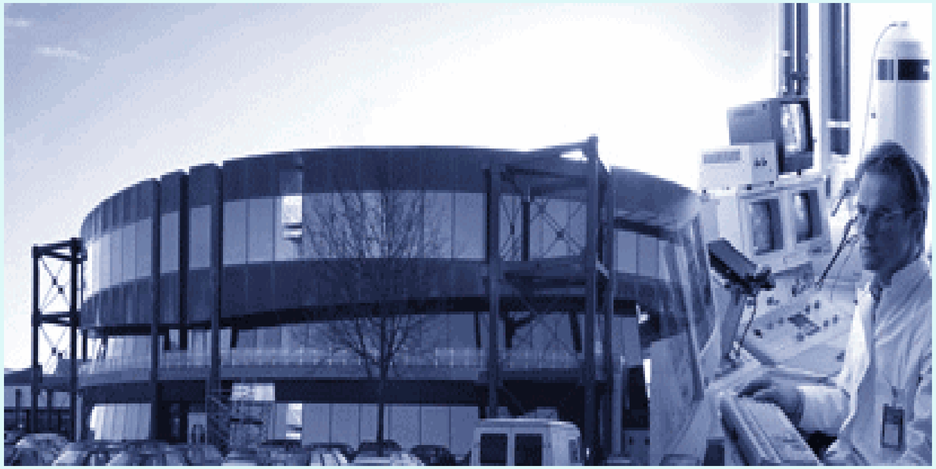
Océ Development Processes

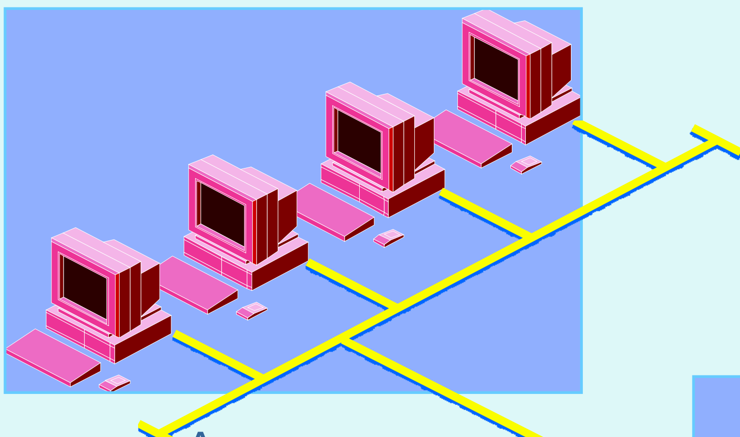


Ed Brinksma, ESI

presentation sources:

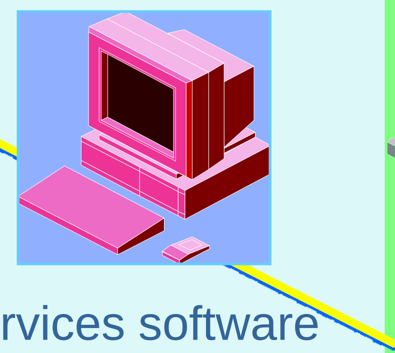
- Ron Notermans (VP R&D Océ)
- Peter van den Bosch (developer Océ)
- Lou Dohmen (architect Océ)
- Roelof Hamberg (formerly Océ)
- Gerrit Muller (BoDERC project)

