# Fluid and Mechatronic Systems, Flumes activities in MODPROD

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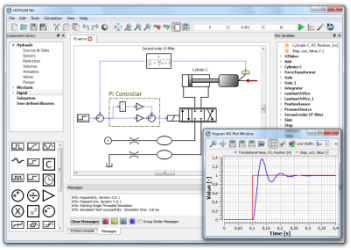


# *Flumes Research Areas*

***Aircraft Systems***

Aircraft design

Onboard systems

Subscale flight testing

***Fluid Power***

Hydraulic system and component design

Mobile systems

Measurement and control systems

Noise and vibrations

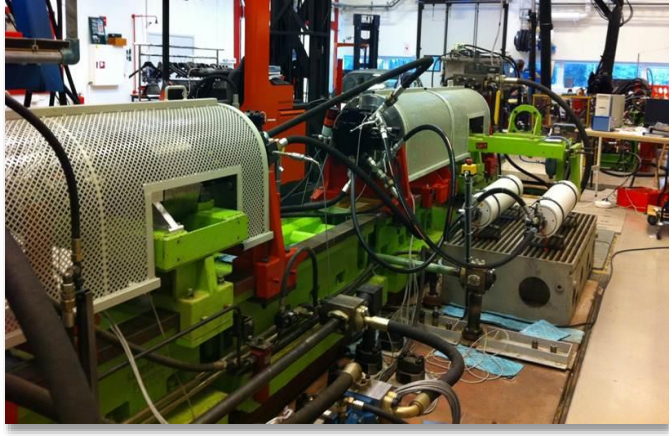
Modelling and simulation

Systems Engineering

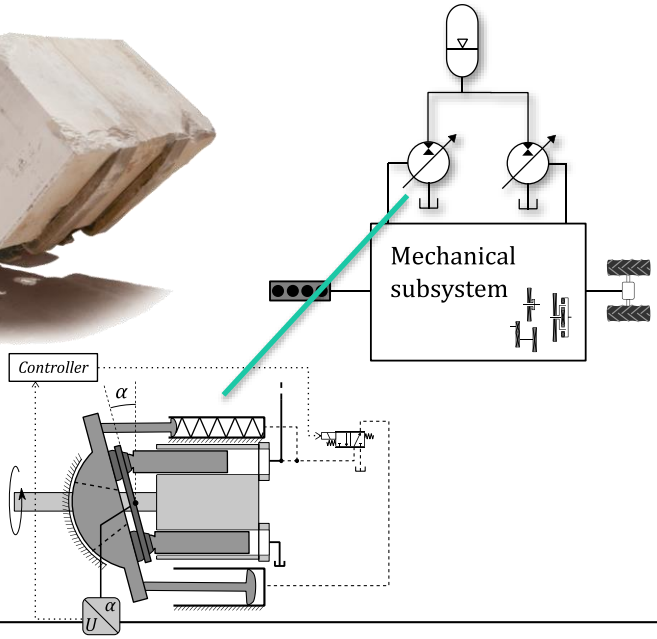
Mechatronics

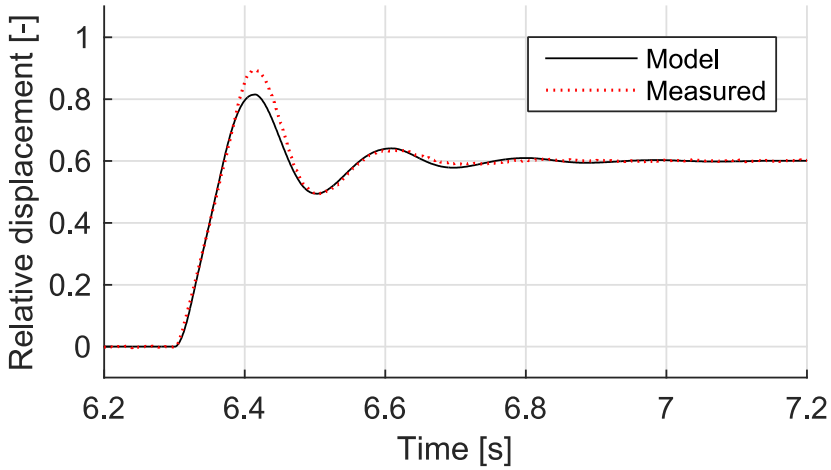
Design analysis and optimisation

# Modelling of a Displacement Control Actuator – For Hydraulic Hybrid Applications

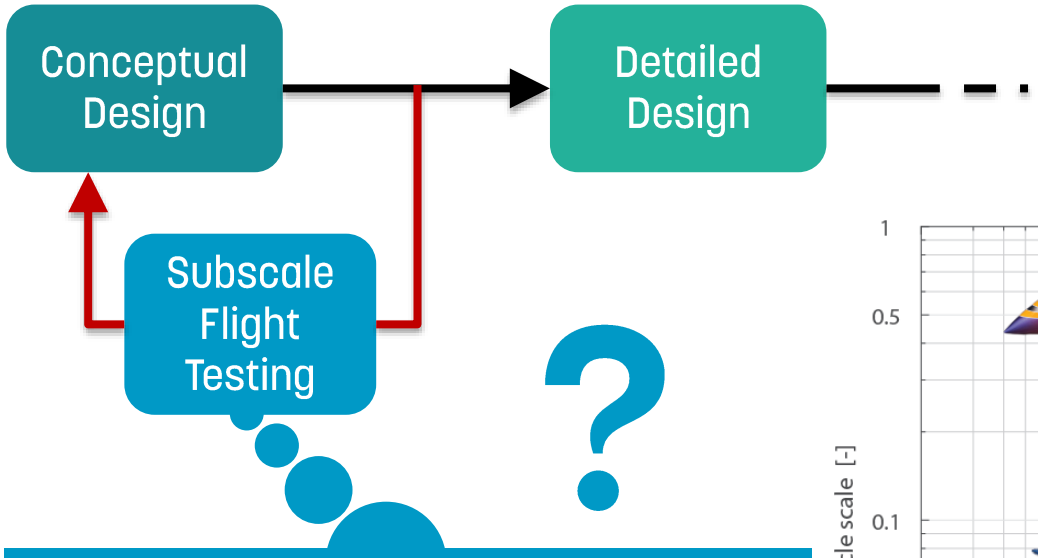


- Dynamic model in Hopsan
- Using the built-in optimisation tool for adaptation of model parameters (validation with rig tests)

