# Function Based Engineering with AutomationML – Towards better standardization and seamless process integration in plant engineering


**Florian Himmler**

*evosoft GmbH, Hugo-Junkers-Straße 11, 90411 Nuremberg, Germany* *University of Erlangen-Nuremberg, Chair of Information Systems III, Lange Gasse 20, 90403 Nuremberg, Germany*

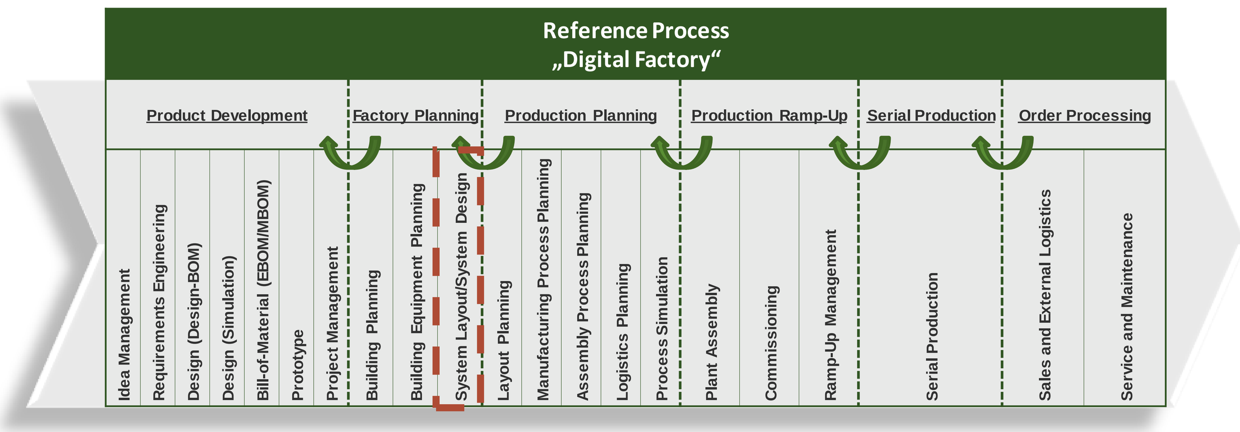

## Plant Engineering & The Digital Factory

### Definition "Plant Engineering"

**Definition "Plant Engineering"**

*That branch of engineering which embraces the installation, operation, maintenance, modification, modernization, and protection of physical facilities and equipment used to produce a product or provide a service*

### Plant Engineering @ The Digital Factory




- Plant Engineering is an ***essential part of the Digital Factory***.
- The ***System Layout/System Design*** process – covering all activities performed which are needed to plan the factory building, its equipment and the systems used for production – also ***includes the plant engineering*** process

## Motivation

**Situation**

- The ***complexity of the plants*** to be engineered, the ***number of involved disciplines*** as well as the ***quality requirements*** of the customers ***have increased*** significantly.
  - ➔ This forces companies within this branch to ***improve their engineering efficiency***

**Problems**

- ***Insufficient degree of integration of the different disciplines*** involved in the engineering process (e.g. mechanics, electrics etc.)
- ***Heterogeneous system landscapes*** with a low degree of integration
- ***Redundant data, data inconsistencies and high development costs*** when changes are required

**Challenge**

- ***Two main challenges*** in order to increase the engineering efficiency
  - Development of a concept for an ***interdisciplinary integration of all disciplines*** involved in the ***engineering process***
  - Development of an ***integration concept*** which improves the degree of ***integration between the tools*** of existing system landscapes by using ***standardized application interfaces***.

**Solution**

- Definition of a ***standardized application interface*** for plant engineering ***based on AutomationML*** to foster…
  - …the ***standardization and modularization of industrial plants*** throughout the complete engineering lifecycle.
  - …the ***seamless integration of all IT systems*** involved in the ***engineering process.***

## Contact


**Florian Himmler**

***evosoft GmbH***
Hugo-Junkers-Str. 11
90411 Nürnberg
Germany
florian.himmler@evosoft.com

***University of Erlangen-Nuremberg***
***Chair of Information Systems III***
Lange Gasse 20
90403 Nürnberg
Germany
florian.himmler@fau.de