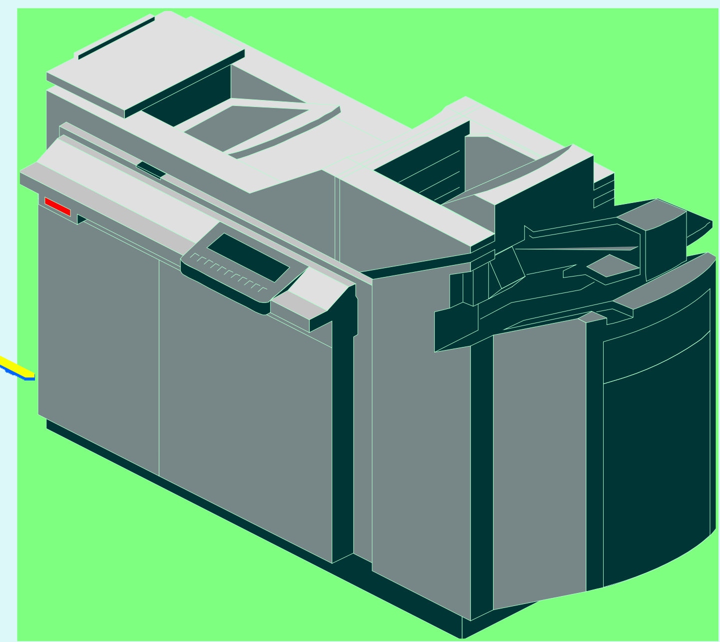
Océ - Document Systems



- **Consultancy**
- **Facility Management**
- **Maintenance**

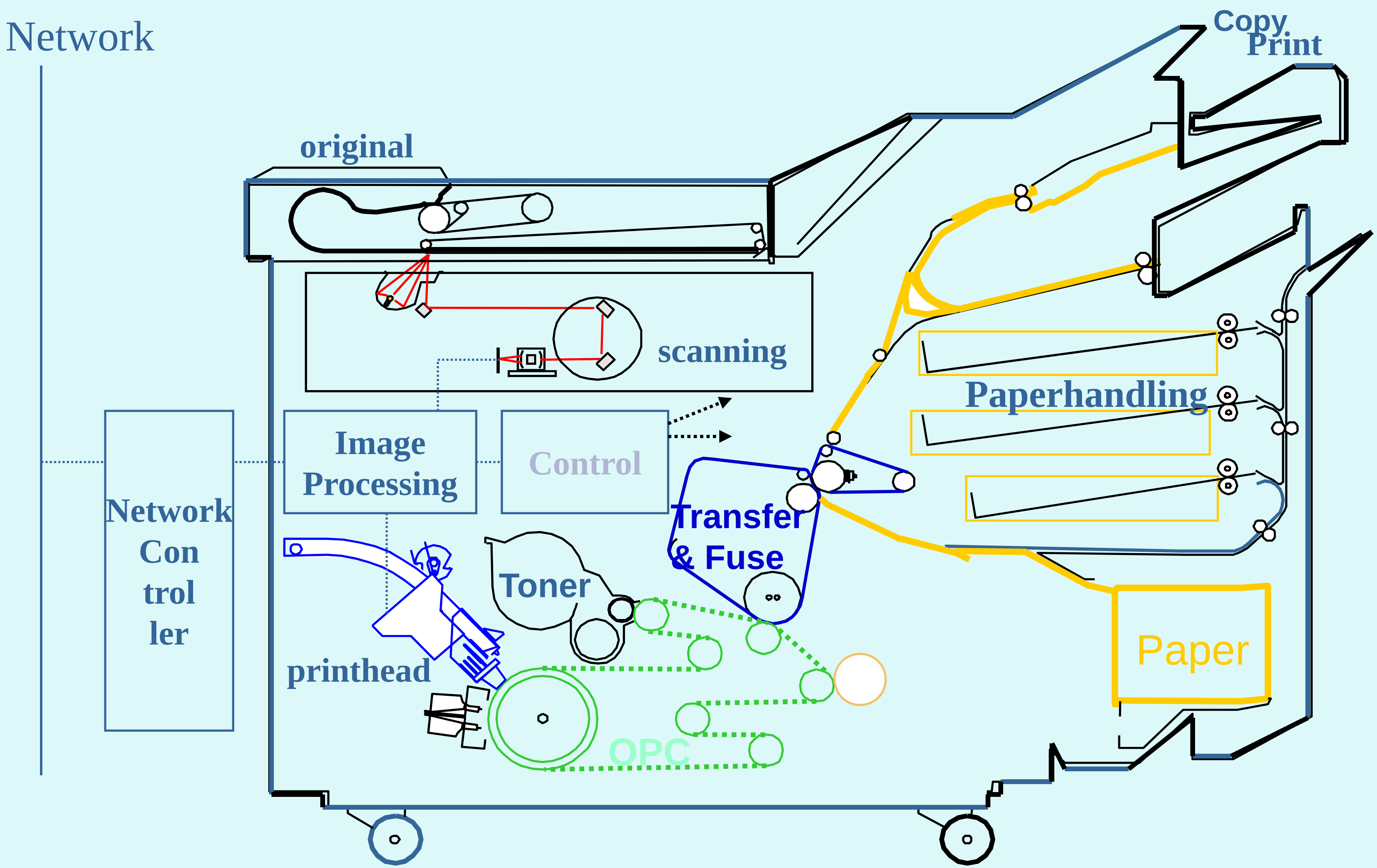
Océ enables its customers to manage their documents efficiently and effectively by offering innovative print and document management products and services for professional environments





Application Software + Machines

Principle of working



Mechanics, Electronics, Procédé
Embedded Software

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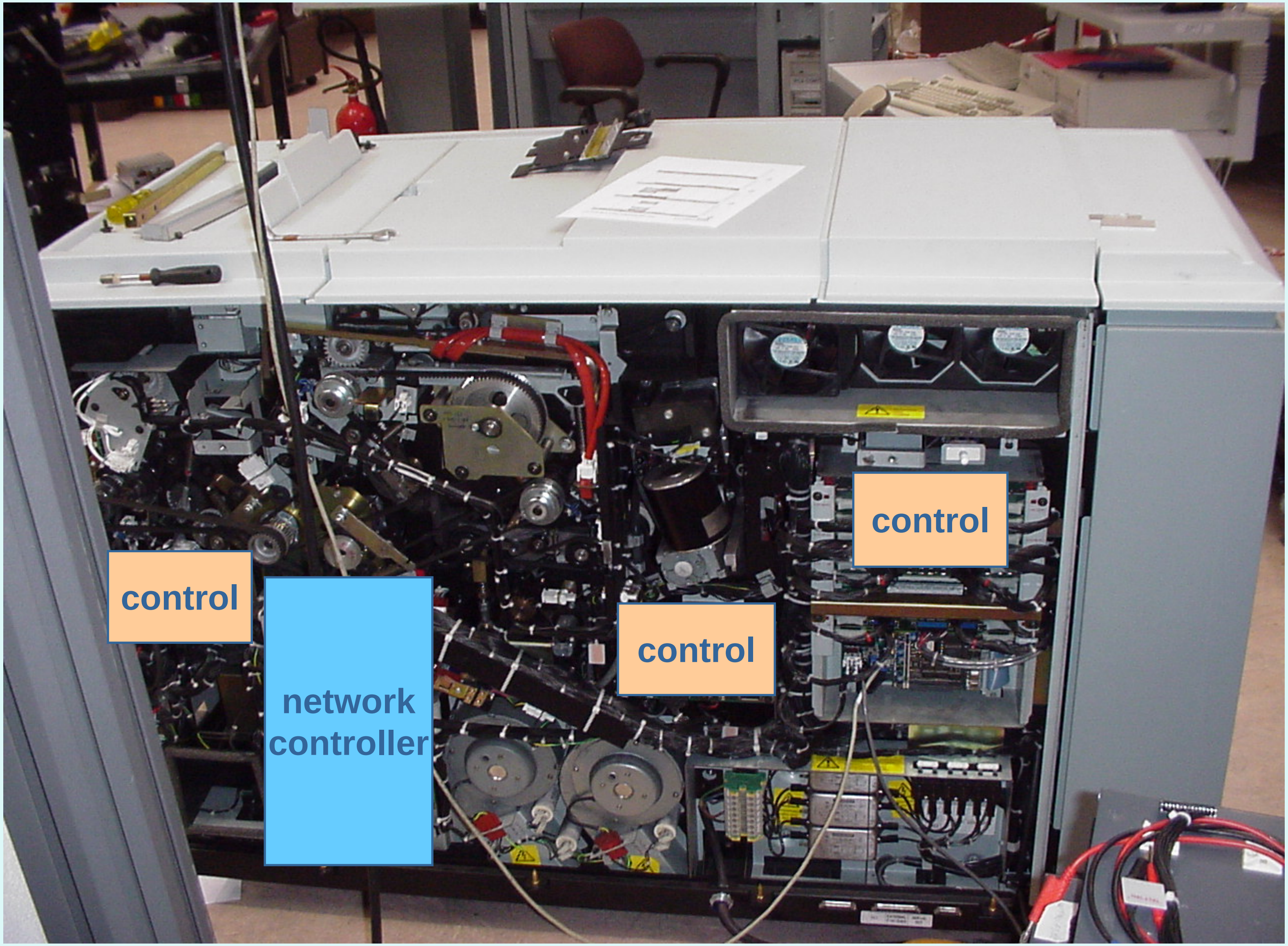

