Putting Chaos under Control:
on how Modeling should Support Design

Hristina Moneva, Roelof Hamberg, Teade Punter

Embedded Systems INSTITUTE

John Vissers

VanDerLande INDUSTRIES

…when talking about complex systems

- How do the complex systems look like?

Copiers and printers

Carrying Industrial Partner Boderc & Octopus project

MR Achiva

PHILIPS

Carrying Industrial Partner Darwin project

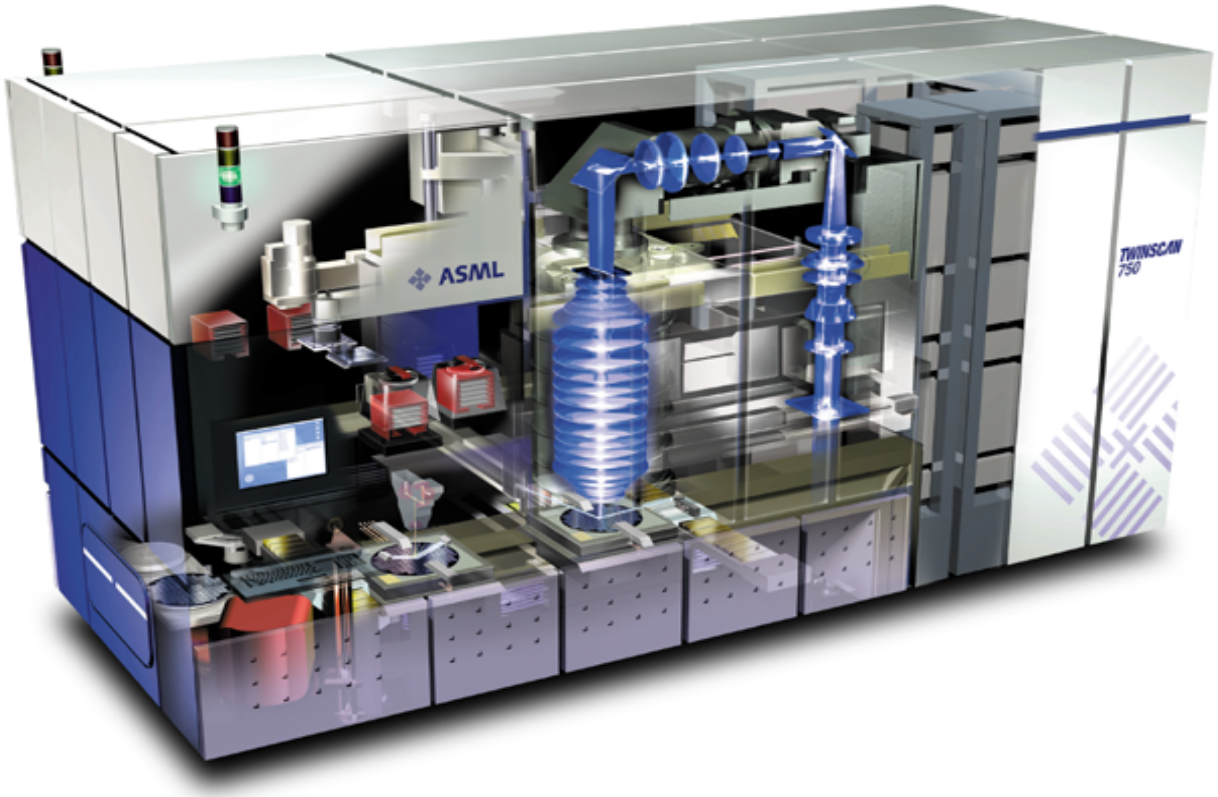
Nexperia TV platform

Carrying Industrial Partner Trader project

Warehouse

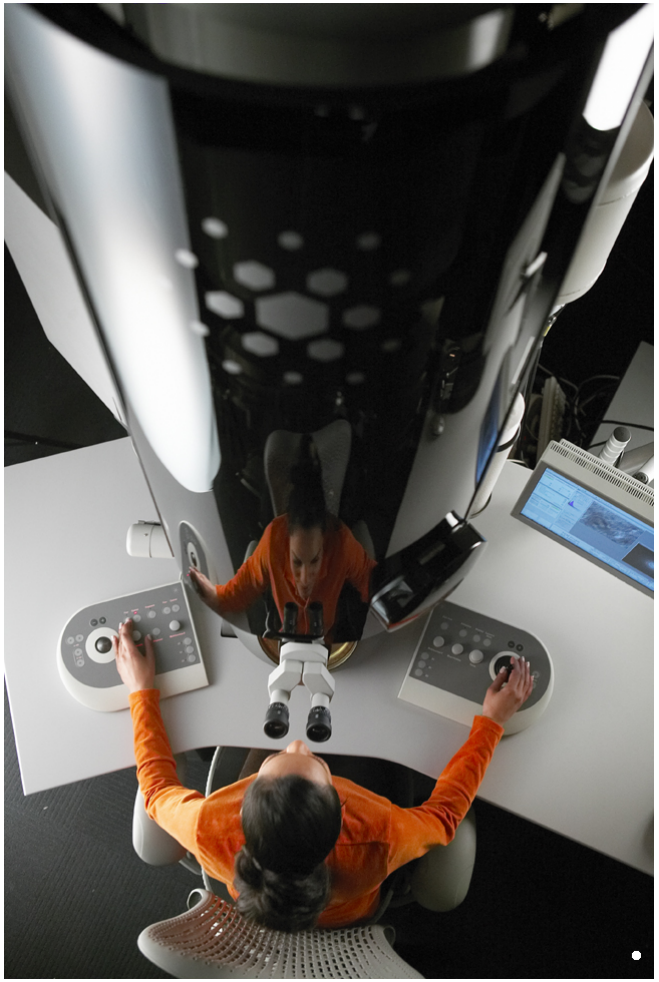
Carrying Industrial Partner Falcon project

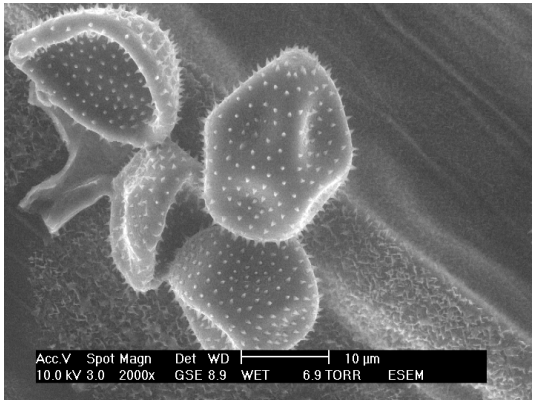
TwinScan Waferstepper



Carrying Industrial Partner Ideals & Tangram project

Electron microscopes





FEI COMPANY™
TOOLS FOR NANOTECH

Carrying Industrial Partner Condor project

Model-based world… aspects of reality

…when talking about complex systems

- Multiple formalisms
  - Each model can analyzed for specific design questions
  - Typical problems:
    - Not a single modeling formalism can answer all possible design questions
    - Difficult to make explicit and synchronize the assumptions hidden in models
    - When changing a model, what are the implications to the rest of the system
  - *How to connect these tools / models in a generic way and how to provide early flaw detection?*
  - *How to connect models which cover different parts of the same system?*

