



Enhancing Industrial Equipment Reengineering with Model-Based Systems Engineering

SWISSED 2025

Comments for Reviewers

Concerning feedback to the timeslot/number of slides:

We tried to reduce the number of slides but want to mention that some of the slides are just section dividers, that will not cost any time. For a better overview, we created this table with the slide and the expected time:

Concerning feedback to the story/content

We try to tell how system engineering can be applied to reengineering of industrial machinery. Our story is based on an example in our Showroom in Munich, where we have a Quality Test Machine, that tests bottles for leakages. Now we want to use a different type of bottle and have to adapt our machine concept. This example is transferred to industrial machinery in general. The following text is a more detailed description of the story, we try to tell.

In the dynamic environment of industrial manufacturing, the continuous improvement of machinery is essential to maintain competitiveness and meet evolving quality standards. This presentation explores the reengineering of a quality test machine for bottles using Model-Based Systems Engineering (MBSE) using Capella.

At the beginning the quality test machine is introduced, detailing its current functionalities and the challenges necessitating its improvement. Using Capella, the existing system is modeled with the aim to create a comprehensive representation of the machine's current state. This model serves as the foundation for identifying improvement opportunities and defining the system's constraints and potential areas for optimization. Subsequently, a model with the proposed enhancements is developed and presented.

Based on this example, the talk will elaborate how Model-Based System Engineering can be applied in an industrial manufacturing context. The principles and methodologies employed in this case study can be generalized to reengineer a wide range of industrial equipment, from assembly lines to packaging systems. By systematically modeling existing systems, identifying areas for improvement, and simulating proposed changes, MBSE provides a structured and scalable approach that can be adapted to different types of machinery and production environments.

We hope that we could highlight again what our contribution is by telling the story how we used an MBSE approach for reengineering a Quality Test Machine for bottles.

Slide Number	Title	Time in min
1	Enhancing Industrial Equipment Reengineering with Model-Based Systems Engineering	0,5
2	Agenda	1
3	Agenda - Introduction	0
4	Speakers	0,5
5	Siemens AG	1
6	Agenda - Quality Test Machine	0
7	Quality Test Machine	1
8	Missing functions of the Quality Test Machine	0,5
9	Agenda - Reengineering of Industrial Machinery	0
10	Problems in Reengineering	1
11	How can model-based Systems Engineering support Reengineering?	2
12	Adapting ACARDIA for Reengineering	1,5
13	Agenda - Actual State of QTM	0
14	Modeling the actual state with Model-Based Systems Engineering	1
15	Modeling the actual state with MBSE – Capabilities, Actors, Entities	1
16	Modeling the actual state with MBSE – Activities for Semi-Automatic Bottle Testing	1,5
17	Agenda - Target State of QTM	0
18	Modeling the target state with MBSE	1,5
19	Modeling the target state with MBSE – Functions for Fully Automatic Bottle Testing	1
20	Modeling the target state with MBSE – Architecture for Fully Automatic Bottle Testing	0,5
21	Video different concepts	0,5
22	Modeling the target state with MBSE - Physical Architecture	0,5
23	Agenda - Transfer to Industrial Machinery	0
24	Why should you use MBSE for Reengineering Industrial Machinery?	2
25	Thank you for your attention!/ Q&A	1,5
26	Contact	0
	Time slot 20 min	Sum
		20

Comments for Reviewers

Concerning feedback to implementation of the machine:

The machine is currently still in the update phase, as we are implementing a new automation code with the added functionalities. During testing of that new code, we could see, that it is now possible to detect and test other bottles with a new bottle height. Our work in the system architecture can be understood as the foundation for the reengineering of the machine, as it contributed to a better understanding and showed needed functionalities in the system context. This helped us to implement the needed components and features.

Concerning feedback to the introduction of a novel approach:

We are aware that the benefits of our approach are the same as MBSE, which is wanted and should simply highlight that MBSE could also be used for Reengineering tasks. The novel approach of our procedure is the adaption of the ACARDIA method for reengineering tasks, by using the Operational Analysis to represent the current state of the machine and developing new functionalities based on that in the following steps (System Analysis, Logical Analysis, Physical Architecture).

Concerning feedback to the adherence to the conference theme (Stories Experienced?):

The presentation will adhere to the theme of the conference, as this Reengineering Process is based on an example, we are building for our Showroom the Digital Enterprise Experience Center.

Agenda

	Topic	Presenter
1	Introduction	Chantal
2	Quality Test Machine (QTM)	Chantal
3	Reengineering of Industrial Machinery	Chantal
4	Actual State of QTM	Jesko
5	Target State of QTM	Jesko
6	Transfer to Industrial Machinery	Jesko

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Speakers



Dr.-Ing. Chantal Sinnwell
Head of Cross-Portfolio Solutions
Domain Lead Systems Engineering
Digital Enterprise



Jesko Drewes
Master Student
Digital Enterprise

SIEMENS

Industrial Business

Digital Industries



Smart Infrastructure



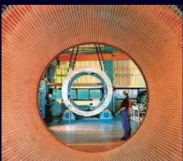
Mobility



Siemens Healthineers¹



Portfolio Companies



Siemens Advanta



Siemens Financial Services



Services

Siemens Real Estate



Global Business Services



¹ Publicly listed subsidiary of Siemens; Siemens' share in Siemens Healthineers: 75%

