

MBSE AND THE HIGH-TECH EQUIPMENT INDUSTRY, HOW DO THEY MATCH UP?

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Capella days

October 13, 2020

HIGH-TECH INDUSTRY IN THE NETHERLANDS



Semiconductor manufacturing equipment



Medical systems



Food processing



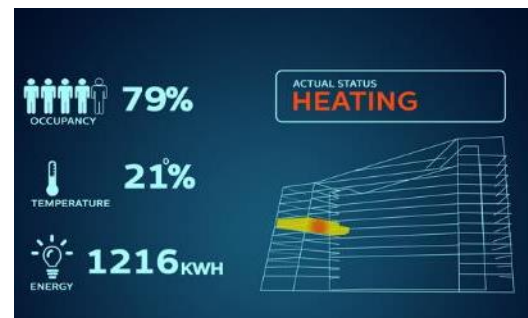
Agricultural robots



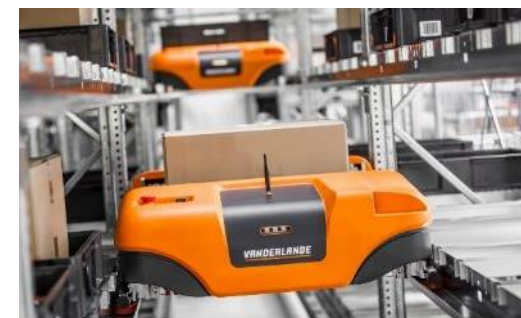
Traffic management



Electron microscopes



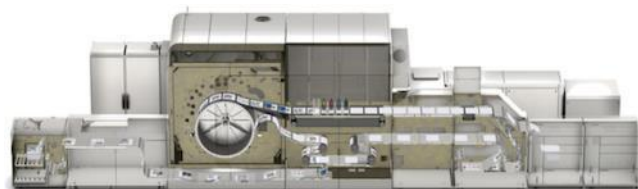
Building control



Robotized warehousing



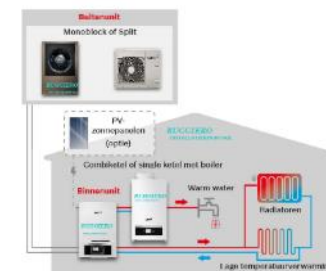
Combat management systems



Industrial printers



Automotive



Residential heating/cooling

ESI AT A GLANCE

Mission: Embedding cutting-edge methodologies into the Dutch high-tech systems industry in order to cope with the ever-increasing complexity of their products.

Synopsis

- Foundation ESI started in 2002
- ESI acquired by TNO per January 2013
- ~55 staff members, many with extensive industrial experience
- 5 Part-time Professors
- Working at industry locations
- From embedded systems innovation to embedding innovation
- TNO program turnover 2018: 10Mio €

Focus

Managing complexity of high-tech systems

Through

- System architecting,
- System reasoning and
- Model-driven engineering

Delivering

- Methodologies validated in cutting-edge industrial practice

Partner Board

ASML PHILIPS

Canon

CANON PRODUCTION PRINTING

TNO

ThermoFisher
SCIENTIFIC

nexperia



Radboud
University
Nijmegen

TU/e EINDHOVEN
UNIVERSITY OF
TECHNOLOGY

UNIVERSITY
OF TWENTE.

TU Delft
Delft University of Technology

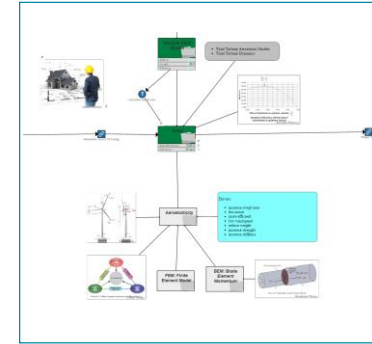
MBSE



Document-centric
Presentations and
Documents



Model-centric
Multi-user, tool-based,
Connected information



MBSE = Model-based Systems Engineering

The System Engineering methodology that focuses on creating and exploiting **domain models** as primary means

the interdisciplinary field of

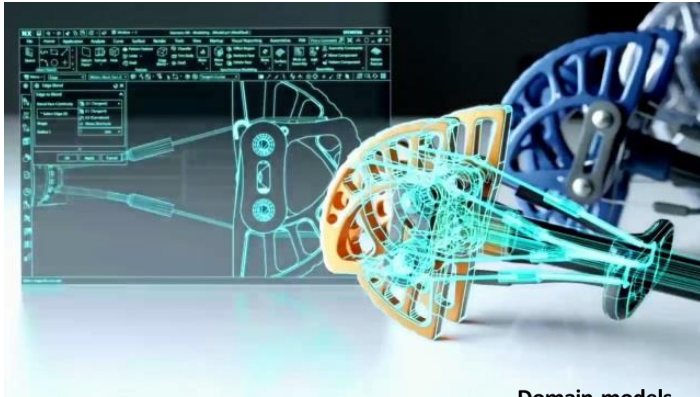
engineering and **engineering management** on how

of **information exchange, analysis, simulation**

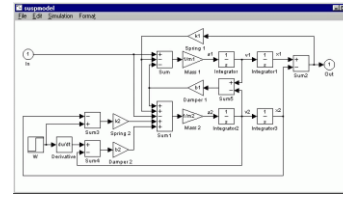
to **design** and **manage effective systems over their full life cycles.**

- Models are the **authoritative, single source of Systems Engineering information** for everyone.
- Models are not add-ons to documents.
Documents (if used at all) are generated from the models.
- MBSE covers the **full System Life Cycle (SLC)**