Current multidisciplinary approach

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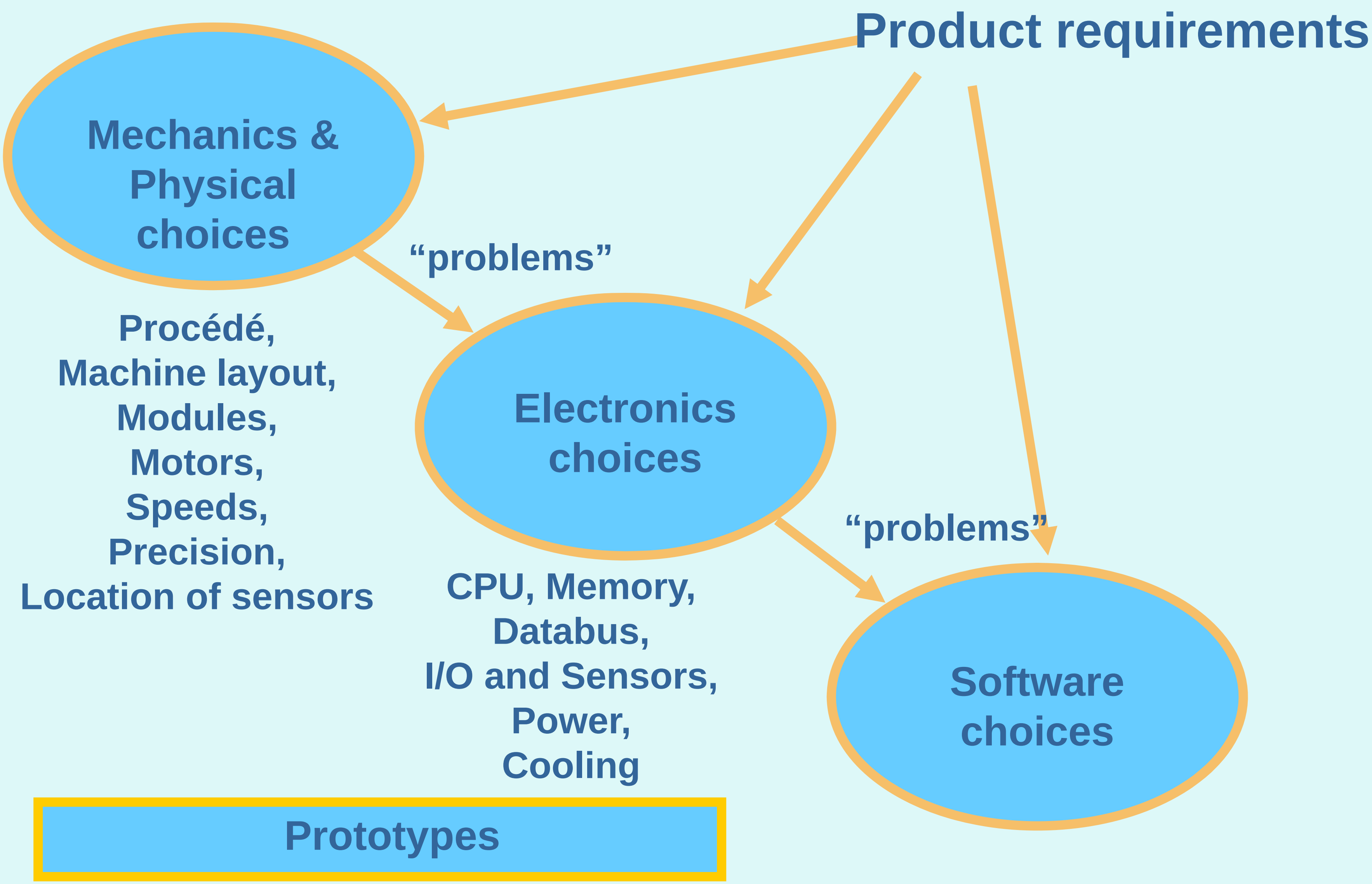
- **Multidisciplinary project teams (M, E, I, ID, Φ, C, …)**
- **Common project goal**
- **Dedication** (1 project per person at a time)
- **Co-location** (1 location per project team)
- **Project organisation processes**
  - Groups per function, following constructional decomposition
  - TC decides (function leaders, architect(s), project leader)
- **Lot of prototyping & testing**
  - **FunctionTest → Labmodel → EngineeringProtoType**
- **Years of experience**

,but…

Mechanics	Electronics	Embedded Software

• Agenda
– Cost price
– Reliability
– Performance
– Precision
• Models
– 3D CAD
– Total construction drawings
– Some local Matlab models
– Specification of time/position tables in Excel
	• Agenda
	– Cost price
	– Energy consumption
	– Life-cycle-management of components
	– Safety and EMC regulations
	• Models
	– System architecture diagrams
	– Circuit simulations (VHDL, PSPICE, Matlab)
		• Agenda
		– Specifications for normal and exceptional behaviour
		– Maximum performance for all jobs
		– Architecture
		  • Modular
		  • Maintainable
		  • Re-use of components
		• Models
		– Use Cases
		– UML
		– Text documents

