Embedded Systems
INSTITUTE

ArtistDesign Workshop on Embedded Systems in Healthcare 2009

Boudewijn Haverkort

Opening

Abstract

The Embedded Systems Institute is committed to extending knowledge about embedded systems. It has the explicit aim of making this knowledge publicly available.

This presentation gives an overview of the Embedded Systems Institute, the challenges on Embedded Systems and our way-of-working with academic and industrial partners. Further it gives an overview of our main projects with the Carrying Industrial Partners.

artist

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Artist Design Workshop on Embedded Systems in Healthcare







Boudewijn Haverkort

Scientific director ESI

December 7, 2009

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Welcome to the

Embedded Systems Institute!







Artist Design Workshop on Embedded Systems in Healthcare, December 7, 2009

ESI was founded in 2002 by partners from industry and academia

NXP founded by Philips

PHILIPS

océ

ASML

TU Delft
Delft University of Technology

TU/e technische universiteit eindhoven

University of Twente
The Netherlands

Embedded systems focus: high economic value world-wide

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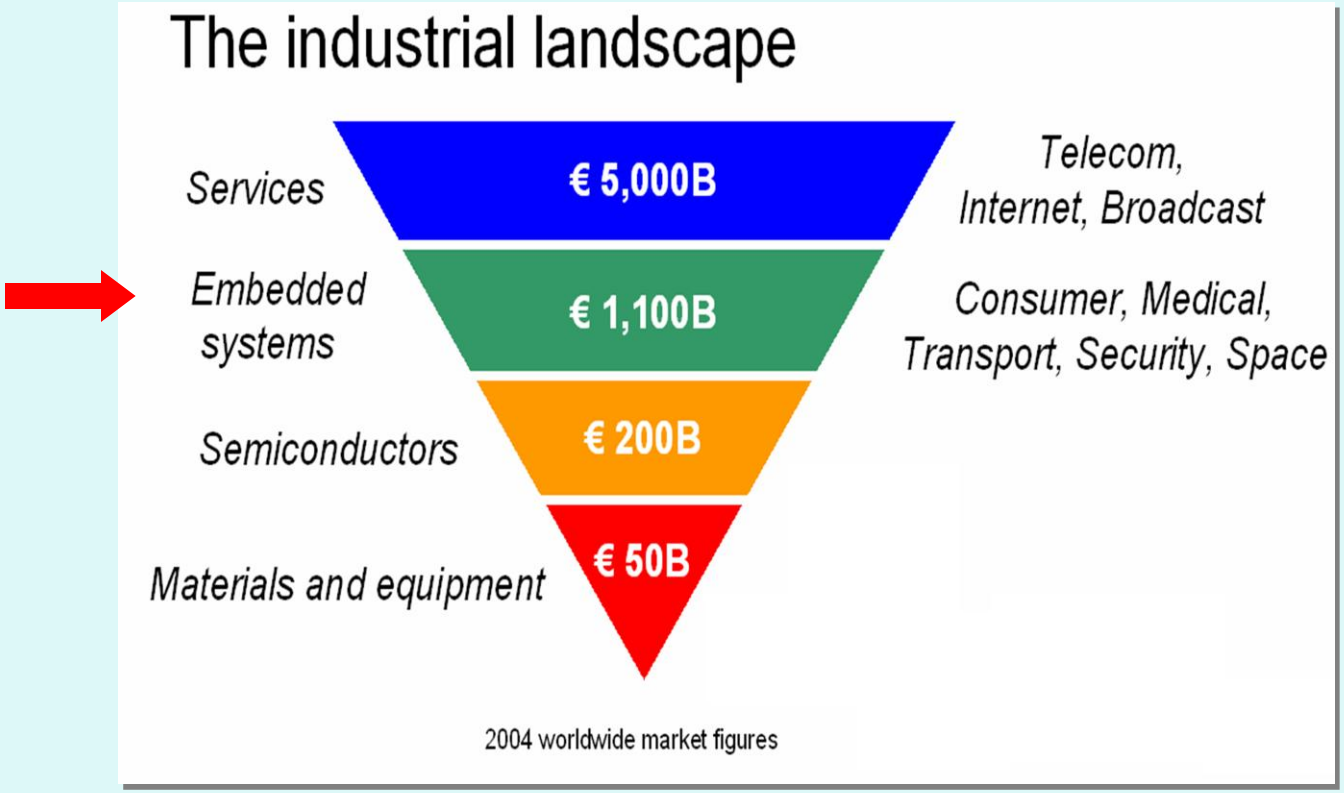

