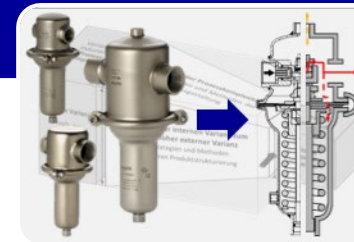Marc Zuefle, Jan Küchenhof, Markus Berschik, Dieter Krause

Enhancing Collaborative Modular Product Development: Interface Allocation and Associated Responsibilities

25th International DSM Conference, Gothenburg

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- We are working together with a lot of companies (most SME) on reducing variety-induced complexity
  - A bunch of those companies develops also multi-disciplinary systems

  - This leads in a lot of companies to challenges according
    - Responsibility in modules
    - Responsibility of interfaces
    - Structured Collaboration in modular Architectures
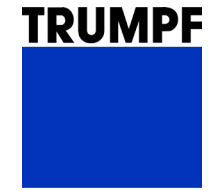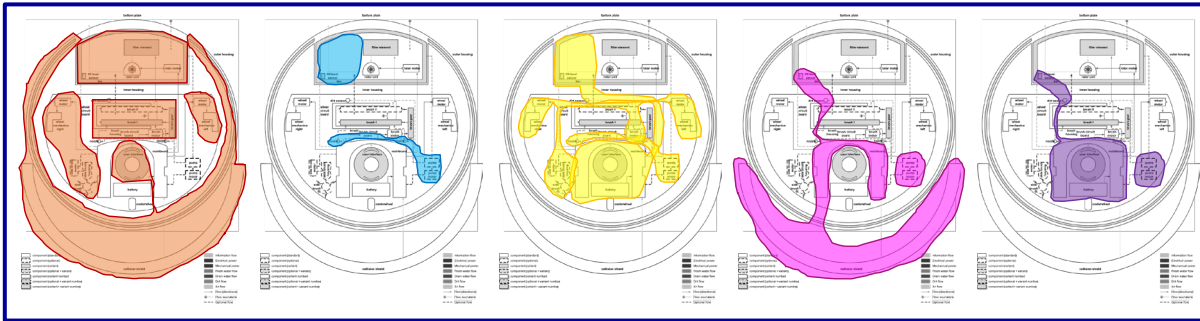
> How to **methodically support** companies in **assigning responsibilities** to their **modular architecture and interfaces** by using matrix-based approaches