Model-based world… aspects of reality

…when talking about complex systems

- Multiple formalisms
- Concurrent engineering
  - Simultaneous development of multiple people from diverse disciplines
  - Typical problems:
    - Not keeping track of design decisions
    - Not explicit enough to the rest of the team
    - What are the implications to the rest of the system → which components are affected
    - Forget to re-run some experiments → not consistent results
  - *How to provide model and result history related to the design decisions taken?*

Model-based world… aspects of reality

…when talking about complex systems

- Multiple formalisms
- Concurrent engineering
- Not feasible to model the complete system
  - *Only ~10% of the system is being modeled*
  - *Typical problems:*
    - *No modeling formalism can answer all design questions*
    - *It is not cost effective to model the complete system*
  - *How to connect models which cover different parts of the same system?*

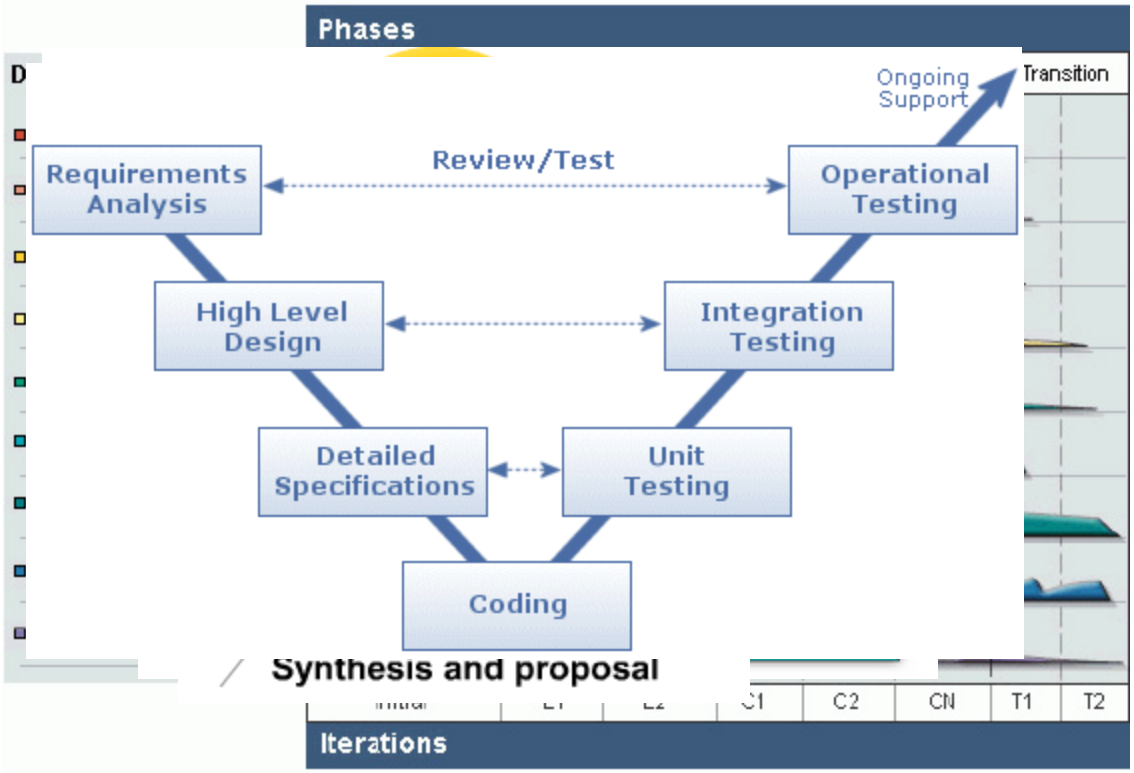
Putting Chaos under Control:
on how Modeling should Support Design

Design Framework concept

Ask yourself a question…

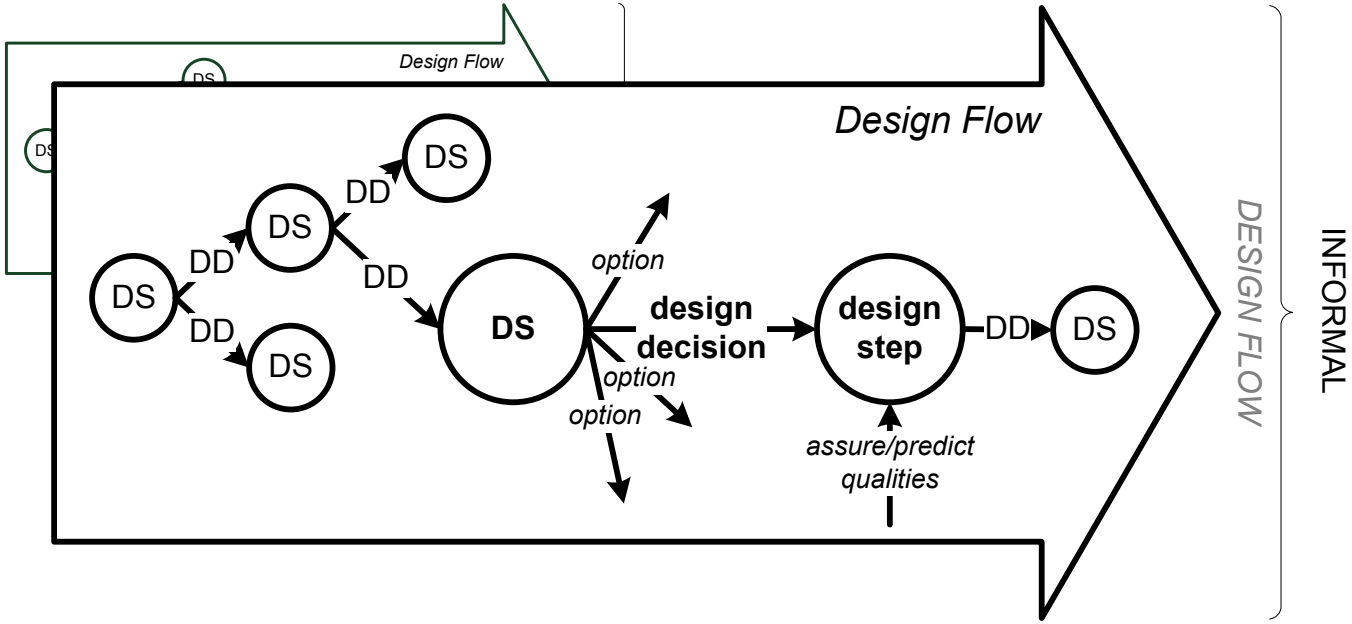
- Why do we design?
- Why do we model?
- Do we make the most of the models we develop?!

