Fostering a culture for System Architects / Systems Engineers / (SW) Developers

Creating a Systems Engineering / Systems Thinking mindset in Philips

Gert van Schothorst / Wouter Kaandorp
Philips Innovation Engineering / Systems Engineering Excellence
February 4, 2025

PHILIPS

Storyline

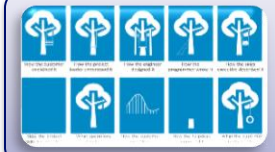
- Systems Thinking as basis for Systems Engineering
- Creating an enterprise mindset by building a Systems Engineering Community
- The role of training for System Architects / Systems Engineers / (SW) Developers
- The promise of MBSE for multi-disciplinary collaboration with one language
- Wrap-up / Reflection

Gert van Schothorst

Systems Thinking as basis for Systems Engineering

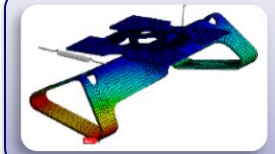
What Systems Engineering brings…

Creating systems engineering / systems thinking mindset in Philips



Meeting end user needs

Managing complexity of systems



Quantitative underpinning of design decisions

Examples

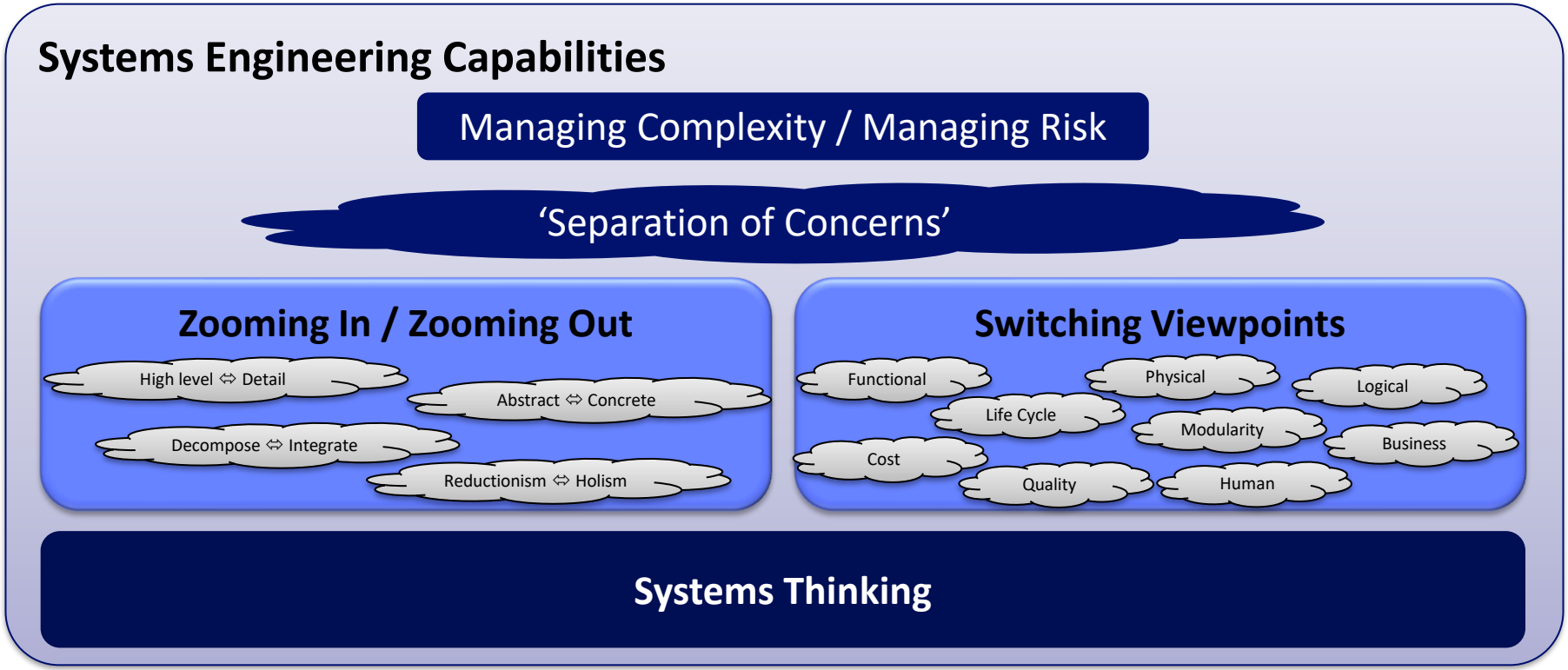
- Requirements Engineering, translating user needs into design, requirements flowdown
- Stress testing design by FMEA, ‘test-to-fail’ approach, Verification & Validation

