CONTRIBUTIONS TO ENGINEERING DESIGN
Systemmodels – Optimization – MBSE

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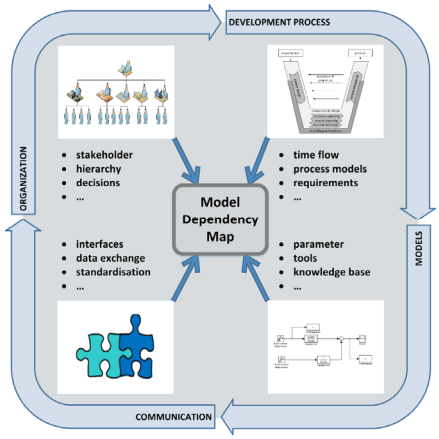
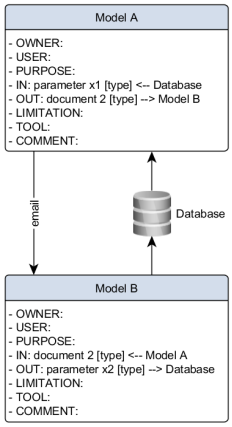
Model Dependency Maps for transparent concurrent engineering processes[1]

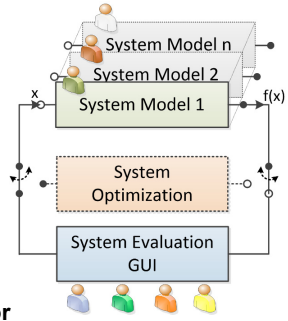
- **Concurrent model based mechatronic design** by engineers from **different disciplines** on different sub-systems needs a bunch of different models.
- These **models**, **decision making steps** and the **in-** and **output data** establish a **complex interdependency network**.
- Using a small set of symbols, a **Model Dependency Map (MDM)** can be built to **visualize** and **analyze** this **interdependency network**.
- MDMs provide **different views for specific analyses:** tool view, parameter view, a view to support the **development of system models**.
- Views help extracting the required information from the MDM to **achieve a better comprehension of the mechatronic system**.

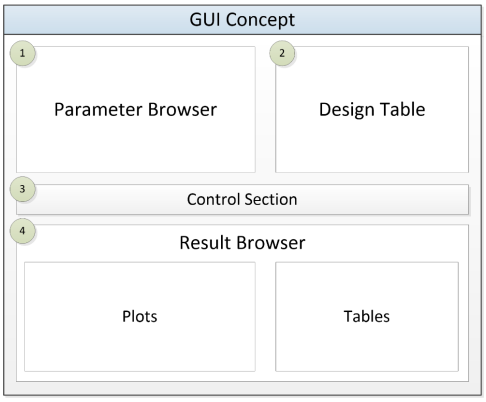




A Design Optimization Framework for multidisciplinary mechatronic systems[2]

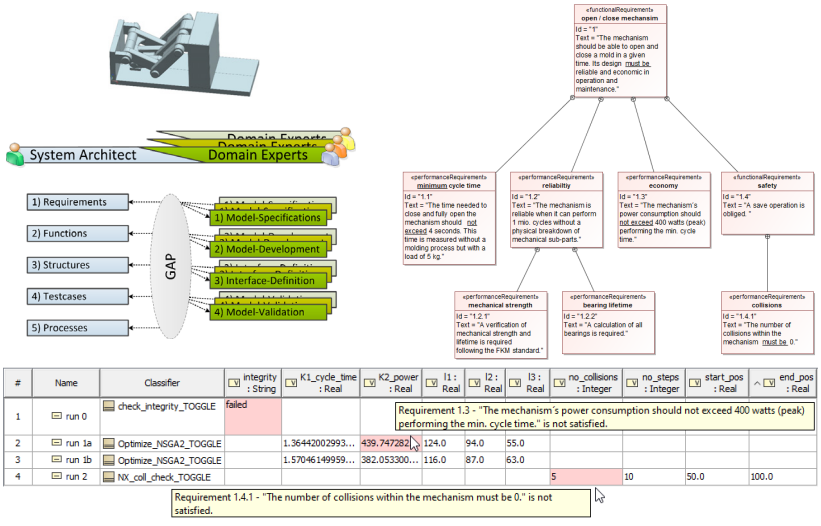
- The **design optimization framework** combines **system modeling** with a **genetic multi criteria optimization** algorithm and a **system evaluation GUI** to manage the automated simulation and validation processes as well as the finding of the optimal solutions.
- The **system models** have to answer the system questions with satisfying accuracy and might be computationally inexpensive.
- The best way to **evaluate various solution concepts** is by comparing their **Pareto fronts** in the design objectives´ domain.
- The system evaluation GUI:
  - provides graphical information about the **basic system behavior** and influences of design parameter changes
  - allows checking the **validity of system models** by comparing their optimal designs with those obtained in detail design phases
  - guides users through the **simulation processes**, investigates the design parameters' influence on the systems behavior, and manages all parameter value exchange between several simulation tools





Integration of domain-specific simulation models into descriptive system models by using SysML[3]

- Industry examples show a need to **bridge an existing gap** between system architect´s and domain experts´ models.
- To this end **executable domain models** are integrated into a descriptive system model using a **Model Based Systems Engineering (MBSE)** authoring tool.
- With such MBSE tools also **requirements** and inter-dependencies with respect to the **system´s structure**, **functions** and **behaviors** can be modeled.
- Domain architects use **simulation models** to study the system behavior and to **verify specific system requirements**.
- System architects can re-use such simulation models to **track system validity** in case of design changes.
- The approach was developed / tested with an optimization and collision check simulation model of a toggle lever.



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[1] Friedl M., Weingartner L., Hehenberger P., Scheidl R., "Model Dependency Maps for transparent concurrent engineering processes": Proceedings of the 14th Mechatronics Forum International Conference, Mechatronics 2014, pp. 614-621, 2014

[2] Friedl M., Scheidl R., Hehenberger P., Kellner A., Weingartner L., Hörl M., "A Design Optimization Framework for Multidisciplinary Mechatronic Systems": Proceedings of TMCE 2016 - Tools and Methods for Competitive Engineering, pp. 3-12, 2016

[3] Friedl M., Kellner A., Weingartner L., "Integration of domain-specific simulation models into descriptive system models by using SysML": Submitted to and accepted at IEEE/ISSE 2017 - International Symposium on Systems Engineering 2017