MODELS ARE WIDELY USED IN SYSTEMS ENGINEERING



Domain models



Causal graph

Expert knowledge exchange

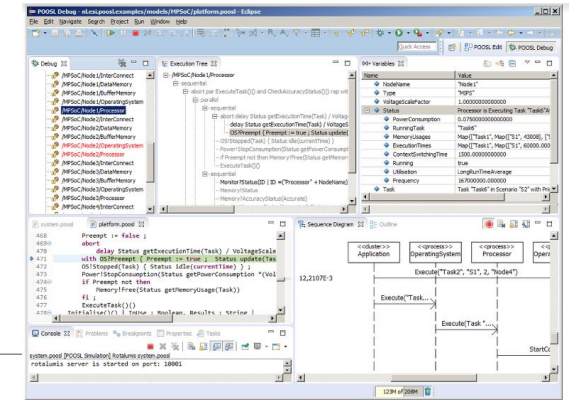
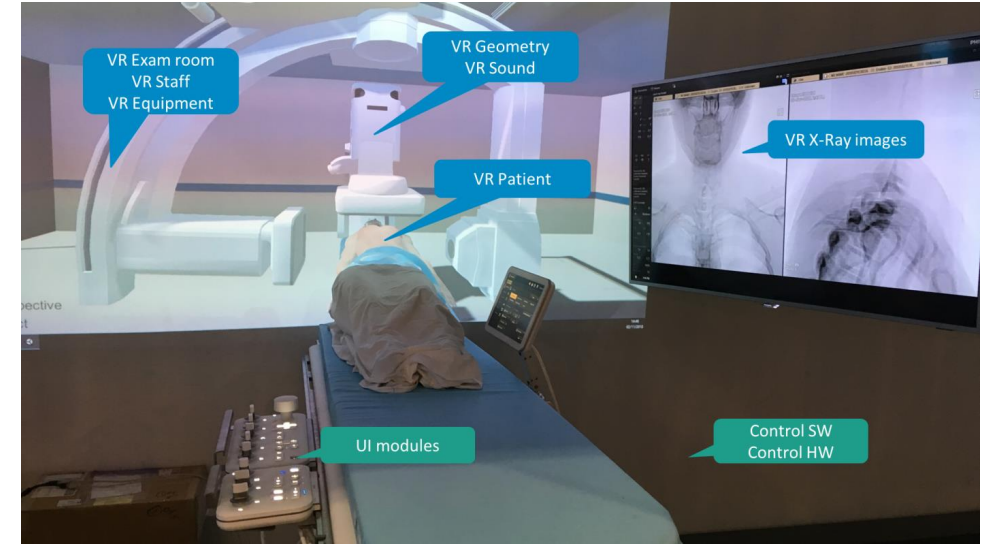
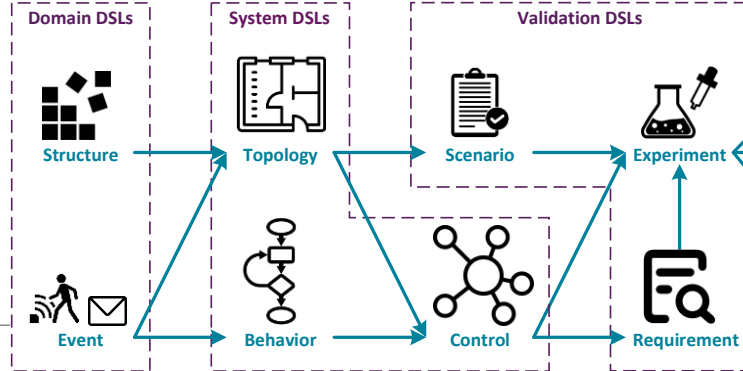
Fishbone

Root-cause analysis

Bayesian network

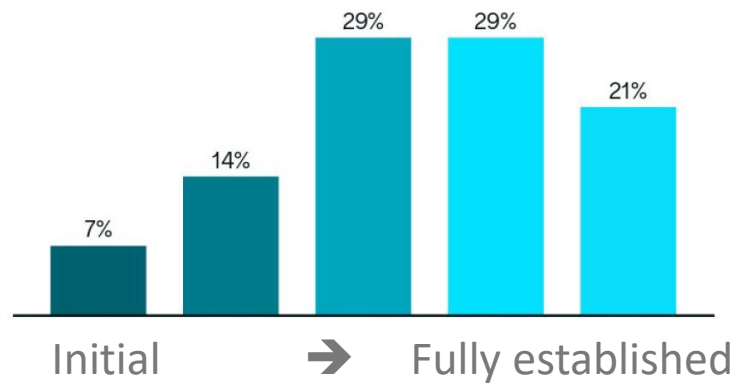
Root-cause analysis

Automated transformations

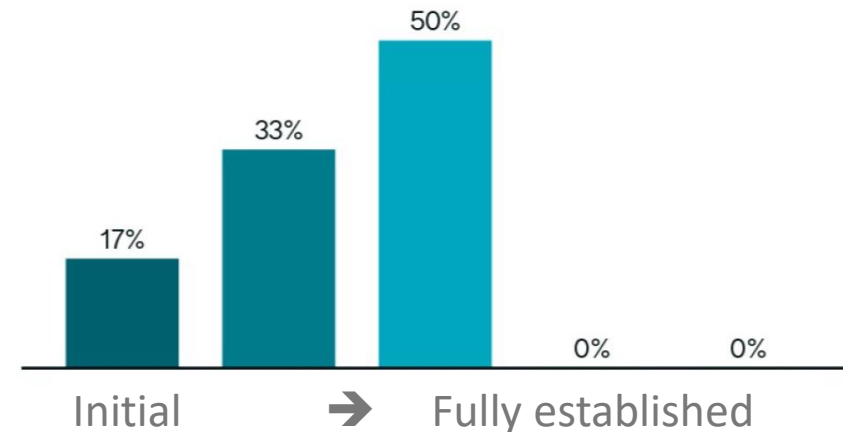


SE IS ESTABLISHED – HIGH TECH EQUIPMENT INDUSTRY IS EXPLORING MBSE

Where is your organisation with respect to SE in general?



Where is your organisation with respect to MBSE?