Digital Industries



77,000 employees¹



€ 21,9 billion in revenue²



Software (industrial)
#1 market position



Factory Automation
#1 market position



Motion Control
#1 market position



Process Automation
#2 market position



Customer Services

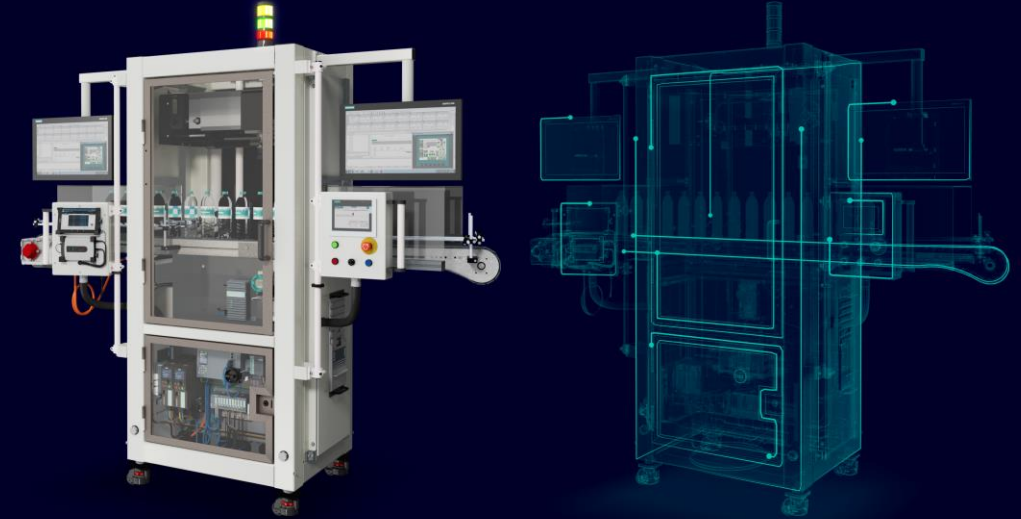
¹ As of September 30, 2023 | ² For fiscal 2023

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Quality Test Machine

- demo machine in showroom
- manufactured for fair by industrial machinery partner
- build out of Siemens components
- used for 5 years in our showroom
- key functionality: testing if bottles are leak-proof



Currently under update to show state-of-the-art solutions for Engineering, Manufacturing and Service

Missing functions of the Quality Test Machine



Missing production data



Missing connectivity



Error in automation

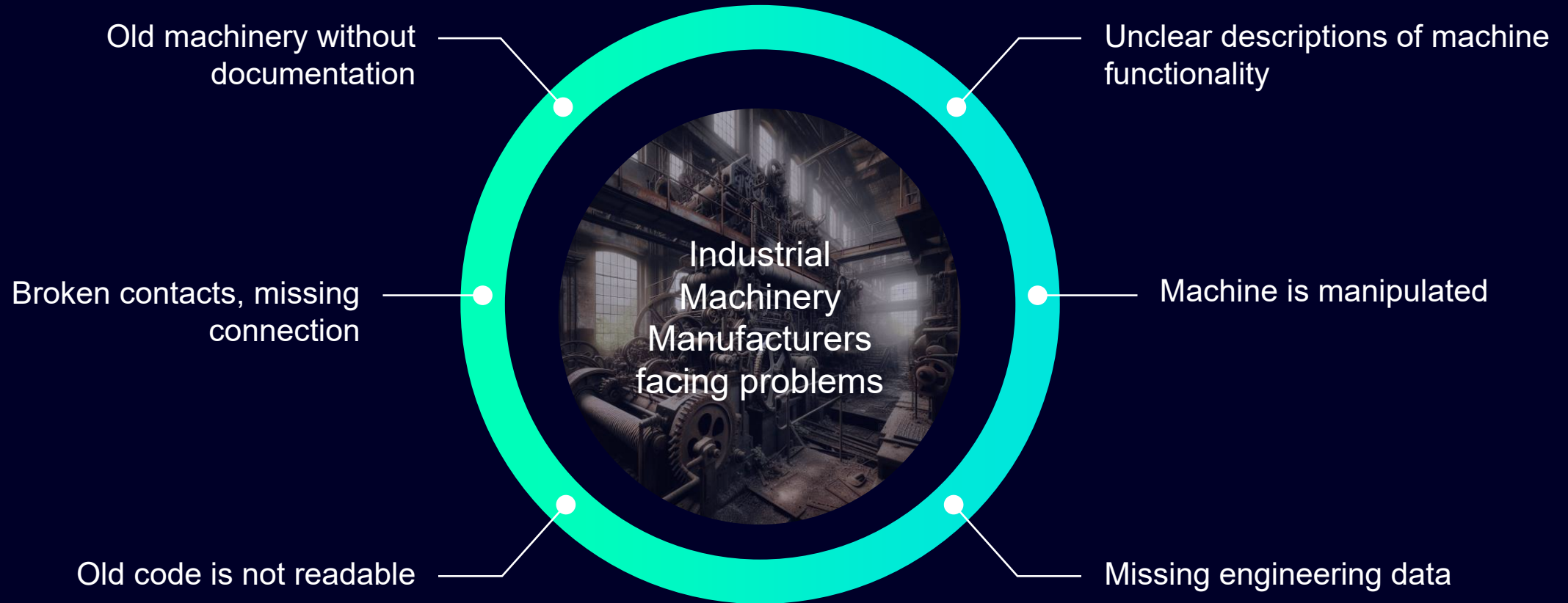


No maintenance possible

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Problems in Reengineering



How can model-based Systems Engineering support Reengineering?