Design Framework concept



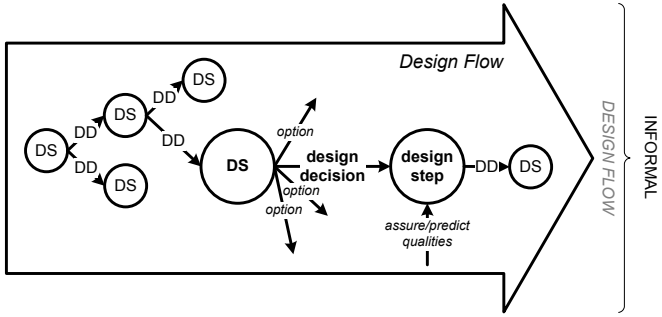
What does it mean to design?

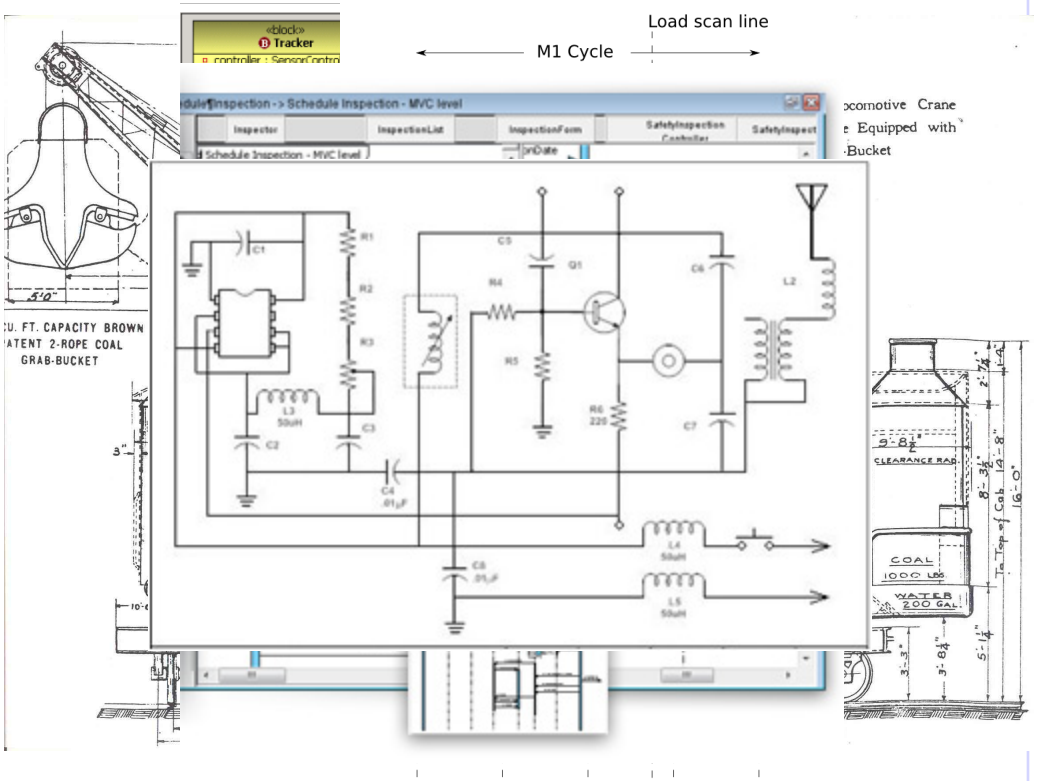
Design Framework concept



What does it mean to design?