Missing: the cookbook to achieve value and RoI

DEMYSTIFYING MBSE – A STUDY BY ESI AND PARTNERS

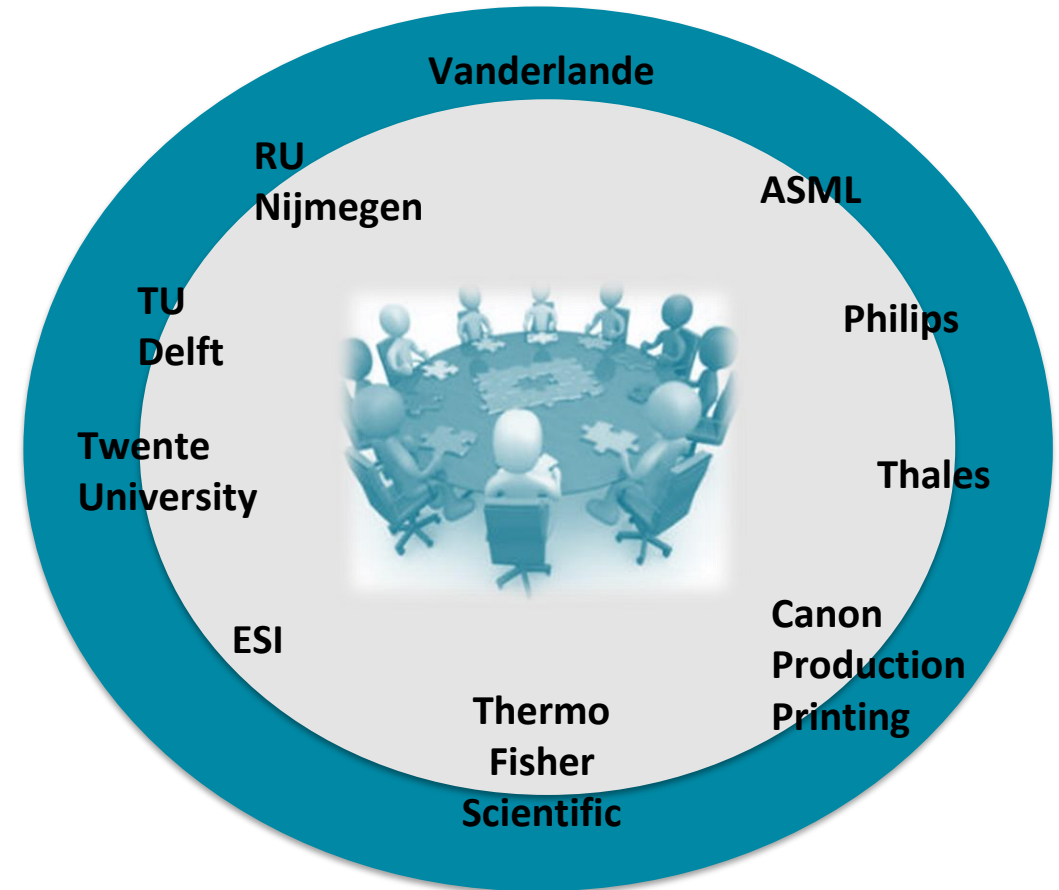
*“MBSE tools are developing fast.
It is necessary to keep up-to-date experience.”*

MBSE study objective

- **Assess and learn together** whether and how MBSE provides a handle towards increasing system complexity

Today

Initial report on needs and investigation topics



MOTIVATION FOR INVESTIGATION MBSE IN HIGH-TECH EQUIPMENT INDUSTRY

- Cope with increasing complexity
- Knowledge management, transfer, and personnel know-how
- Communication
- Re-use and platform development
- Process and quality improvement

“Current solutions are made so complex over the lifecycle we are an enemy to ourselves”

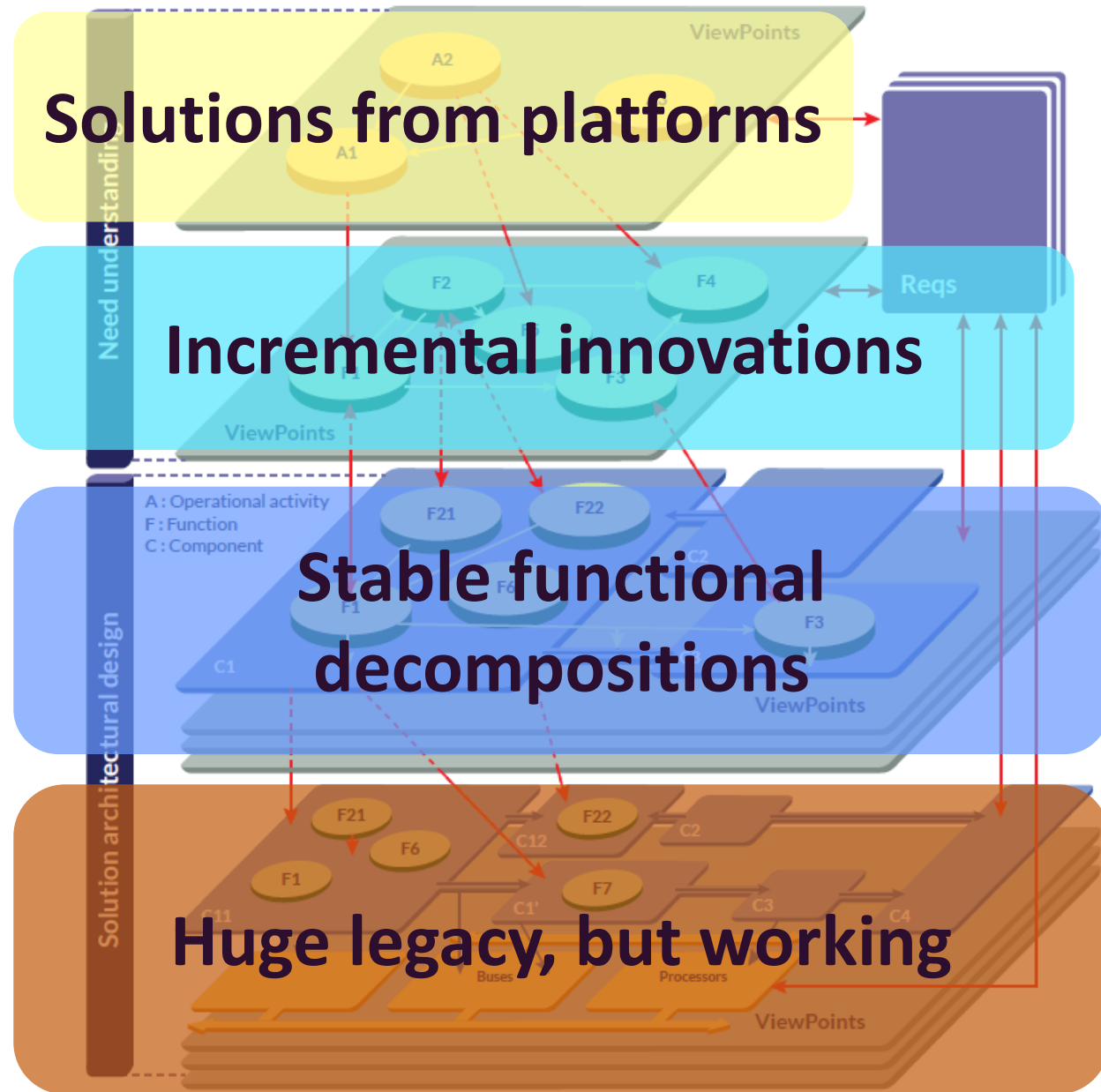
HIGH-TECH R&D

VERSUS

MBSE

(ARCADIA)