High-tech embedded systems sector in the Netherlands

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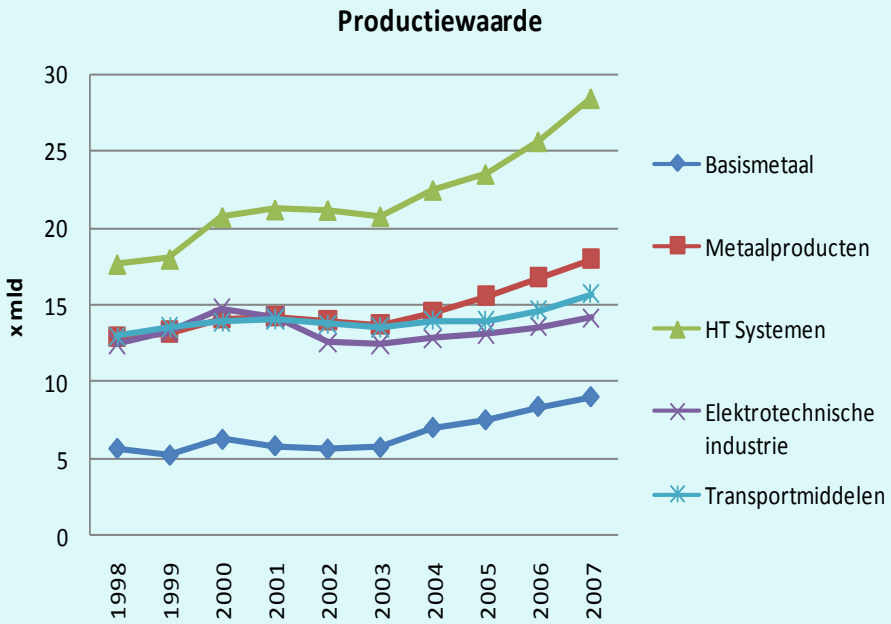

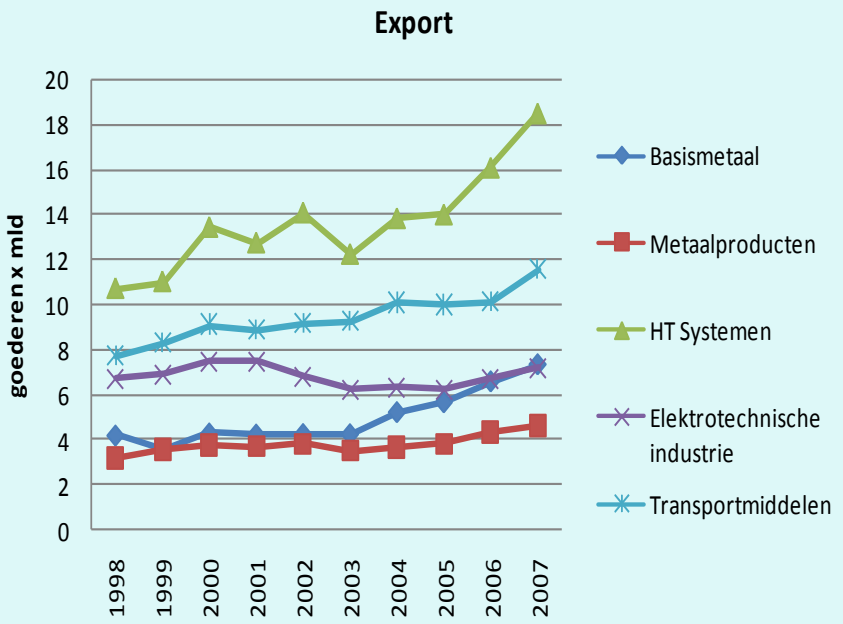

(figures published by courtesy of High tech Systems Platform & Berenschot, 2009)