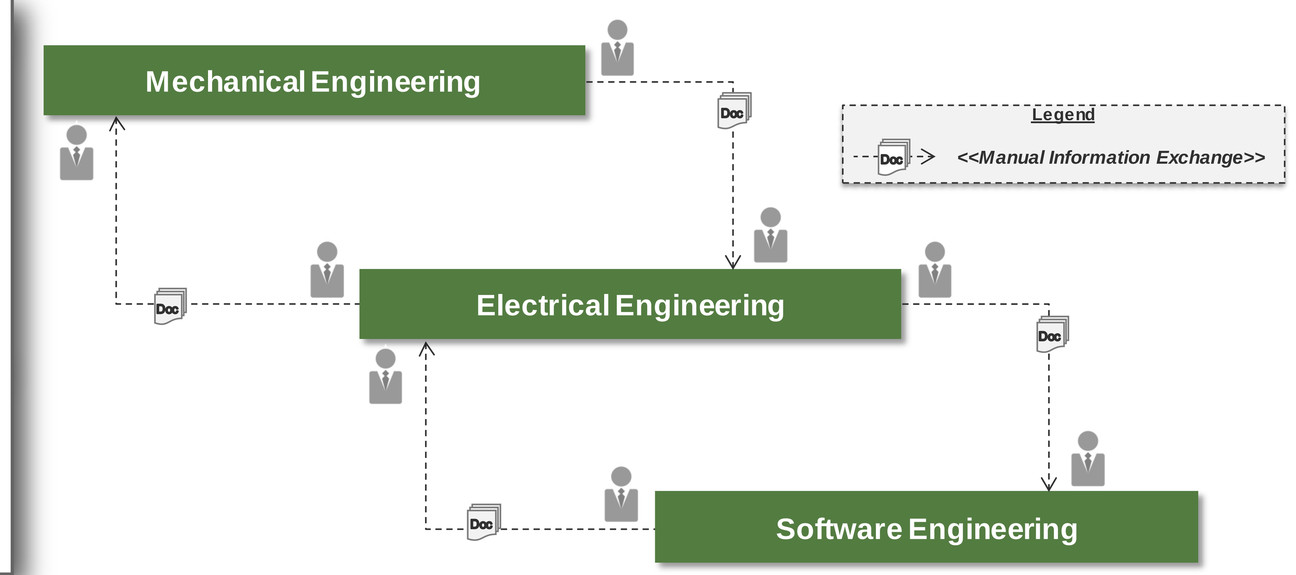

## Integrated Plant Engineering

### AS-IS Situation in Plant Engineering

- Collaboration characterized by ***unstructured and manual exchange of information***
  - ***Triggered by the personal needs*** of the involved engineers
  - Scheduling of ***person-to-person meetings*** with the engineer of other disciplines
  - ***Information is exchanged by unstructured information objects*** like documents, spreadsheets

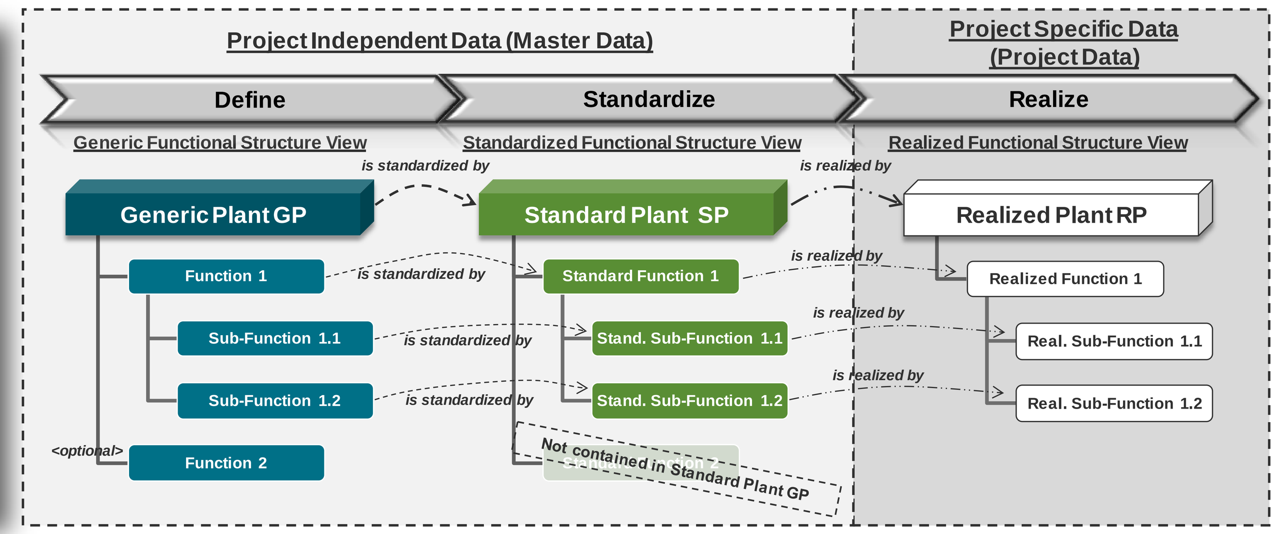
This leads to an ***inefficient and error prone engineering*** process due to

