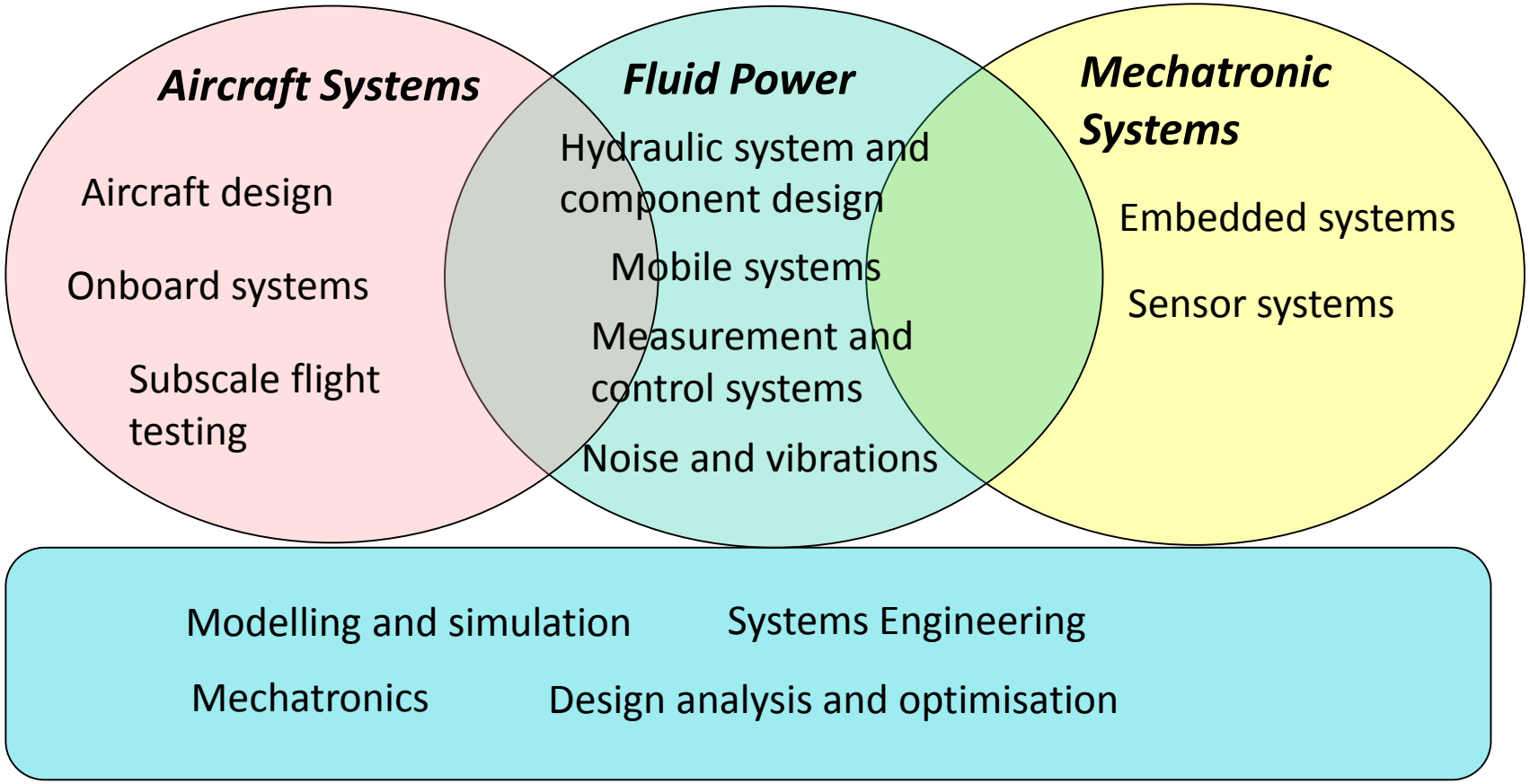
Fluid and Mechatronic Systems

Petter Krus
Division of Fluid and Mechatronic Systems
Department of Management and Engineering

LINKÖPING UNIVERSITY

Flumes Activities



Some Industrial Partners and Applications

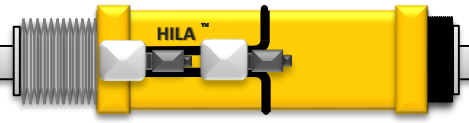
Aircaft
Saab AB

Hiab, Sunfab etc

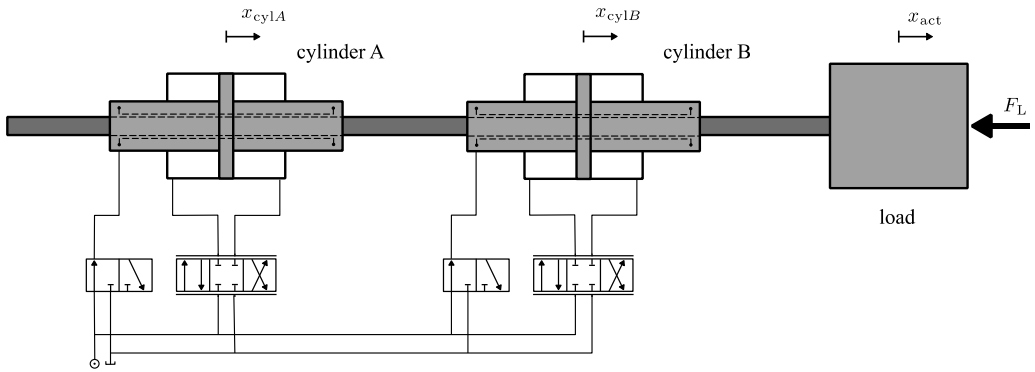
Construction Machines
Volvo CE

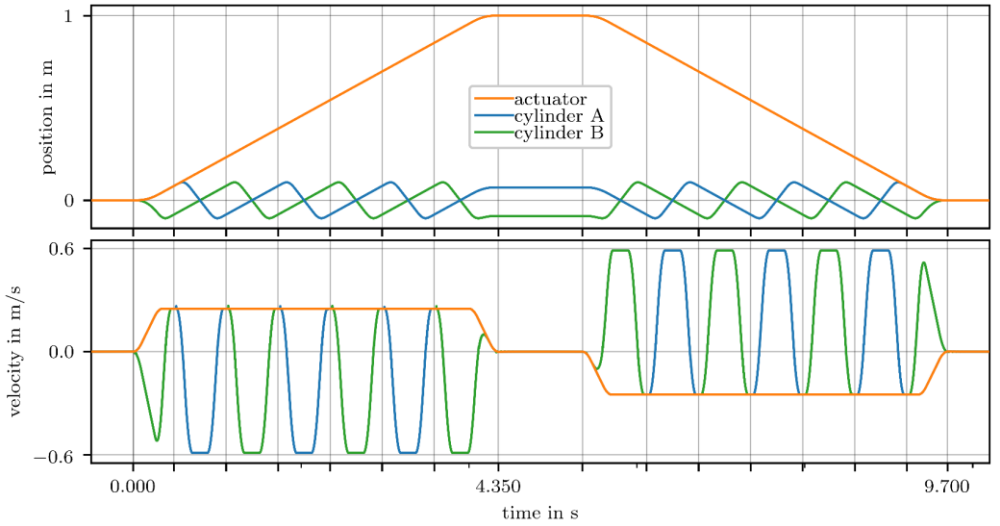
Rock drills
Epiroc (formerly Atlas Copco)