ESI Research Collaboration

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Noldus Information Technology

PHILIPS
Consumer Electronics
Medical Systems
Research
Applied Technologies

2008: approx. 150 fte

TU/e technische universiteit eindhoven

Radboud Universiteit Nijmegen

NXP founded by Philips

Technolution AUTOMATION TECHNOLOGY

TUDelft Delft University of Technology

THALES

TNO

Universiteit Leiden

RuG

ASML

University of Twente The Netherlands

FEI COMPANY TOOLS FOR NANOTECH

océ

imec

DESIGN TECHNOLOGY INSTITUTE

VANDERLANDE INDUSTRIES

vrije Universiteit amsterdam

CHESS

Imtech ICT

Universiteit Antwerpen

TASS software professionals

CWI

DEMCON advanced mechatronics

Universiteit Maastricht

UNIVERSITEIT VAN AMSTERDAM

Industrial Network

ESI

Academic Network

KATHOLIEKE UNIVERSITEIT LEUVEN

Research cooperation with leading Dutch high-tech multinational industries & SME's

Research cooperation with all Dutch universities with embedded systems research

ESI International Collaboration

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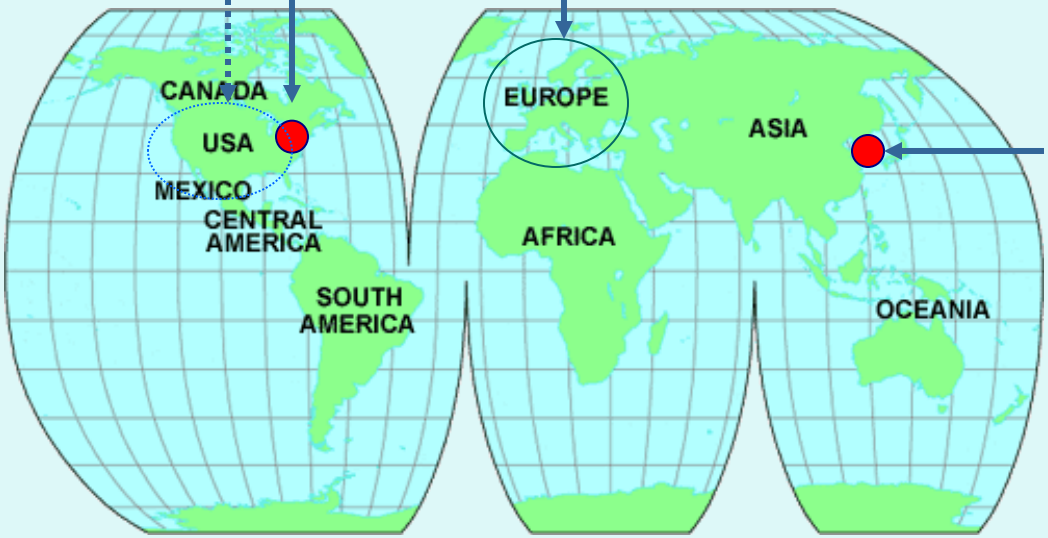
Joint education & training programs:
- ➔ System Engineering curriculum
- ➔ Course programs (e.g. for IBM, Samsung)
- ➔ Joint industrial consultancy

Research programming:
- ➔ Research agendas & roadmaps
- ➔ EU research initiatives (FP7)
- ➔ JTI (Artemisia)

Stevens Institute of Technology, Hoboken, New York

NSF: COMPASS

NoE: Artist2, HYCON
FP6: Cosine, Emtech
FP7: Genesys, Quasimodo,Multiform, ArtistDesign
TP: Artemis



Center for Embedded Software Technology Daegu, South Korea

Peer institute in Asia:
- ➔ Experience build-up in industrial-academic research collaboration
- ➔ Joint research workshops & seminars
- ➔ Student exchange

Embedded system engineering challenges





Embedding intelligence in the form of software into physical “things”, products and infrastructures

❑ Multi-disciplinary design	EE,ME,CS,control
❑ Software complexity	integrating software
❑ Physical environments	time,power,speed,...
❑ Distributed or networked	interaction, emergence
❑ Constrained resources	time,memory,power,...
❑ Critical applications	safety,high-volume
❑ Quality standards	conformance,security
❑ System evolution	evolvability

Academic foundations

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We need a new formal foundation for embedded systems, which systematically and even-handedly re-marries computation and physicality.