- ***redundancy and inconsistency of data***
- ***slow information exchange***
- ***isolated, territorial mindset***



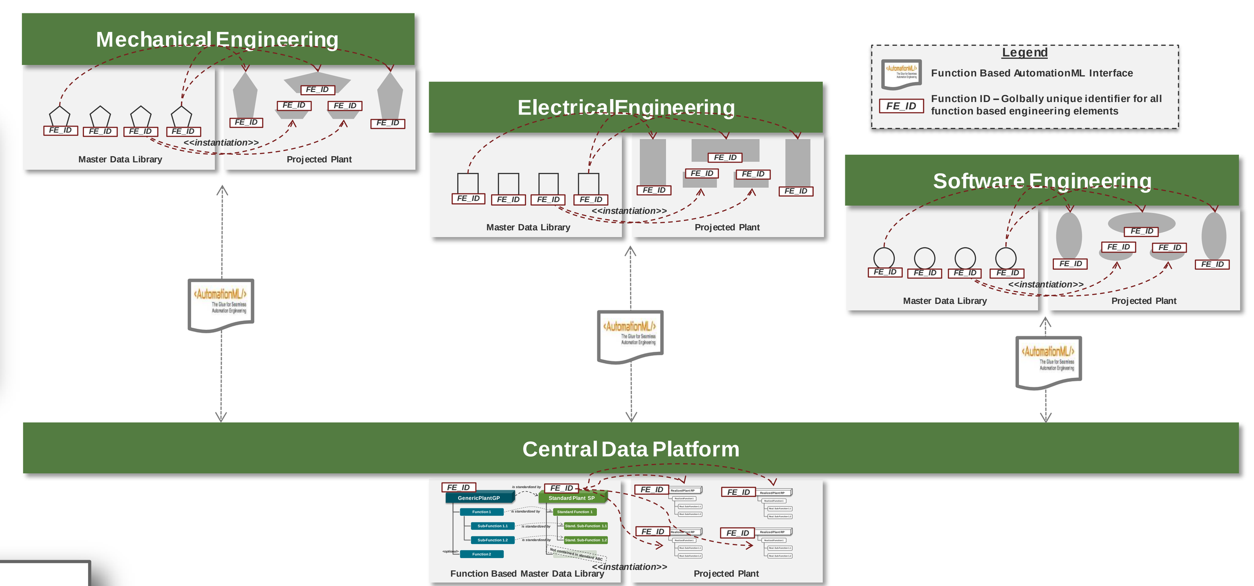

### Function Based Engineering

- Novel engineering approach, exclusively ***based on the functions and sub-functions a plant consists of.***
- Framework based **three process steps**:
  - ***1. Step "Define":*** Break the object/plant down into its ***functional structure***.
  - ***2. Step "Standardize": Define standardized objects/plants*** based on the functional structure defined in the preceding step.
  - ***3. Step "Realize": Instantiate one of the standardized objects/plants*** defined in the preceding step to use it in a specific project or production context.