Kuhl et Al. 2021 Birk et al. 2021; Krause et al 2014; TRUMPF 2022; iRobot 2022

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- In **previous work** we enabled **modular multi-disciplinarity in an MDM perspective**
  - Focus on **which component** is **influenced** by which sort of **development discipline**
  - What **impact** has this **on the module cut** & **how to harmonize**
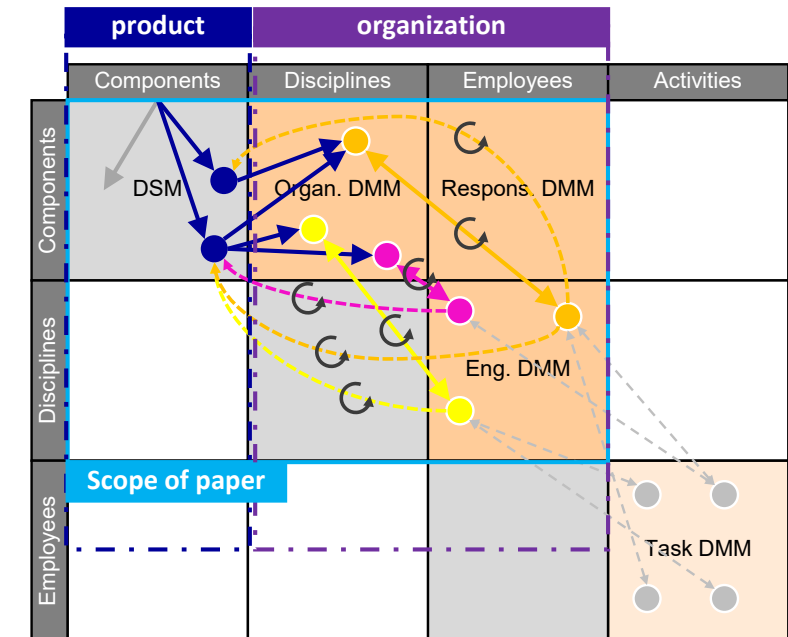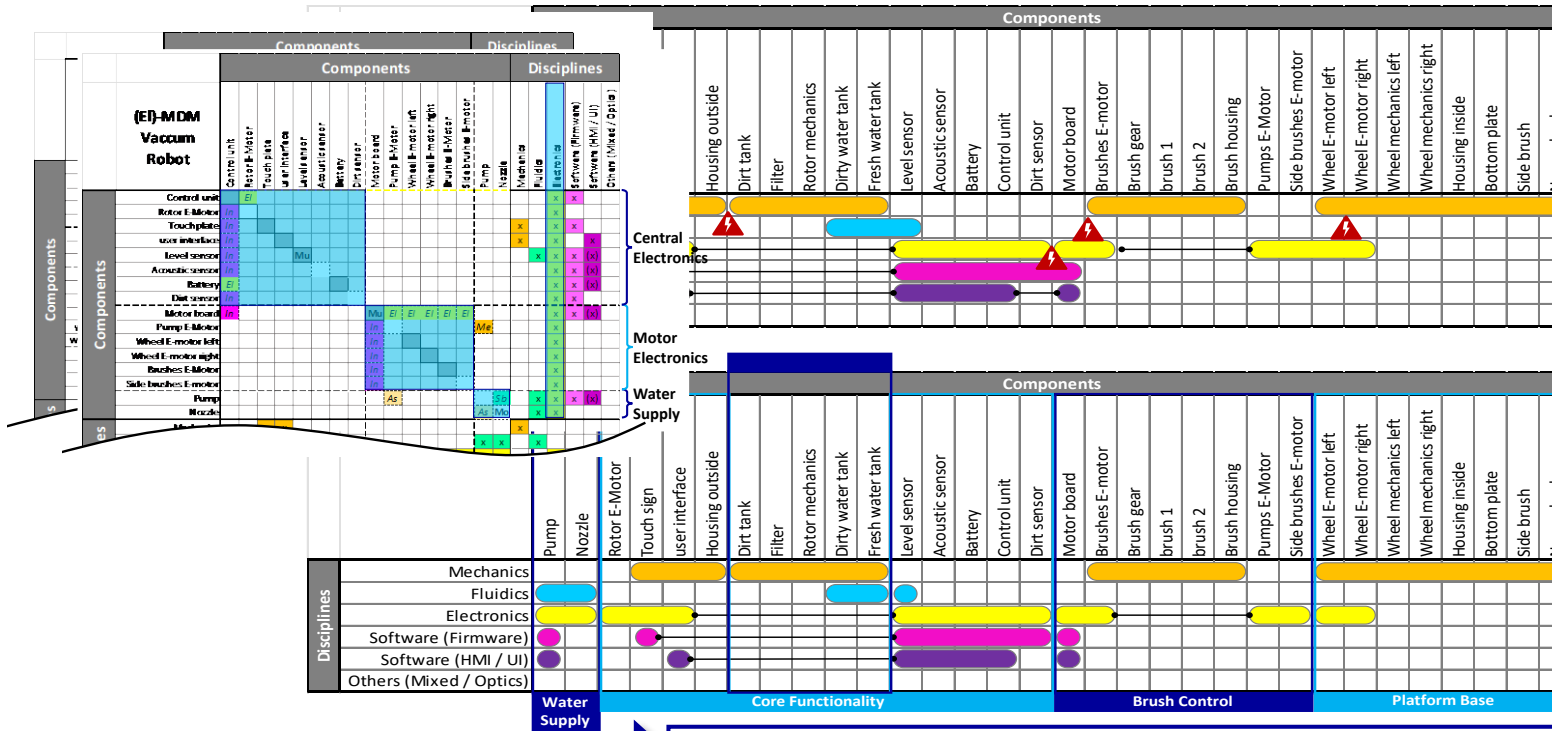
Harmonization of the **Product Domain itself** does **not** lead to **efficient architectures**. **People Domain** has to be taken into account and **responsibilities have to be defined**.