Henzinger & Sifakis

We need a new formal foundation for computational systems, which systematically and even-handedly re-marries performance and robustness.

What is being computed? At what cost?

How does the performance change under disturbances? (change of context; change of resources; failures; attacks)

Engineering perspective

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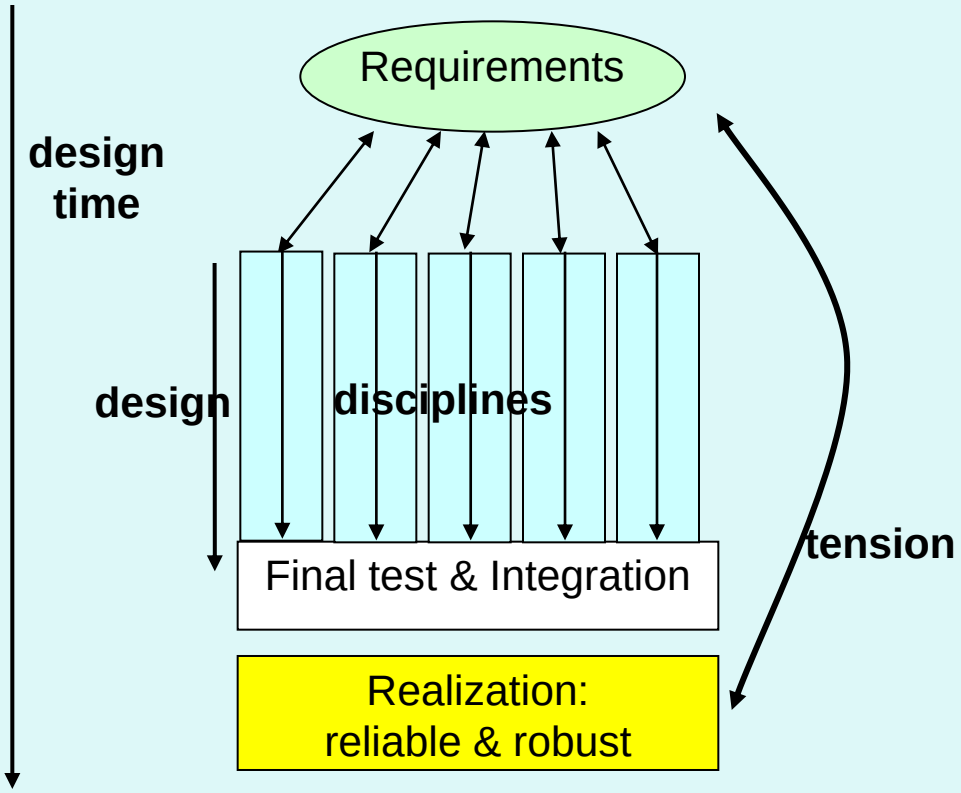
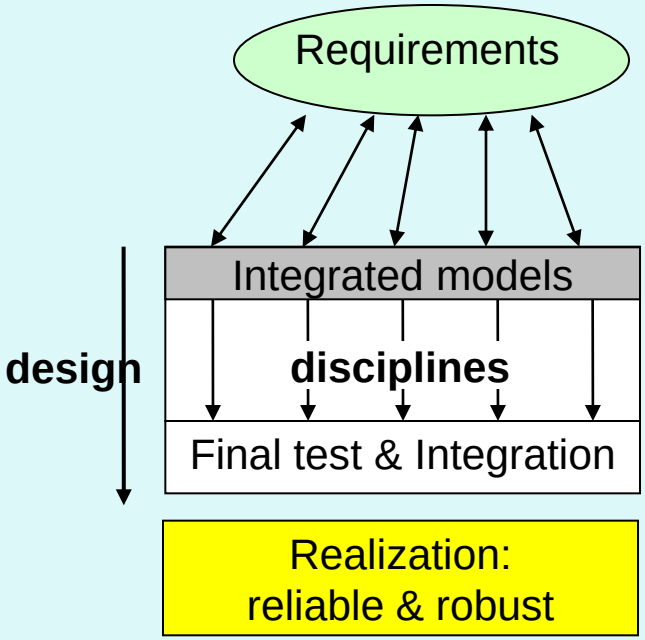
To develop an engineering discipline for *dependably* integrating embedded systems technology into high-tech systems