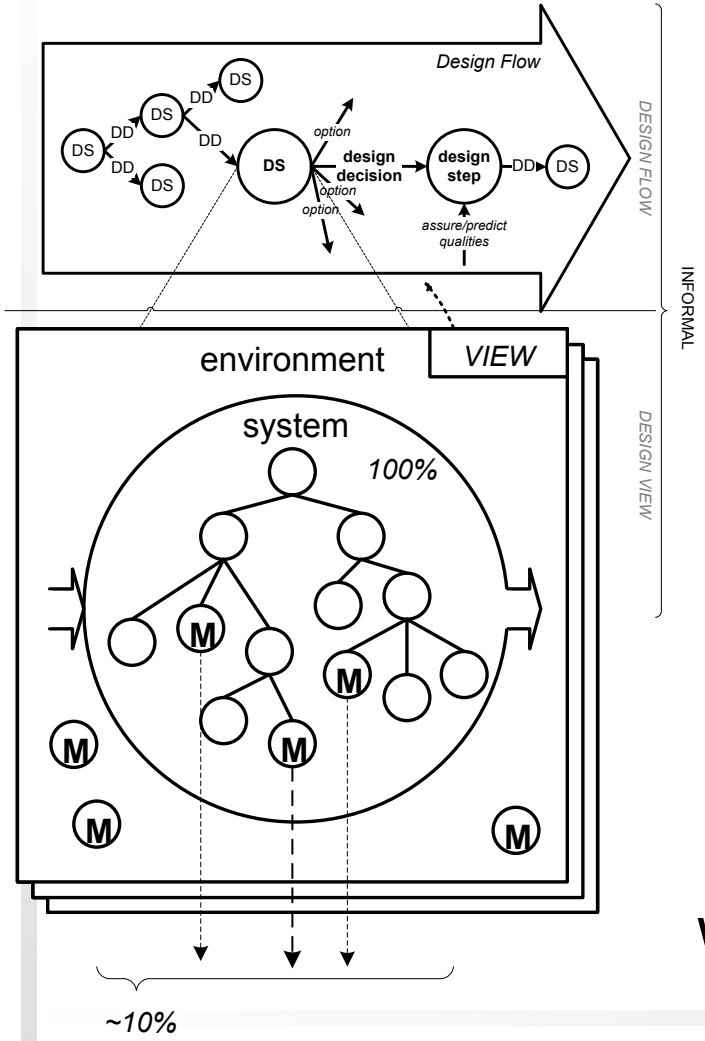
Design Framework concept

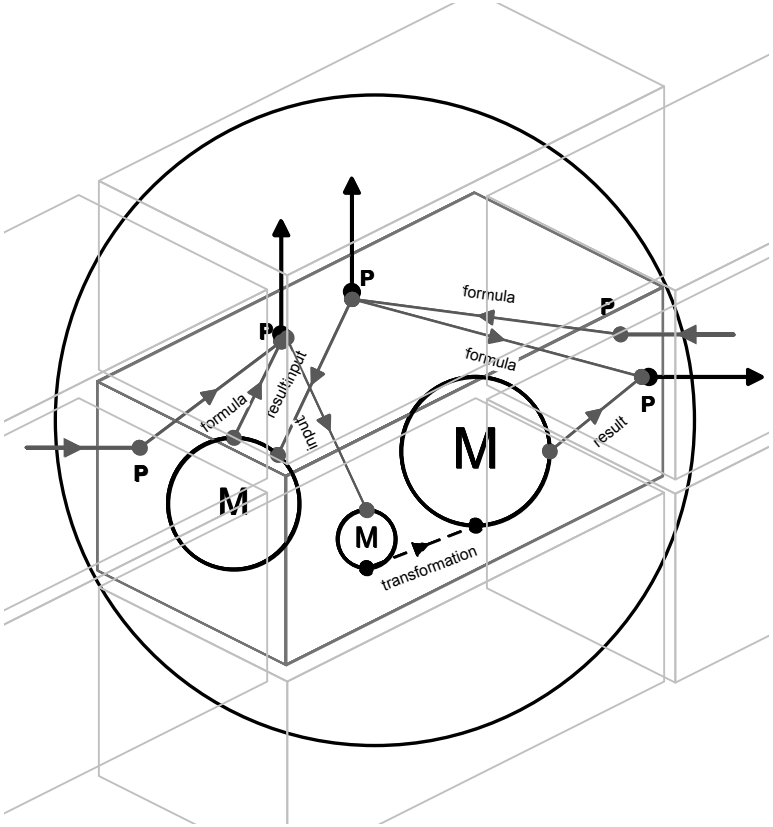




What does it mean to refine the system?

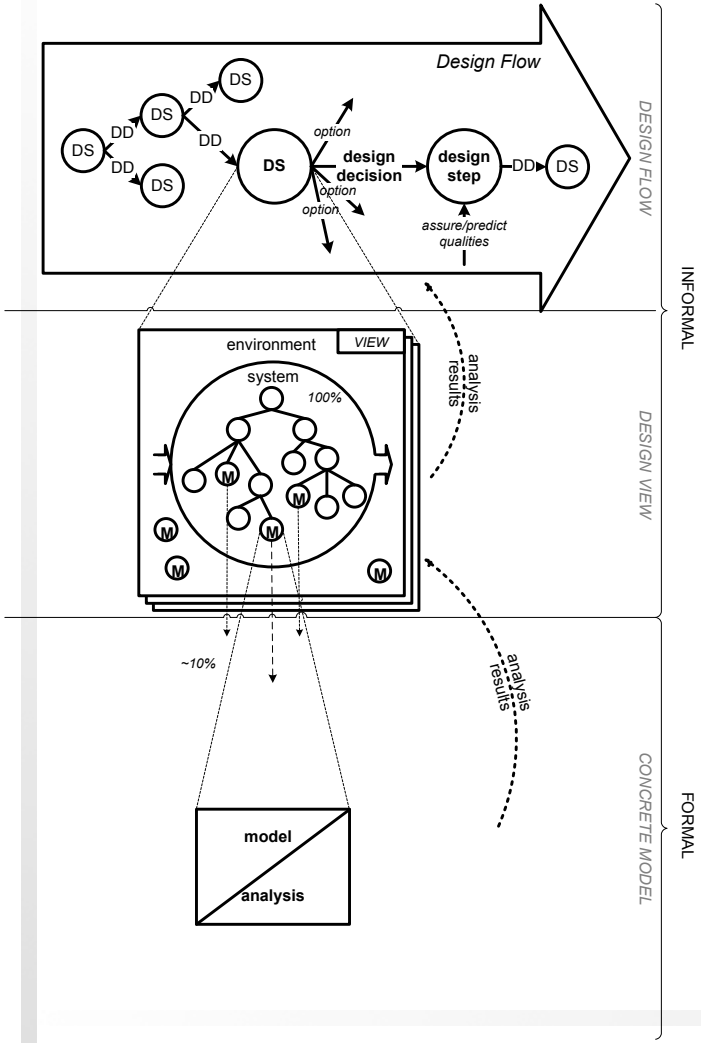
Design Framework concept

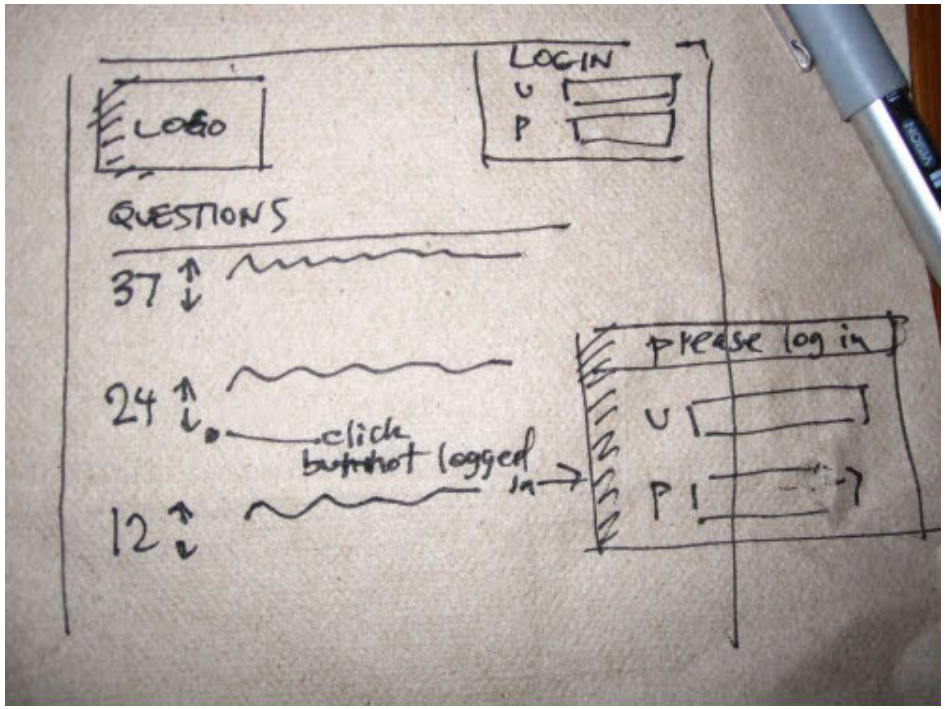




What does it mean to refine the system?