- Functional Analysis, Block Diagrams, System Decomposition, Interface Definition, Architectural Views
- Model Based Systems Engineering (MBSE)

- Modelling, Analysis & Simulation
- Quality by Design, e.g. by Technical Budgeting, Design for RAM (Reliability, Availability, Maintainability), Tolerance Analysis, Design for Test (DfT)

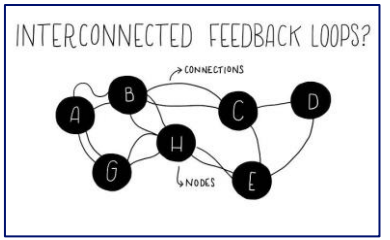
Create a common systems engineering approach in Philips, working with the same tools and sharing best practices

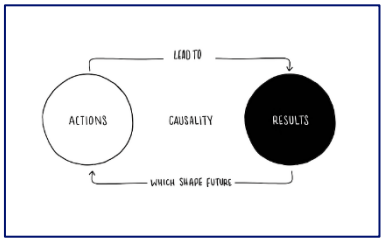
High level view on Systems Engineering

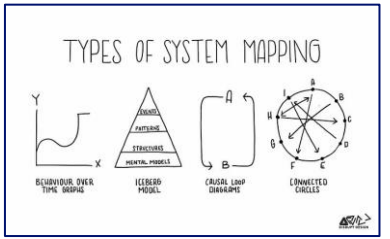


Systems Thinking – Six Key Themes

- **Interconnectedness:** real world is dynamic, chaotic, interconnected array of (feedback) relationships
  → *Systems thinkers see this through*
- **Synthesis:** understanding the whole along with the relationships and the connections - ability to see interconnectedness – balancing between holism and reductionism
  → *Systems thinkers combine analysis with synthesis*
- **Emergence:** things coming together, interacting together, behavior evolving over time
  → *Systems thinkers see the dynamics rather than statics*
- **Feedback Loops:** reinforcing and balancing loops – will determine systems behavior
  → *Systems thinkers identify feedback mechanisms and exploit them to influence system behavior*
- **Causality:** how things influence each other in a system
  → *Systems thinkers use reasoning to understand and influence system dynamics*
- **Systems Mapping:** using visualization methods to see interconnections, causality, feedback loops
  → *Systems thinkers exploit mapping methods, e.g. Mind Mapping, to make better decisions*







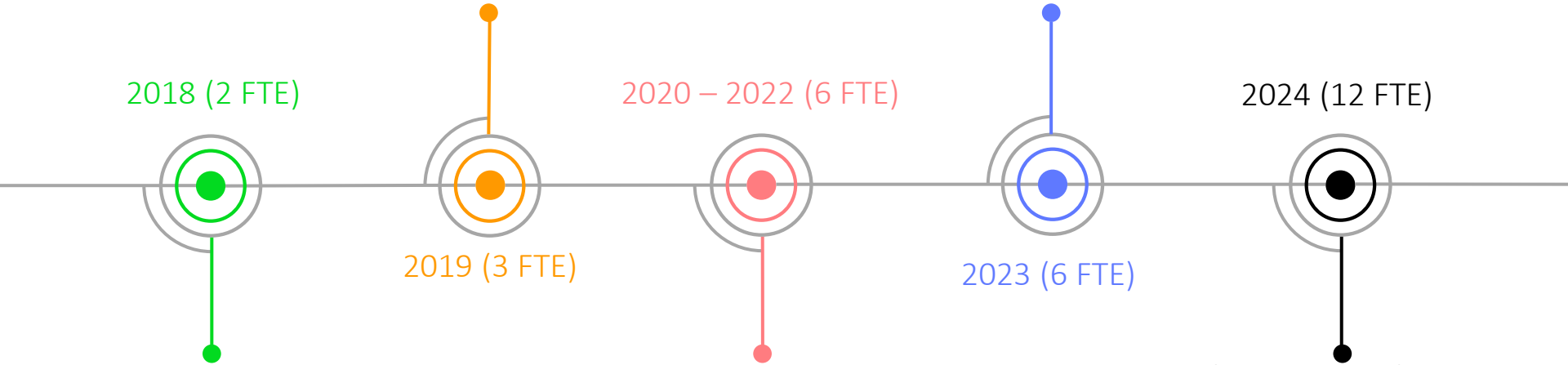
Source: https://medium.com/disruptive-design/tools-for-systems-thinkers-the-6-fundamental-concepts-of-systems-thinking-379cdac3dc6a (including graphics)