Connect the status quo with the machine update



Clear description of the system functions



Better understanding of the problem



Clear responsibilities for the reengineering process



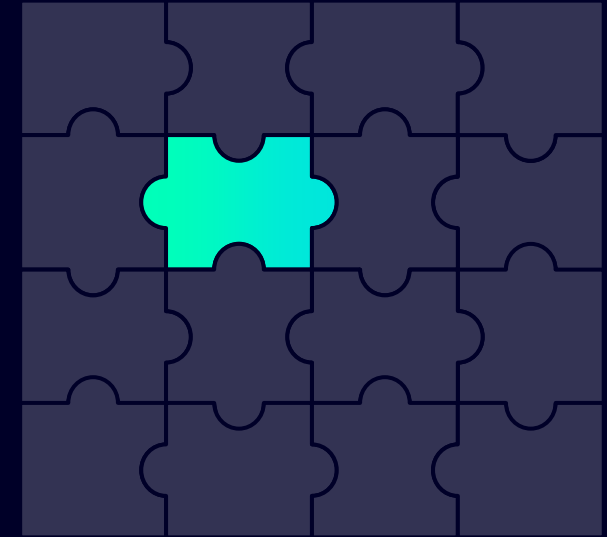
Document decisions



Enhance System Quality and Performance



Risk reduction for the Reengineering Project



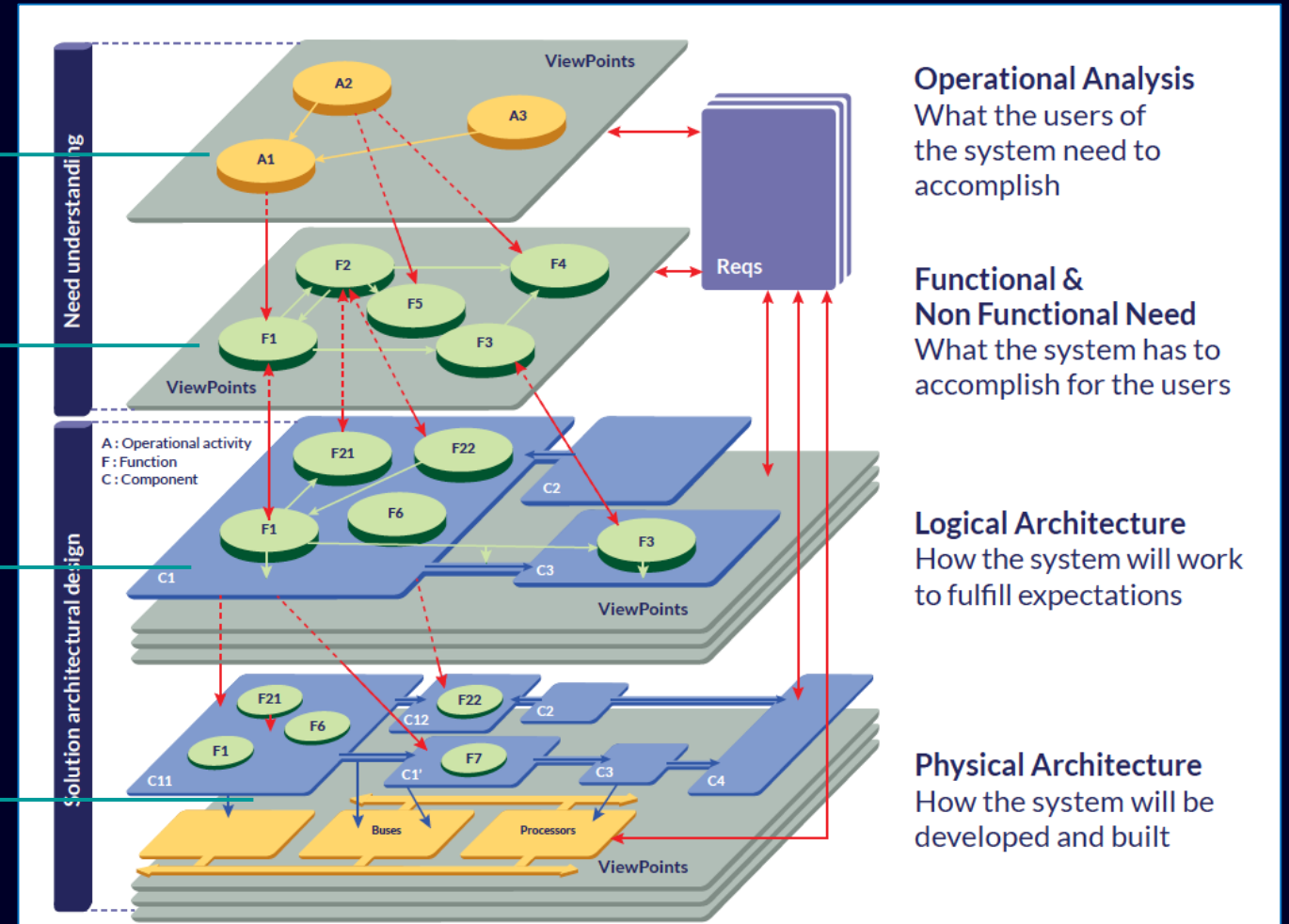
Adapting ACARDIA for Reengineering

Model the current state of the machine including functions and components