Large and growing SW content



Operational Analysis

What the users of the system need to accomplish

Functional & Non Functional Need

What the system has to accomplish for the users

Logical Architecture

How the system will work to fulfill expectations

Physical Architecture

How the system will be developed and built

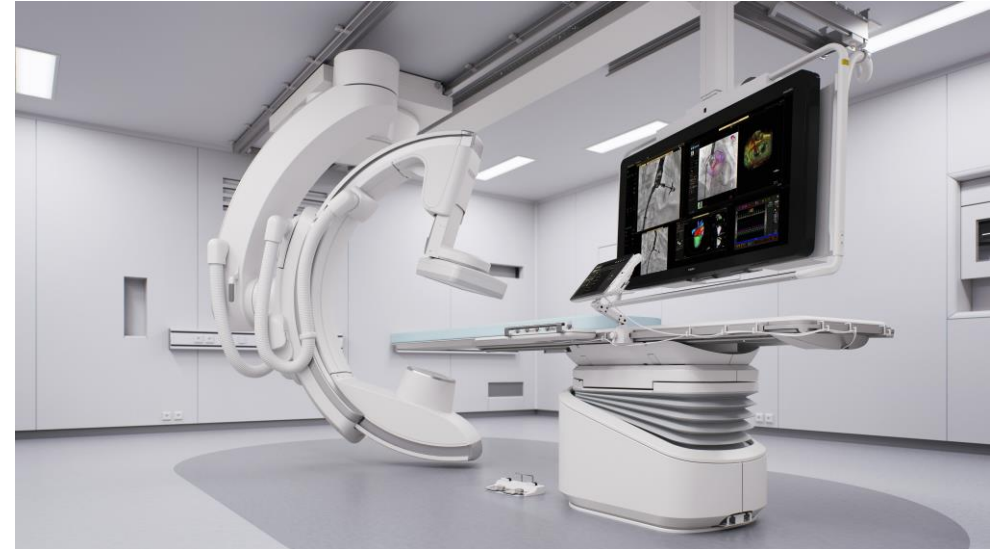
INVESTIGATION TOPICS FOR MBSE IN THE HIGH-TECH EQUIPMENT INDUSTRY

1. Support incremental, brown field development
2. Address large need for knowledge management and knowledge transfer
3. “Configure-to-Order” solutions from platforms
4. Connect SW to Systems Engineering



1955

Over many generations

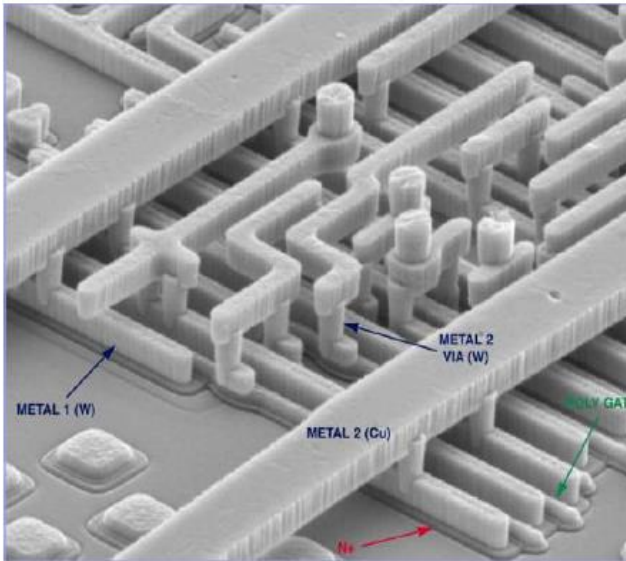


2020

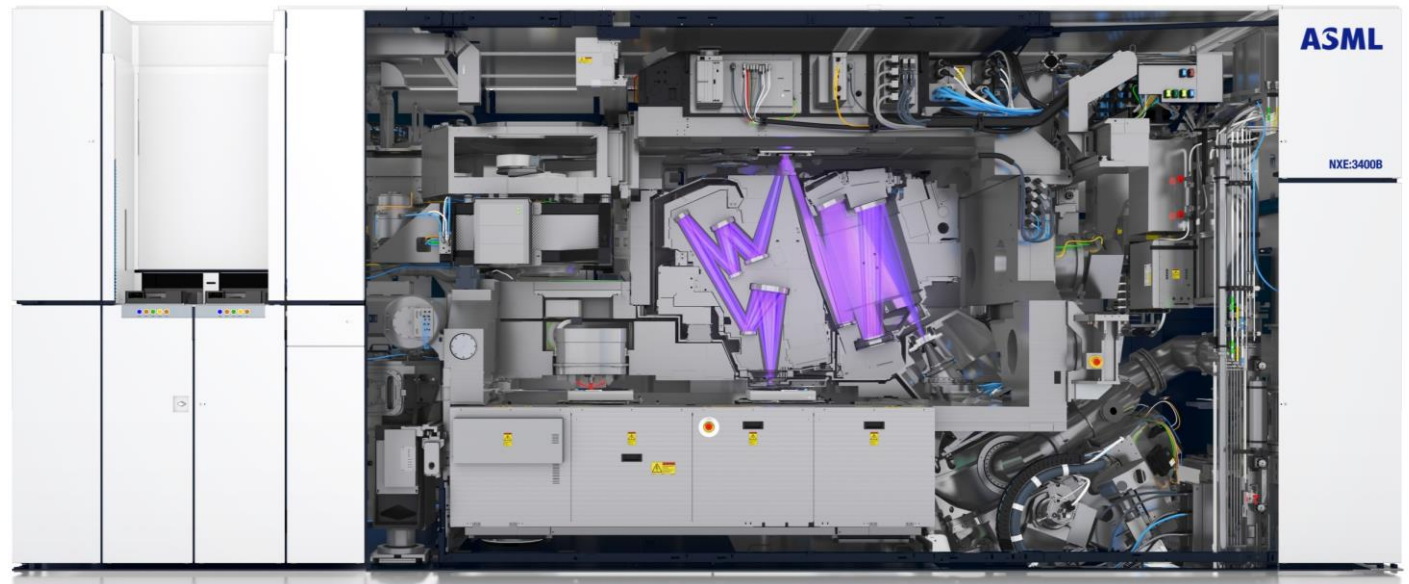
INVESTIGATION TOPIC 1.