Zuefle et al., 2023, Introduction of the Module Harmonization Chart; Zuefle et al., 2022, Assessing the Influence of Digital Innovation

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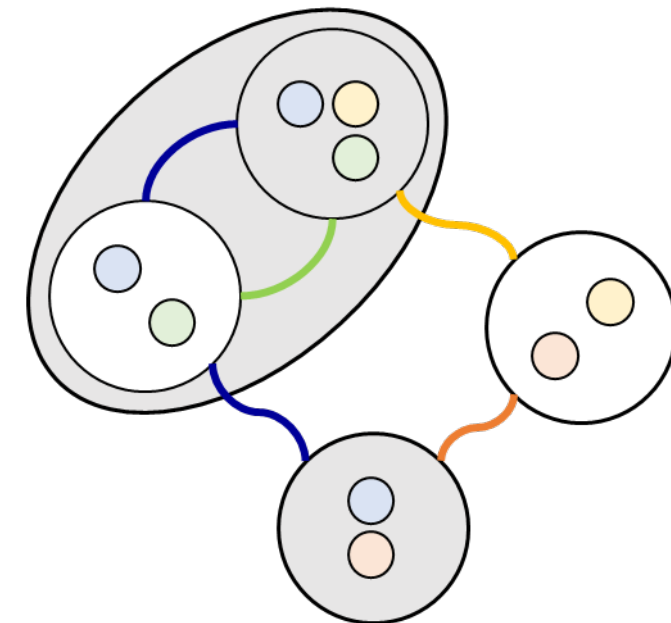- **MDM** has to be **extended by Employees or Roles** able to be responsible for systems of interfaces (e.g., electrical engineer, mechanical engineer, etc.)
  - Therefore, DSM, MDM and DMM with discipline information are the **status quo for this paper** (in this case mapped by the MHC* tool)
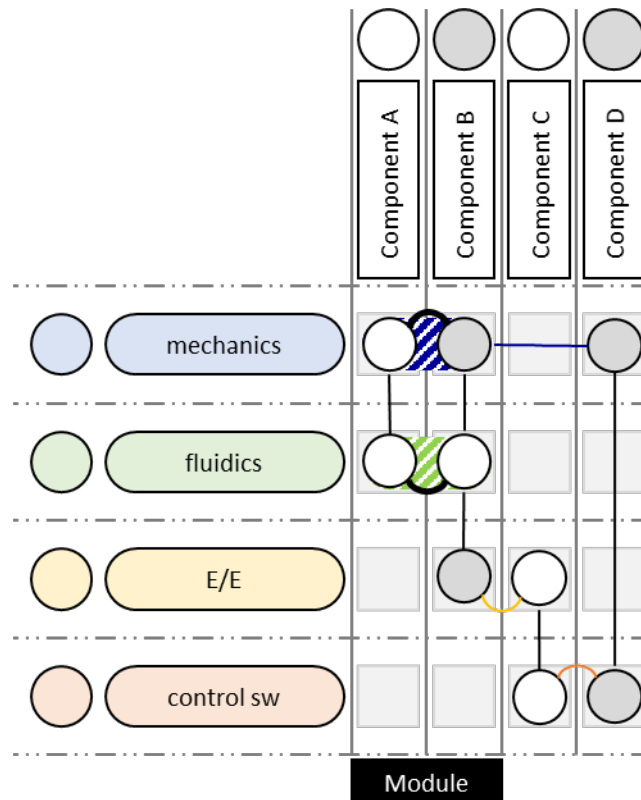
| simplified MHC (DMM like) | Component DSM | System Graph for Visualization |
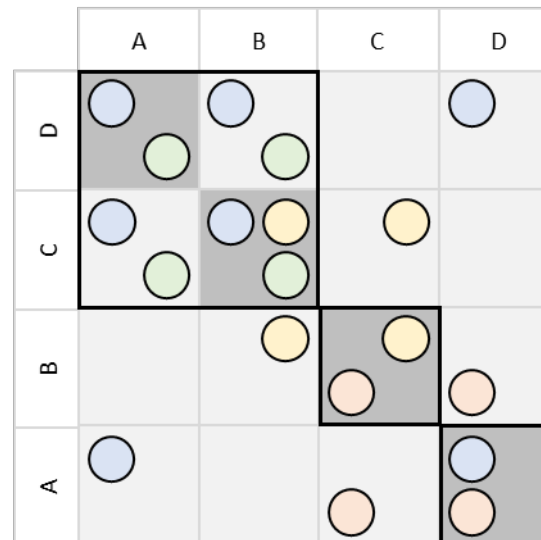
*MHC = Module-Harmonization-Chart

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- **Employees/Roles are distributed to components**
  - Due to the fractional behavior of a system, **multiple employees** from different disciplines can be **assigned to one component***
  - Therefore helpful the prior allocation to a specific discipline