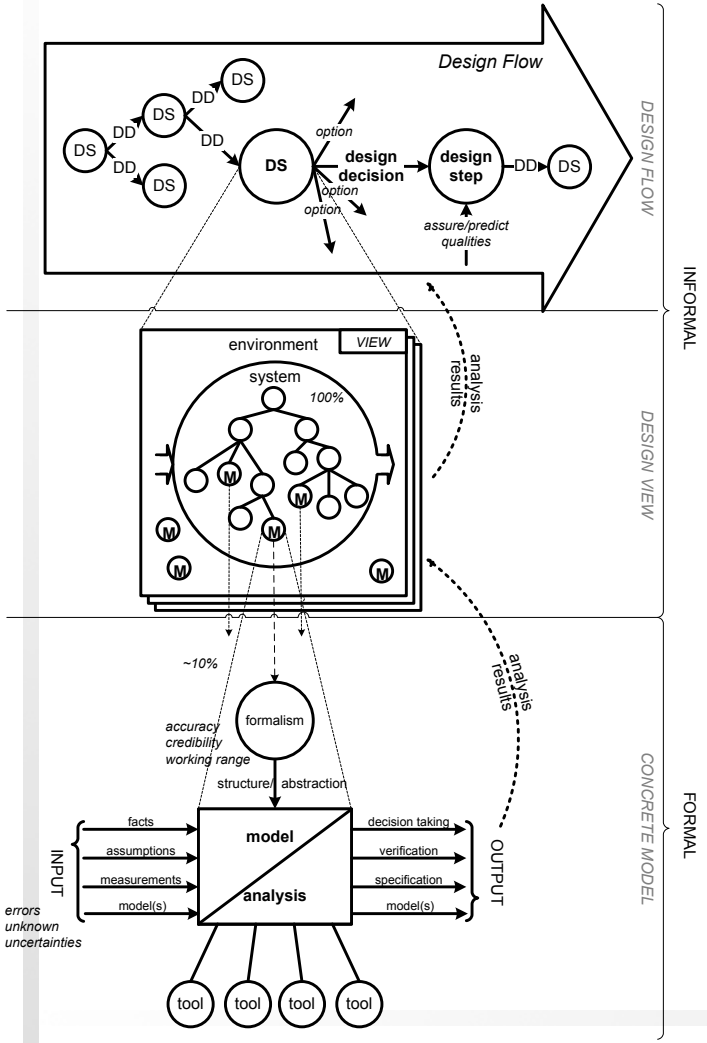
Design Framework concept

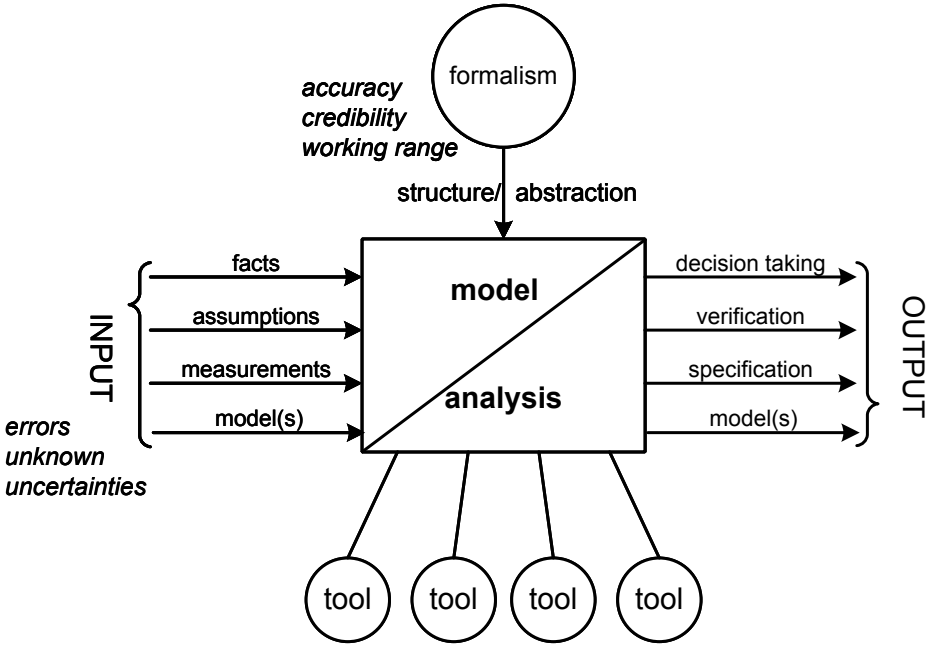




What is a model?