De facto decision process



Problem characteristics

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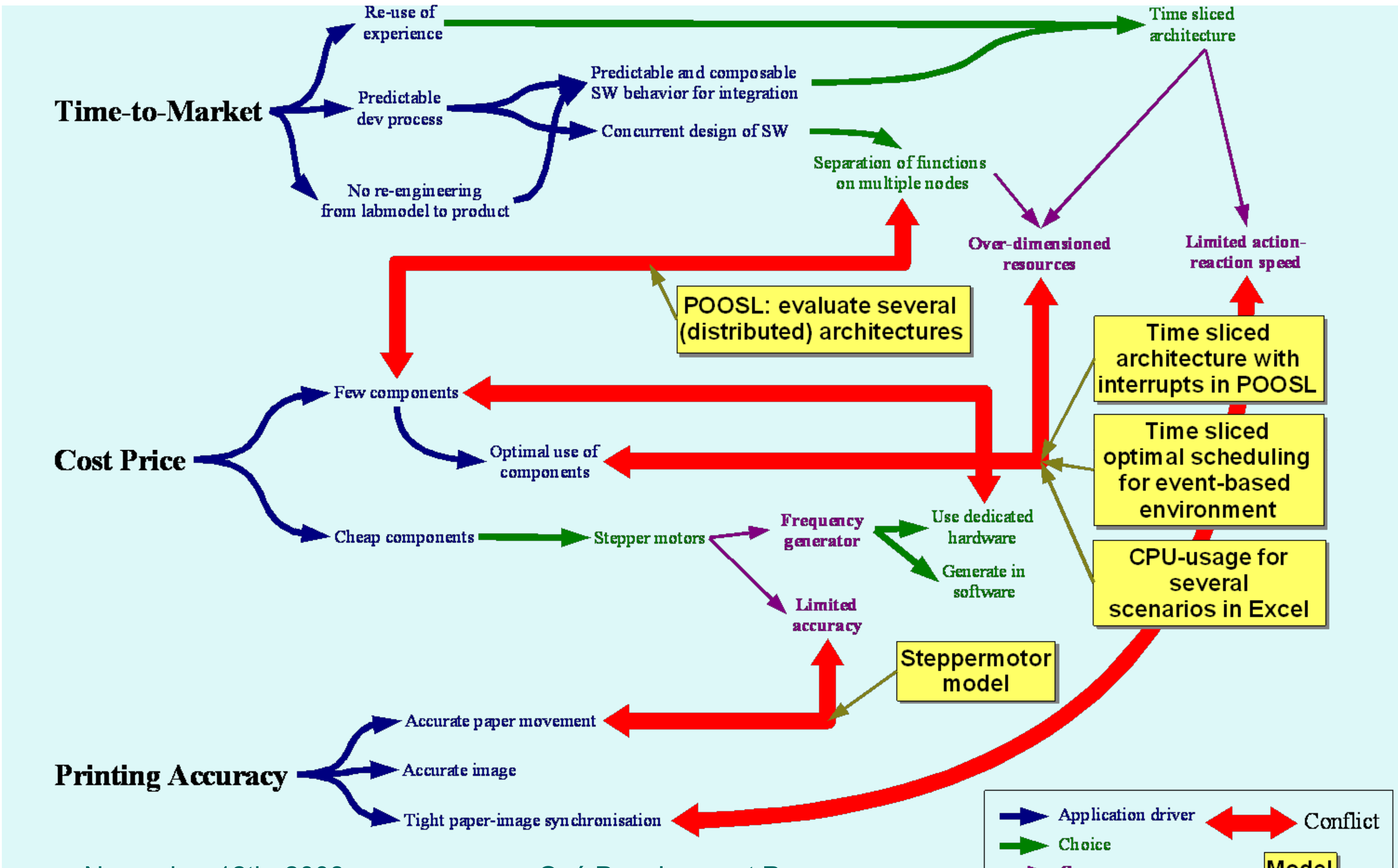
- **Development of complex products with**
  - highly interactive sub-domains,
  - where only few people master both ends
  - of the physical and the software world
- **Long lead times**
  - Sequential order of work
  - Coincidental “just-in-time” delivery by hard work
  - Need for more predictability and shorter lead times
- **Software is often on the critical path**
  - Impact of software in earlier phases
  - Integral system approach is required

High level design method

1. **Preparation of the design**
    a) Identify (customer) key drivers and requirements
    b) Identify realization aspects of concern
    c) Consolidate core domain knowledge
2. **Selection of critical design aspects**
    a) Identify tensions and conflicts (qualitative)
    b) Gather facts and identify uncertainties to quantify tensions and conflicts
3. **Evaluation of design aspects**
    a) Build small models
    (small = hours to 4 weeks of effort)
    b) Perform measurements

Example step 2a)
Identify tensions & conflicts (qualitative)



Example step 3a)
Build small models: Printer topology & sheet flow

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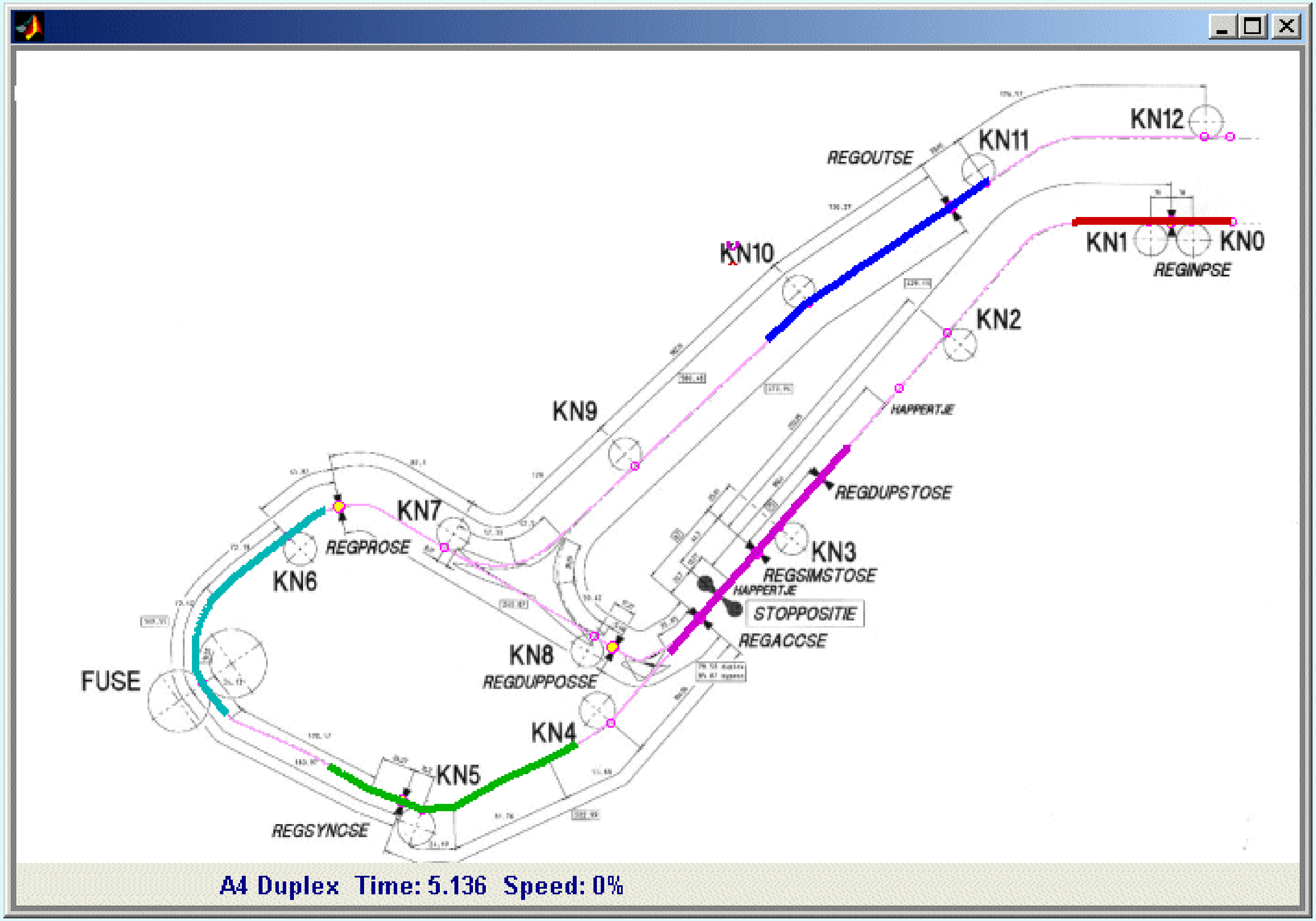

