiquity of software
- Integration of engineering disciplines
- Model Based Design

Probabilistic Risk Assessment

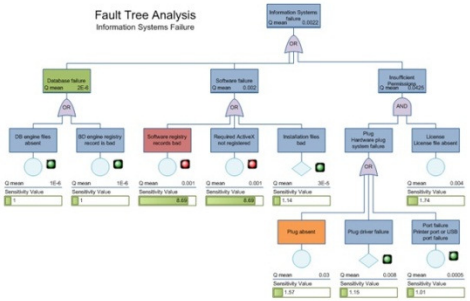
System Specifications
(and experience feedback)



Modeling

Improvements
Certification

Models



Fault Trees, Event Trees, Markov Chains, Stochastic Petri Nets…

Virtual Experiments

- Failure Scenarii
- Reliability Indicators

Issues:

- **Completeness** of specifications with respect to safety concerns
- **Distance** between system specifications and safety models
- **Size** of the models
- **Complexity** of virtual experiments

Filtering

A model is designed to capture/study one aspect of the system.
It should be at the **right level of abstraction**.

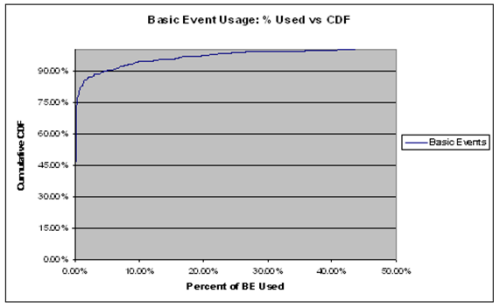
Easy to say, but difficult to achieve

The designed model:

- ~2500 basic events PSA

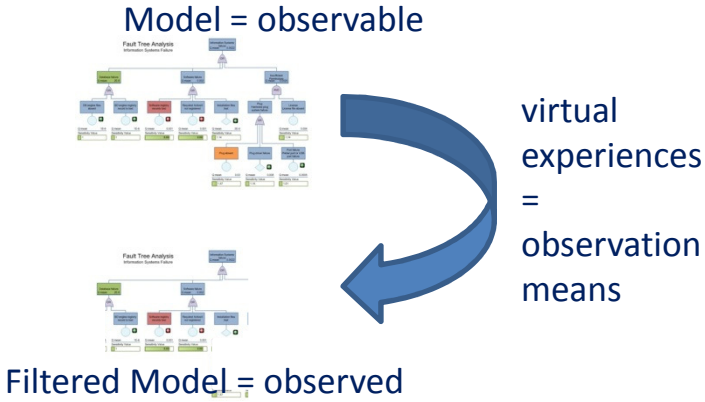
The calculated model:

- ~100000 cutsets
- 95% of the CDF with less than 5% of BE, 100% with 25%



Challenge/research direction:

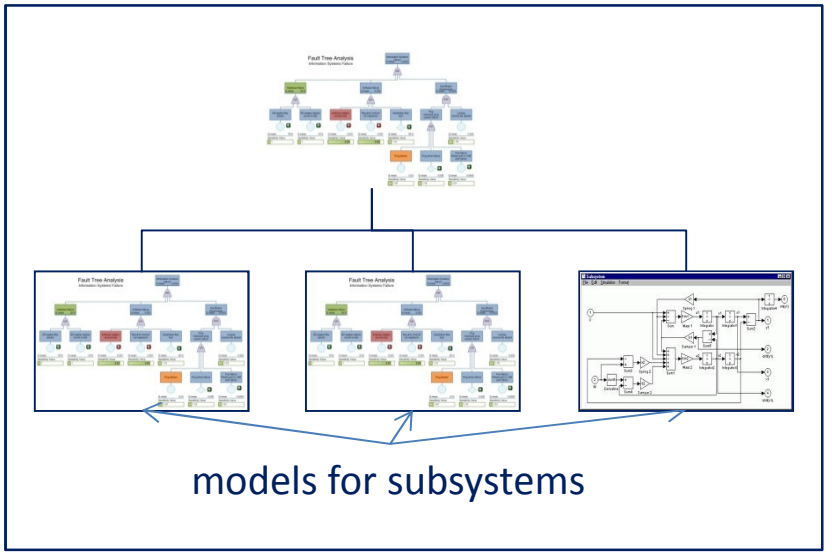
Design mathematical concepts, algorithms and tools to **filter** models w.r.t. to results of virtual experiments (typically, calculation of failure scenarios)



