Actuation 2015

Sub-Project 3

Methods & Tools

TUHH | INSA TOULOUSE | POLITECNICO DI TORINO | MTA SZTAKI | The University of Nottingham UNITED KINGDOM · CHINA · MALAYSIA | TUM TECHNISCHE UNIVERSITÄT MÜNCHEN | IK4 TEKNIKER Research Alliance | DLR | ONERA THE FRENCH AEROSPACE LAB Centre de Toulouse | AIRBUS GROUP | NLR | π! PARAGON S.A.

Model-Based Design Tools

Designing an EMA poses a big challenge to the engineer due to the complex interdependencies among its components. Dedicated design assistance tools have been created to:

- Enable fast evaluations using models with a low level of detail
- Generate secondary parameters with only few data from the actuator under design
- Provide suitable computing and optimization capabilities for the preliminary design process
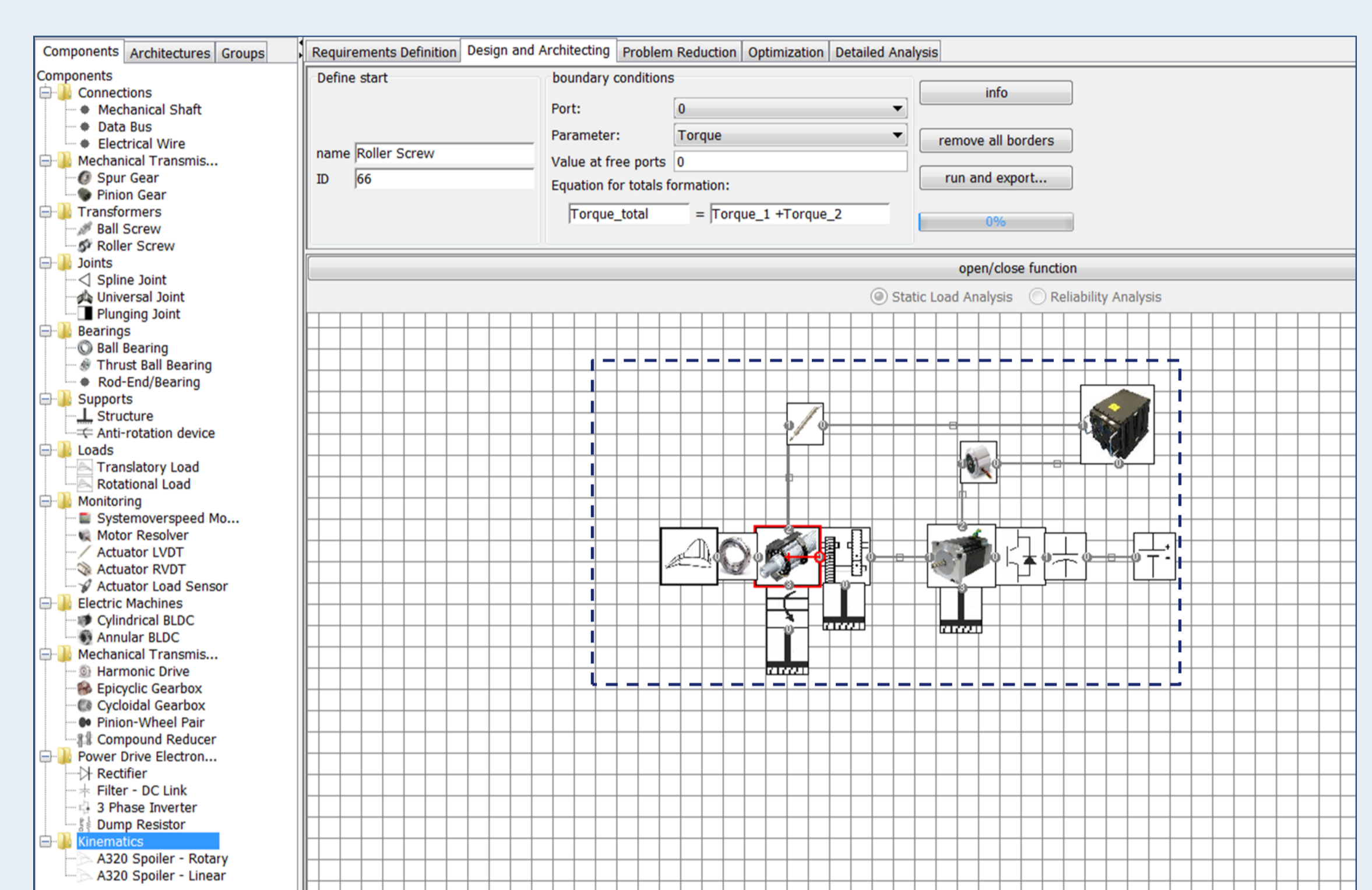