PHILIPS

Gert van Schothorst

Creating an enterprise mindset by building a Systems Engineering Community

Timeline Philips Systems Engineering (Center of) Excellence



Kick Off Central Activities

- *First SE Assessment in Businesses*
- *Establishing Center of Excellence*
- *SE/MBSE Excellence Masterclass*

Ramping Up of Initiatives

- *Definition of SE Training Curriculum*
- *Establishing SE Community of Practice*
- *Establishing Global SE Leadership Team*
- *Creation of SE Job Profiles in Philips*

Maturing the Program

- *Solidifying SE Core Excellence Initiatives*
- *Expanding on MBSE Initiatives*
- *Setting up pilots with business*

Consolidating & Reorganization

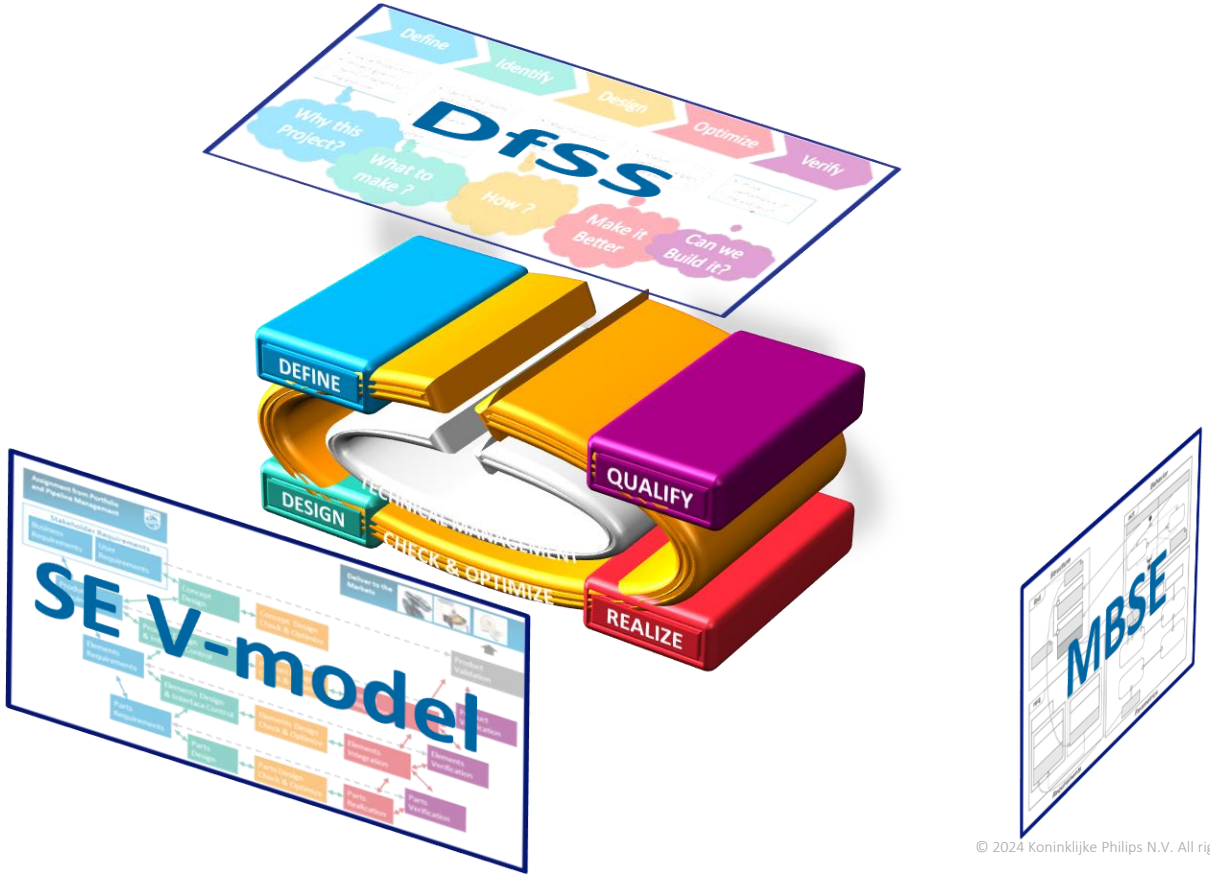
- *Consolidation of Program*
- *Adapting to major reorganization (surviving…)*