Model the target functions of the system adopting current functions

Model the target logical components reusing current components

Model the target physical components



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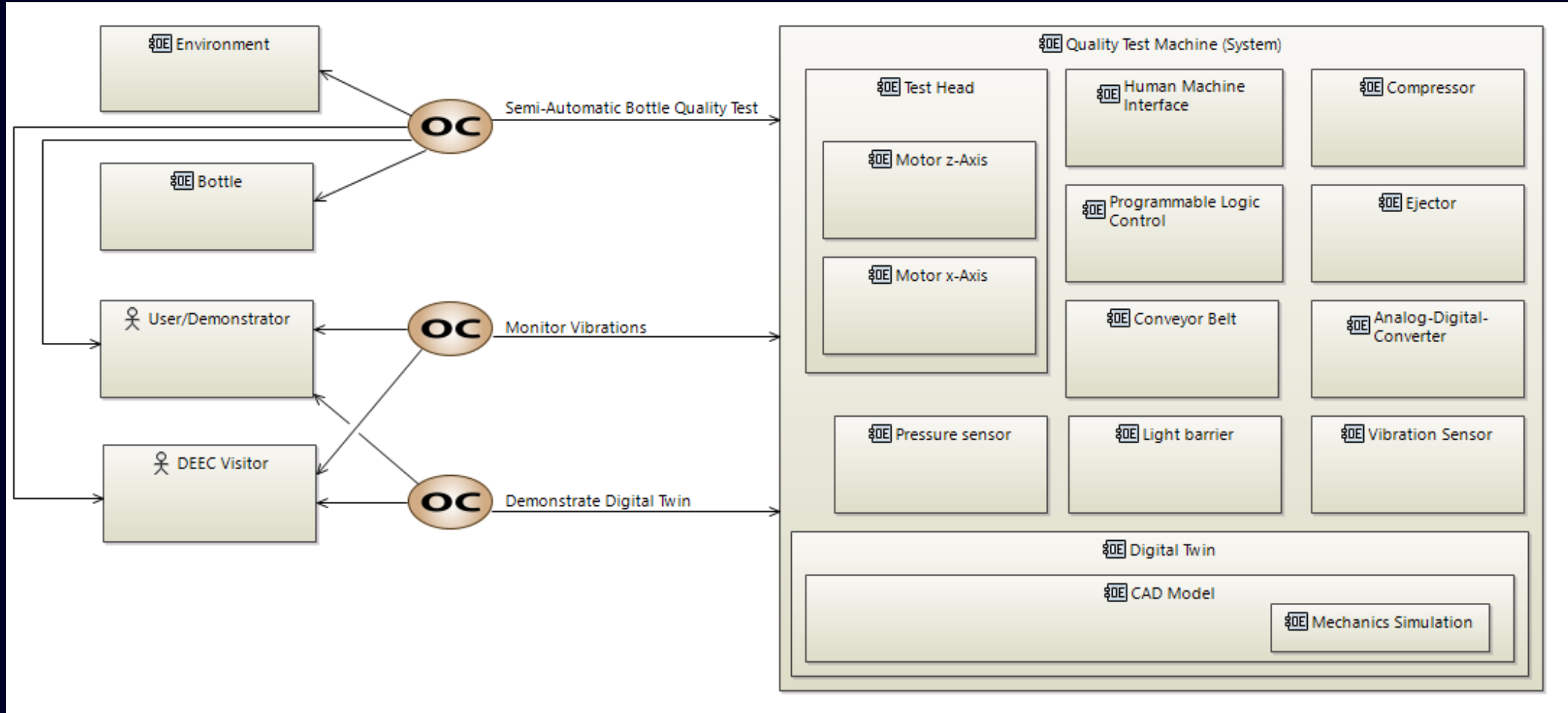
Modeling the actual state with Model-Based Systems Engineering



- Develop a general understanding, what current machine is doing
- Understand who is involved in the project
- Define known system components
- Assign functions to the known system components
- Find missing components