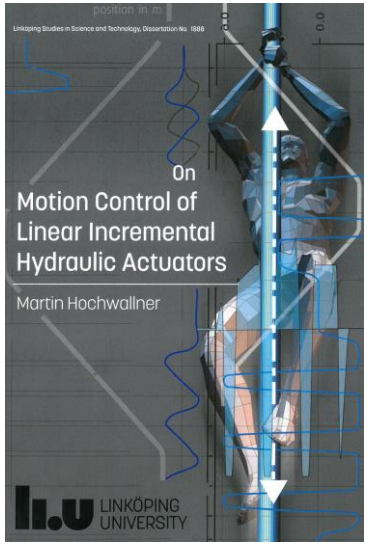
Martin Hochwallner
Magnus Landberg

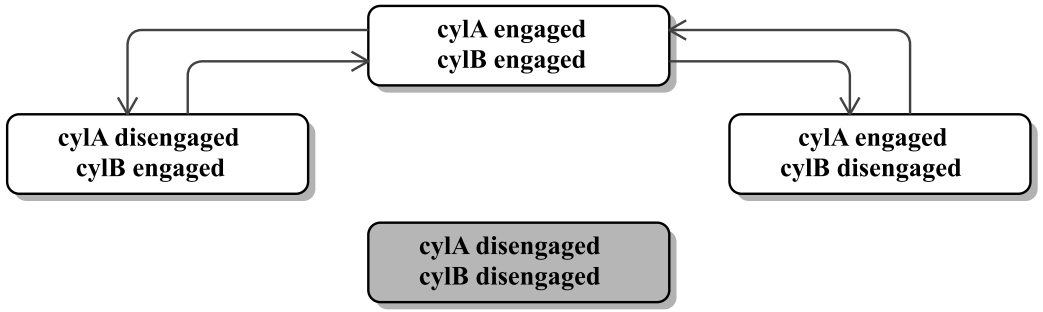


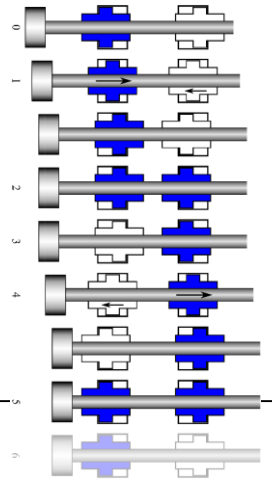
Linear Incremental Hydraulic Actuator





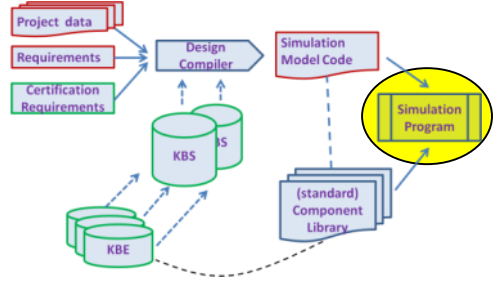


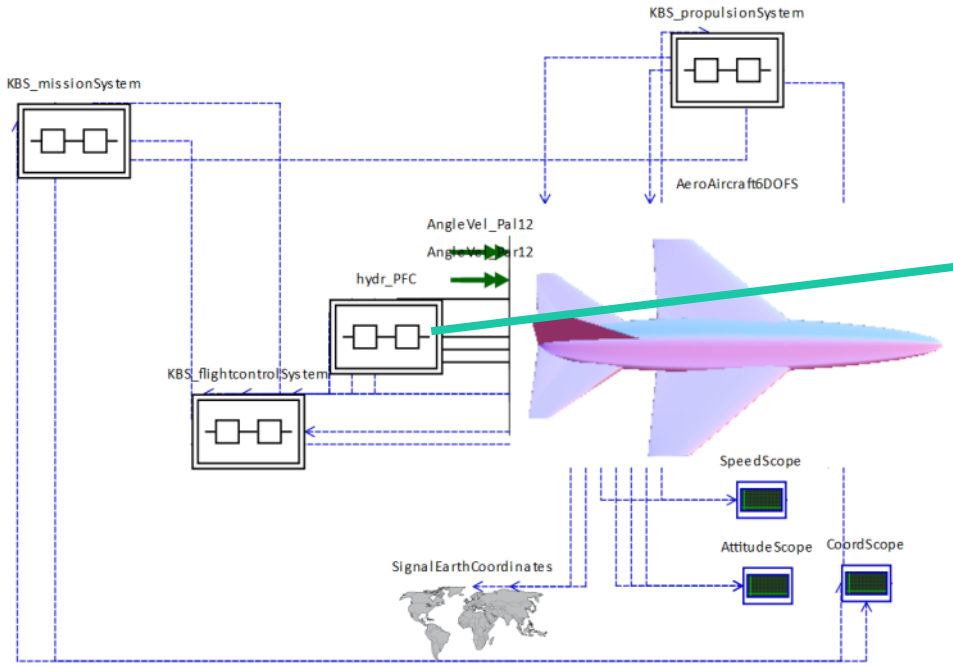


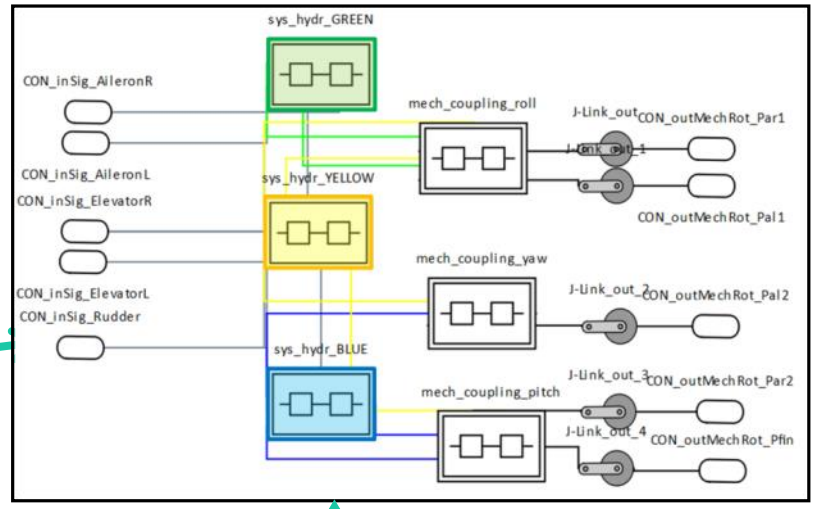


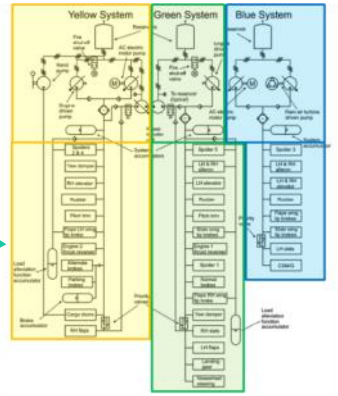
Ingo Staack