Knowledge-Based Design Environment PreDEMA

Electromechanical actuators have different design drivers compared to hydraulic actuators such as:

- Thermal effects – electric motor and power electronics
- Inertial forces – electric motor and gearboxes
- Mechanical fatigue – mechanical transmission components

Sizing tasks can thus not be conducted using operating points but with transient mission profiles. For this purpose, a toolbox for the analysis of mission profiles and extraction of relevant performance indicators has been set up.
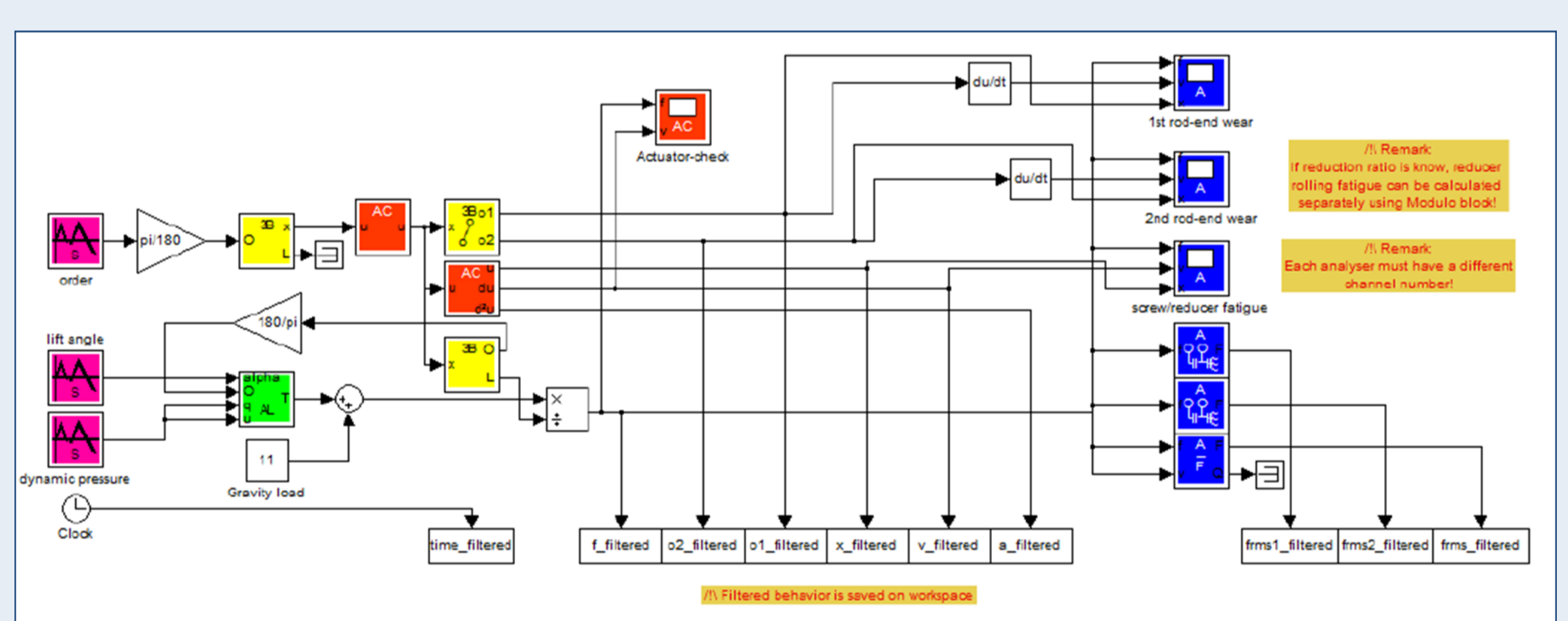