Example step 3a)
Build small models: Semi-Static Power Decomposition

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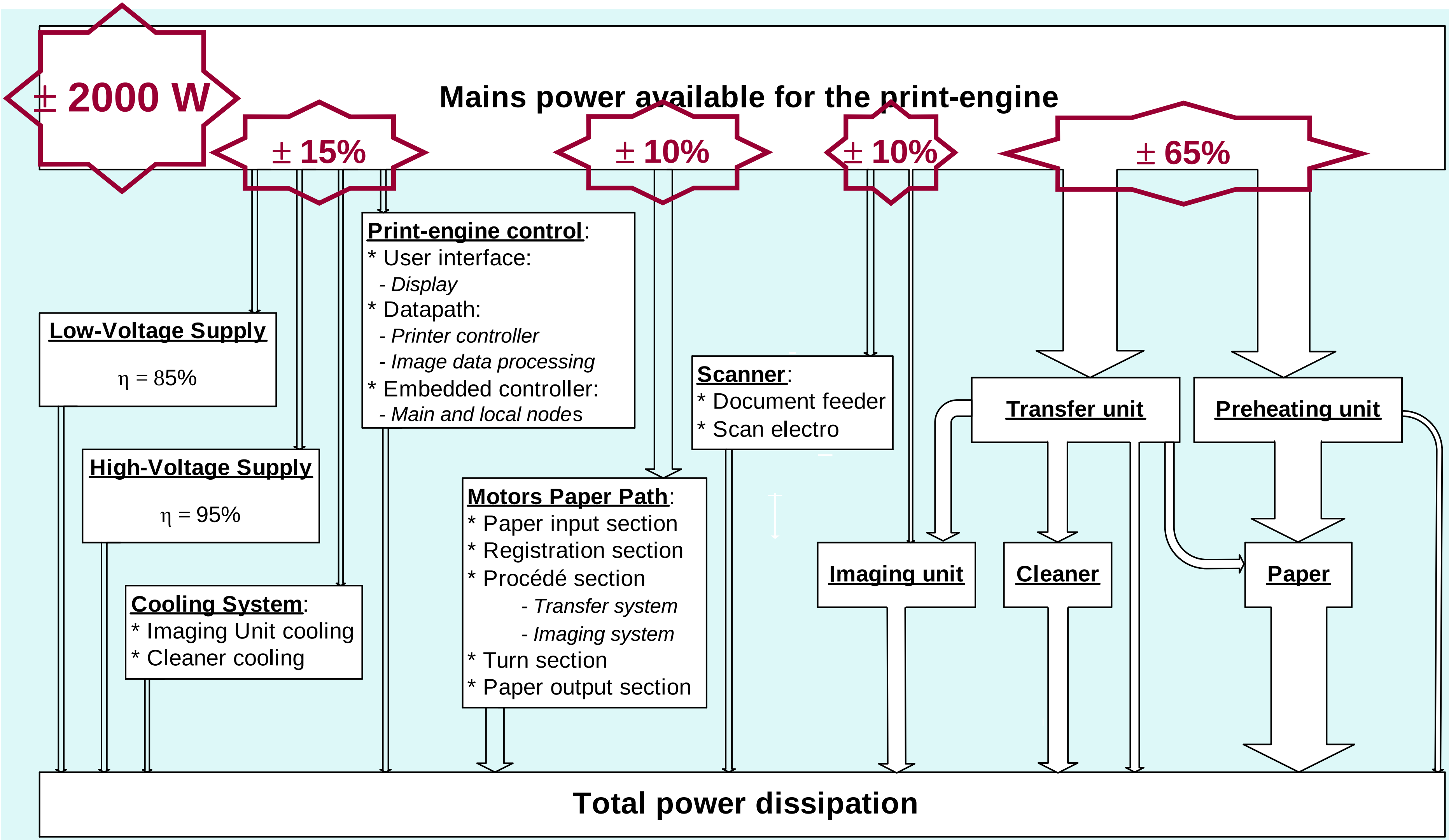