KBE for System Definition

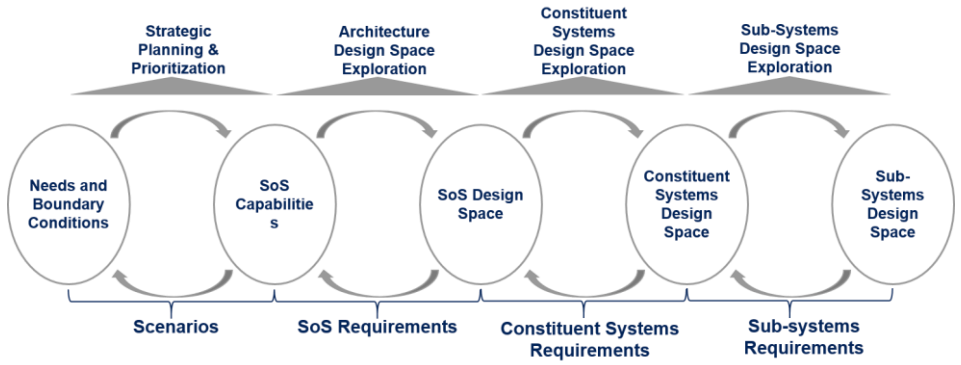




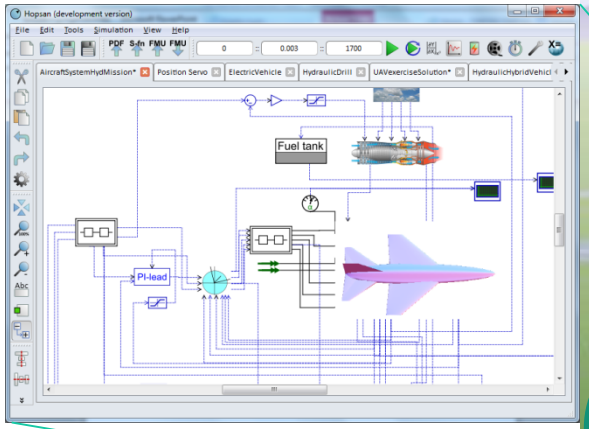


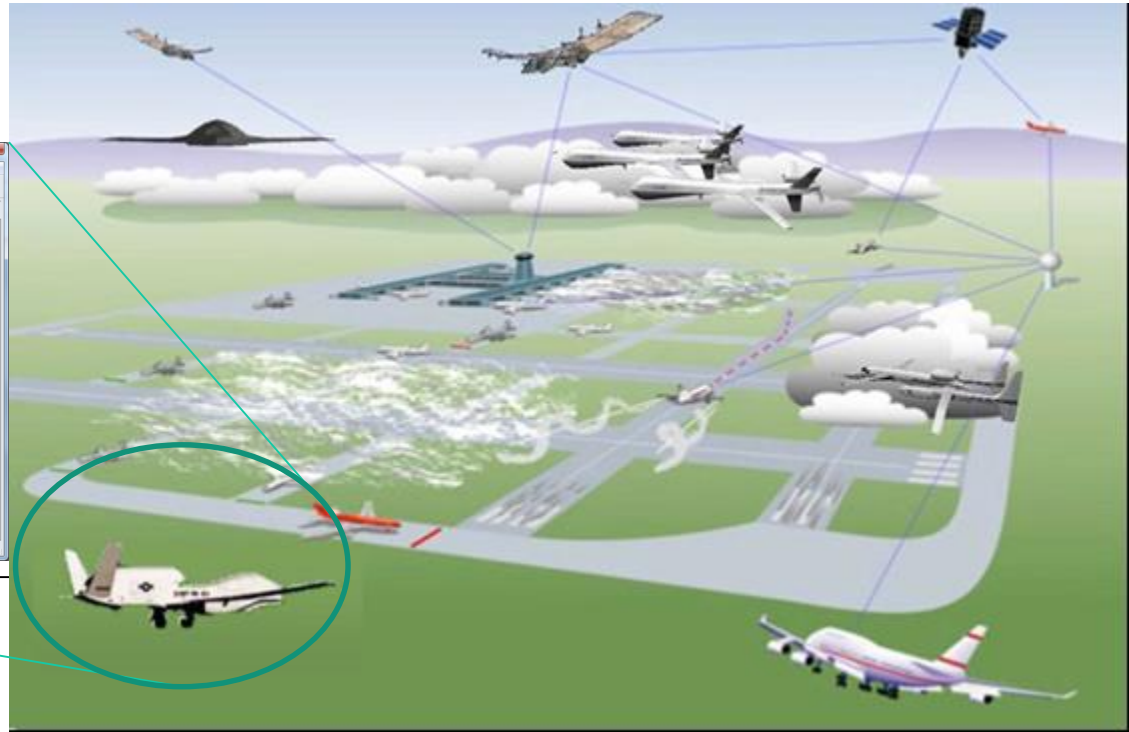


Systems of Systems Engineering



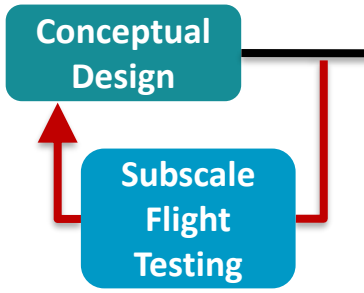
Ontology for SoS

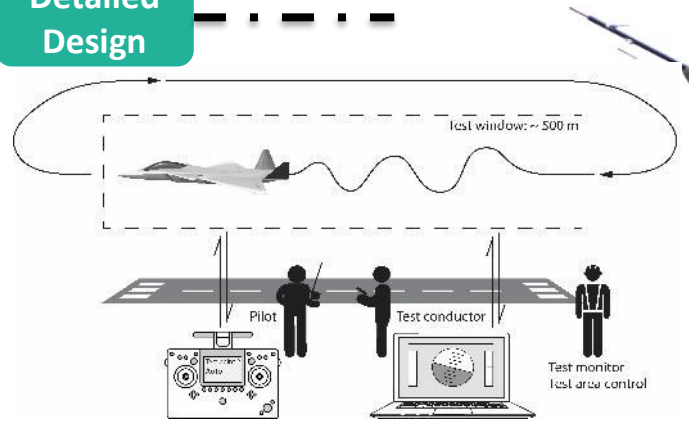




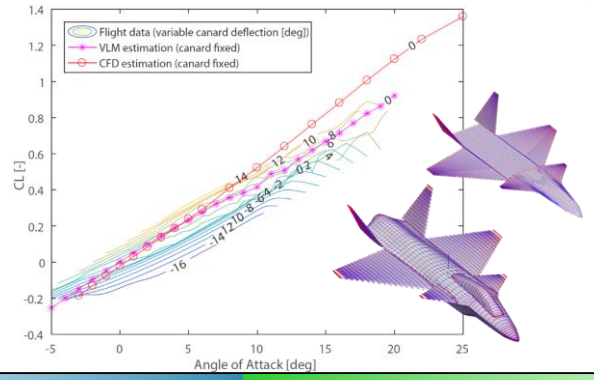
Subscale Flight Testing in Aircraft Conceptual Design