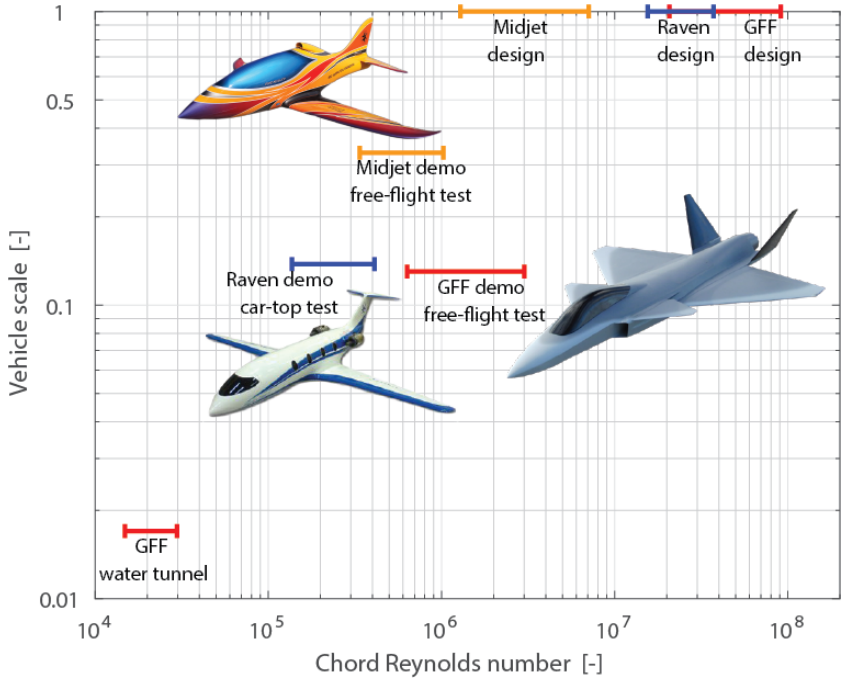


# Subscale Flight Testing in Aircraft Conceptual Design




- How to choose the scaling method?
- How to acquire the right data?
- How to extrapolate the results?

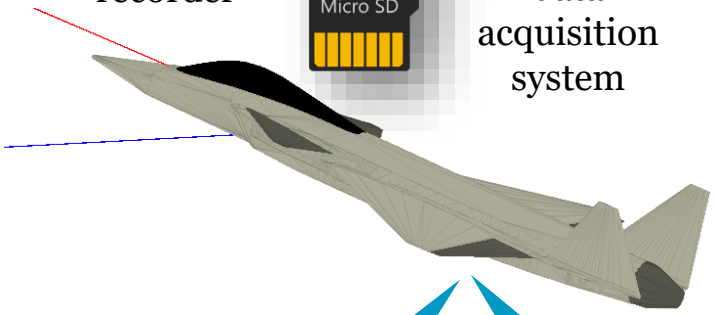


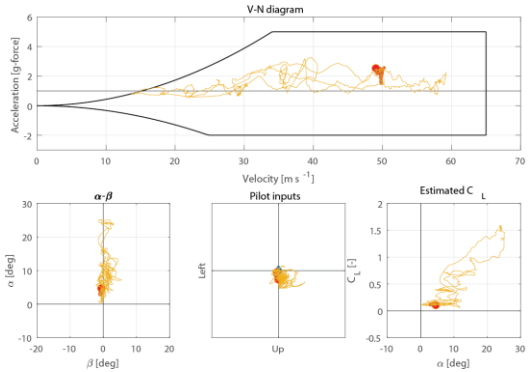
# Subscale Flight Testing in Aircraft Conceptual Design

Onboard video recorder

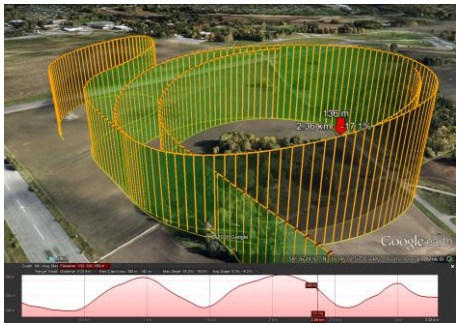
Micro SD

Miniaturised data acquisition system






Tools for visualization and analysis of flight test data

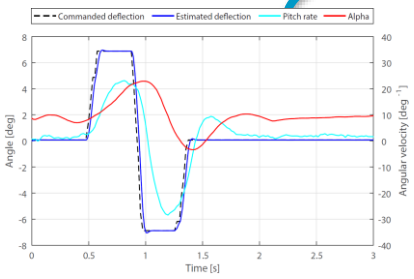


Specific flight test design for very confined airspace

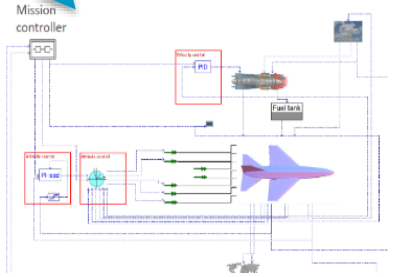
Bi-directional low-latency control link (RC equipment)


Bi-directional telemetry link (ground station)