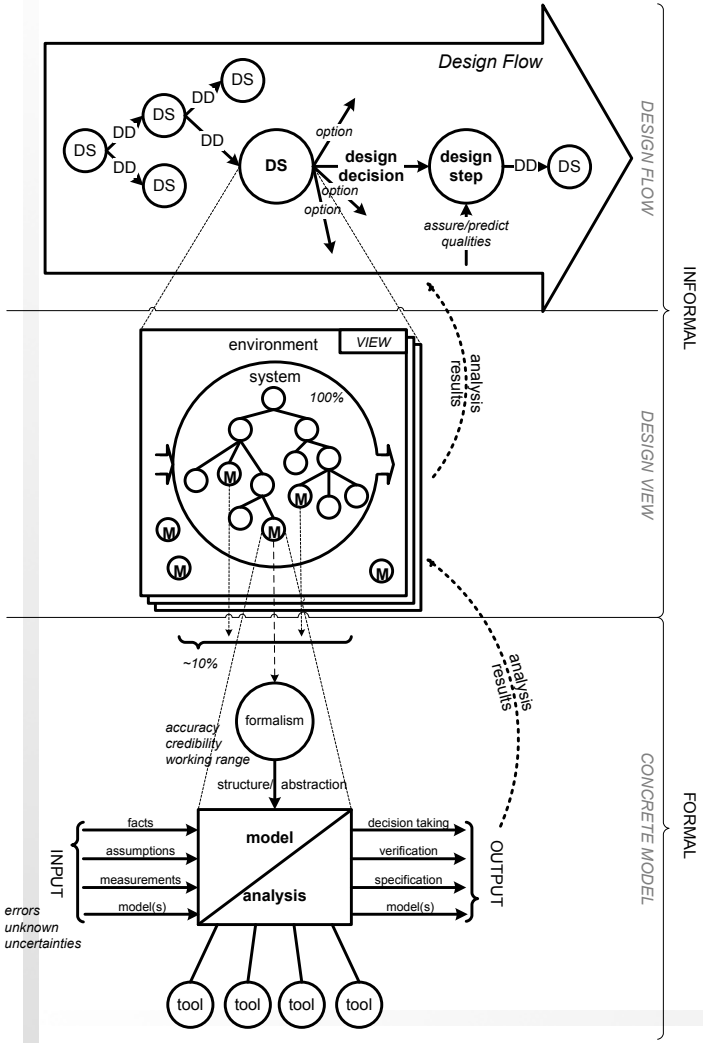
Design Framework concept



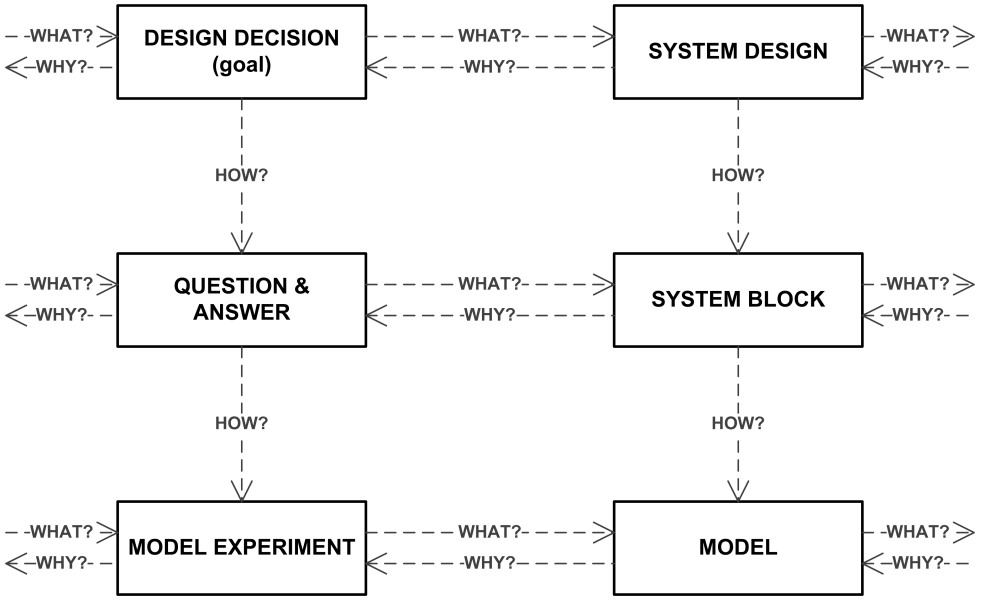


What is a model?

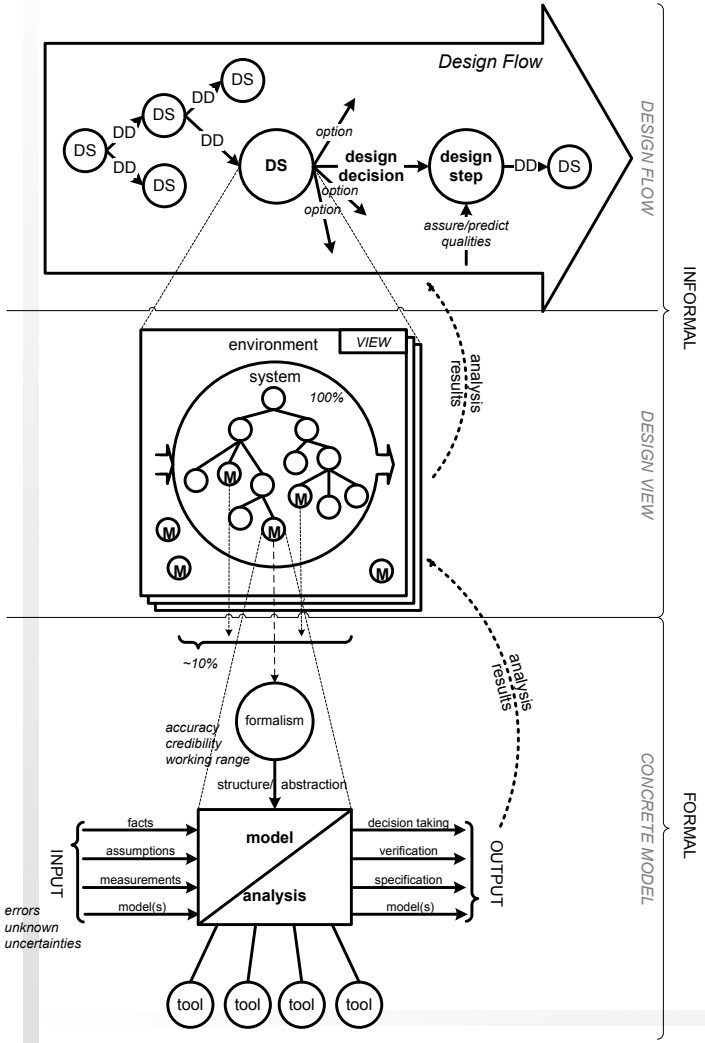
Design Framework concept



"WHY & WHAT" REASONING



Design Framework concept

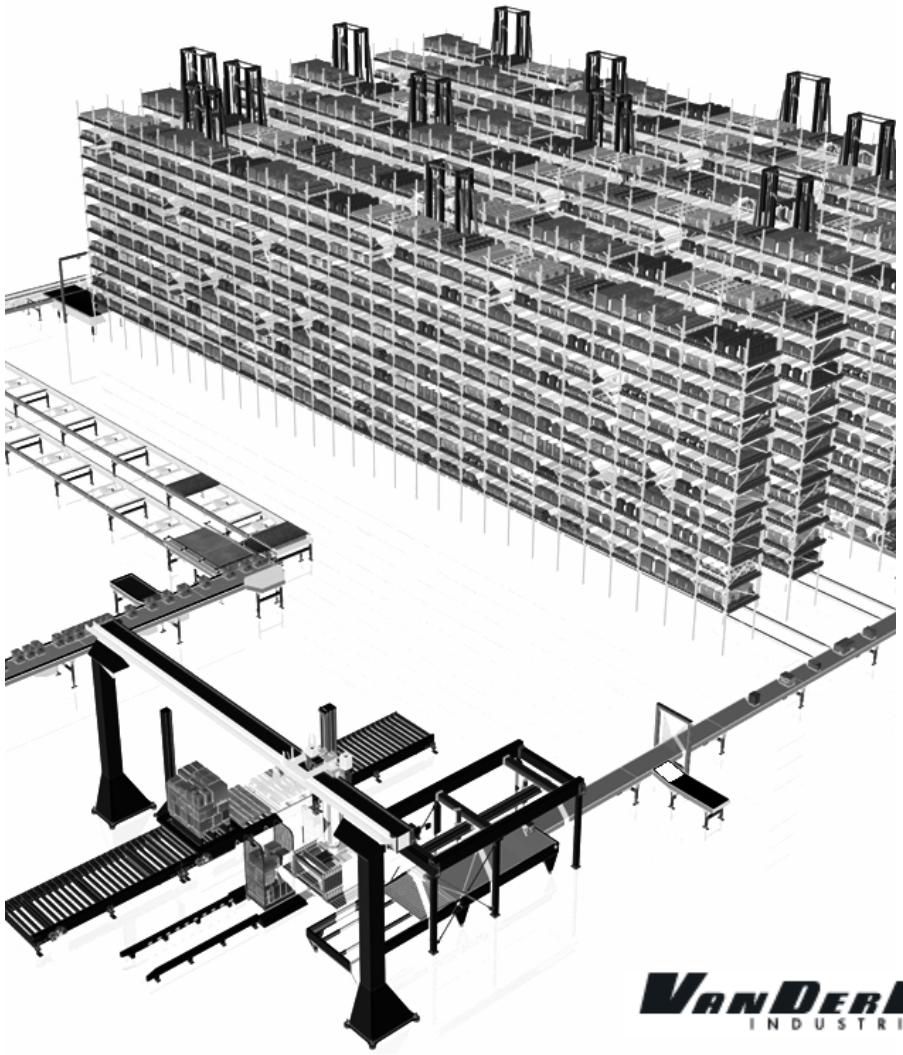


FEATURES

1. Model and result management
2. Conflict detection
3. Decision tree and impact of design decisions
4. Reuse
5. Merge and branch
6. Representations, such as design process as a time-based graph and statistics per view, component, user
7. Domain tailoring for process and views as well as glossaries, taxonomies, and domain-specific phenomena
8. Relationship-based exploration or cause-effect analysis