- For **assigning responsibility** the **interaction/collaboration** between the **components and employees/roles** is important
  - Sort of interface/coupling
  - Level in Modular Architecture
 - Amount of communication patterns
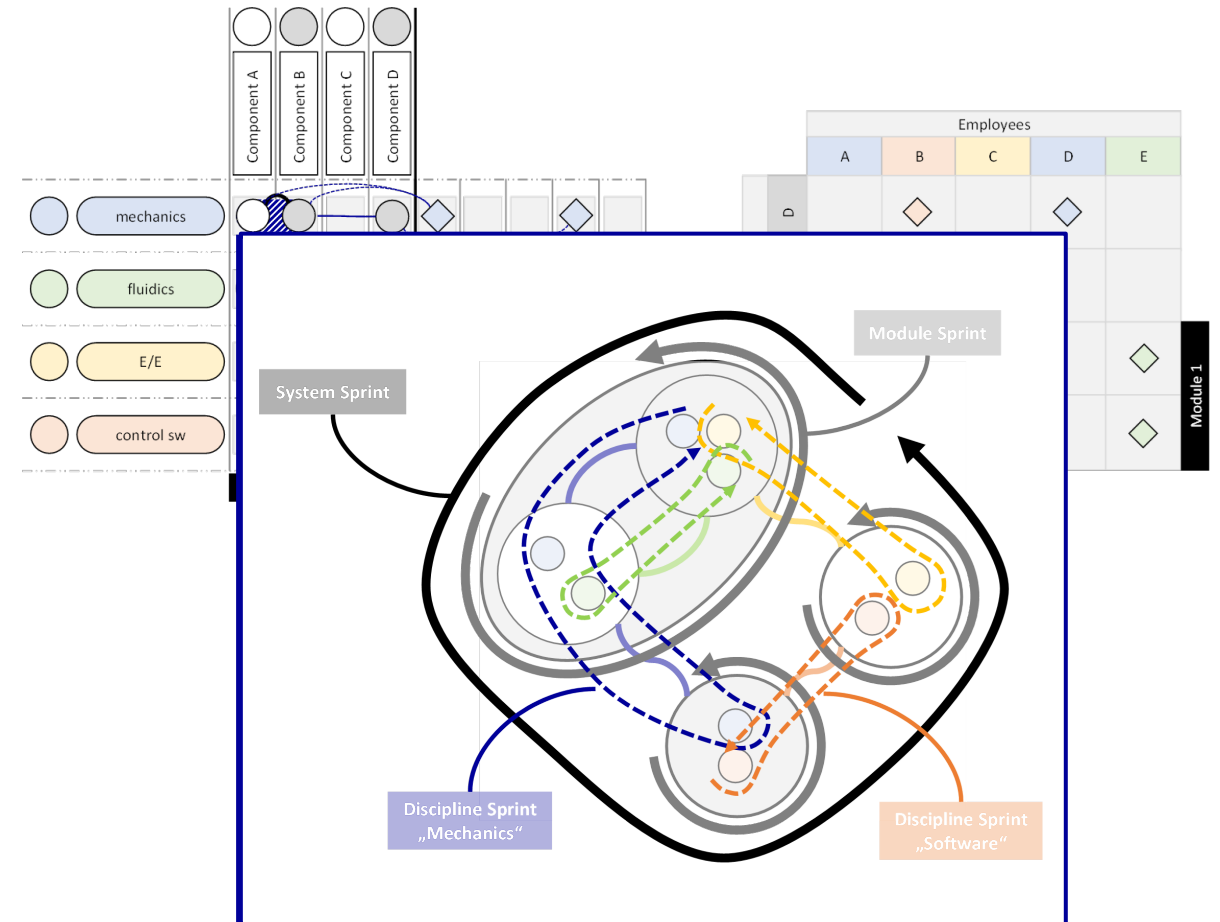
Collaboration organized by **specific Interaction/Communication** - Sprints for "Decision Making"

*due to the fact, that an component do not have to be an atomic element. It is only the lowest level in this particular analysis
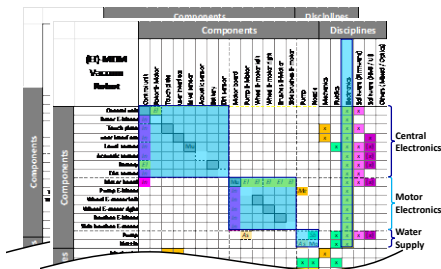
Krause and Gebhardt, 2023, Methodical Development of Modular Product Families; Cabrera et al., 2008, High Level Model Integration for Design of Mechatronic Systems