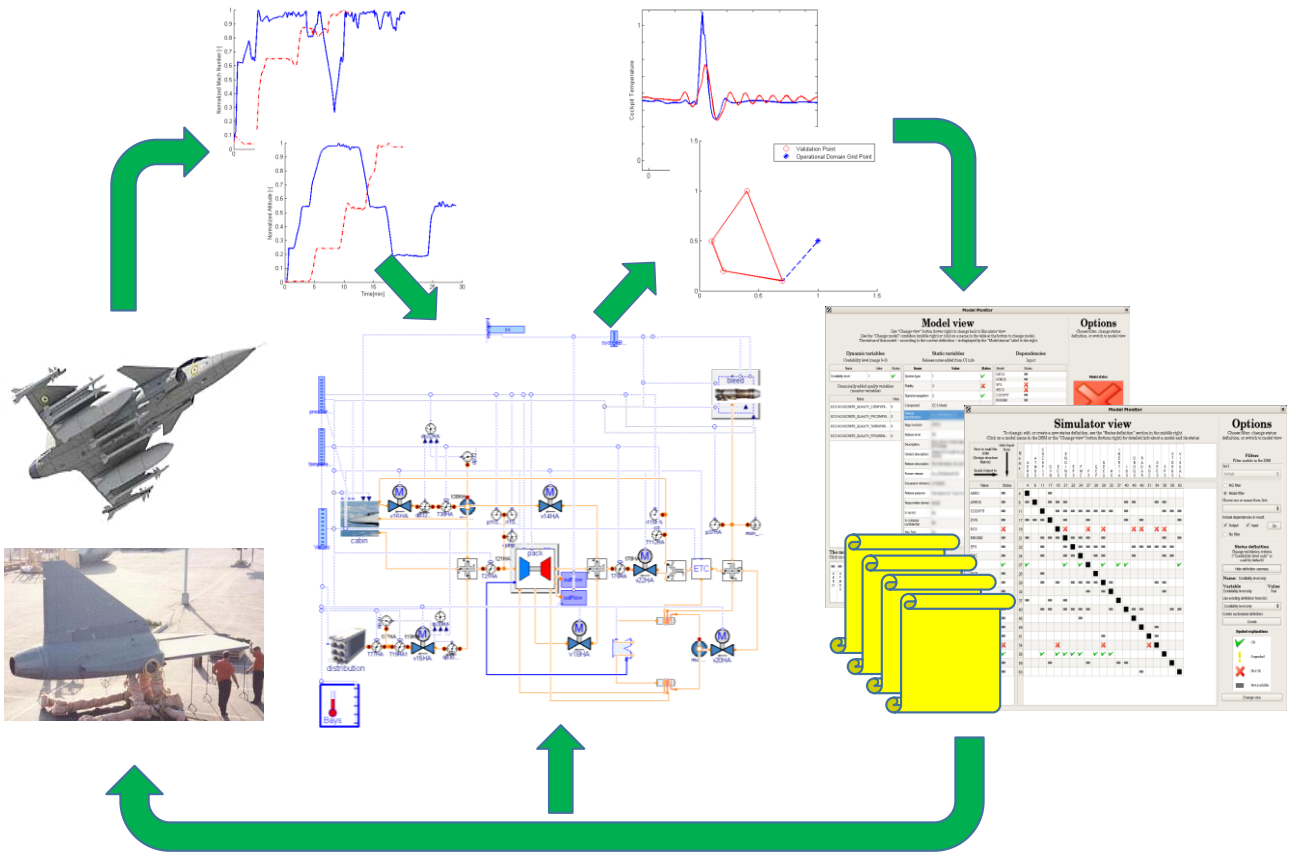

Parameter estimation




Simulation model improvement



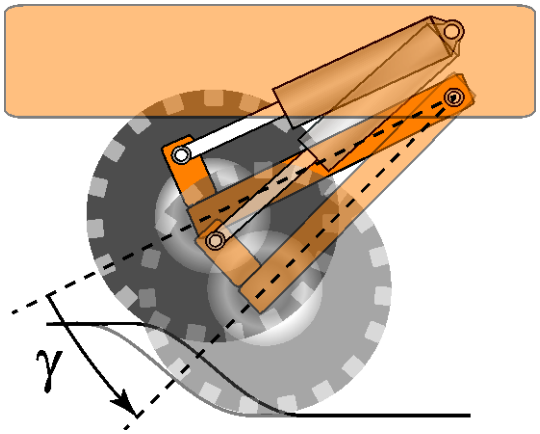
# Methods for Automating Model Validation

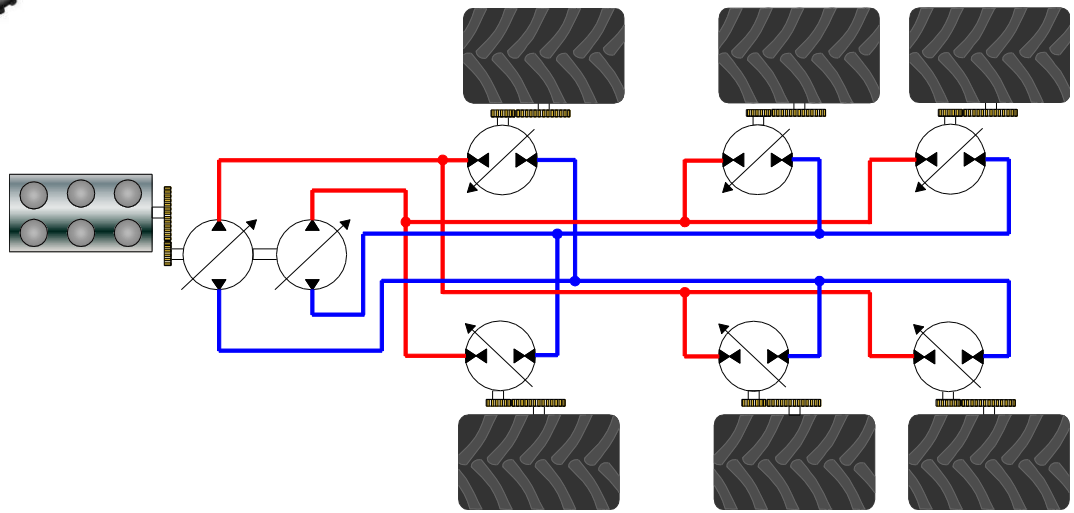


Liselott Ericson
Alessandro Dell'Amico

# Hydraulic Transmission in Forestry Machines

- Six wheel drive hydraulic transmission
- Pendulum arms to e.g. evenly out ground pressure
- Reduced impact on soil
- Improved productivity