- **Desired functionality (both qualitative and quantitative)?**
- **Allowed complexity?**
- **How do we get there?**
- **Which methods and techniques are needed?**

Problem 1: Late integration



Current practice
early partitioning



Advocated practice
early integrated modeling
late partitioning

Problem 2: System design tensions

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Trade-offs between crucial *cross-cutting* design objectives:

- **Performance:** quantified hard and soft real-time behavior, use of resources, optimization of cost functions, etc.
- **Dependability:** availability, reliability, safety, integrity, confidentiality
- **Evolvability:** easy modification or extension by re-use of available design assets, product families, generic system components, etc.
- **Costs**
- other **–ilities (e.g., energy, security)**

A wide variety of system types!

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	Digital Television	Lithography Systems	Medical Systems	Mobile Phones	Automotive Systems	Digital Printers	Military Systems
Life Span	Medium	Long	Very Long	Very Short	Long	Long	Very Long
Lead Time	Short	Short	Medium	Very Short	Long	Medium	Long
Volume	Very High	Low	Low	Very High	Very High	Medium	Low
Cost	Very Low	High	High	Very Low	Medium	Medium	High
Feature Extension	Growing	Medium	High	Growing	Growing	Low	Growing

Model-driven design helps!

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- heterogeneous modeling & analysis
- support for de/composition
- support for high abstraction levels
- support identification of design tensions
- support for (automated) refinement/synthesis
- **models as first-class citizens that guide the design process and form the basis of communication**

Maturity of model-driven design and methods?

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1. incidental application
2. defined application method
3. repeatable
5. optimized application method

This needs an empirical framework

inspired by SEI CMM

ESI answer: Industry-as-Laboratory

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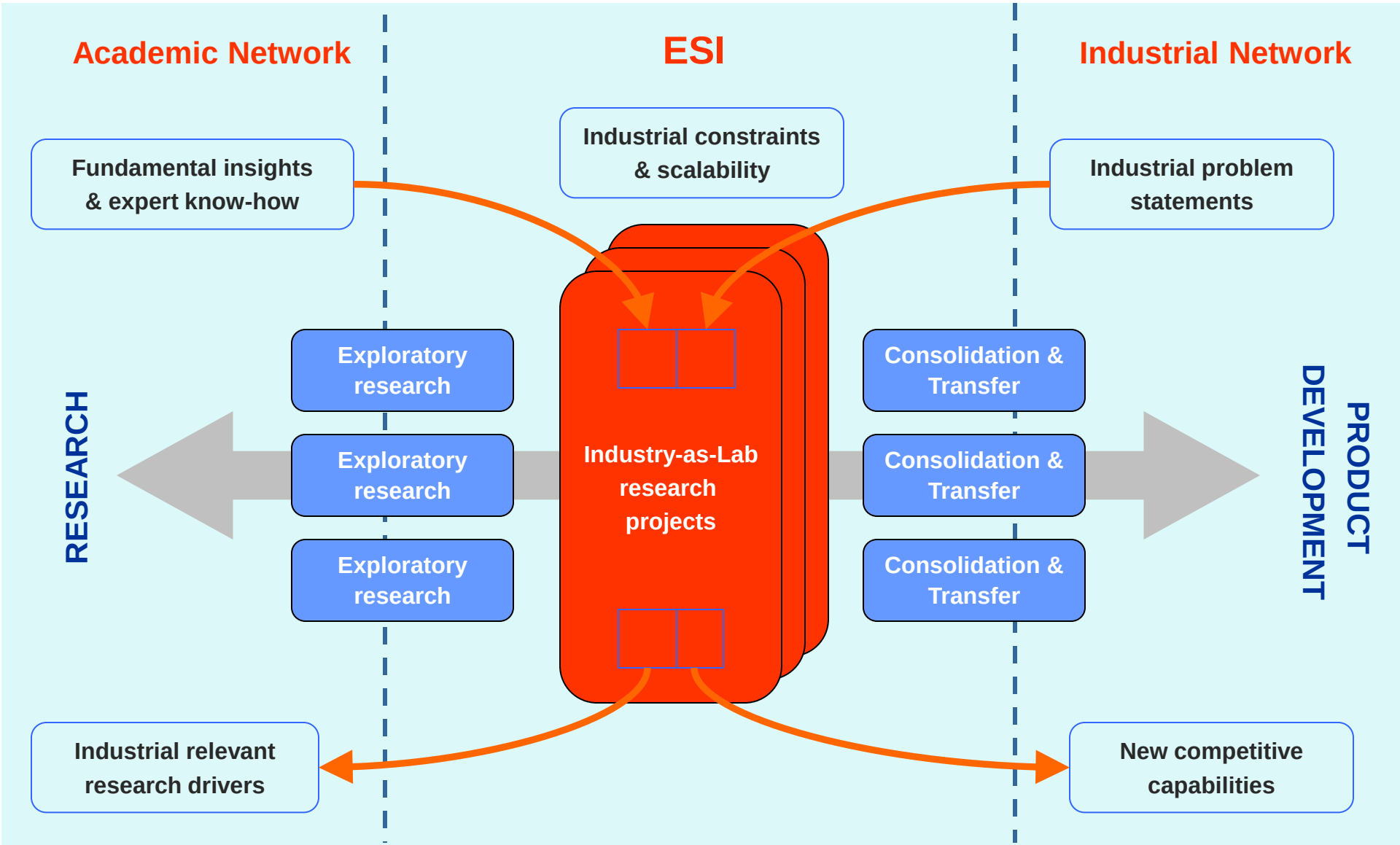