CAN MBSE BE EFFECTIVE IN INCREMENTAL AND CONCURRENT ENGINEERING?

MBSE with long living systems and assets



The product



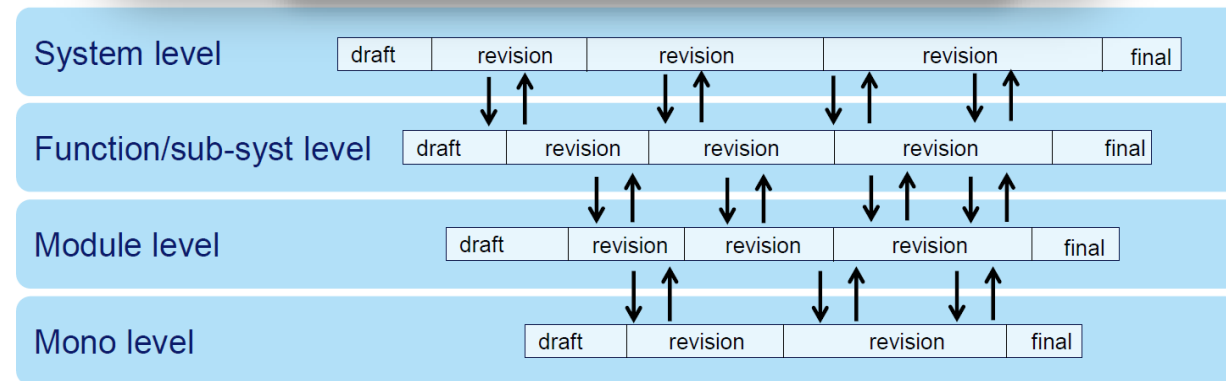
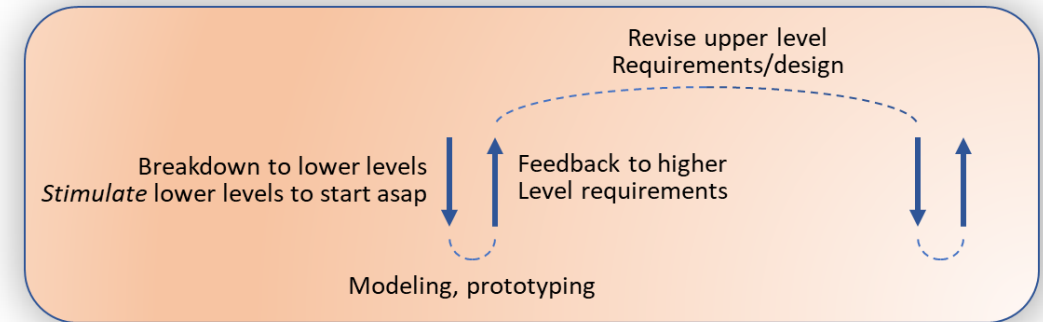
The production equipment (lithography step)

INVESTIGATION TOPIC 1.

CAN MBSE BE EFFECTIVE IN INCREMENTAL AND CONCURRENT ENGINEERING?

MBSE with long living systems and assets

- Fast development cycles
- Increments are less than 10% new , over 90% stays the same
- The previous system is available
- Many legacy assets without models



“High-Tech industry vs MBSE: risk-hungry vs risk-averse”

Concurrent engineering (ASML)

INVESTIGATION TOPIC 2.

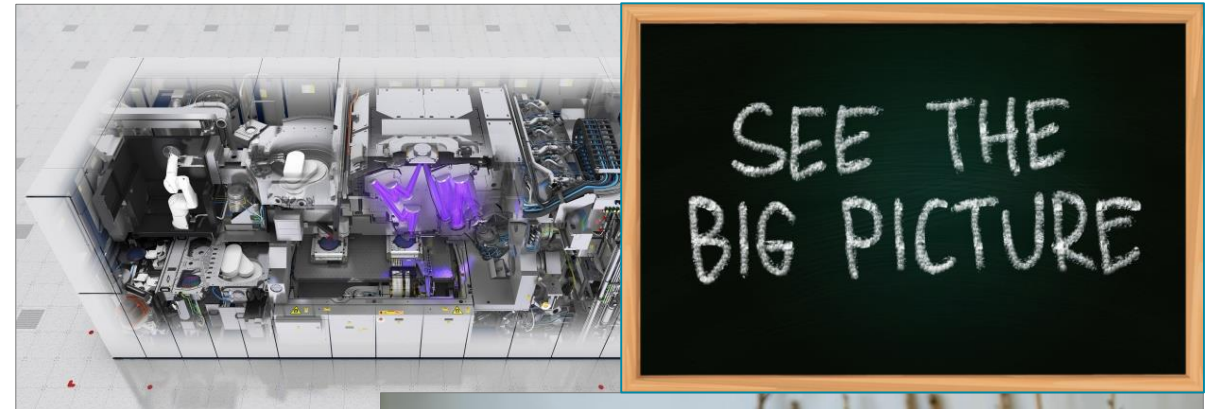
CAN MBSE SUPPORT KNOWLEDGE MANAGEMENT & KNOWLEDGE TRANSFER?

Reduce dependency on experienced people

How to apply MBSE to:

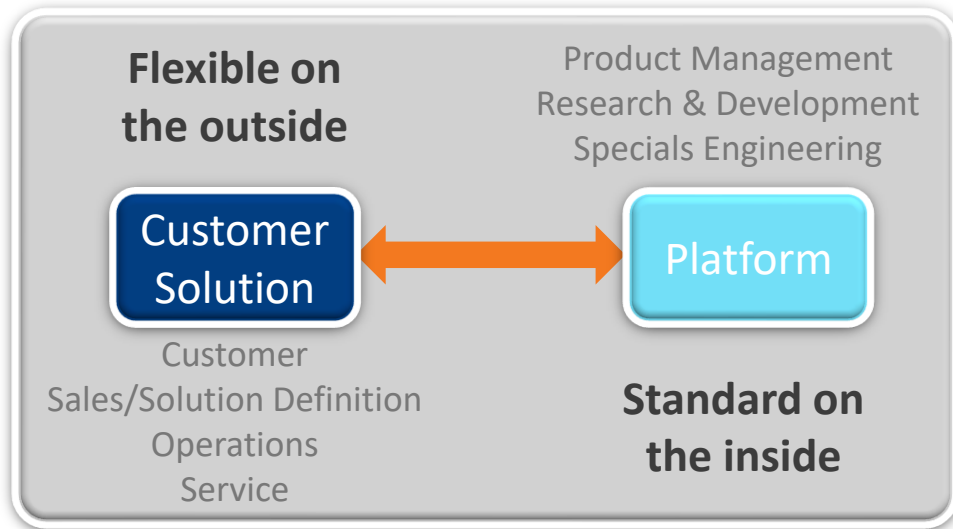
- Provide overview/oversight system
- Capture knowledge in a transferable way for systems with long lifetimes
- Enable impact assessment of change requests
- Reduce learning curve for new people, attractive to new talent and recruiting