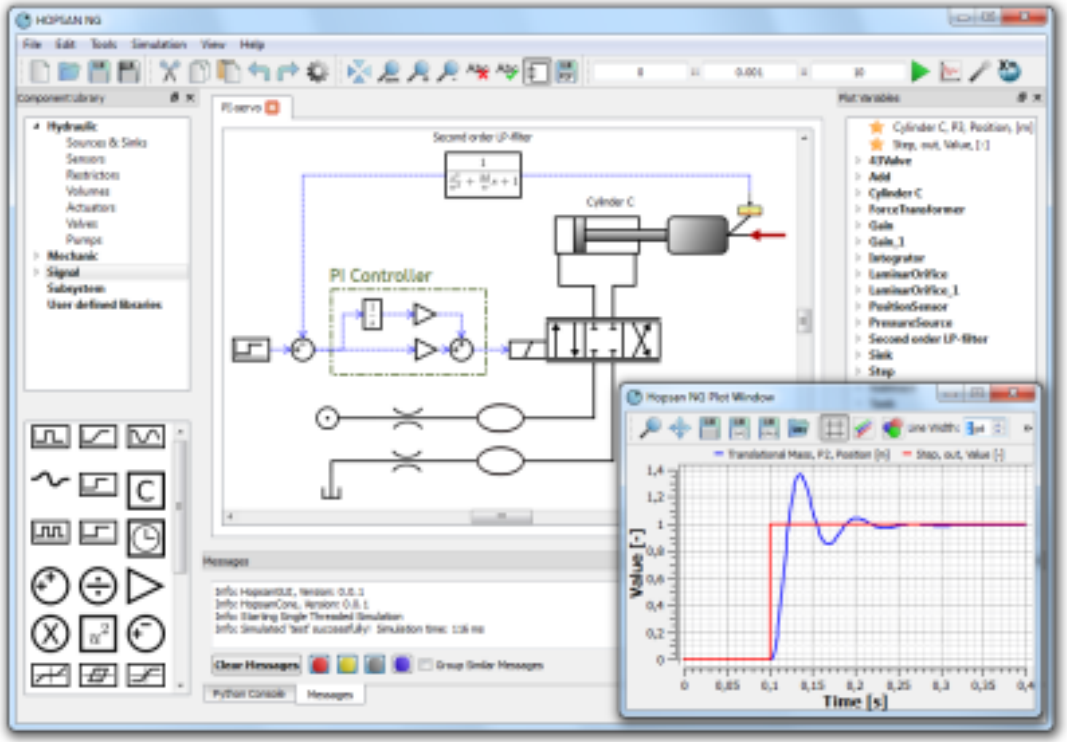


# HOPSAN

- Bidirectional delay-lines
- Modelica support is under development
- Open source that can be downloaded from http://www.iei.liu.se/flumes/system-simulation/hopsanng

Friday afternoon workshop= “happy hour”



# System simulation

- Real-time Simulation (RTS), and Faster than Real Time Simulation (FRTS) Technologies
  - Distributed modeling
  - Parallelization of simulation models for multi-core processors
  - Hardware in the loop simulation
- Using bilateral delay line (transmission line modelling, TLM) for model partitioning


$$p_1(t) = p_2(t - T) + \frac{T}{C}[q_1(t) + q_2(t - T)]$$

$$p_2(t) = p_1(t - T) + \frac{T}{C}[q_2(t) + q_1(t - T)]$$

# Atlas Copco: Rock drill Simulation and Optimization using the HOPSAN simulation package

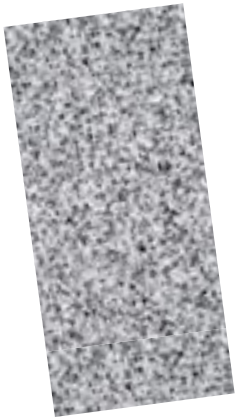
Atlas Copco has 45% of the world market in rock drill equipment