Scaling up & Maturing

- *Scaling up trainings, pilots, …*
- *Inclusion of RAM and DfSS Programs*
- *Extension towards SW Systems Eng.*
- *Preparing for future, e.g. AI4SE/SE4AI*

Systems Engineering in Philips – speaking one language

SE Methodology Model based on Philips SE Framework



PHILIPS

SE Leadership Team Instrumental in building SE Community

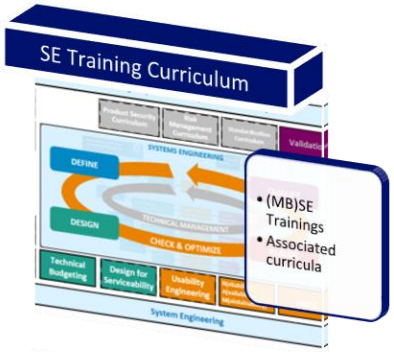
SE CoE Team

Philips Businesses

Systems Engineering CoE

Business SE Leadership Team

SE Community – where we are now



- # of community members:
  - ~800 SE overall
  - ~200 MBSE
  - ~300 RAM
  - ~400 DfSS
- # of training consumptions per year is ~2500
- Yearly Philips SE Conference, with ~250 participants
- Monthly CoP meetings with ~60 – 100 participants

PHILIPS

Take Aways – building a SE Community (arbitrary order)

- **Assure you have Sr. Management buy-in, in whatever form**
- **Start small – keep the goal in mind – make iterations in building SE Excellence**
- **Develop a key message / SE Framework that addresses needs in your company**
- **Exploit waves in your company to accelerate maturing your program**
- **Work with HR / have a consistent training program in place**