Validation

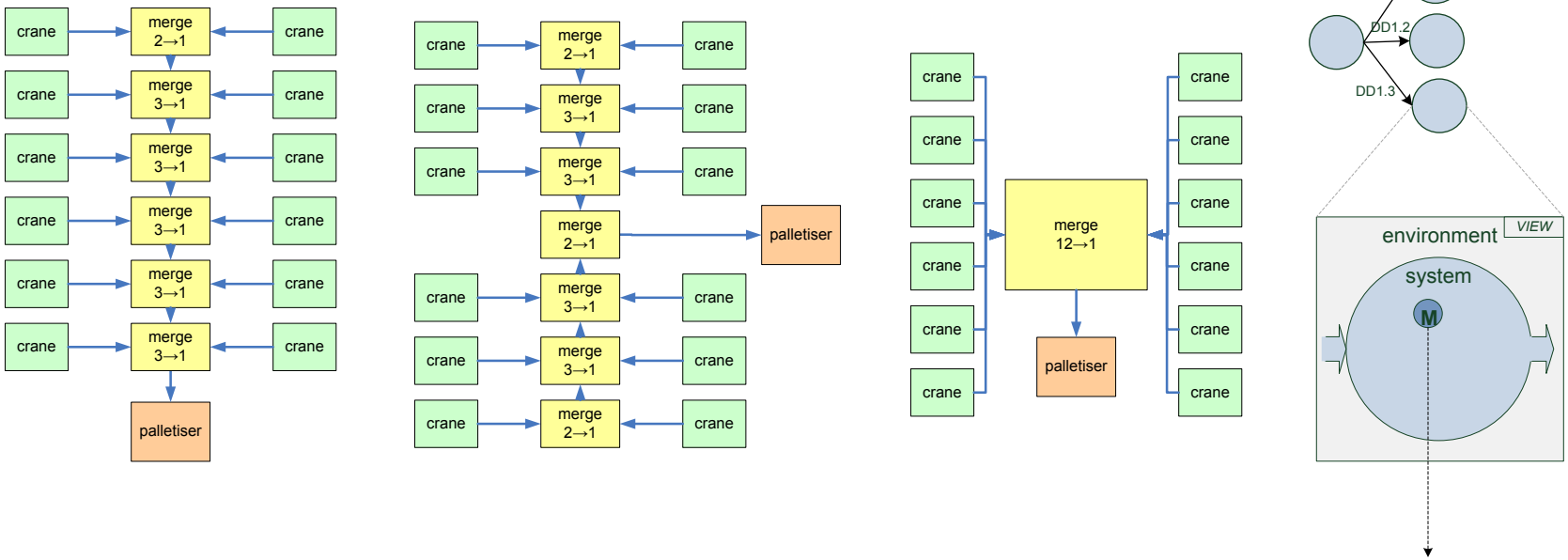
- Problem
- Concept



Application: Automatic Case Picking development

1. Main risk: performance under sequence constraints

Options: different component connections

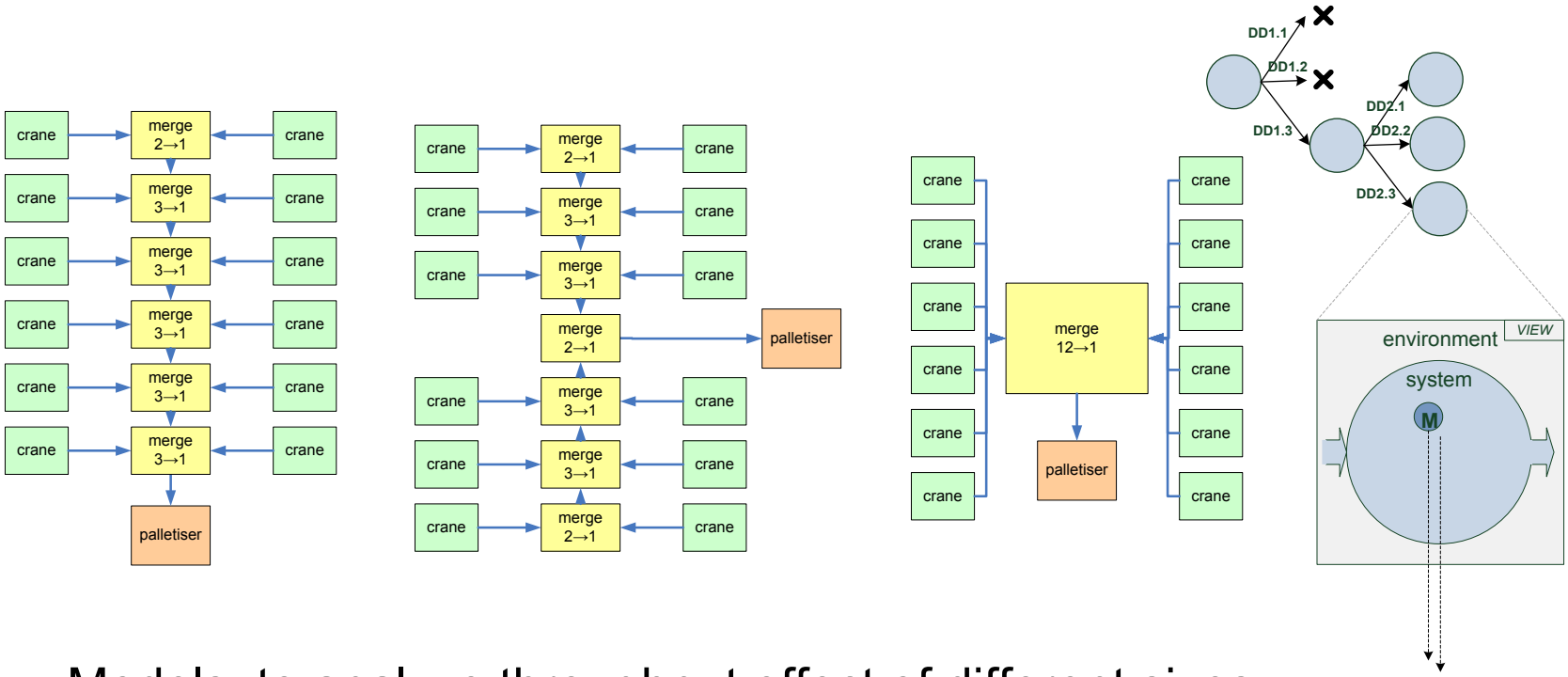


Models: to analyze throughput of different options

Application: Automatic Case Picking development

2. Main risk: performance and availability due to failures

Options: different buffer sizes

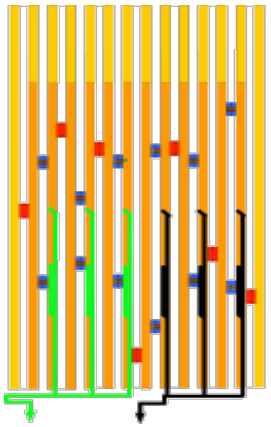


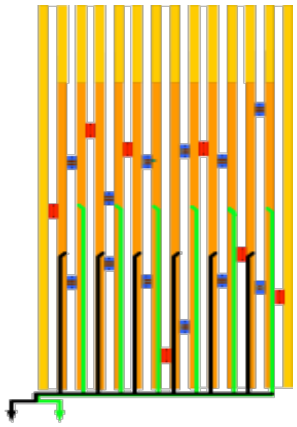
Models: to analyze throughput effect of different sizes