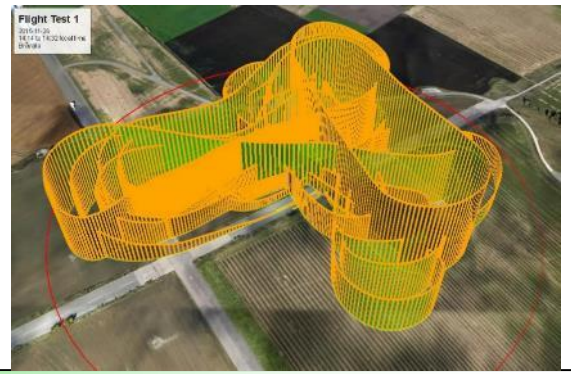
MSDEMO: Methods for subscale demonstration and control law testing
MESTA: Methods for subscale flight testing and analytics





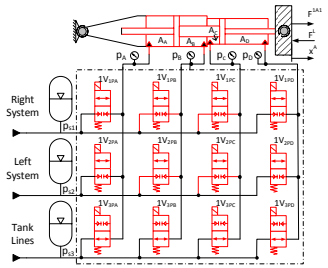
Scale	**13 %**
Length	**2,4 m**
Wingspan	**1,5 m**
TOW	**18,5 kg**
Propulsion	**Jet 160 N**



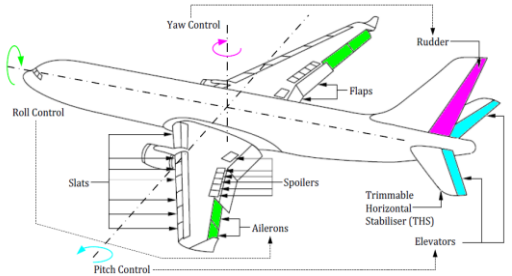


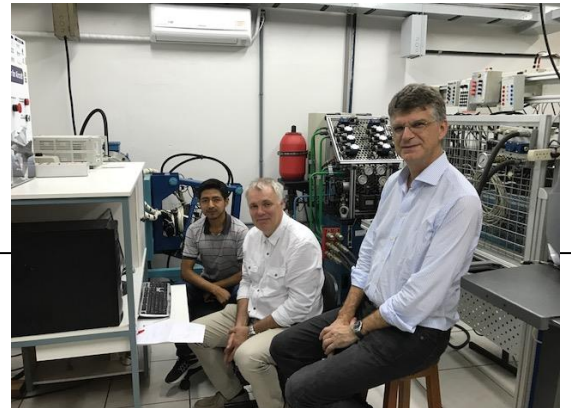
LINKÖPING UNIVERSITY
SAAB

Aircraft Actuators, UFSC, Brazil



- **Research Projects:**
  - Development of innovative hydraulic systems with increased energy efficiency for aircraft onboard systems
  - Sandwich PhD/ Abroad (SWE) (CNPq/CISB/SAAB calls)
    - **Cristiano Cardoso Locateli**, March to September, 2014
    - **Henri Carlo Belan**, October, 2014 to February, 2015
    - **Marcos Paulo**, Jan-July 2018.
    - **Lie Pablo Grala**, 2016
  - Call of Innovation Projects CISB 02/2014 - Support for International Missions
    - **Victor J. De Negri,** March 16 – 20, 2015
  - Call of Innovation Projects CISB 02.2015 - Senior Researcher Scholarship
    - **Victor J. De Negri,** February 01 to March 02, 2015