Mission Profile Analysis Toolbox YouSize

Parameter sets

Modeling and Simulation

In the context of modeling and simulation, the research institutions involved in Actuation 2015 are developing a standardized actuator library. The main objectives of this task are:

1. Coverage of important physical effects for optimized design.
2. Switchable component models for multi-level simulation.
3. Fault-injection support - standardized coverage of relevant component failure modes.
4. Well-documented, tested, and validated models.
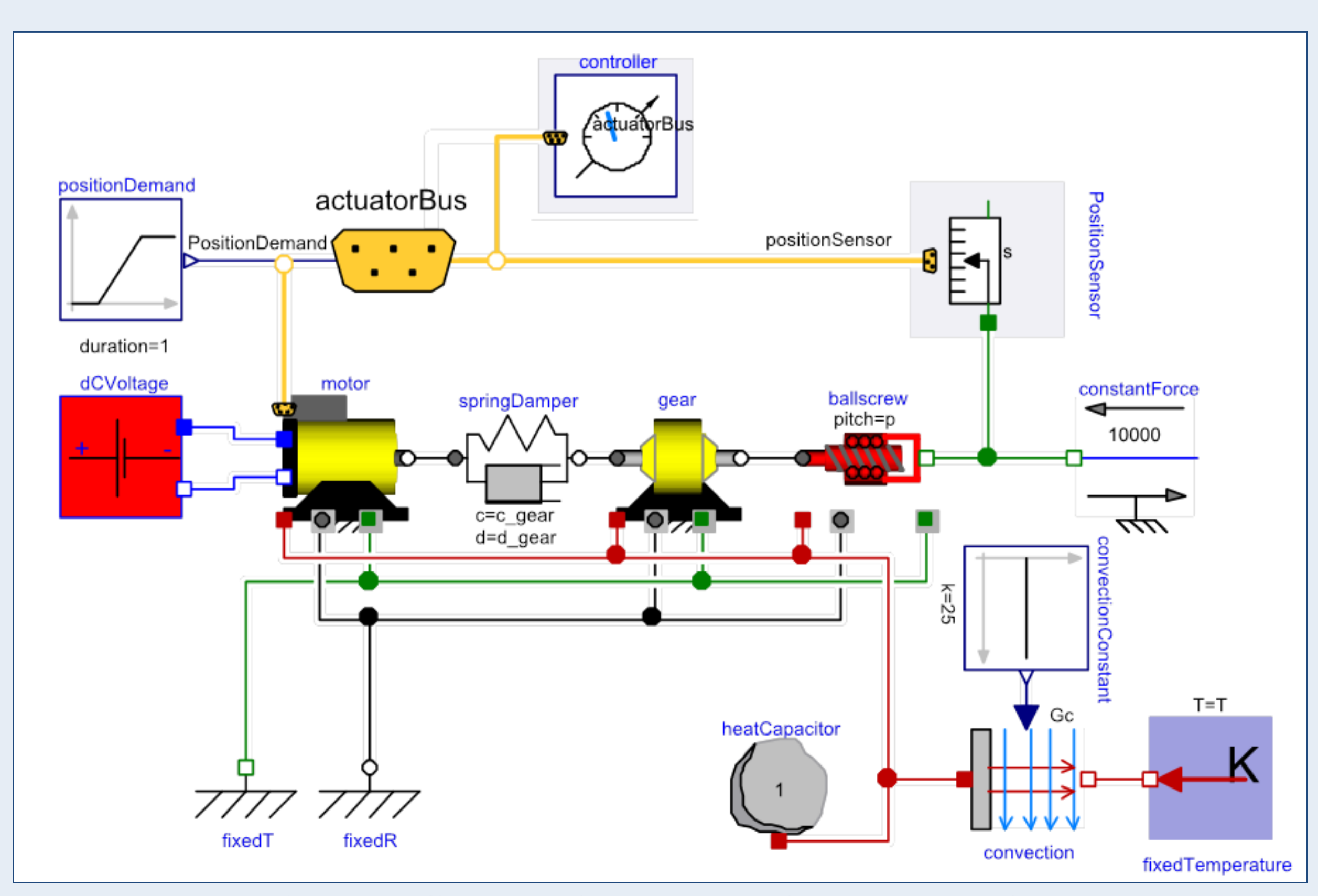
**EMA Model Created with the Modelica Actuator Library**