“Improve quality and accelerate time-to-market by really understanding your product over generations”

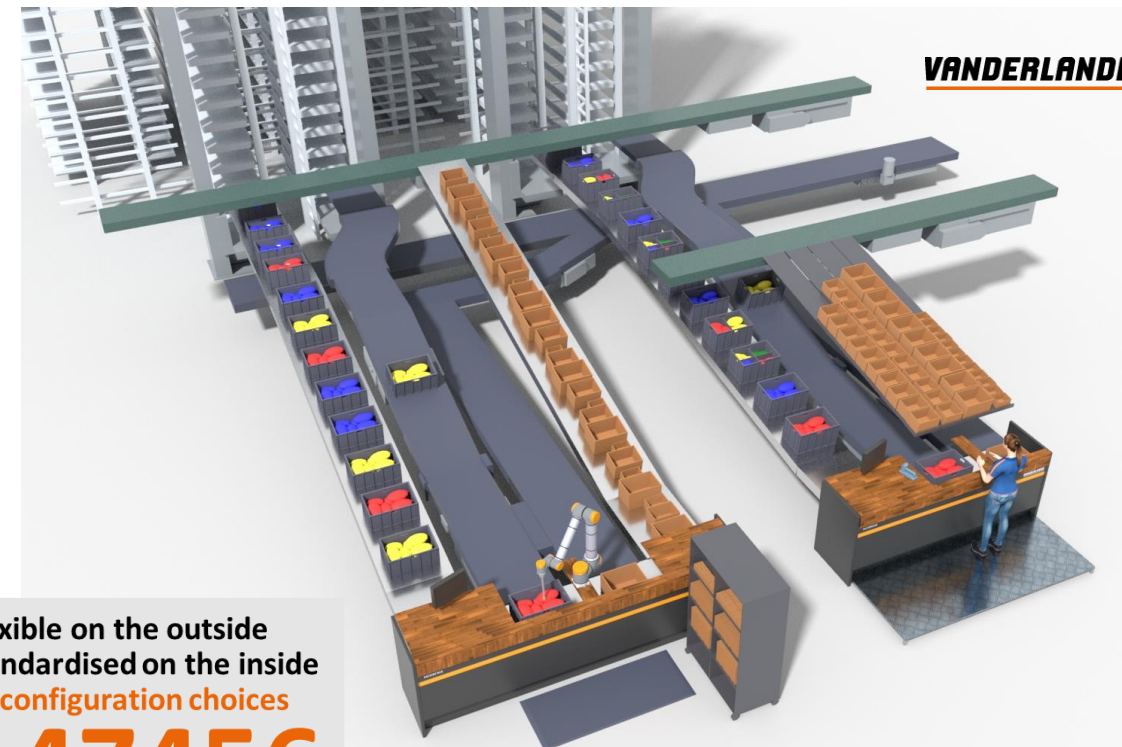


INVESTIGATION TOPIC 3.

MBSE FOR CONFIGURE-TO-ORDER SOLUTIONS OUT OF PLATFORMS



“How to assure that solutions remain compliant to both platform AND to customer requirements?”



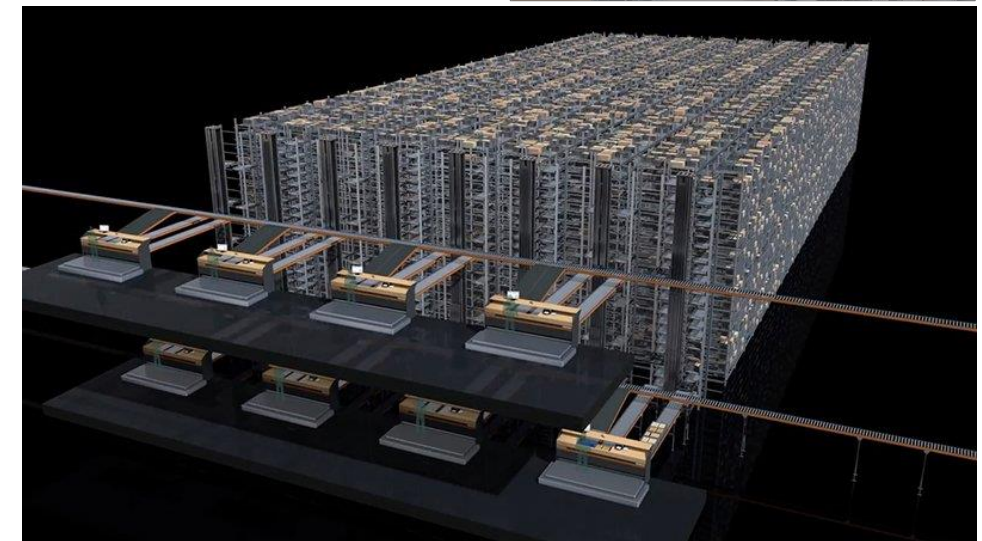
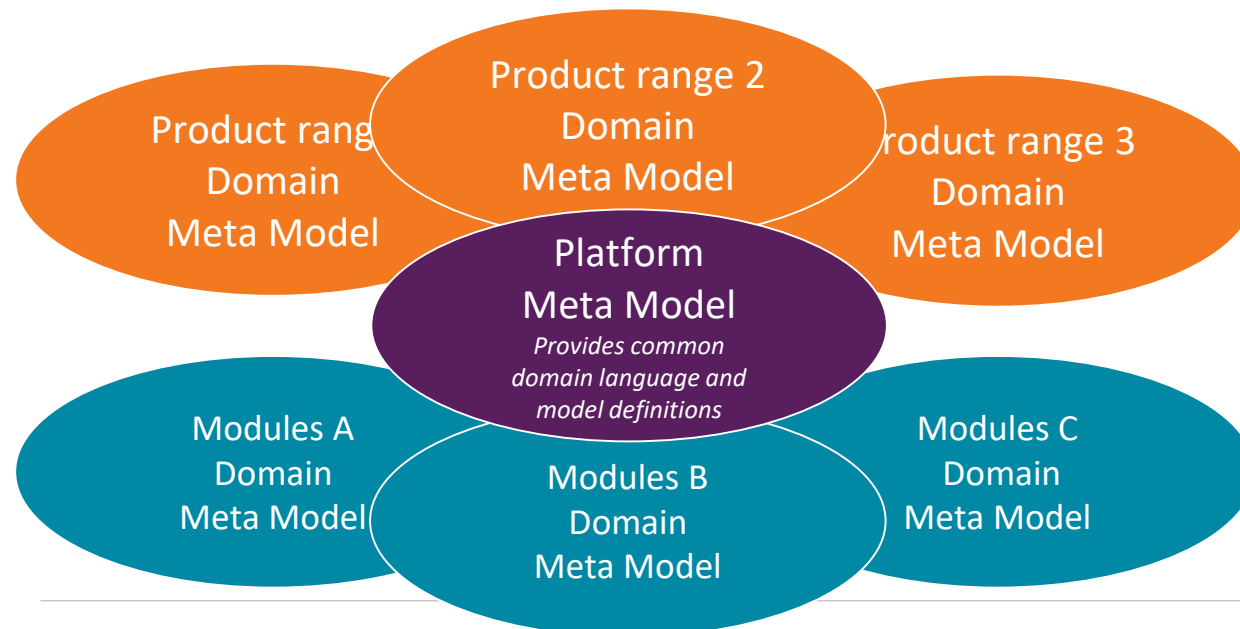
Flexible on the outside
standardised on the inside
16 configuration choices
147456
different Goods to Picker modules