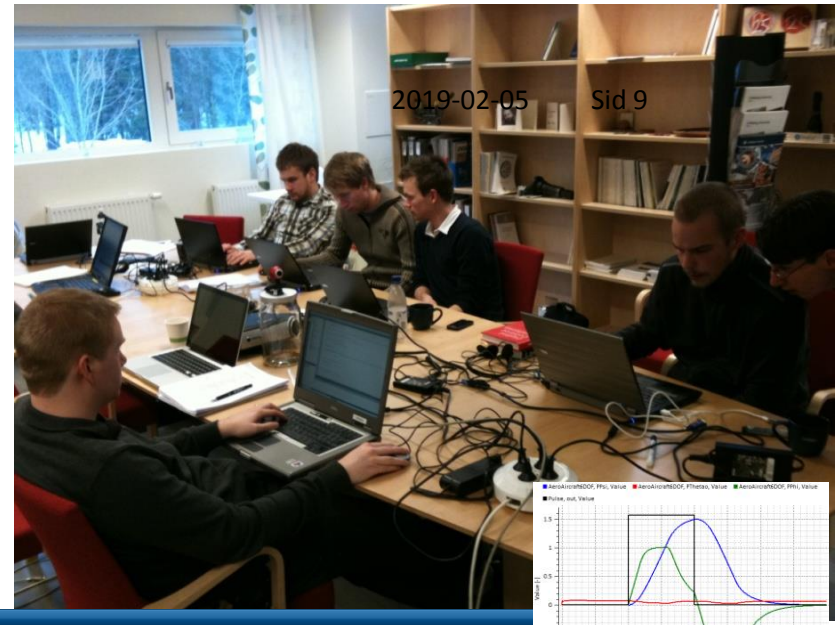


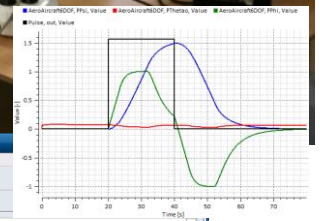
System simulation, Hopsan

- 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

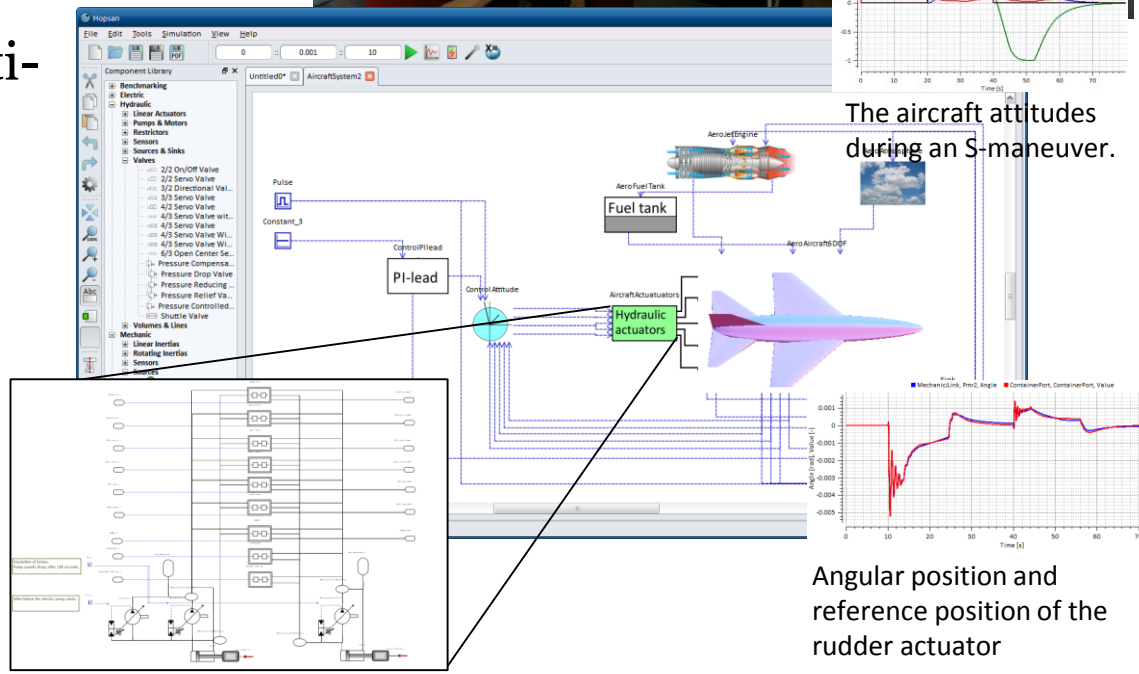
$$p_1(t) = p_2(t - T) + \frac{T}{C}[q_1(t) + q_2(t - T)]$$

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





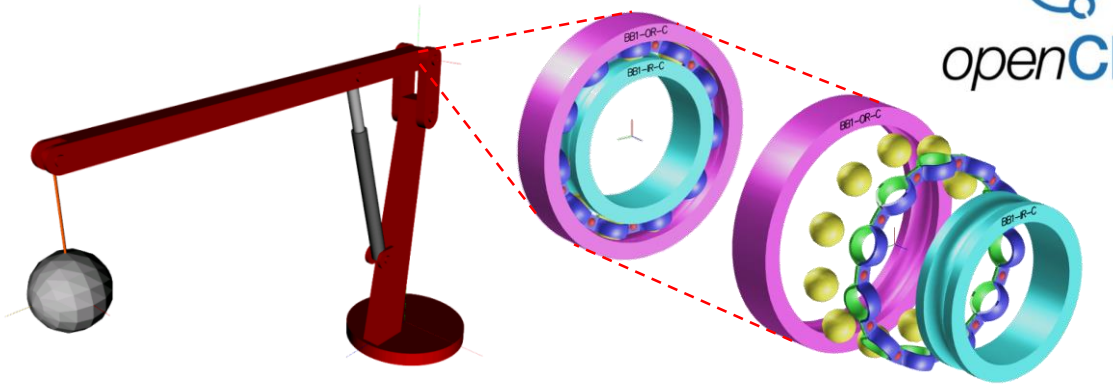
The aircraft attitudes during an S-maneuver.

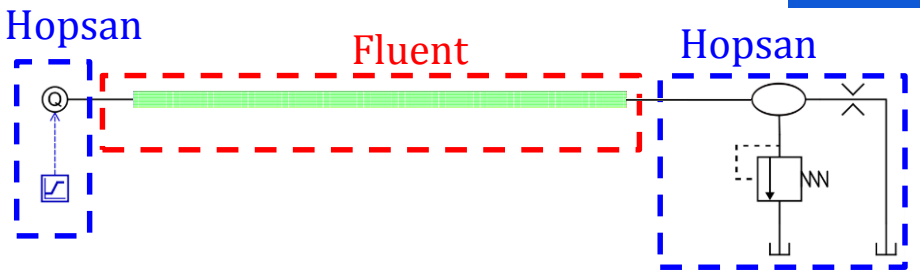


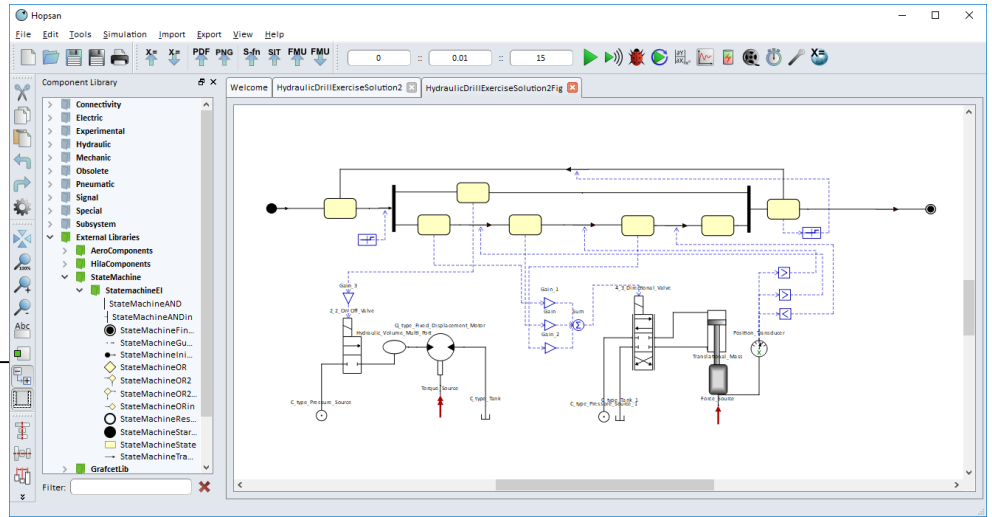
Angular position and reference position of the rudder actuator

Hopsan

- Open-source
- Pre-compiled components
- Connectivity:
  - FMI-support (import-export), Matlab S-function export.
- Build-in, Frequency analysis, Optimization etc
- Used by Epiroc (former Atlas Copco) and many SME, Used extensively in our courses.
- Statemachine library for hydbrid system simulation.
- Also library for Grafcet