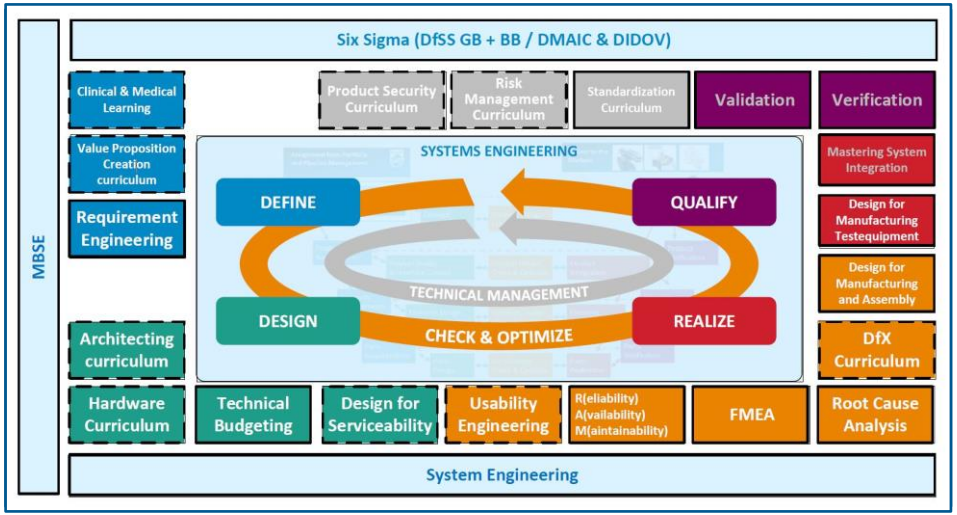
Wouter Kaandorp

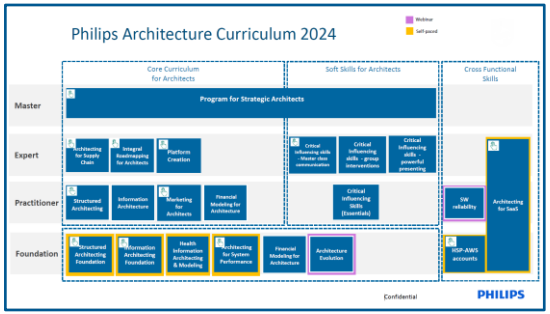
The role of training for System Architects / Systems Engineers / (SW) Developers

The role of training for System Architects / Systems Engineers / (SW) Developers

2018 : Challenge: Raise the Systems Engineering skill-level with training

- There is a huge training offering @ Philips.
- **2018:** Point the (aspiring) Systems Engineer to the relevant training in the overwhelming offering at Philips
- **2024:** Redesign as more relevant trainings become available, we want to align the training offerings with our Systems Engineering Framework, and we want to point to adjacent fields.
- We want to offer the complete technical training program in cooperation with the Architects community and Hardware Engineering



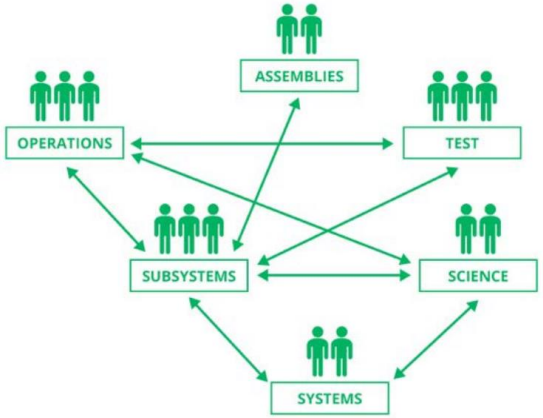


PHILIPS

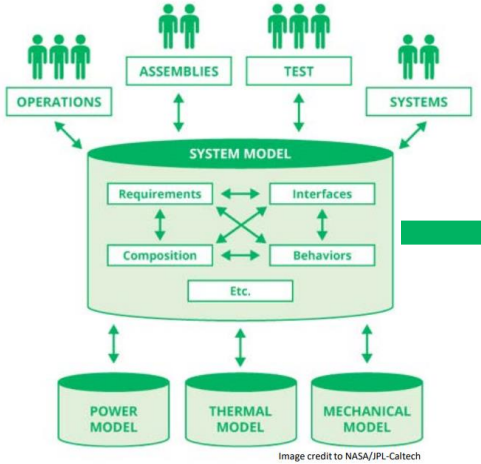
Wouter Kaandorp

The promise of MBSE for multi-disciplinary collaboration with one language

Traditional versus **Model Based Systems Engineering**



Traditional Systems Engineering



Model Based Systems Engineering

- Set of interconnected models
  - Models are an **abstraction** of reality
  - **Structure, behavior** and **requirements**
- Standard language
  - Graphical notation
  - **Syntax, semantics**
  - **Visual** focus
  - Static and dynamic
- Shared system **information base**

Document-Centric → *Model-Centric*

*Taken from the MIT Webinar (Bruce Cameron) on Systems Engineering and Architecture as is

PHILIPS

What makes MBSE different from Model Based Engineering?