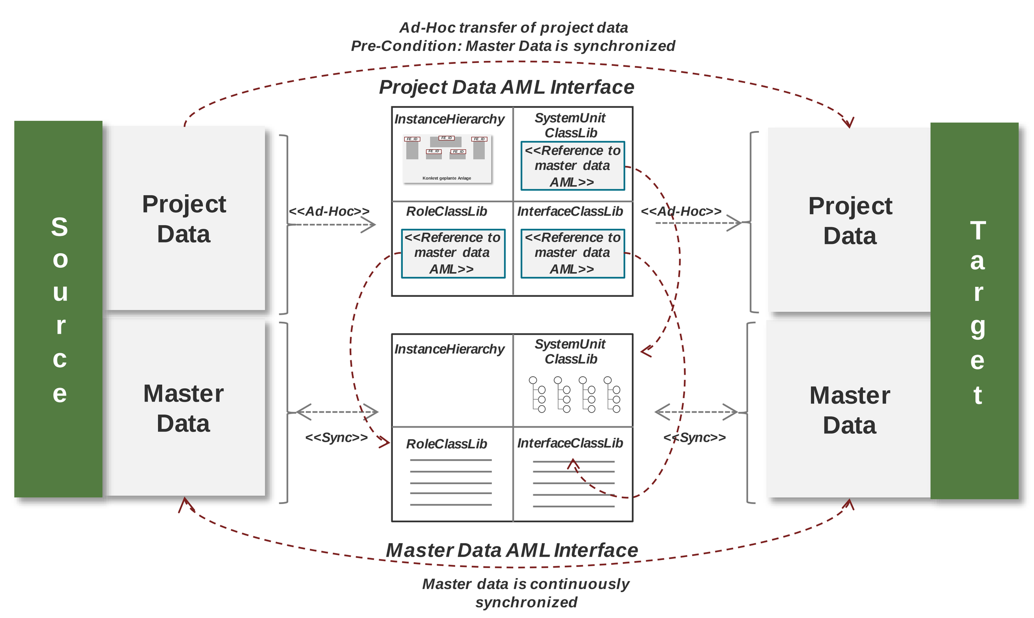

### TO-BE Situation in Plant Engineering

- ***One Central Data Platform as Single Point of Communication*** for all applications of the engineering domains, such as mechanical engineering, electrical engineering, software engineering etc.
- Usage of ***AutomationML as standardized information exchange format***




### AutomationML Concept

- The ***data model*** which needs to be exchanged using AML consists of a total of ***20 different classes, various relationships (1:1, 1:n and n:m)*** as well as ***inheritances*** between some of the classes.
- **Basic Requirements**:
  - Separation of ***Master Data and Project Data***
    - ***Master data*** is ***independent of a specific project***, defined once and ***reused in multiple projects***
    - ***Project data*** always ***has a project-specific context***, and is created by ***instantiation of master data***
  - Representation of ***Cardinalities and Constraints***
  - ***Mapping of Attributes*** with the same Semantic
  - Representation of different ***Ports and Interfaces***
  - Representation of all kinds of ***Documents***
  - Support of the whole ***Plant Realization Process***