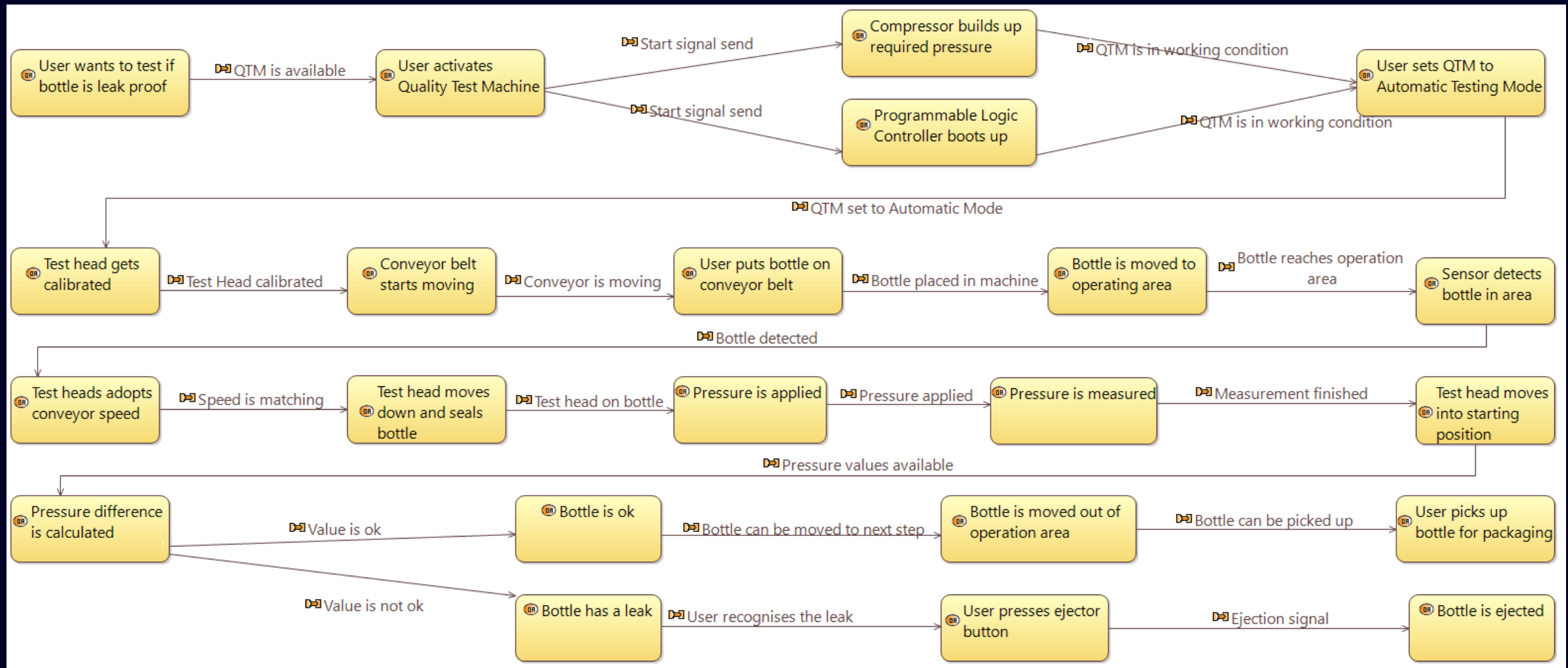


Modeling the actual state with MBSE – Capabilities, Actors, Entities





Modeling the actual state with MBSE – Activities for Semi-Automatic Bottle Testing



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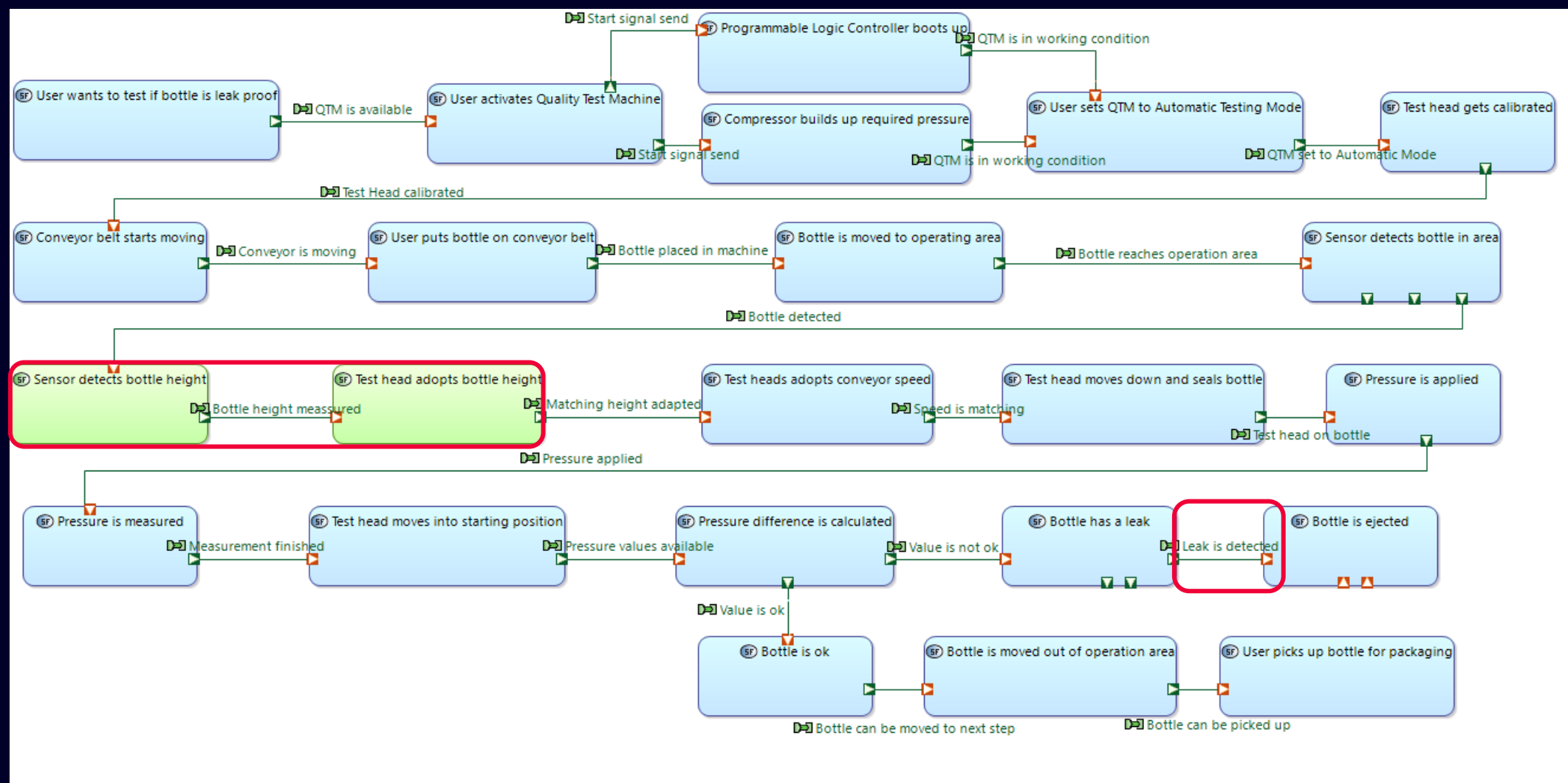
Modeling the target state with MBSE