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- Due to the **previous harmonization** of the modular architecture across development disciplines:
  - the interfaces are synchronized
  - there is a common module understanding
  - similar interfaces between the modules*

- **Assigning Employees/Roles** to components
  - Enables **responsibility** for **discipline-specific modules**
  - Increases **transparency** of **team composition** in module
  - Provide **transparency** for **responsibilities of interfaces**

- **Responsibility can be taken from product DSM**
  - According to Inputs in the Matrix

◇ Employee
◯ Component
▢ Module (also disc.-specific)
↻ Sprint
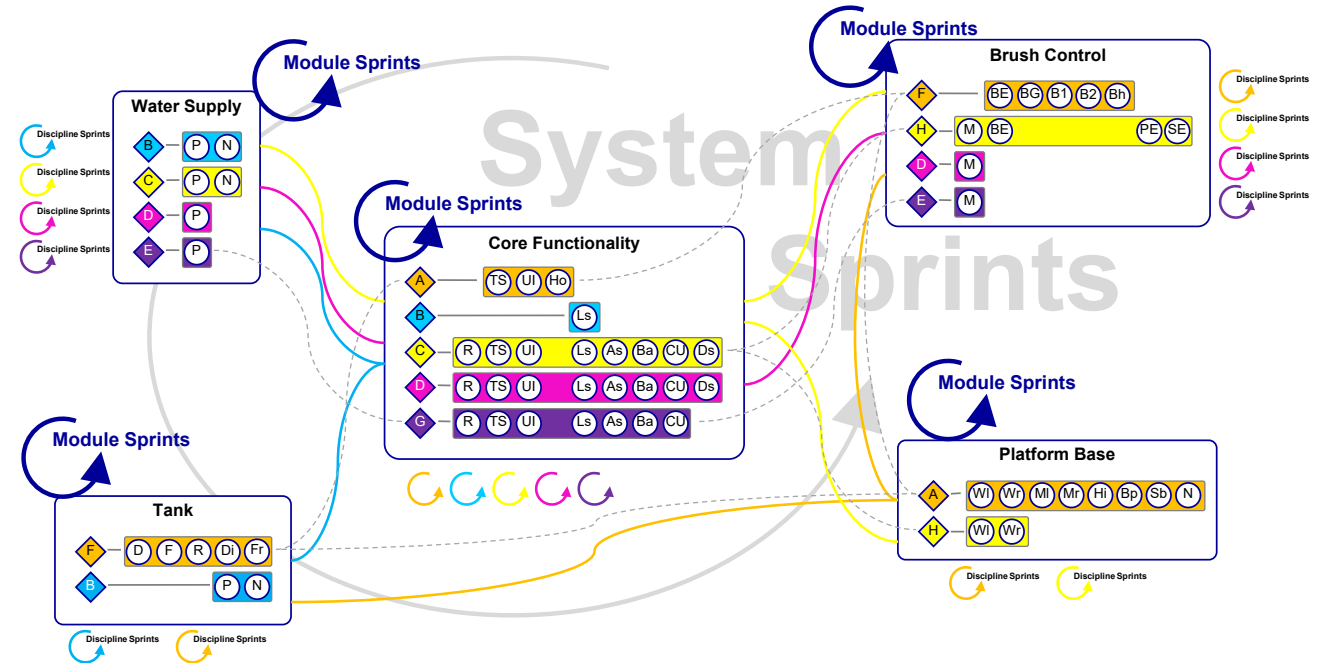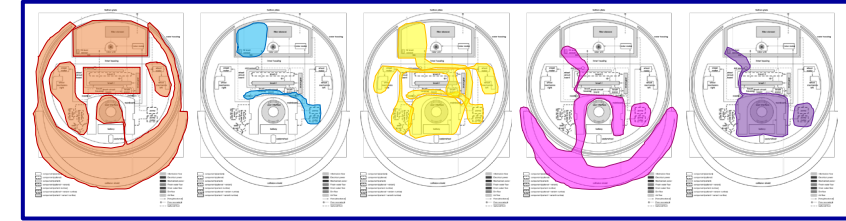
*This does not always have to be given, there can also be several modules of individual disciplines in one module again.