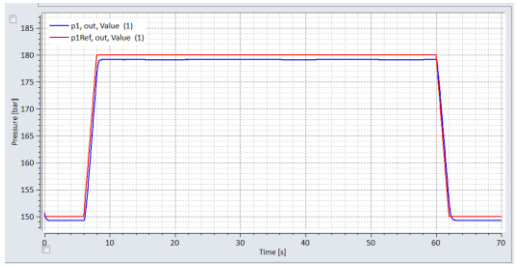


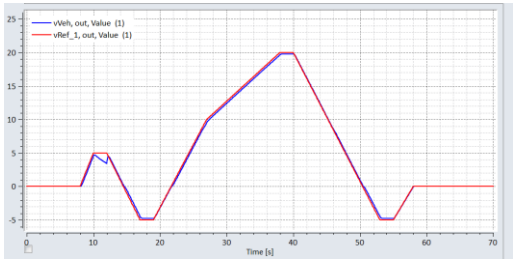


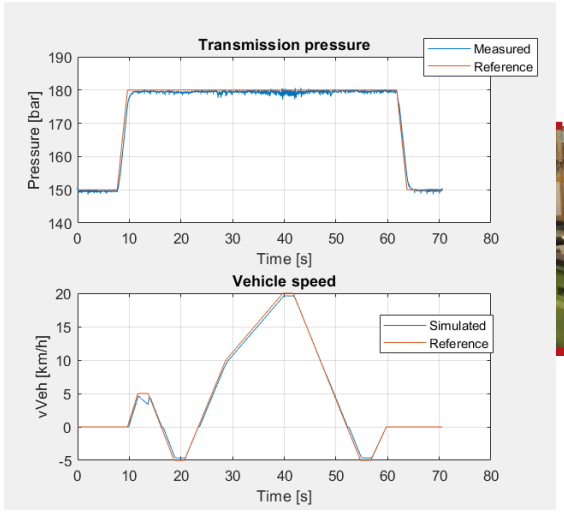
Viktor
Larsson

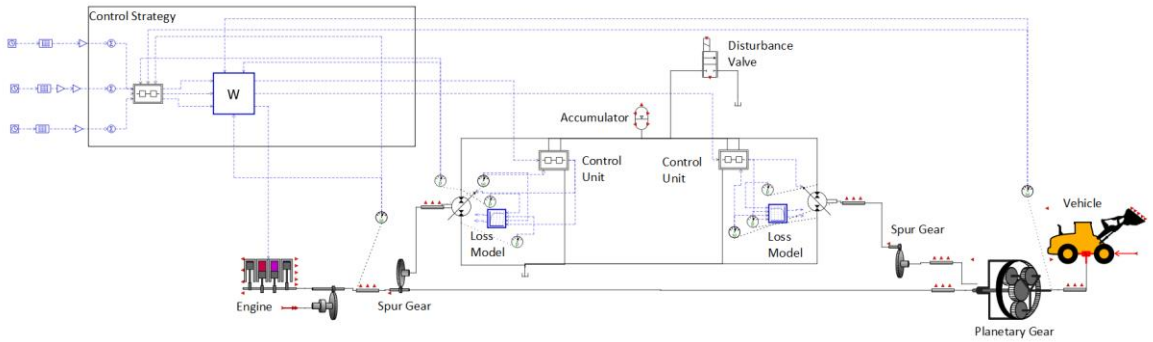
Simulation of Transmission

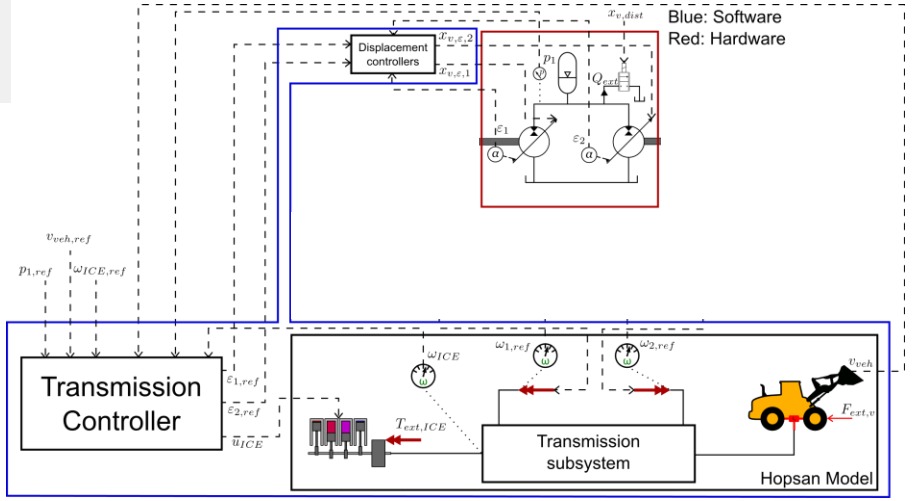
Hardware in the Loop Simulation



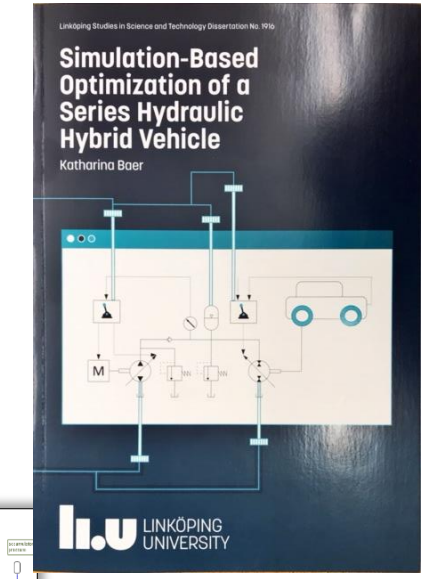


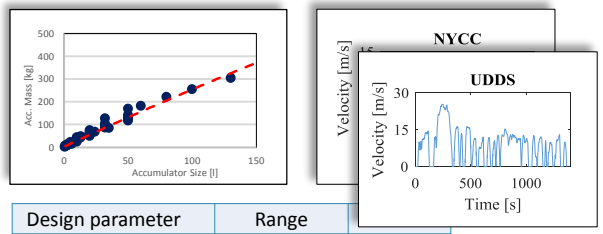






Simulation Based Optimization Methodology for Series Hydraulic Hybrid Vehicles (SHHV)