Uncertainty and Reliability Analysis

Due to the lack of experience with EMAs in the aerospace industry, uncertainty must be taken into account when performing reliability studies. To accomplish this, two different methods are being developed:

- Creation of probability distributions for EMA component failure rates followed by reliability analysis using bayesian networks
- Use of interval arithmetic to quantify uncertainties in conjuction with model-based reliability methods and reliability block diagram RBD analysis
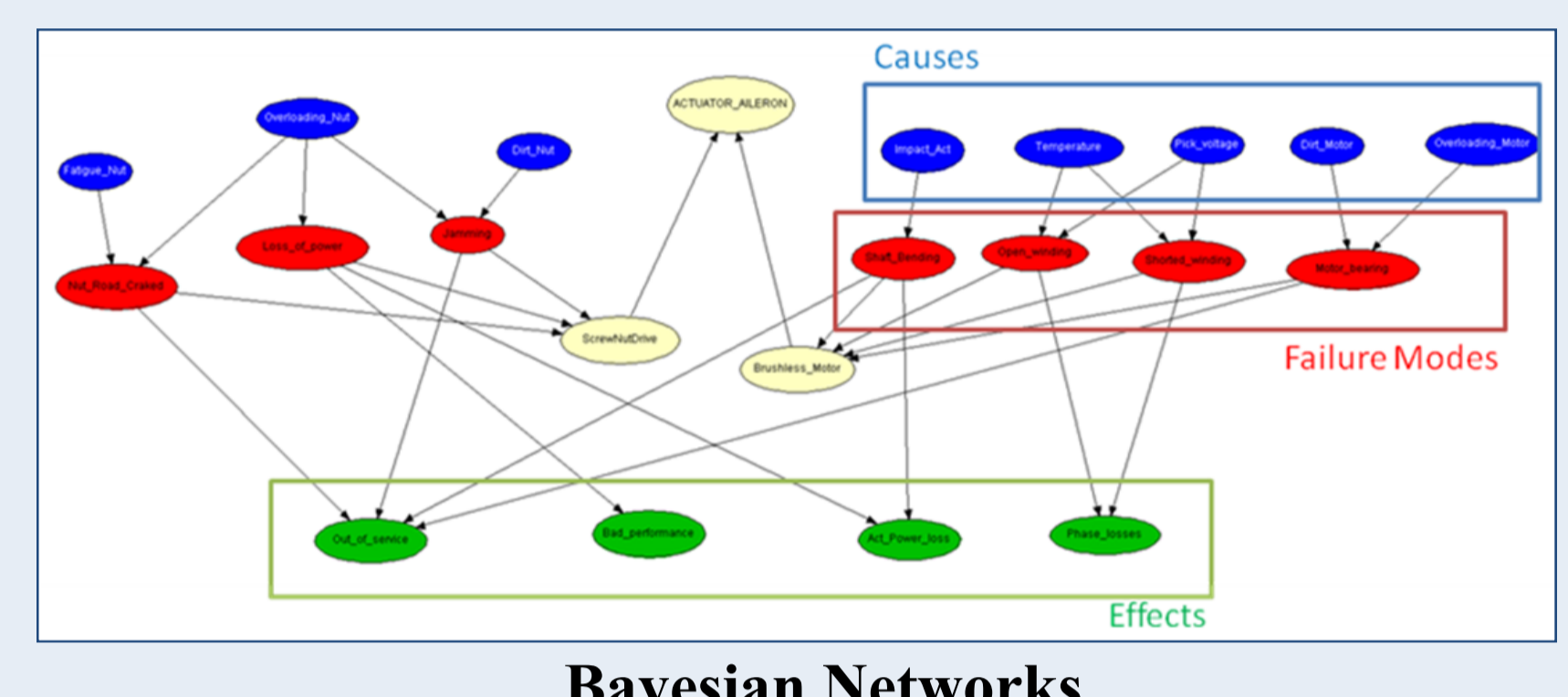