Example step 3b)
Measure: Dynamic behavior motors paper path

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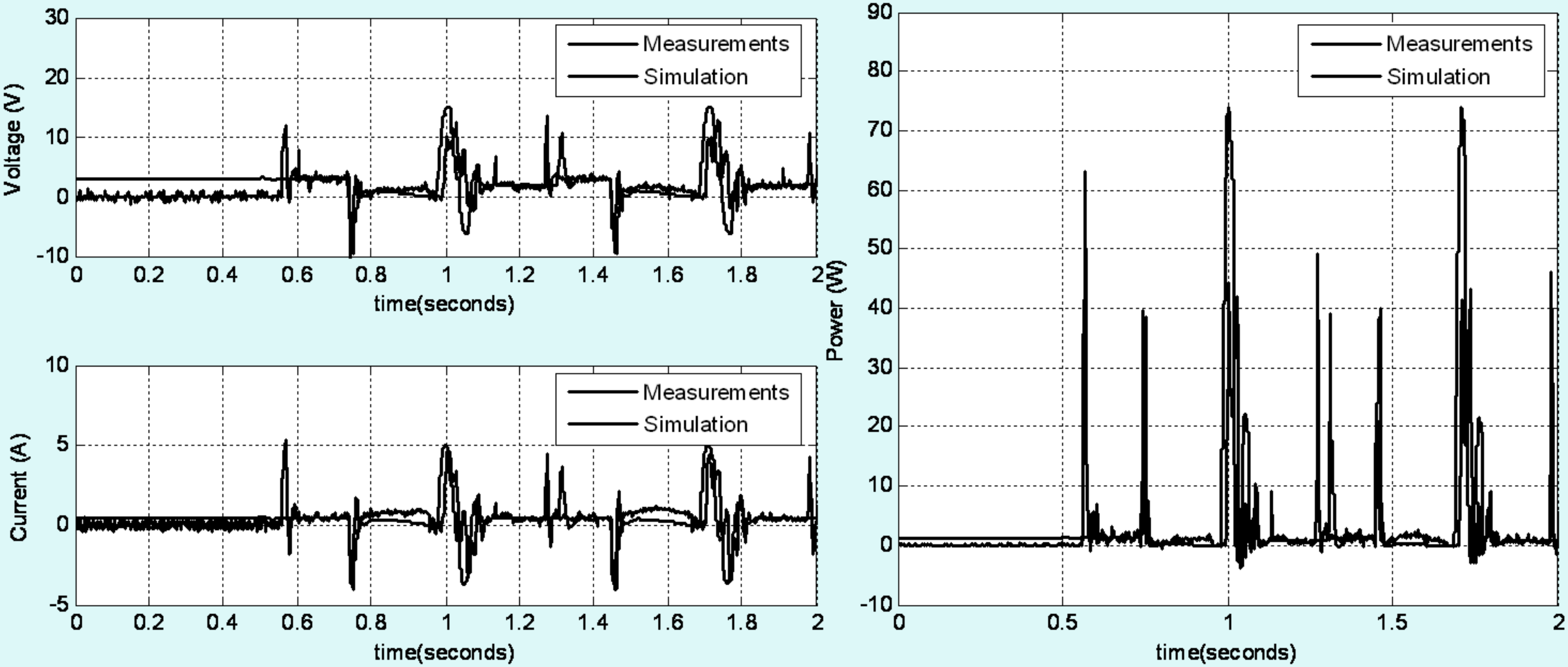

Iteration: dynamic workflow model

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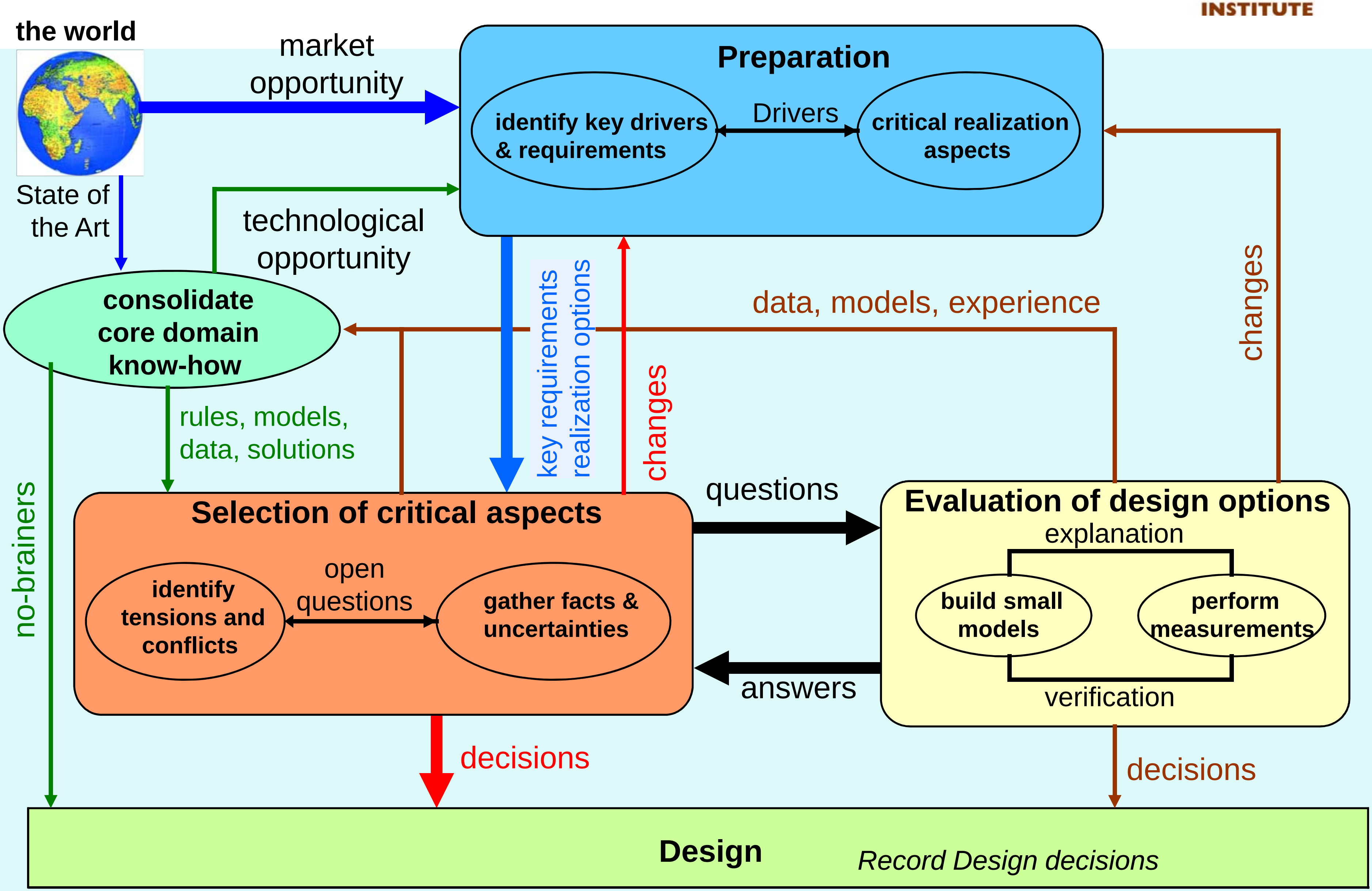