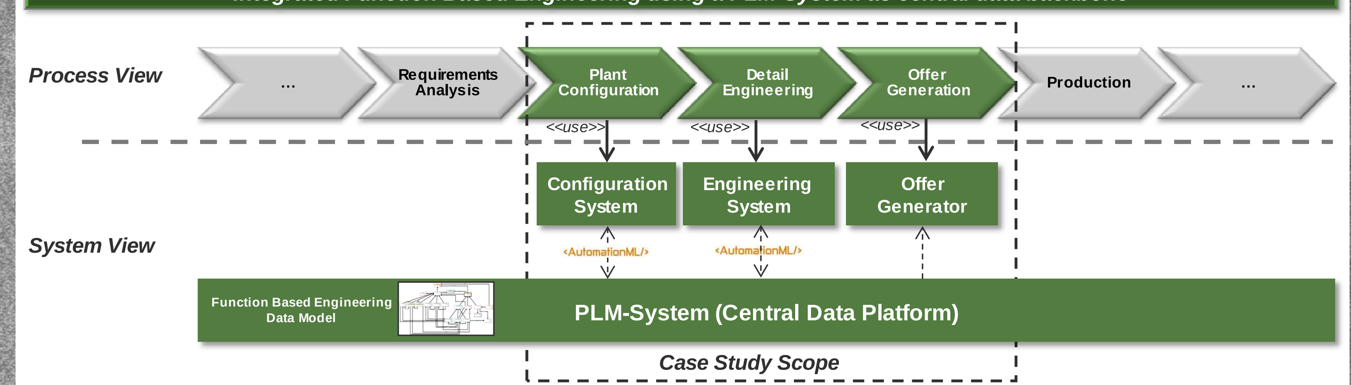



## Evaluation

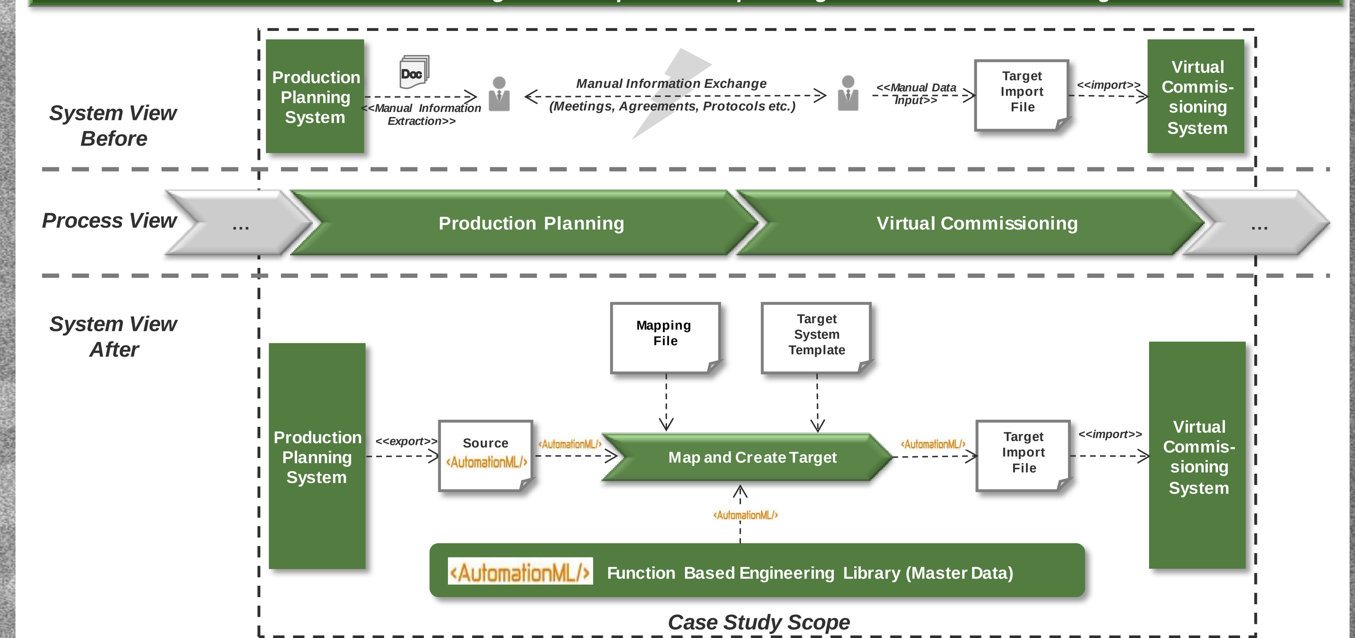
### Case Study

- Execution of two ***case studies*** in order to ***prove the feasibility*** of the AutomationML concept
- The ***first case study*** was a ***greenfield project*** and has been performed in an environment that is ***independent of any particular sector***
- The ***second case study*** has been set up in an ***existing process and system landscape (i.e. brownfield)*** of an ***automotive company*** to be able to evaluate the concept in a ***sector-specific*** setting

**Case Study 1: Greenfield – Sector Independent**
*Integrated Function Based Engineering using a PLM-System as central data backbone*




**Case Study 2: Brownfield – Automotive Sector**
*Seamless data exchange between production planning and virtual commissioning*




### Evaluation Scorecard

| Criteria | Tendency | Interpretation |
|---|---|---|
| Process Cycle Time | ⬇ | We were able to reach a ***high degree of automation*** for the interfaces between the systems in use. This led to a ***significant reduction in the manual work*** when transferring information between the process steps. |
| Data Redundancy | ⬊ | Due to the introduction of the central master data repository we were able to ***reduce the degree of data redundancy***. All information that is ***master data***-relevant and does not change during the projects is ***stored one time only*** in the repository. |
| Data Quality | ⬈ | Due to the reduced data redundancy rate, the ***data quality with regards to the master data was higher*** because this data was always referred back to the repository.<br>Before, the master data needed to be synchronized between the systems by manually entering and adjusting the data. Manual interfaces are always error prone and time consuming. After the case studies, those synchronizations can be performed automatically. Errors as described above can be eliminated and the time involved can be reduced (see Process Cycle Time). |
| Extensibility | ⬈ | By using a central master data repository in combination with the AML interface, ***new systems can be integrated very easily*** |
| Initial Costs | ⬆ | The ***initial costs*** for setting up the master data repository were ***rather high*** because the plants needed to be engineered using the Function-Based Engineering framework. This is ***a one-time effort*** and is initially needed during the setup phase only. |