INVESTIGATION TOPIC 3.

MBSE FOR CONFIGURE-TO-ORDER SOLUTIONS OUT OF PLATFORMS

One language and modular reference architecture needed across a business

- Modular structure fosters ownership and acceptance
- Platform meta model is the common core



INVESTIGATION TOPIC 3. MBSE FOR CONFIGURE-TO-ORDER SOLUTIONS OUT OF PLATFORMS

Configure-to-order requires two MBSE approaches

MBSE for a platform

- Modelling a configurable, modular and reusable asset repository with enablers



*Manage
complexity*

MBSE for a solution

- Modelling a system with user needs/requirements, an integrated behavior & structure, and additional emergent behavior



*Hide
complexity*

“MBSE to manage complexity vs MBSE to hide complexity”

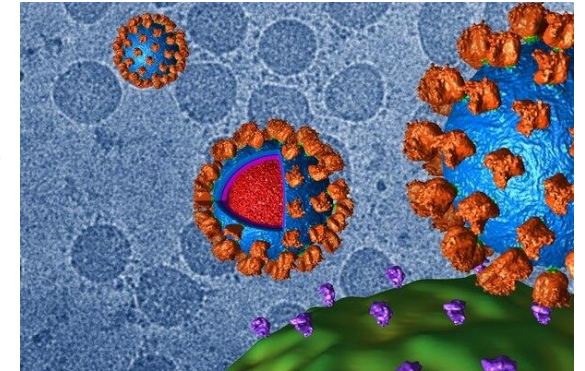
INVESTIGATION TOPIC 4. HOW TO CONNECT SW TO (MODEL-BASED) SYSTEMS ENGINEERING?

SW sees the most rapid innovation

How to mix SW into Systems Engineering with MBSE

- How to link SE and SW models
- How to prove that SW services deliver the solution
- Integration of cloud and data analytics

“Terabytes of data from tens of thousands of particle views must be processed to achieve 3D reconstruction”



3D reconstruction



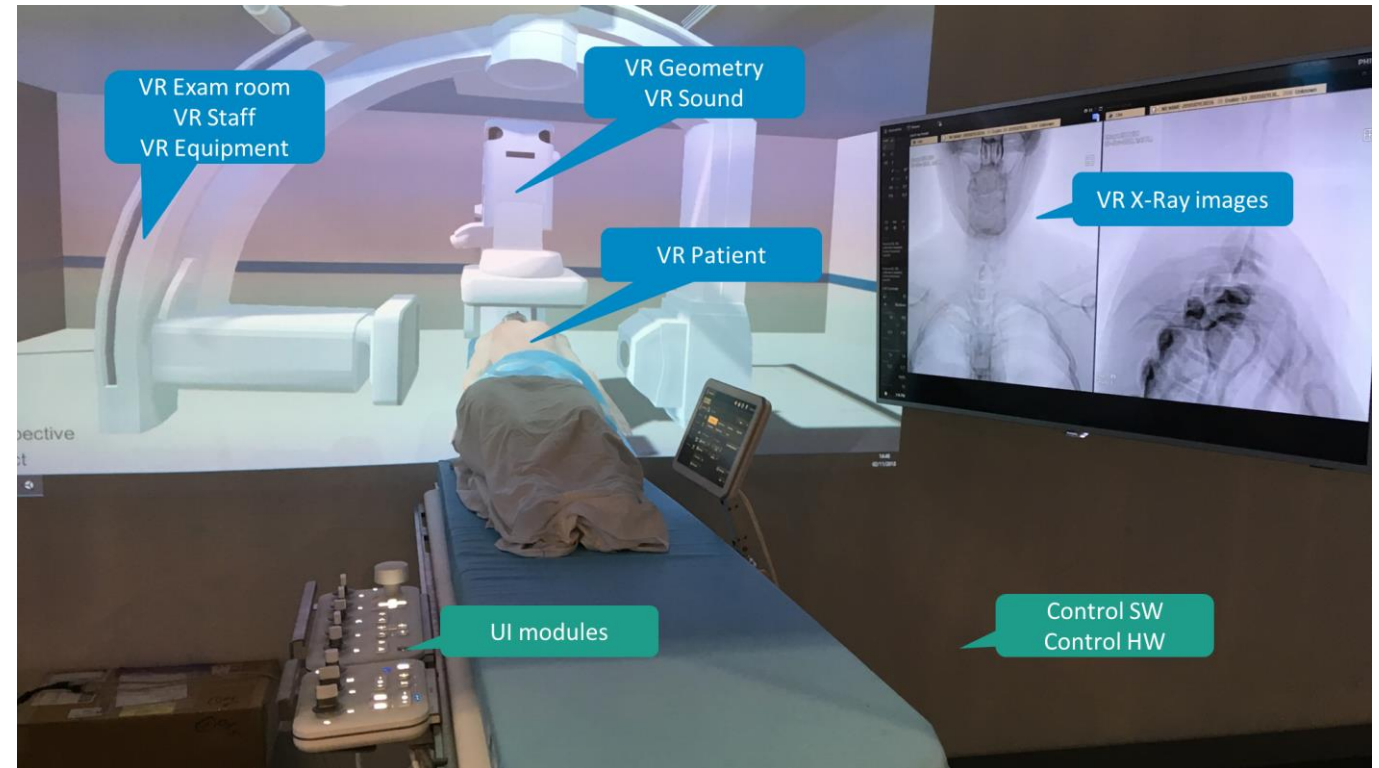
TFS Electron Microscopy: data and SW intensive workflow