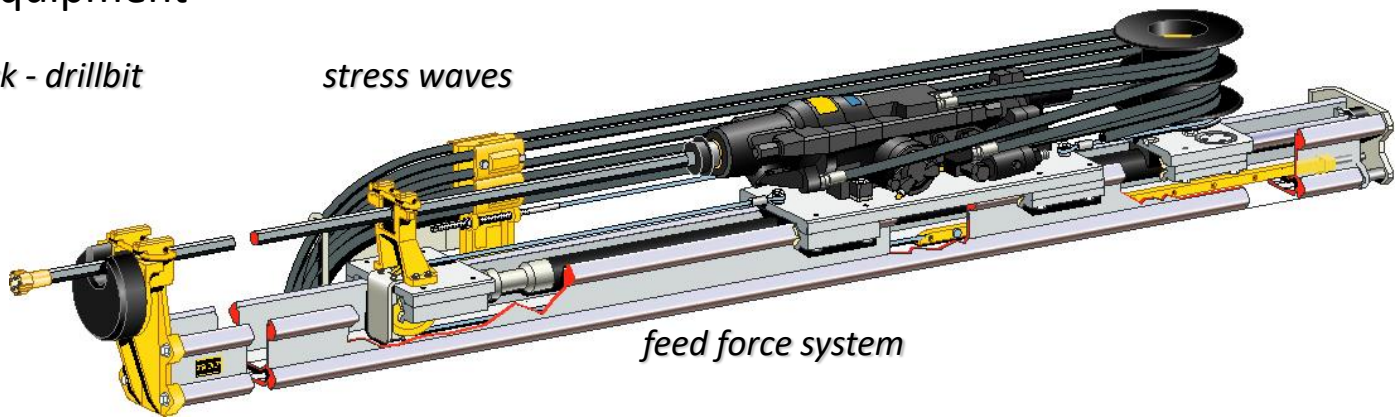
*rock drill systems*

*supply system*

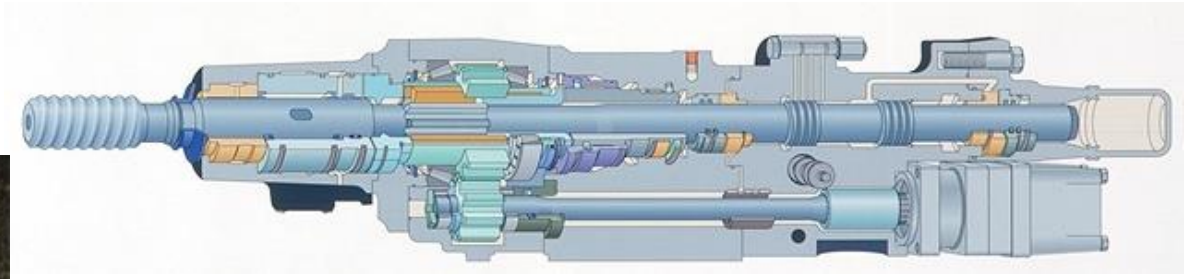
*rock - drillbit*

*stress waves*





*feed force system*

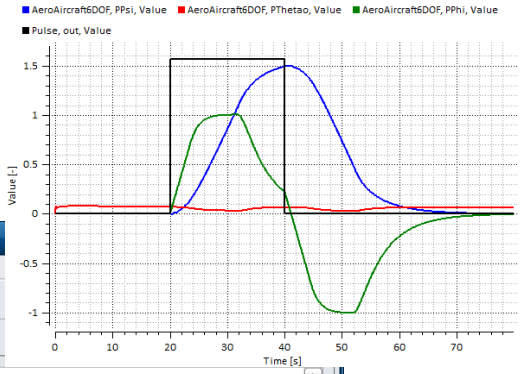


*stress wave*