- Adapt functions and system components used in the actual state
- Model needed functionalities for the improvement
- Define needed new components
- Optimize links, exchanges and information flows
- Differences are automatically highlighted with color
- Build a clear holistic overview early in the reengineering process
- Assign responsibilities for specific system elements
- Document changes and differences to the old system

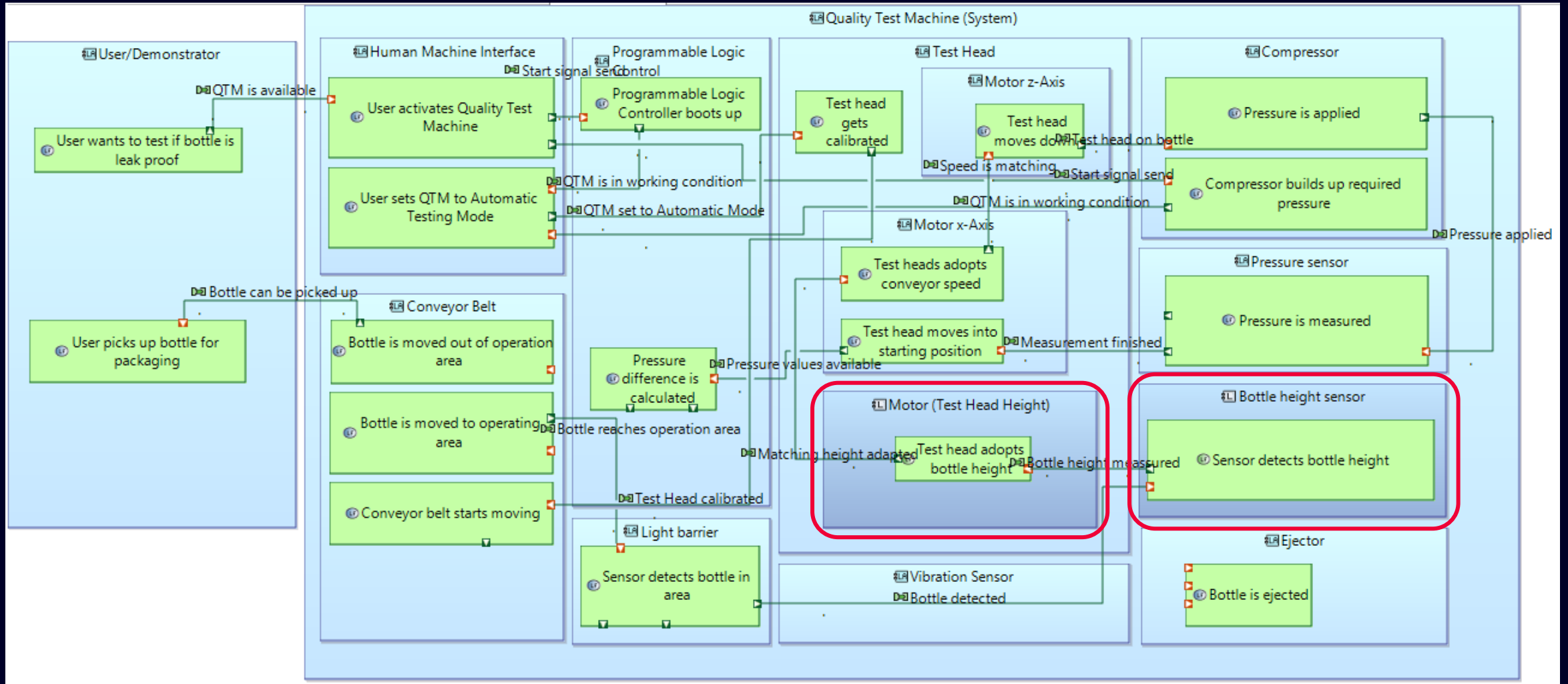


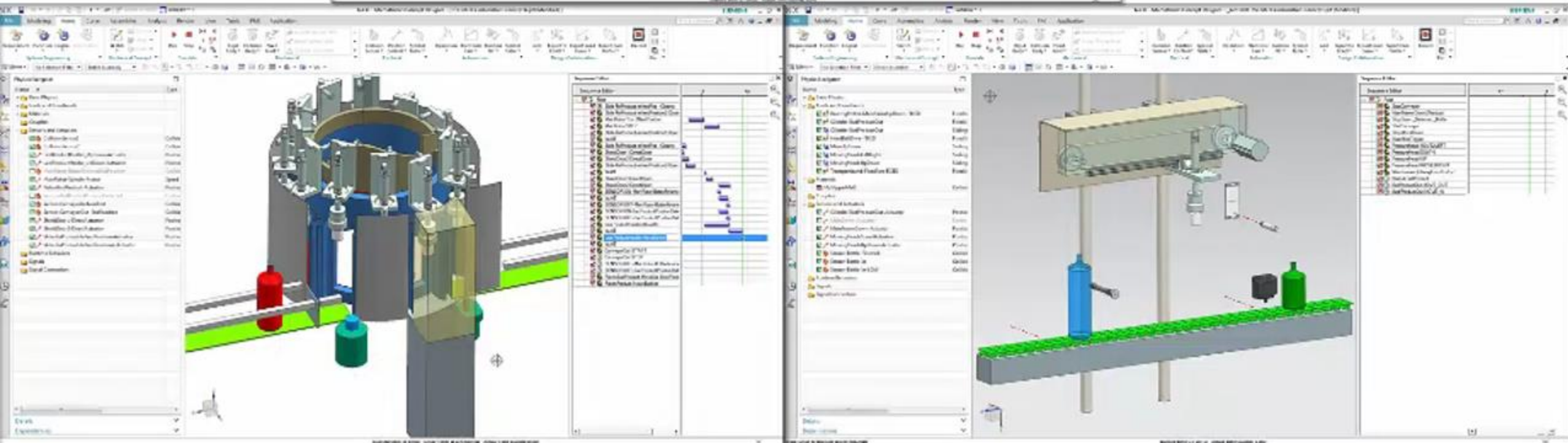
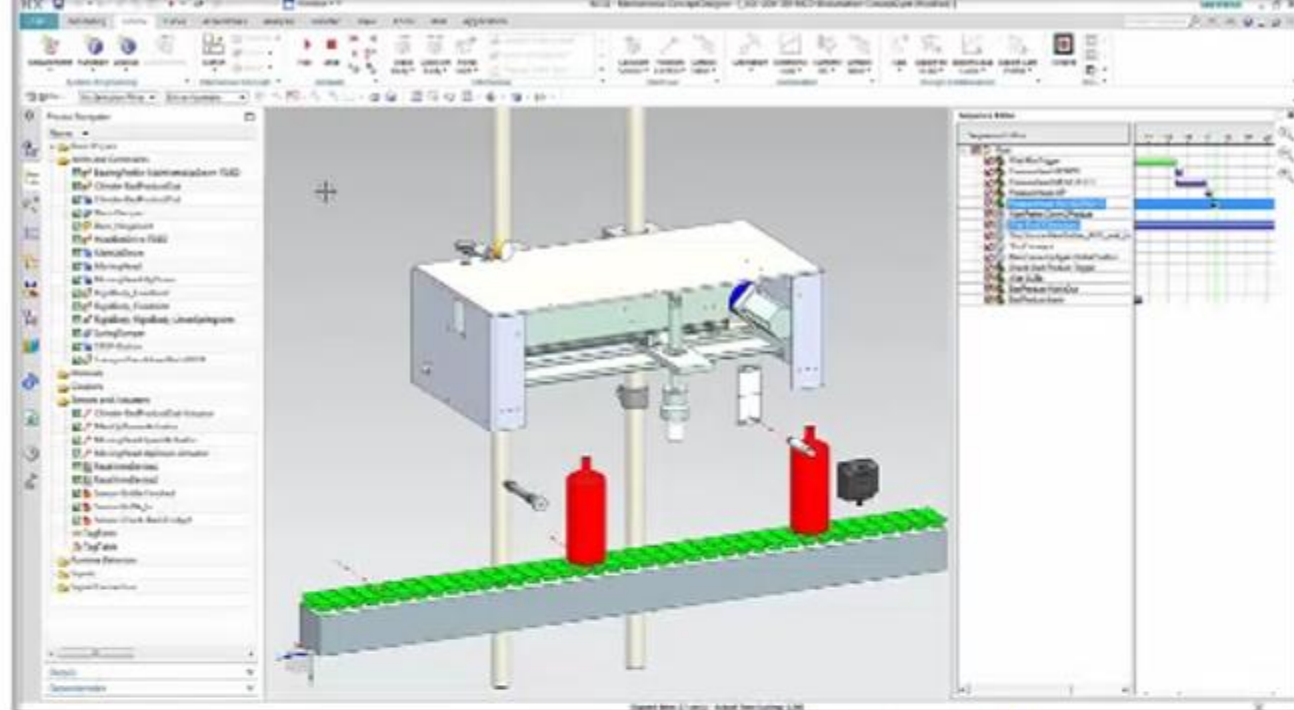


Modeling the target state with MBSE – Functions for Fully Automatic Bottle Testing