A successor project:
Octopus (2007 – 2012)

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Challenges:

- Current systems are developed to operate reliably within a **very well specified range** of conditions (e.g. temperature, energy, humidity, etc)
- Such systems often do **not easily adapt** to environmental or product usage fluctuations

- An approach is to design and implement rapidly; equivalent to “next release”
  - Essential to **understand** the effects of design changes
- Another approach is **system’s adaptability**
  - Adapt the actual use of the product at run-time

Octopus objectives

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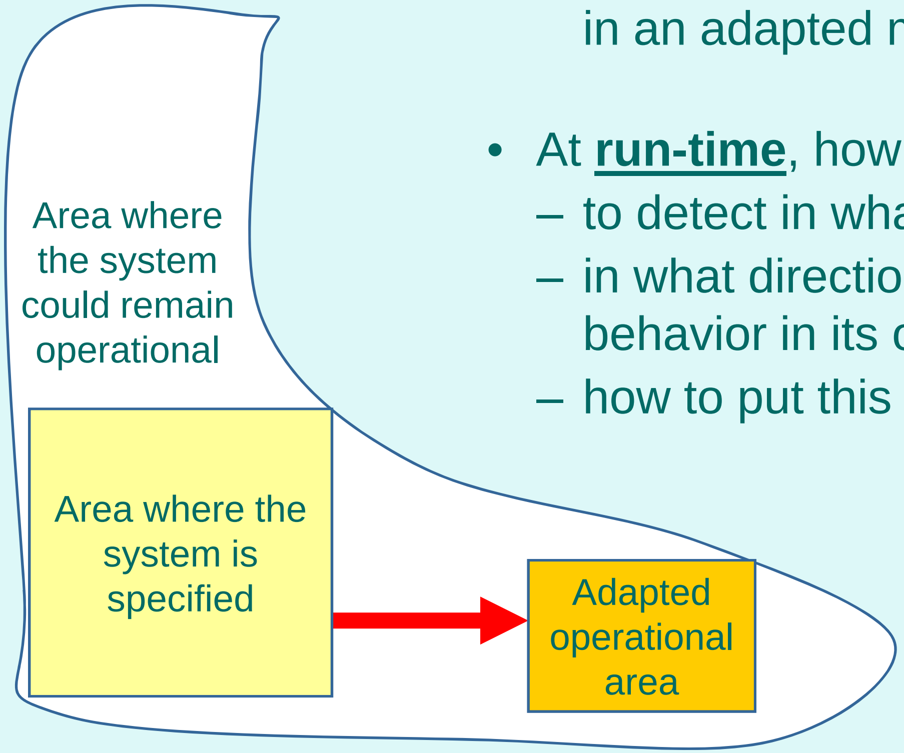
- At **design-time**, how
  - to build systems that are kept in a predictable, reliable, and operational mode,
  - while performing their task in an adapted manner?

- At **run-time**, how
  - to detect in what state the system is,
  - in what direction to adapt the product behavior in its operational space, and,
  - how to put this adaptability into effect?



Research approach Octopus (1)
1. Virtual prototypes

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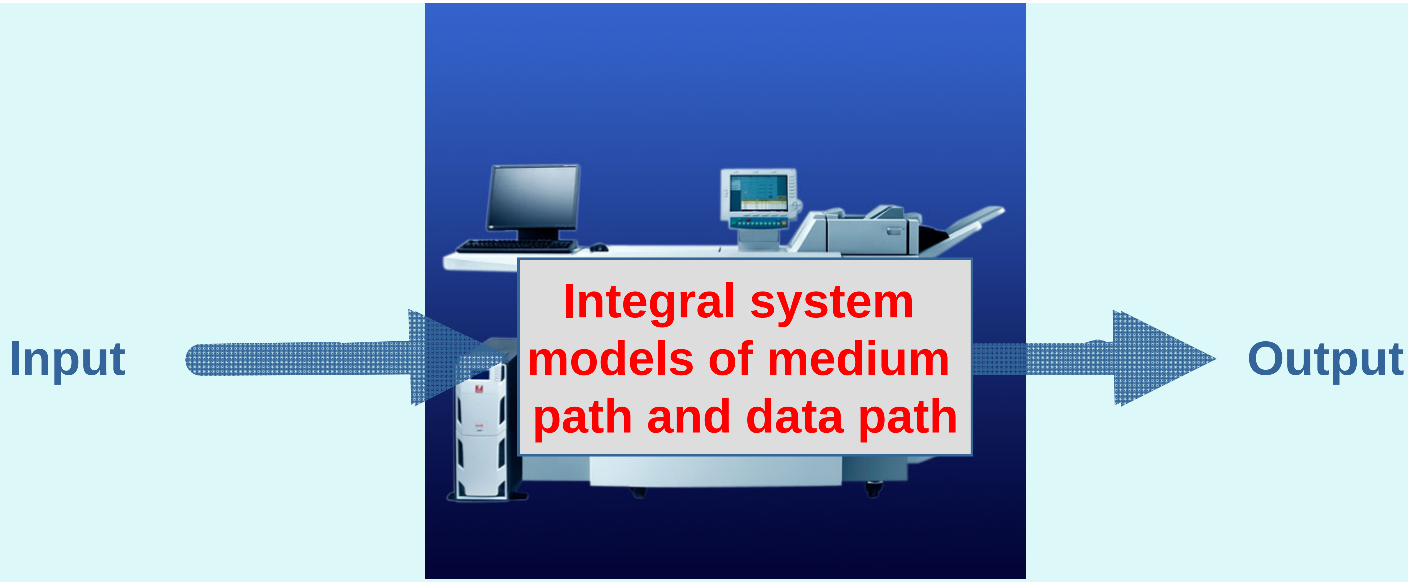

1. Make good predictions early in the design phase
2. Develop integral models that cover medium and paper path, mechanics, black-box view of print process, etc.
   – including performance, resource usage, energy, space, …
3. Experiment with model without expensive (e.g. time-consuming) prototypes
4. Gradually replace models with real components
5. Tightly link architectural and design trade-offs
6. Validate integral models