Carrying Industrial Partners

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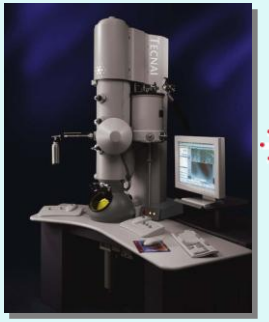

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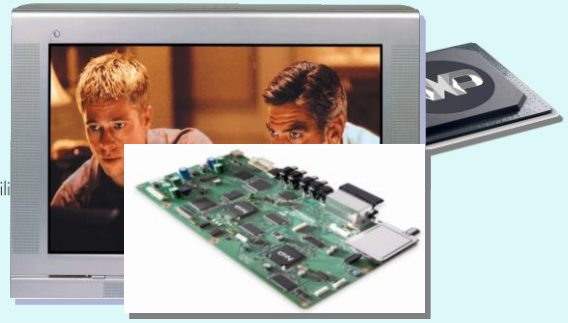
TOOLS FOR NANOTECH

NXP founded by Phili



VANDERLANDE® INDUSTRIES

PHILIPS
Medical Systems

ESI Industry-as-Lab Project portfolio

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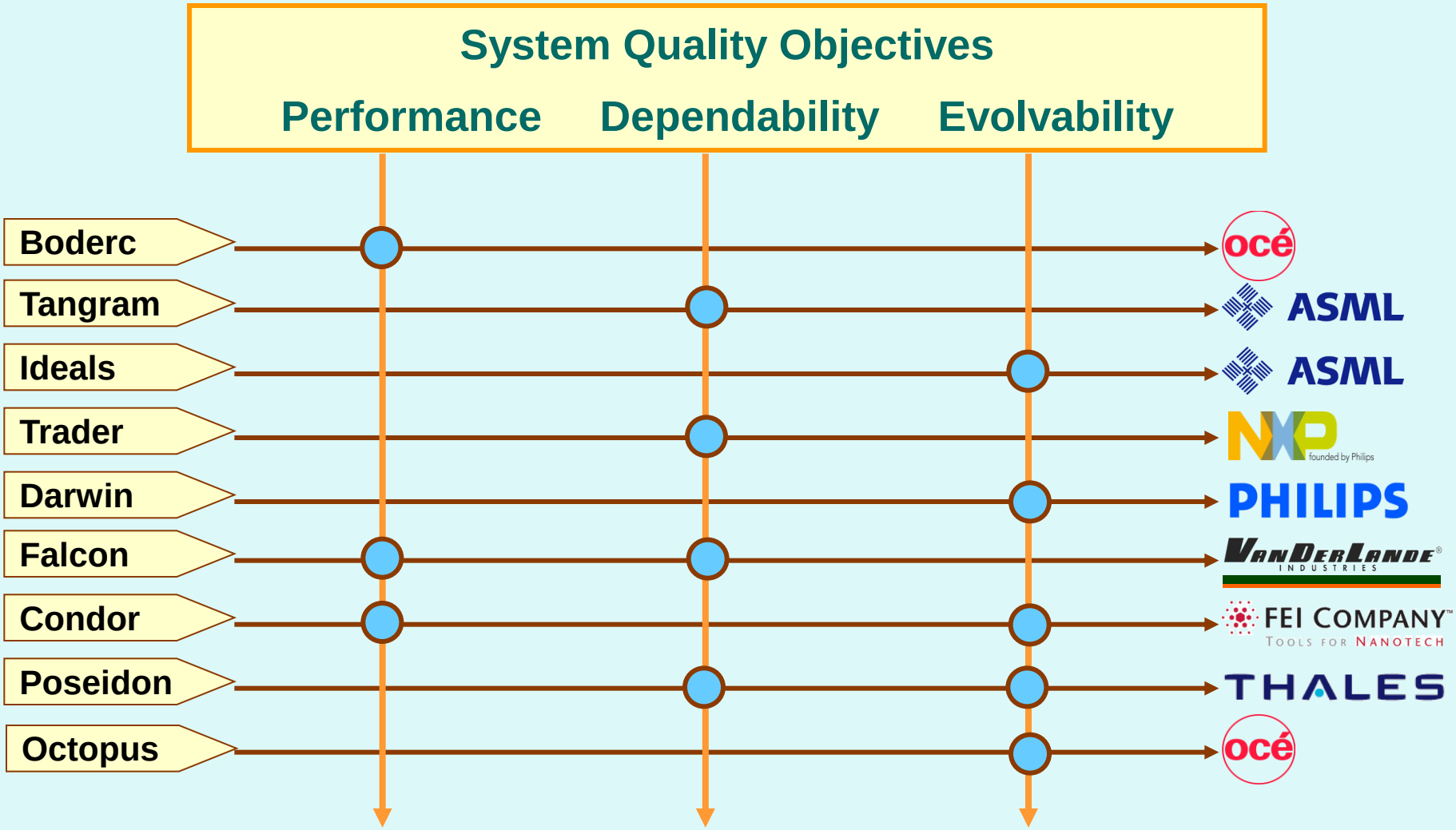

Summary

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- **Embedded systems engineering is a challenging field that needs substantial & coordinated efforts from academia and industry to become a mature design and engineering discipline**
- **Industry-as-laboratory is a powerful applied research paradigm to study and advance industrial validity and scalability of exploratory research results**
- **Model-based design methods are essential for professional embedded system engineering. Initial research results show (selection):**
  - well-orchestrated combinations of specialized models are likely to yield better results than using monolithic, multi-aspect models
  - need for integration of control and software engineering paradigms.

AD-WESH Program

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9:15	**Pierre America** (ESI) **Piërre van de Laar** (ESI)	Healthcare in 2020: Consequences for Embedded Systems
9:45	**Wim Pasman** (Philips)	A (R)evolutionary Architecture for Philips Cardio Vascular
10:30	*break*	
11:00	**Elisabetta Farella** (Università di Bologna)	Sensing and Actuating in Assistive Environments
11:45	**René Roos** (Cochlear)	Cochlear Implant Systems: Today's Challenges in Embedded Firmware Design
12:30	*lunch break*	
14:00	**Thom van Beek** (TU Delft)	Capturing User Requirements using Workflow Scenarios
14:45	**Johan Henning** (Nucletron)	How to Design Long Lasting Devices for a Fast Changing World?
15:30	*break*	
16:00	**André Stollenwerk** (RWTH Aachen)	Embedded Contributions to an Intensive Care Safety Concept
16:45	Discussion	Consequences for Future Research
17:30	**Boudewijn Haverkort**	Closing