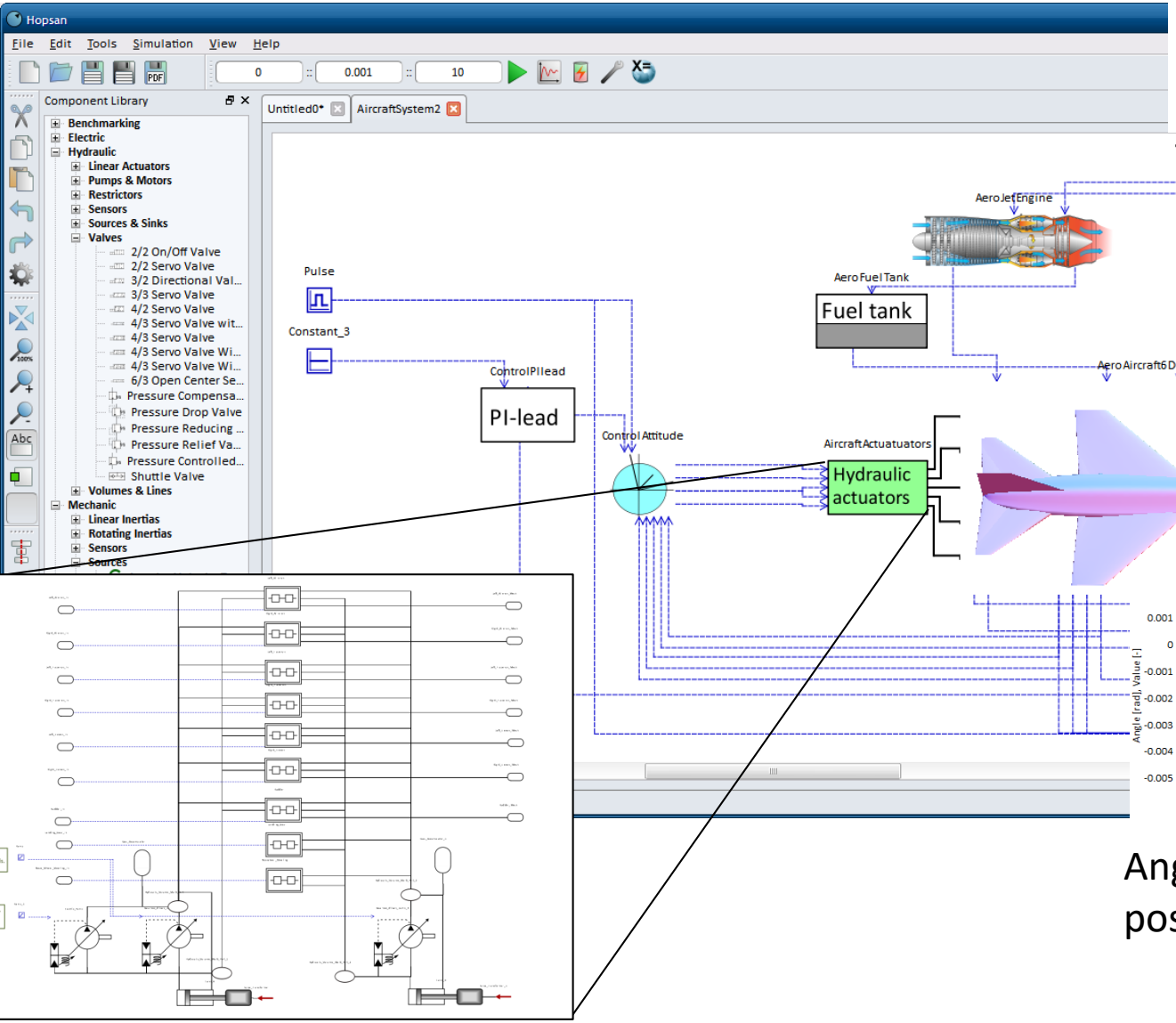
*rotation*

*feed force tranfer and damping*

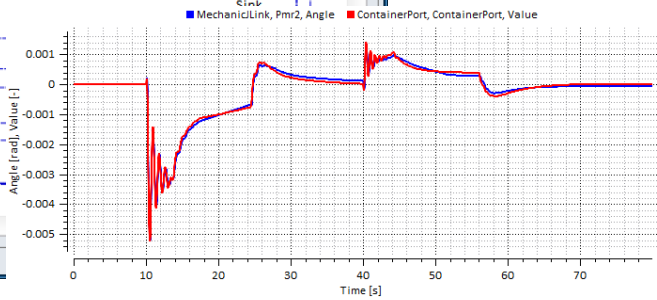
*percussion*



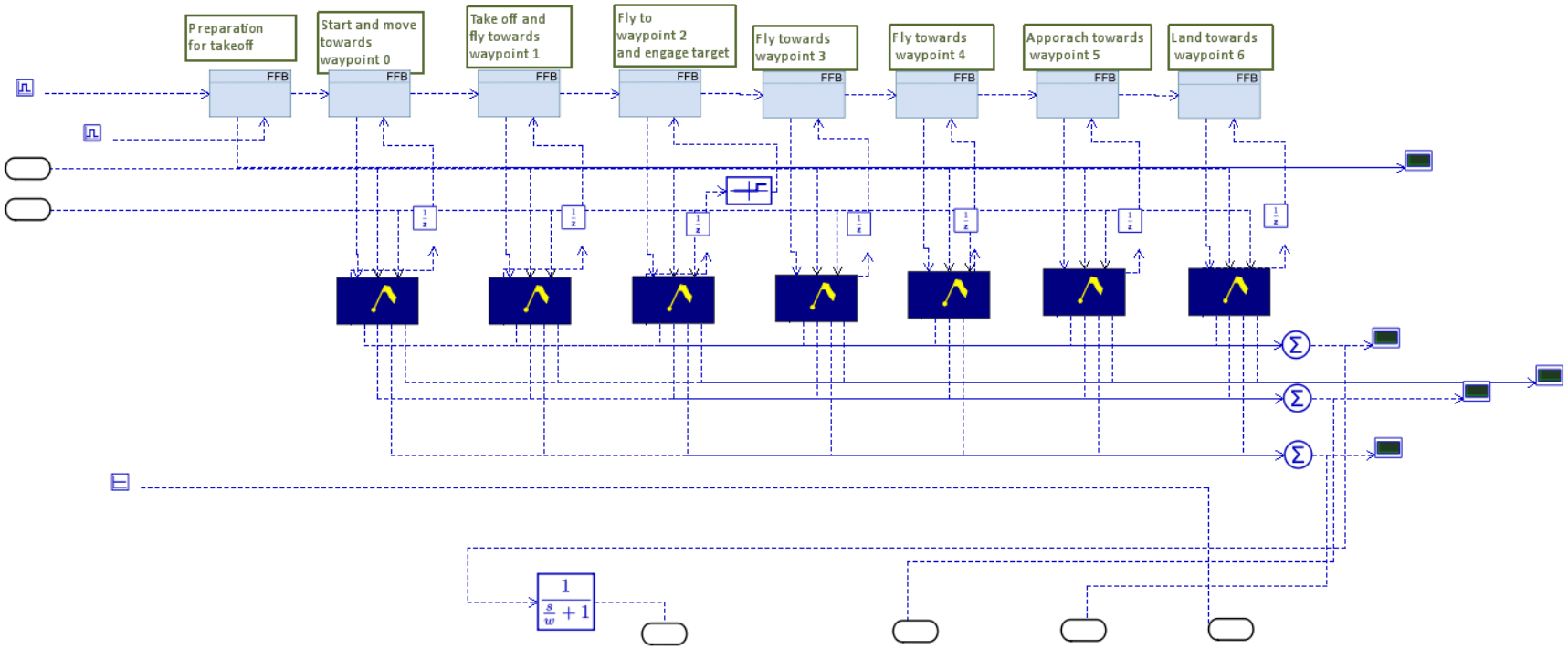

The aircraft attitudes during an S-maneuver.