Bayesian Networks
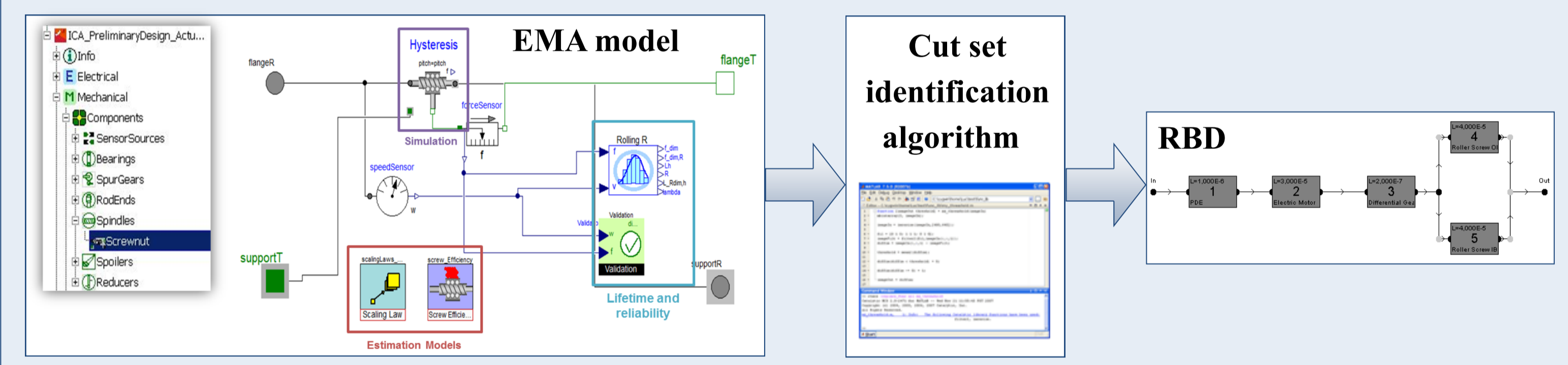
Model-Based Reliability Methods

Virtual Integration

It is of high importance to carry out an aircraft-level evaluation on the impact of using EMAs for flight control applications. Hence a virtual integration platform is being created to study e.g.:

- Transient effects on the aircraft's electrical power system
- The effects of EMAs' dynamics and potential failures on aircraft flight performance
- Environmental conditions affecting the actuators
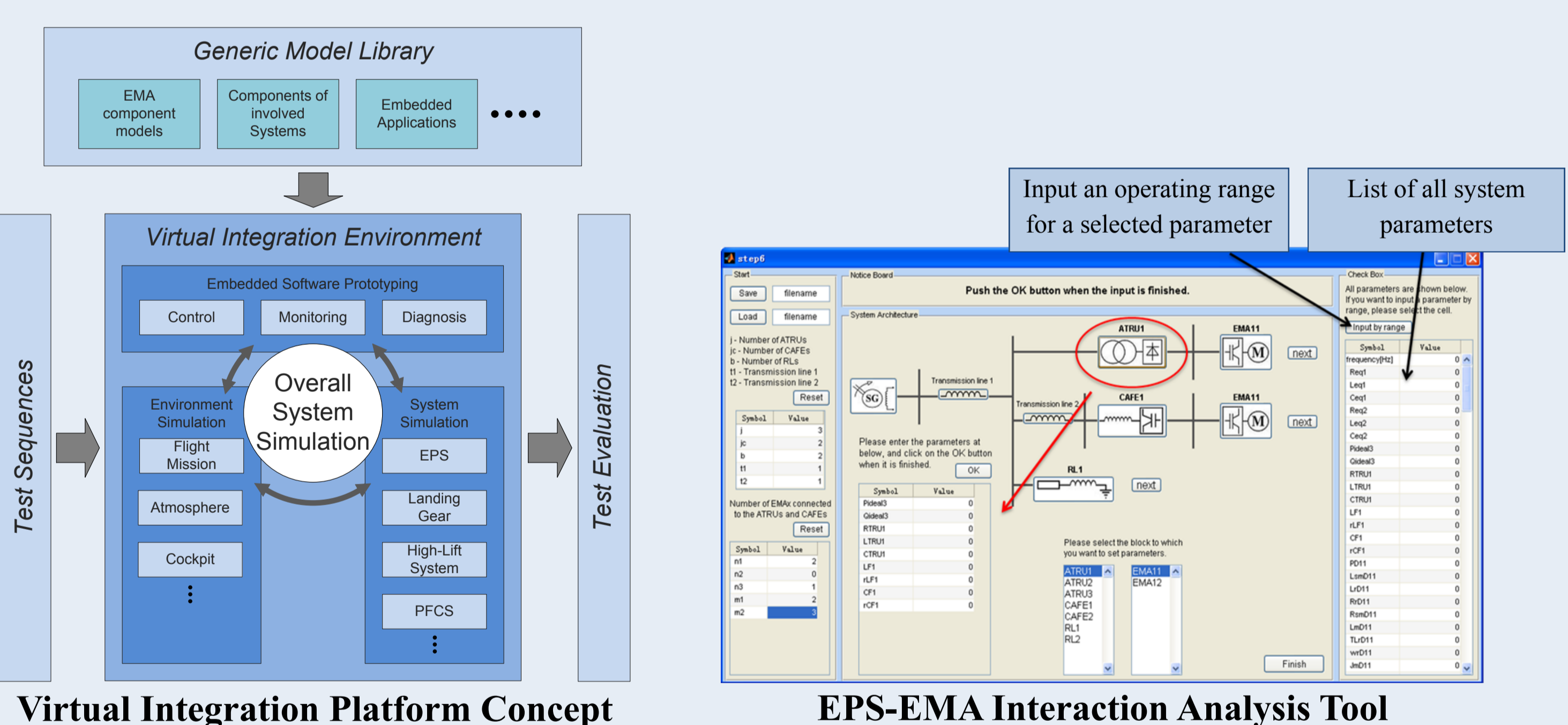
Virtual Integration Platform Concept