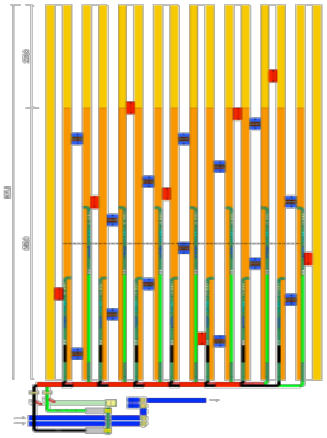
Application: Automatic Case Picking development

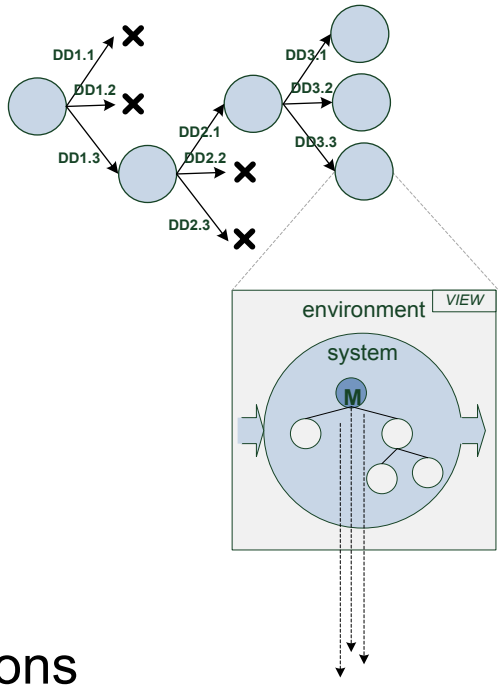
3. Main risk: convey-ability and serviceability of transport

Options: different layouts







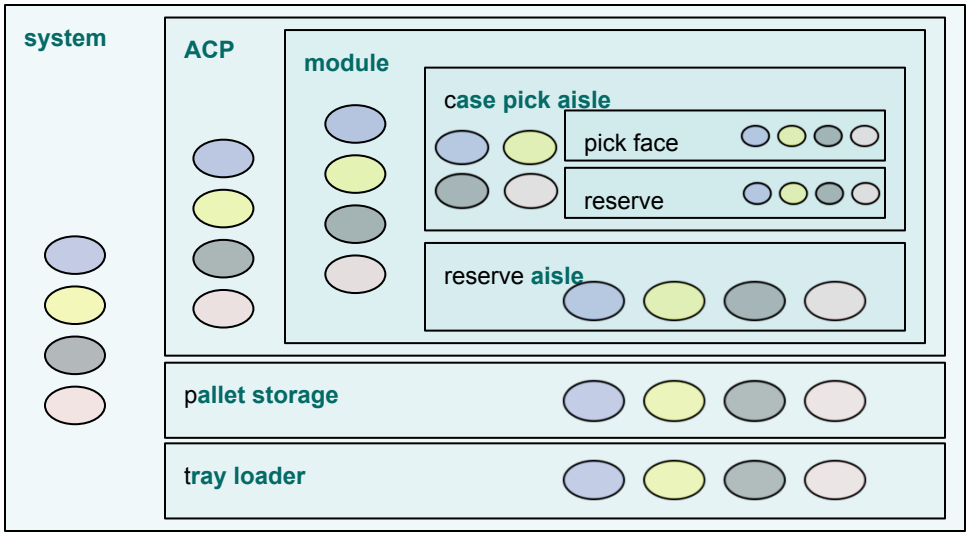


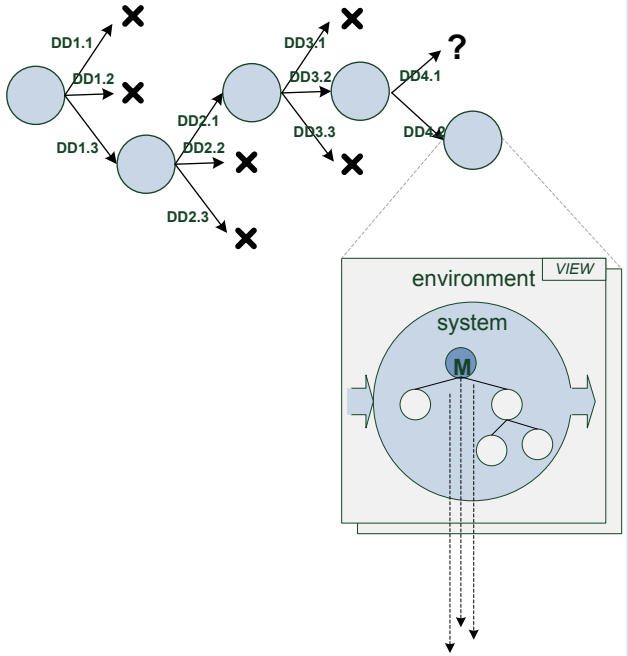
Models: to analyze effective throughput of options

Application: Automatic Case Picking development

4. Main risk: resource utilization when replenishment is done

Options: high level control with different rules





Models: to visualize the effect of different rule sets

Observations

- Problem
  - Hard to keep models and inputs synchronized
  - Many implicit assumptions are hidden in the models
  - Explicit model and result management is needed!

- Concept vs. Practice
  - The overall concept fits the observed practice very well
  - Flow: risk-driven
    - Risk reduction is a leading factor
  - Views: functional and structural
    - Tangible representation to share common understanding
    - *Alignment with architectural styles (Y-chart, 4+1, SysML …)*
  - Models: various models with different lifespan
    - Synchronization of assumptions and inputs difficult, even in small teams
    - Tension between design questions and known formalisms

SUMMARY

Conceptual model

Industrial validation

STRONG POINTS

Connects heterogeneous models

Design-time conflict detection

Deduct the impact of design decisions

No complete modeling required

CHALLENGES

Develop a prototype

Apply in an industrial environment

THANK YOU!

Embedded Systems INSTITUTE