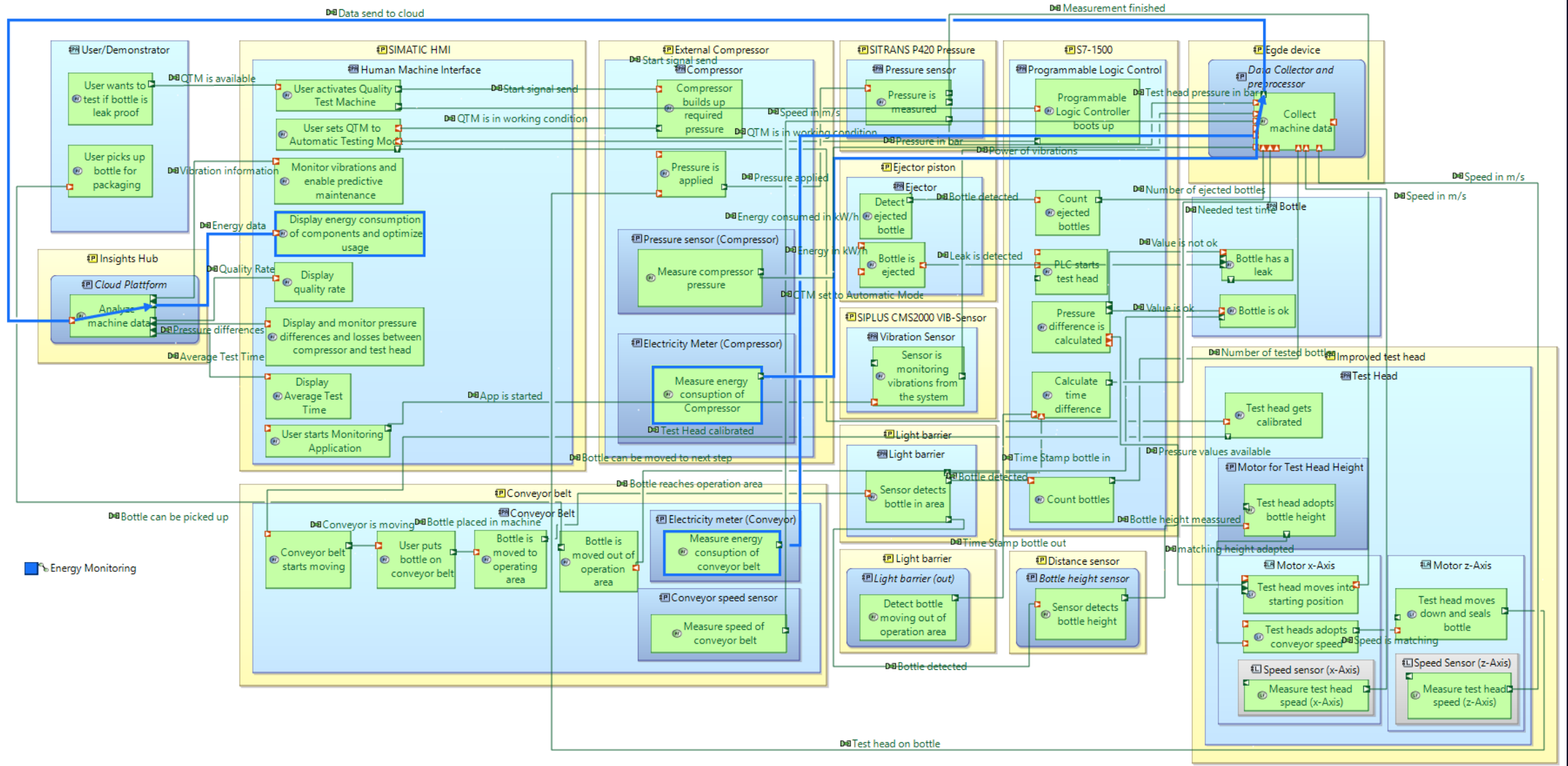


Modeling the target state with MBSE – Architecture for Fully Automatic Bottle Testing





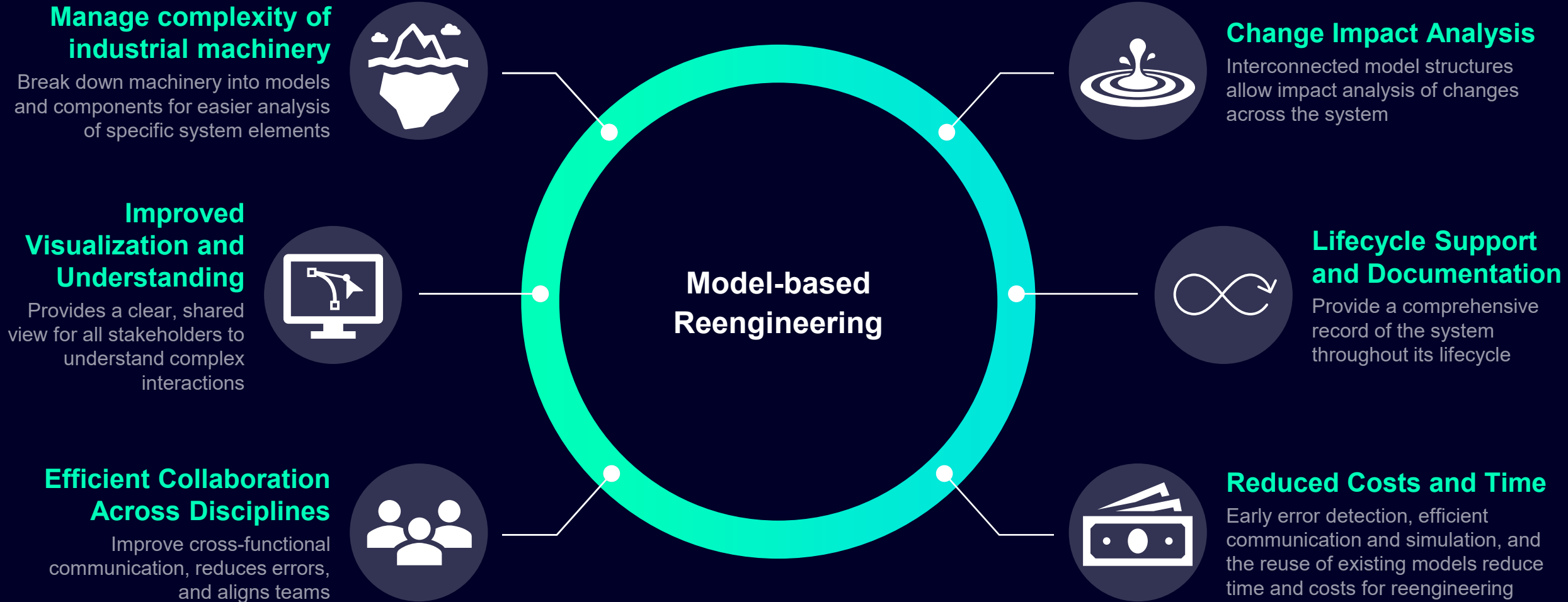
Modeling the target state with MBSE – Physical Architecture



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Why should you use MBSE for Reengineering Industrial Machinery ?



Thank you for your attention!

Q&A



Contact



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