**EPS-EMA Interaction Analysis Tool**

EMA models

Virtual integration platform

Virtual Testing Techniques and Certification

To optimize the testing phase and therefore reduce qualification and certification efforts, virtual testing laboratories based on validated component models are being set up. With the use of these techniques, generic test plans for modular EMAs will be established.
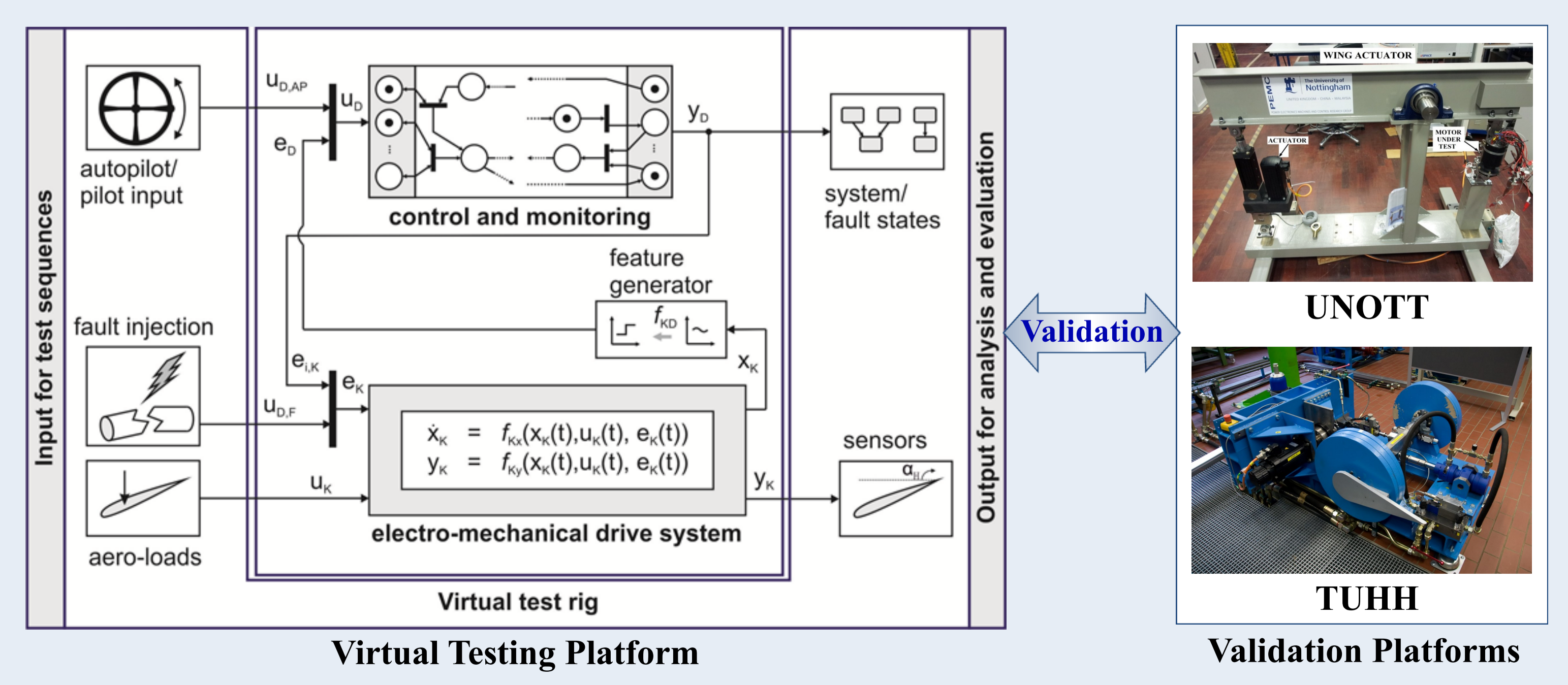
Virtual Testing Platform