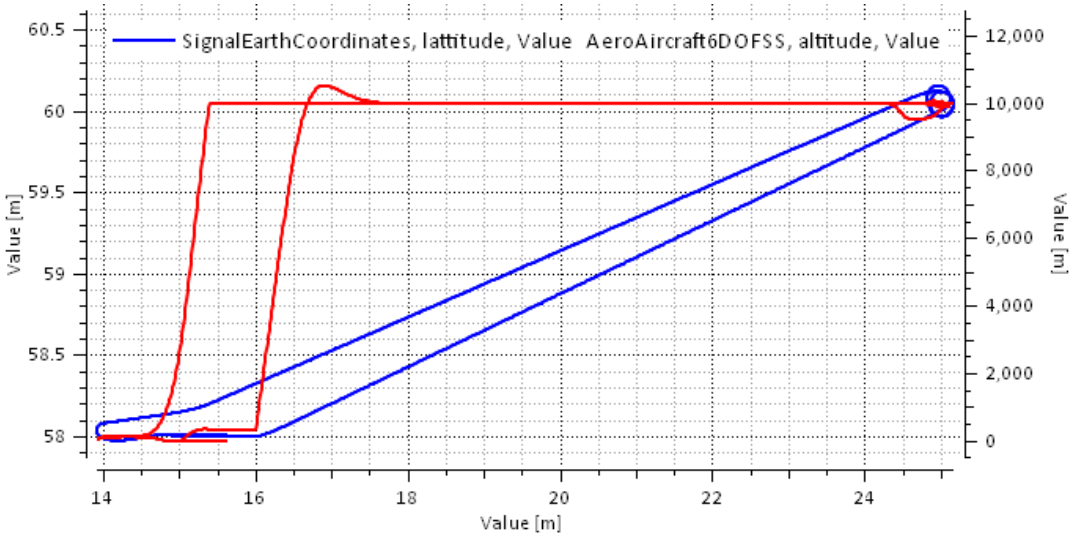




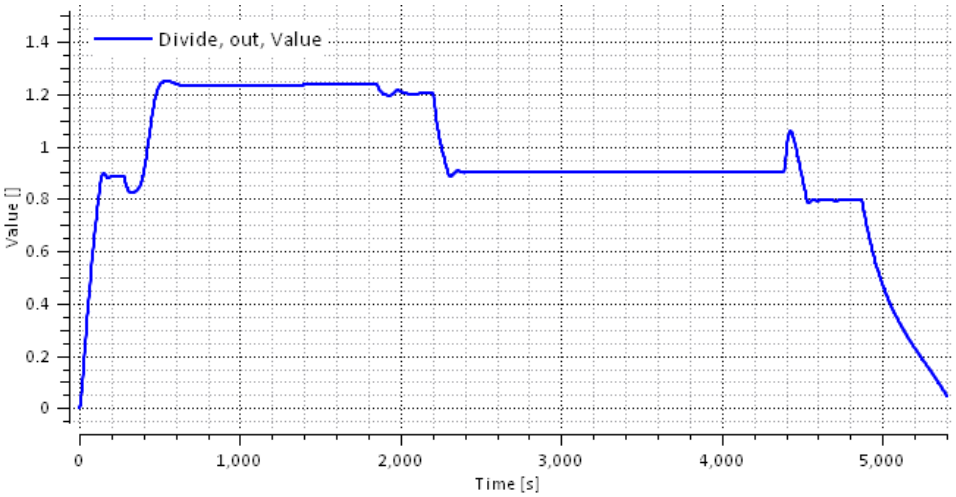




Angular position and reference position of the rudder actuator


Preparation for takeoff
Start and move towards waypoint 0
Take off and fly towards waypoint 1
Fly to waypoint 2 and engage target
Fly towards waypoint 3
Fly towards waypoint 4
Apporach towards waypoint 5
Land towards waypoint 6
FFB
$\frac{1}{z}$
$\frac{1}{\frac{s}{w}+1}$



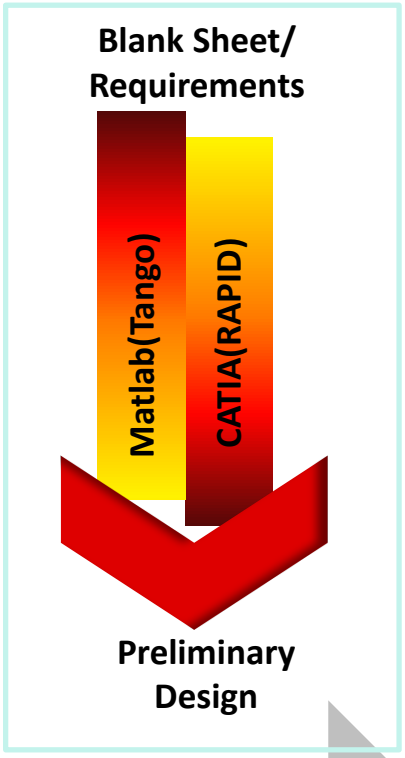

Flight trajectory

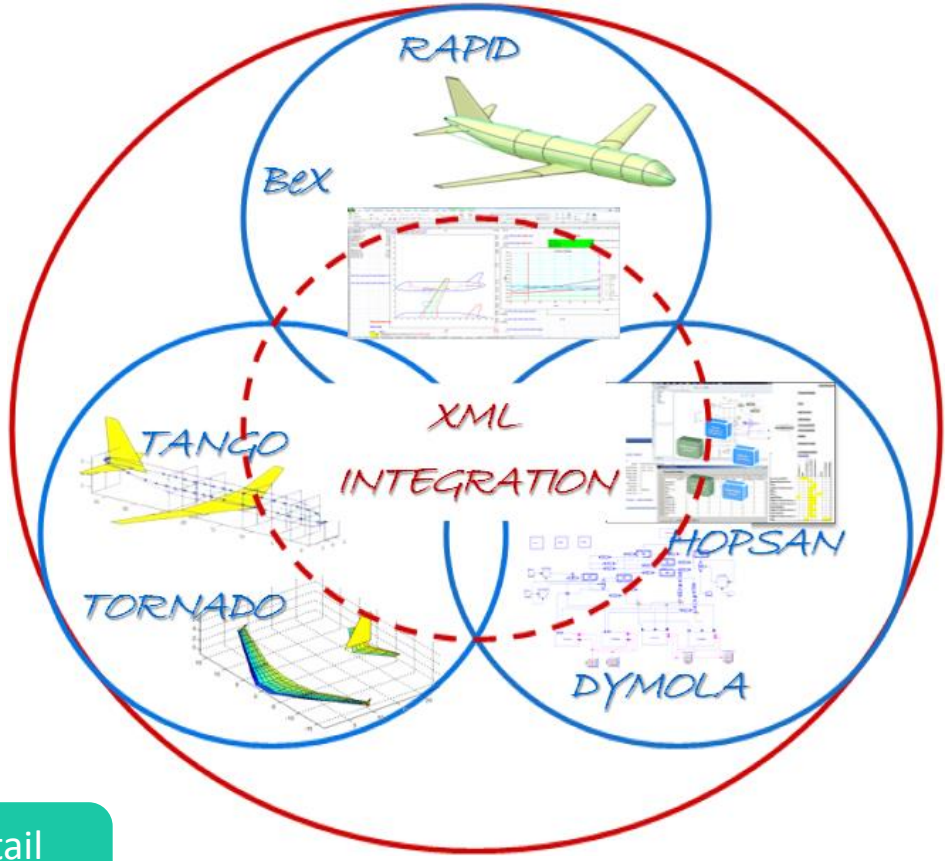


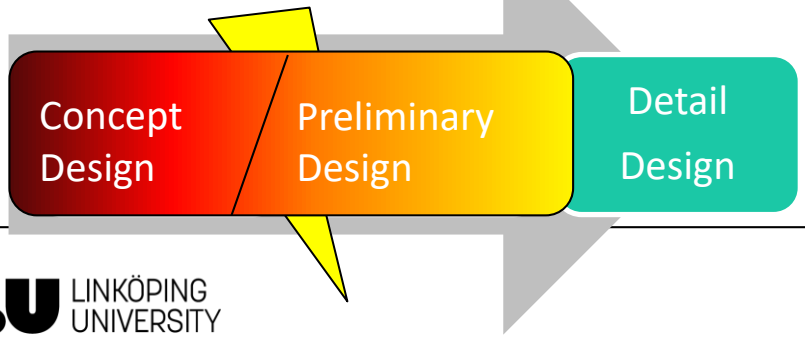

Velocity profile

Simulation time 5400 sec in 24 seconds
216 times real time
(73 times real time including actuation system)