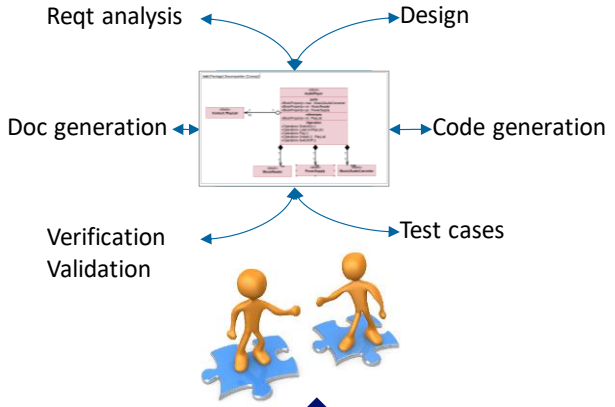
- Model-Based **Systems** Engineering:
  - Describes the entire system's structure and behavior
  - Covers the technical development processes
  - Links to / uses physical-level models to explore / validate design choices

Reqt's

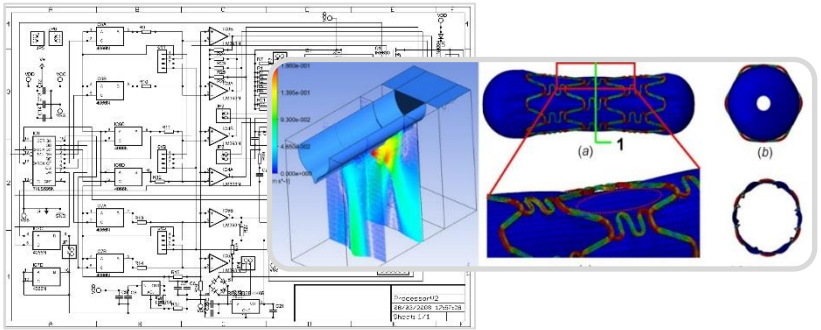
Functional

Logical

Physical



- Model-Based Engineering:
  - Model describes aspects of the system (SW, mechanical, optical, electrical, thermal, …)
  - Logical or (Multi-)Physics model to support design, analysis, optimization and verification of a product, element or part



PHILIPS

In Philips we differentiate 3 levels of model-based design

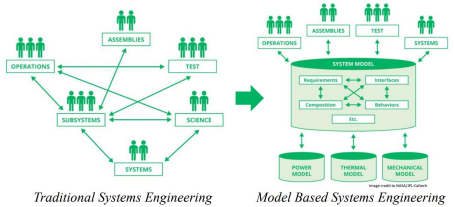
Levels of model-based design

Structure / Specification (System) Models
(From document-based to model-based)

Formalized application of modelling to support 'system requirements, design, analysis, performance and V&V activities covering all lifecycles (concept, design, development, (post)-launch)

- Improved **quality of complex systems**
- Increased **productivity**
- Improved **communication** in global development
- Enabling of **modular** strategies

Most mature | MBSE



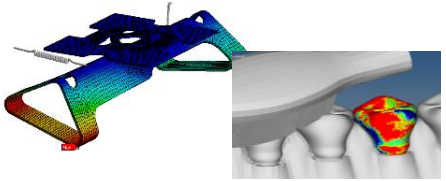
Traditional Systems Engineering *Model Based Systems Engineering*

Virtual Prototypes
(Model-Based Design & Optimization)

Multi-physics, virtual, dynamic models capturing (CtQ) behavior and performance. Delivering benefits:

- **Quantitative** underpinning of design decisions
- Design **(CtQ) optimization**
- Virtual **Verification and Validation**

MBSE to MBD/MBE integrations

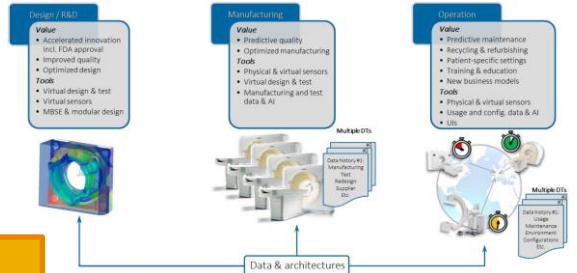


Digital Twins
(Design for Service, Industry 4.0, Hospital 4.0)

Digital model of a real-world asset that reflects its past, current and future state, fueled by continuous data stream. Delivering benefits:

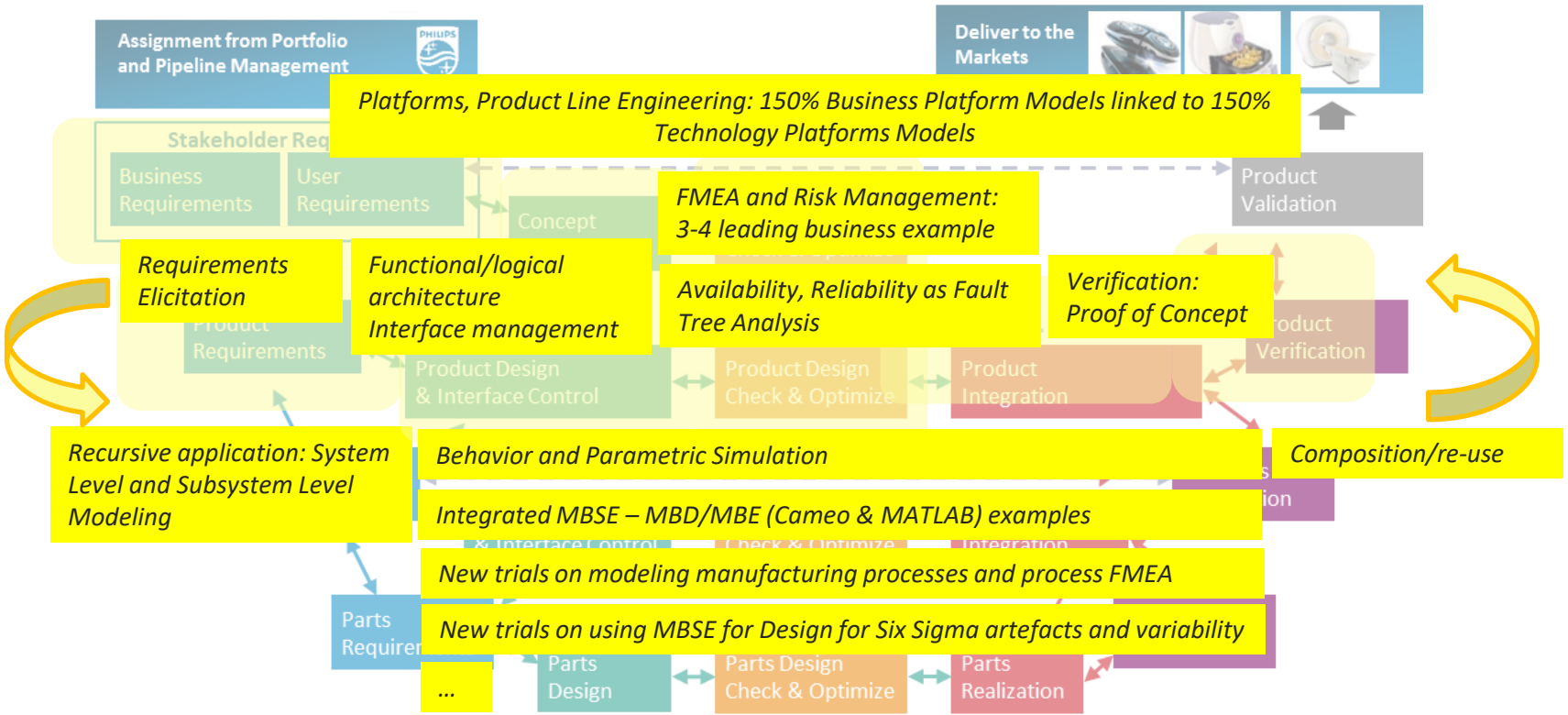
- **I2M:** improved time to market, (clinical) performance, quality
- **O2C:** zero defect, process control
- **Operational:** improved training, predictive maintenance, system performance optimization

A couple examples in place



PHILIPS

Philips MBSE is increasingly covering the V-model of SE Framework



Wrap-up / Reflection

Wrap-up

- Systems Thinking is a rather abstract concept, but an essential basis for Systems Engineers / System Architects
- It takes a long breath, but building an enterprise mindset is possible (to a certain extent)
- In house training curricula (can) play a prominent role in this
- MBSE has a large promise as a common means for speaking the same language (and more)

Reflection

- System Architects don’t (always) see the value of Systems Engineering, including MBSE
- There is still a gap between theory and practice w.r.t. the introduction of MBSE
- Businesses tend to start introducing MBSE while still having a gap in Model Based Engineering practices

PHILIPS