INVESTIGATION TOPIC 4. HOW TO CONNECT SW TO (MODEL-BASED) SYSTEMS ENGINEERING?

Virtualization for early validation, testing, and field feedback

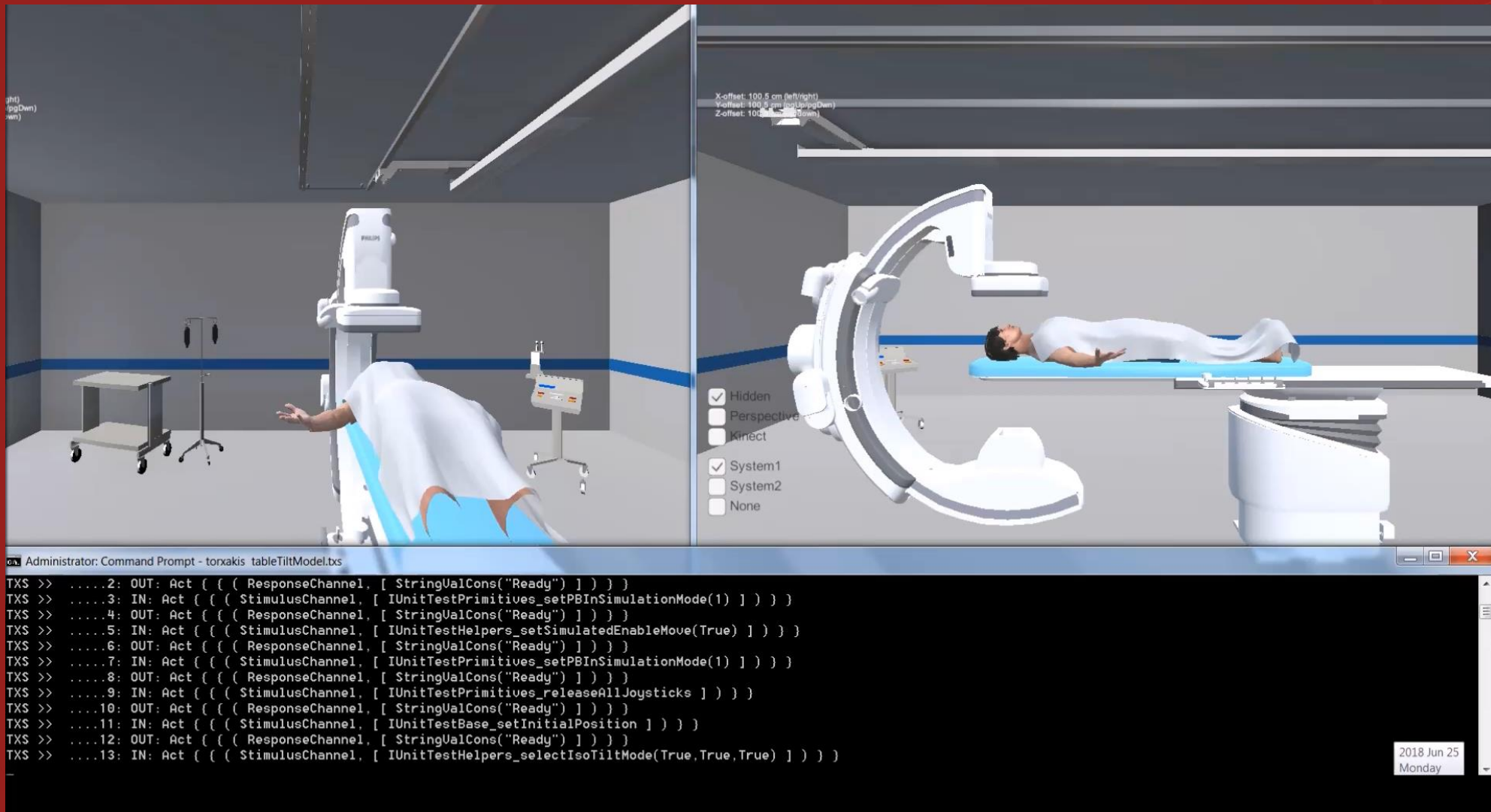


Image-guided
Therapy Systems



A Mixed Virtual System – Operating It





Run (Model Based) Tests on the virtual system

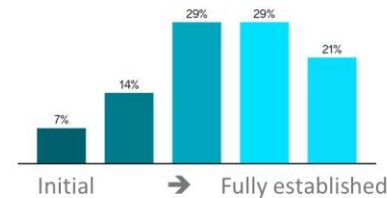
SUMMARY

*“Improving **system oversight**, and improving **legacy / diversity management** are what makes MBSE interesting”*

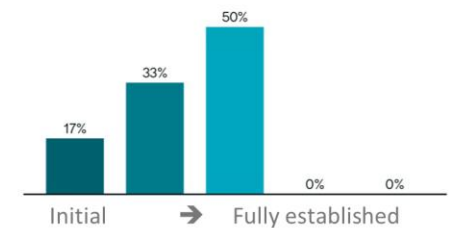
Key MBSE investigation topics identified

- MBSE for incremental, brown field development
- Support knowledge management and transfer
- “Configure-to-Order” solutions from platforms
- Connect SW, data to Systems Engineering

Where is your organisation with respect to SE in general?



Where is your organisation with respect to MBSE?



Organisations are experimenting with  **Capella**

April 2021 join us at the ESI symposium where we will share an update on MBSE for the High-Tech Industry

CONTACT

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