Validation

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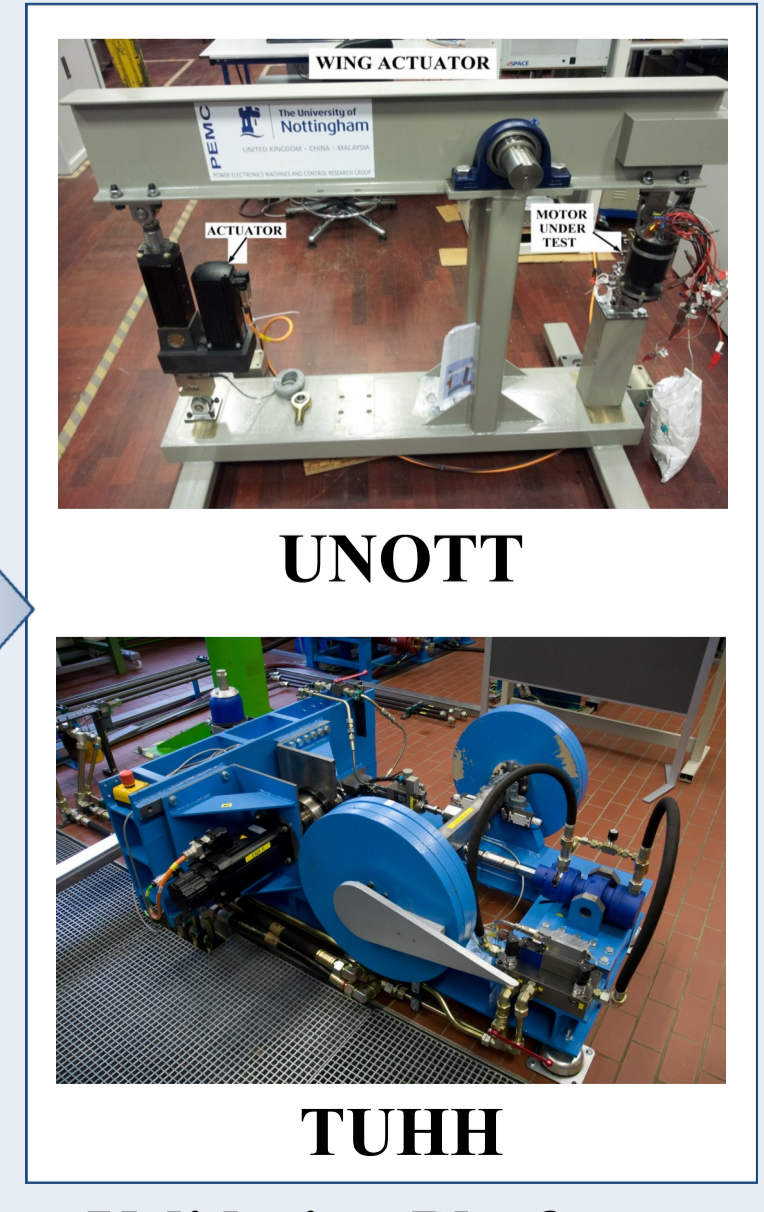
Validation Platforms

Certification agencies will evaluate the feasibility of employing virtual testing methods in the aerospace industry.