Research approach Octopus (2)
2. Adaptivity

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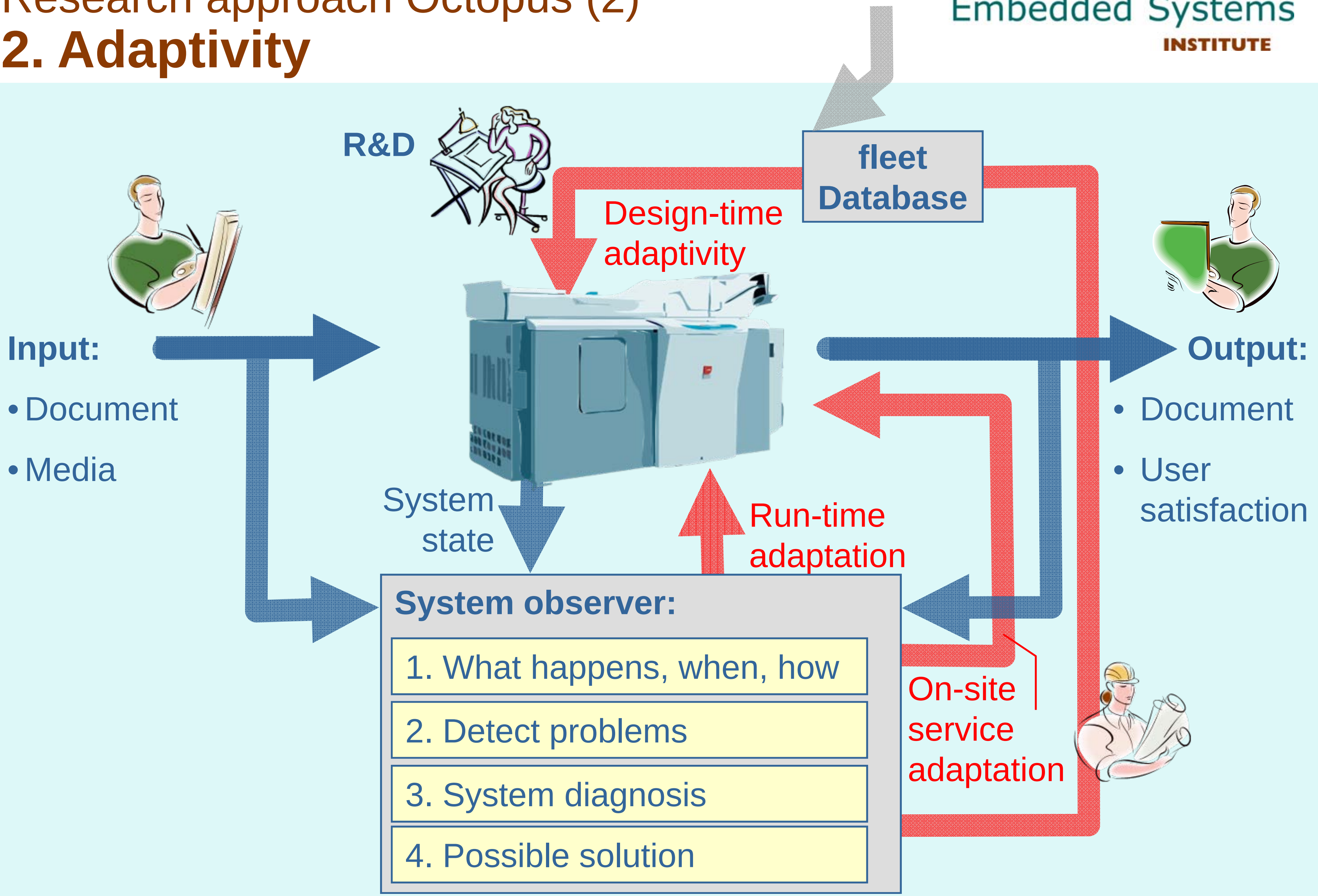

Research approach Octopus (3)
several practical cases

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Bayesian networks

Pareto optimality

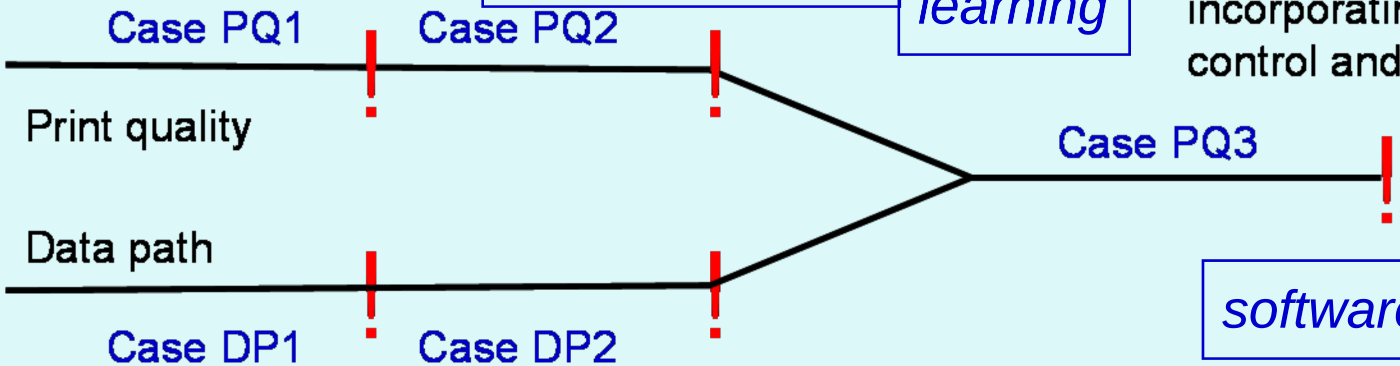
Demonstrator PQ 1
Trade off power consumption and productivity

Demonstrator PQ 2
Multiple trade-offs Including heat and glossiness

adaptive control

learning

Demonstrator PQ3
Full print quality control incorporating physical control and data-path



software architectures

Demonstrator DP1
High performance multiple scenario data path without adaptability

Demonstrator DP2
Data path without adaptability

SDF

Uppaal

PetriNets