Abstraction/Concretization

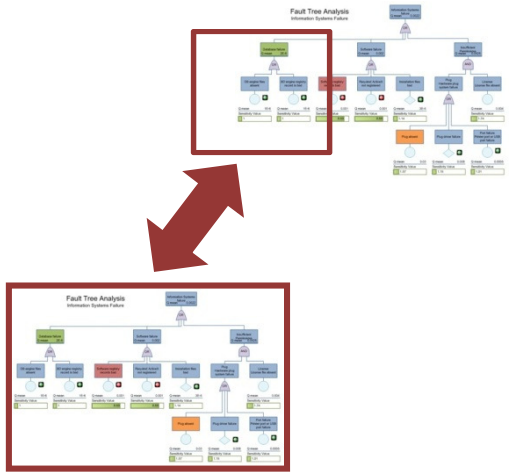
Complex systems need to be described by **multi-scale models**

- The composition of models of subsystems is often too big to be handled
- Models of subsystems are often heterogeneous… and designed by suppliers



Challenge/research direction:

Design mathematical concepts, algorithms and tools to **abstract** the model of subsystems into the model of the system and vice-versa



Standard Representation Formats

Two major trends:

- Models are more and more used as a contractual basis
- A high quality assurance is demanded on models

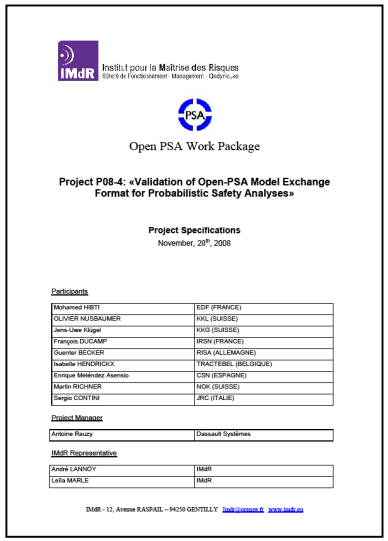
As a consequence, models must be:

- Peer-reviewed
- **Tool independent**

Challenge/research direction:

Define **standard representation formats**, with all the necessary constructs, with a clear and sound semantics

The **Open-PSA Standard Representation Format** for Fault Trees and Event Trees



IMdR Institut pour la Maîtrise des Risques

Open PSA Work Package

Project P08-4: «Validation of Open-PSA Model Exchange Format for Probabilistic Safety Analyses»

Project Specifications
November, 28th, 2008

Participants

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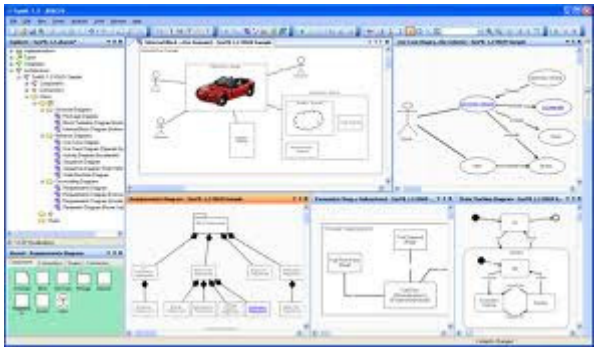
```
<define-fault-tree name="FT1" >
  <define-gate name="top" >
    <or>
      <gate name="G" />
      <basic-event name="C" />
    </or>
  </define-gate>
  <define-gate name="G" >
    <and>
      <basic-event name="A" />
      <basic-event name="B" />
    </and>
  </define-gate>
</define-fault-tree>
```

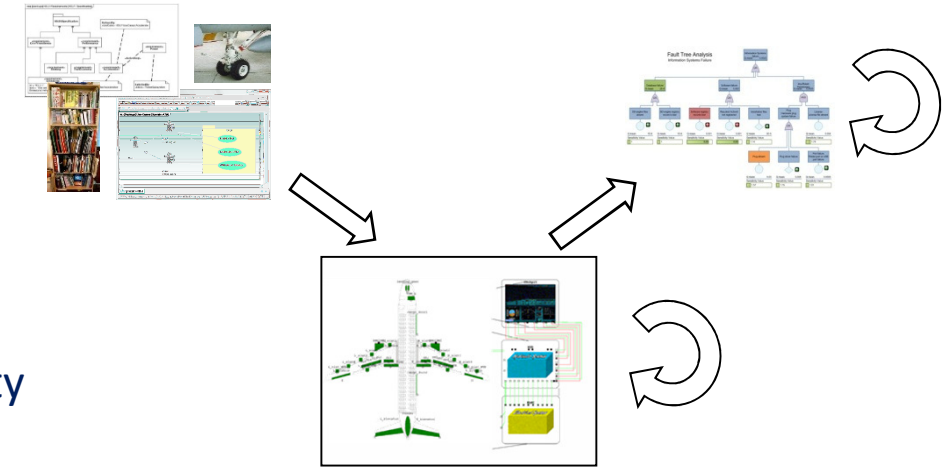
Model Based Design

SysML: an emerging standard of system architecture



Challenge/research direction:

- Better integration of Safety Analyses with System Architecture
- Engineering of models of engineering
- High Level Modeling Languages
- Modeling process as a cognitive activity



AltaRica