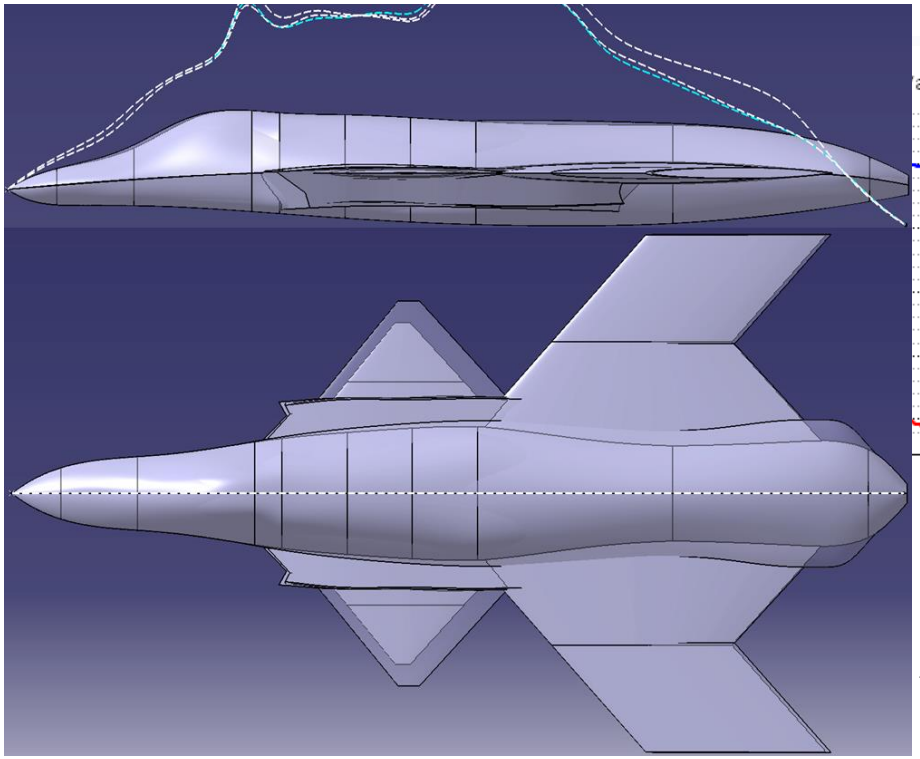
# CADLab: Conceptual Aircraft Design Laboratory

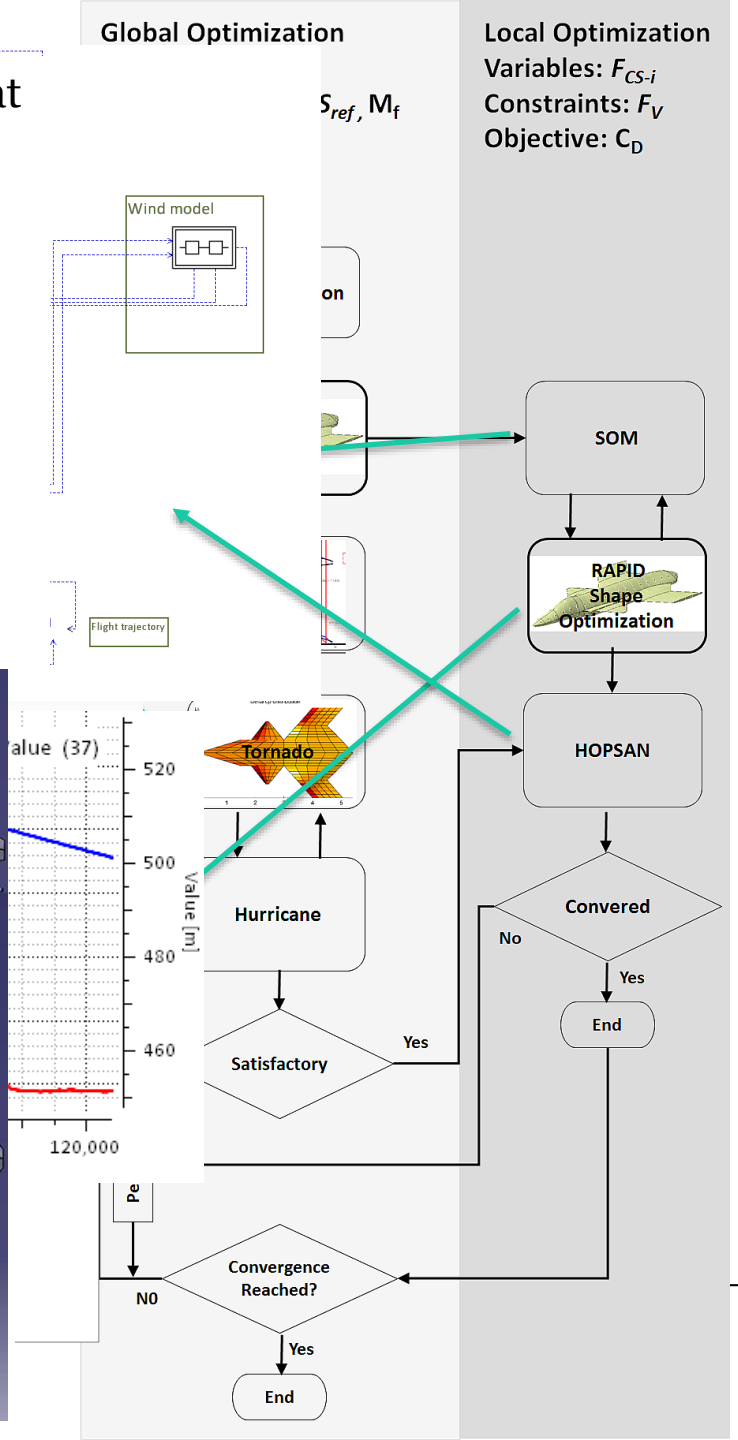


- The geometry is first minimized manually at the engine location to reduce the drag and start with a design closer to the solution.
- Optimization is performed using NSGA-II with 40 individuals and 50 generations.
- The design Mach number of 1.3; the wave drag for initial and optimized geometry are 0.272 and 0.2406.
- MTOW initial -6051, Final -6894





# Model Based Systems Engineering

- Closing the design loop with modelling and analysis, e.g. through simulation.
- Simulation model is used as the basis for design optimization and for design analytics
  - Robustness and sensitivity analysis
  - Methods for experimental validation