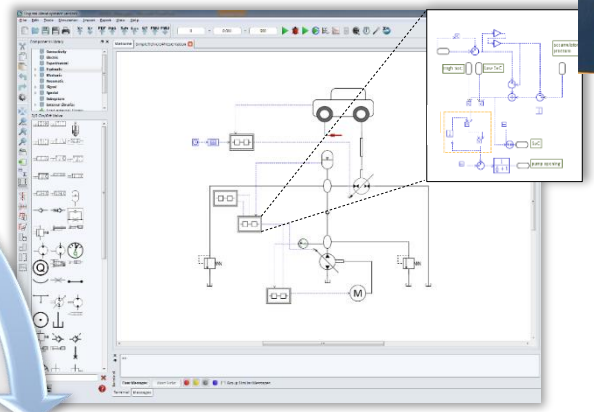




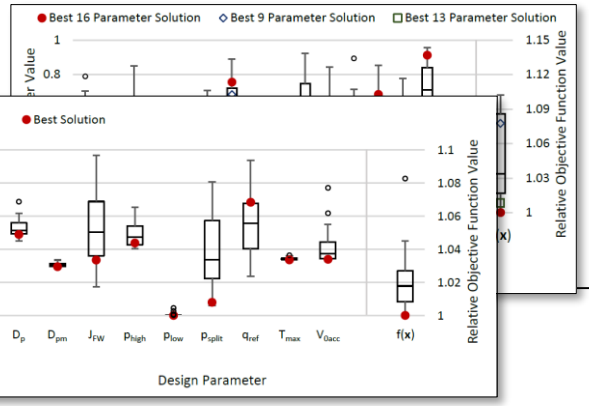
Design parameter	Range	
Pump size	25 … 250	cm^3/rev
Pump/motor size	25 … 250	cm^3/rev
Upper SoC limit	15 … 45	MPa
Lower SoC limit	12.5 … 44	MPa
Diesel engine size	75 … 400	Nm
Accumulator size	10 … 100	l