Zuefle et al., 2023, Introduction of the Module Harmonization Chart; Zuefle et al., 2022, Assessing the Influence of Digital Innovation

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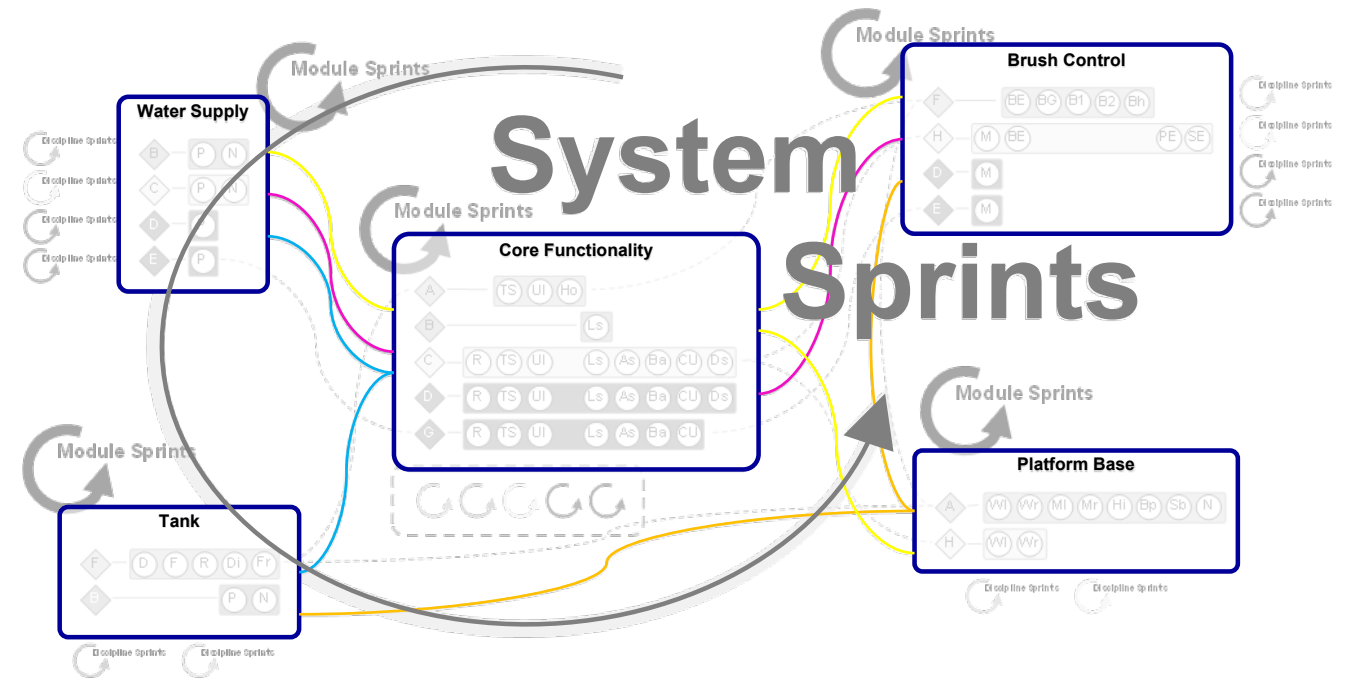
- **Module Sprint**
  - aim to be able to develop the **module itself** as a functioning subsystem
  - **All disciplines exchange information** on a **short cycle** level for best possible cooperation
  - Only **module-internal Interfaces**

- **Discipline Sprint**
  - aim to **ensure effective interactions between modules** by interfaces on **discipline-level** e.g., software code (SW) or mounting (mech.)
  - Only **discipline-specific interfaces** across modules

- **System Sprint**
  - focus on **integrating modules** into the **overall system**, including verification and validation
  - **Overall interfaces** between modules

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- **Multi-disciplinary modular Design** works only when the **Organization is synchronized**
  - Using **matrix-based approaches helps** aligning them to the product domain
  - By using the **DSM and its Input/Output responsibilities can be transferred** to Disciplines, Roles and Employees

- This **simple and intuitive approach** enables companies (mostly SME) **clarifying their responsibilities** in their modular Architecture *(corresponding to the harmonized multi-disciplinary modularization)*

- Further work has to deal with the **extension** by the **linkage of Roles** to Tasks or the linkage of **disciplines to tasks** in the **process domain**
  - This can support the collaboration of software and hardware in a Stage-Gate process, or exemplary in "decision making"

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