SHHV: parameters, application

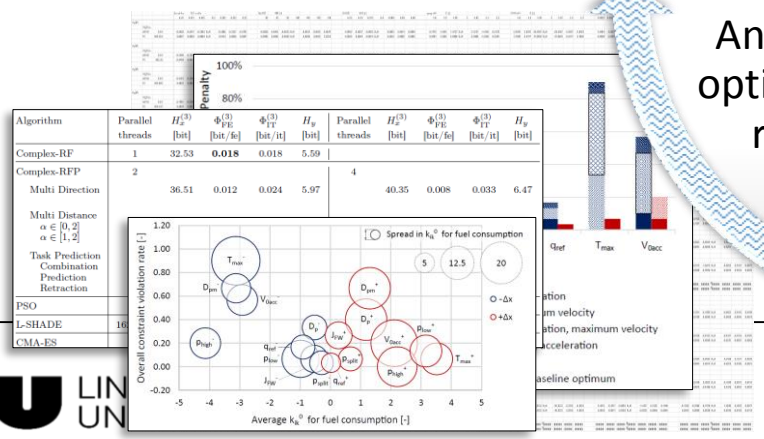
SHHV simulation model



Design optimization

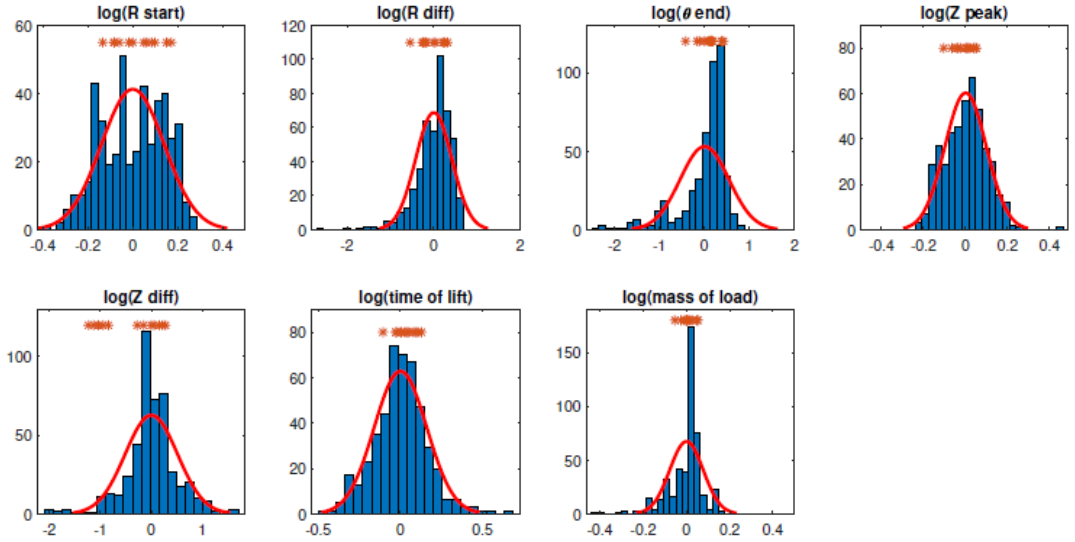


Analysis of optimization results



katharina.baer@liu.se

Drive Cycle Generation for Hydraulic Loader Crane Design



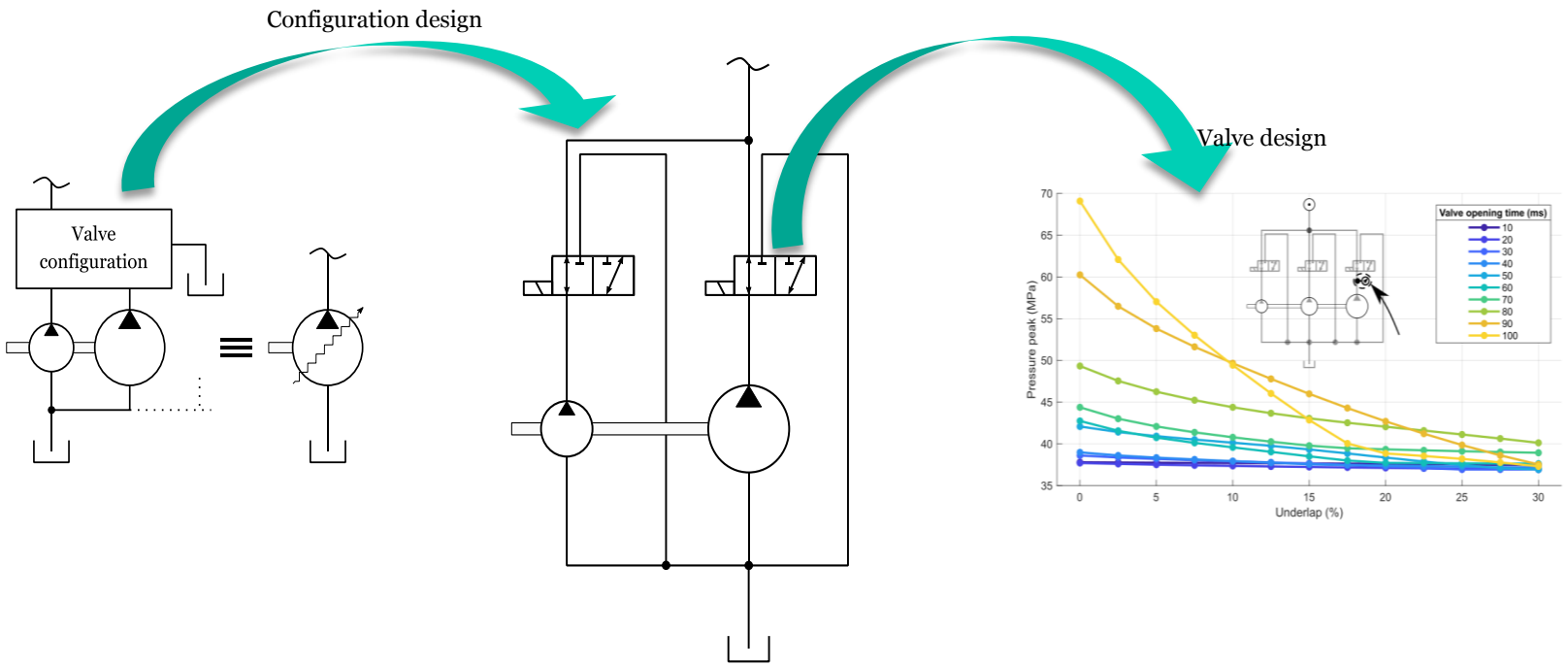
Electrified Hydraulics

Potential:

80% less energy consumption

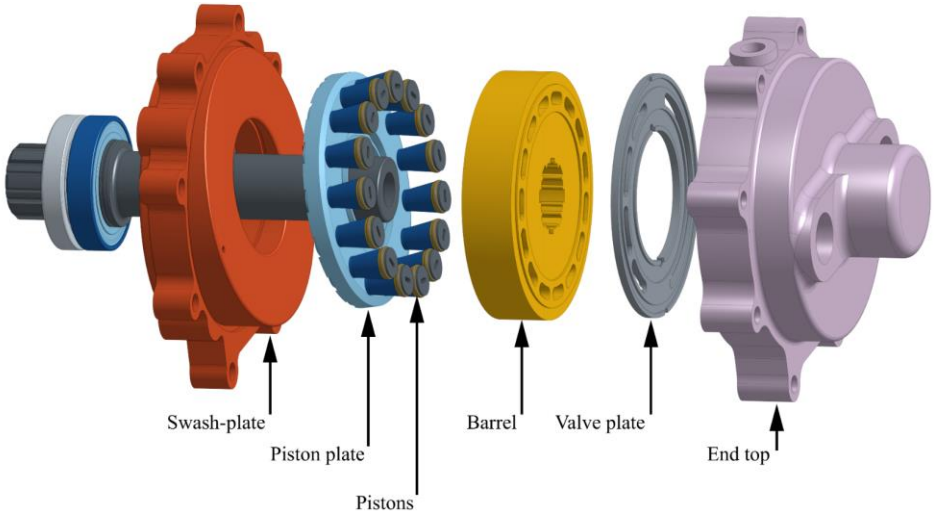
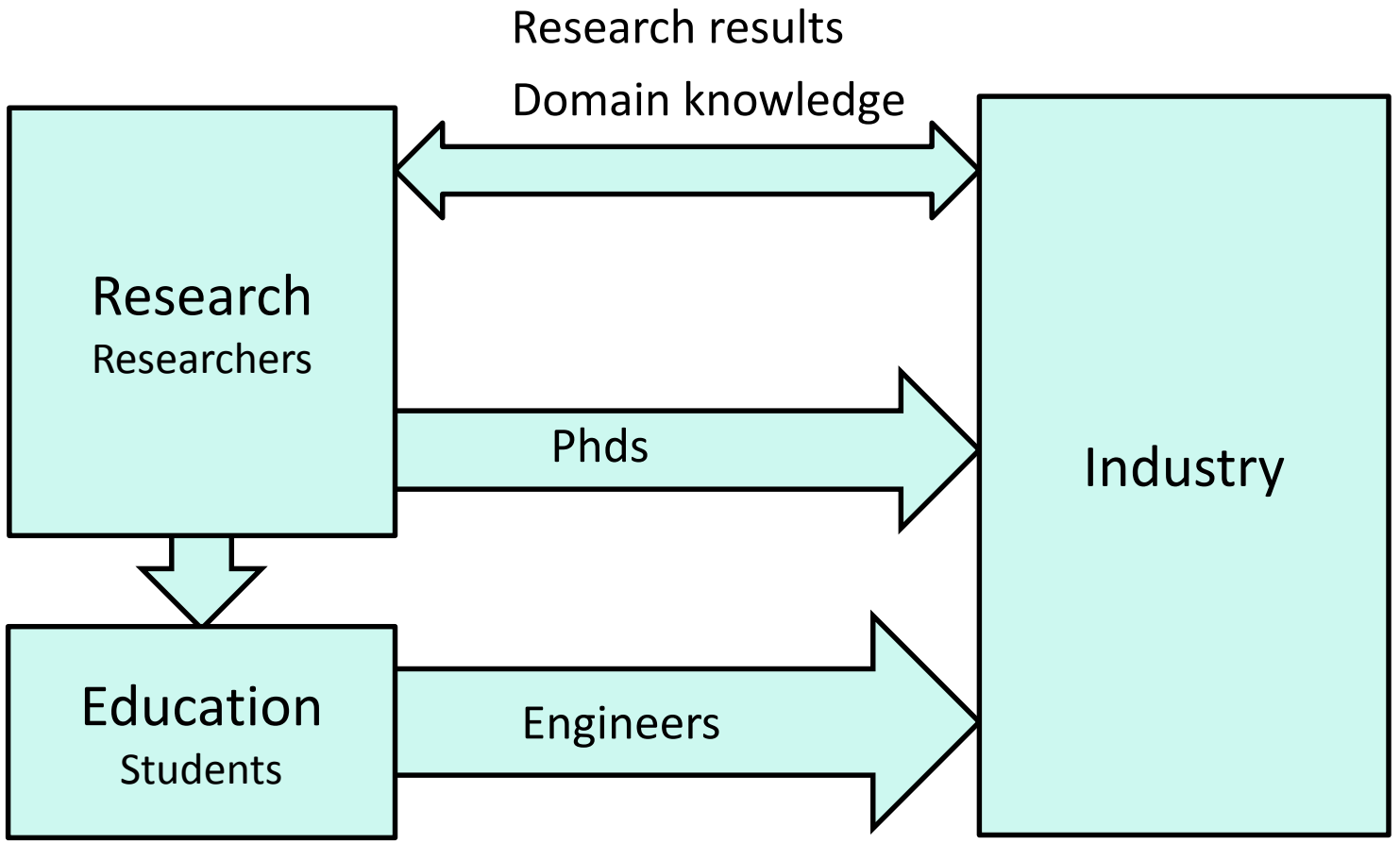
Around 8% fuel saving, overall.

Digital Pumps for Electrified Loader Cranes



Novel Fluid Power Pump/motor

- Cheap to produce
- Energy effective
- Low noise level



Applied University Research for the Generation of Excellent Engineers