Fluid and Mechatronic Systems
Linköping university

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Fluid and Mechatronic Systems
Linköping University, Sweden
Sweden 9.5 million people
Linköping Municipality 140 000 people
Linköping University 27 000 students
Fluid and Mechatronic Systems at Linköping University

One full professor and three assistant professors
8 PhD students

Systems that are characterized by a close coupling between:
  • Mechanical system
  • Power transmission/Actuation system
  • Sensors
  • Control System

This requires, *Multidisciplinary co-design*, i.e. Mechanical design and control system co-design where modelling and simulation are central
Fluid and Mechatronic Systems

Functions implemented in software

Functional requirements

Software design

Hardware design

Mekatronic product

Functions implemented in hardware
Hydromechanical Transmissions System Design

Implemented in Matlab/Simulink
Energy Efficient Mobile Hydraulic Actuation Systems

Project sponsored by Parker Hannifin-Hannifin, USA

Original Load Sensing system (LS) with closed loop controlled pump

Flow sharing system with open loop controlled pump
Conceptual Design of a Closed-Centre Power-Steering for Active Steering
Digital hydraulics

Multi-chamber cylinders

Digital valves

Discrete force spectrum
Electrohydraulic closed-center valves for enabling active steering and reduced energy consumption
A generic test rig
A physical steering gear is in the loop

- The conceptual design is in the software
- Fast servo valves simulates the behaviour of each conceptual design
HOPSAN-NG (Next Generation)

Bidirectional delay-lines
Modelica support is under development
Genuine team work
Freeware that can be downloaded from
http://www.iei.liu.se/flumes/system-simulation/hopsanng
Atlas Copco: Rock drill Simulation and Optimization using the HOPSAN simulation package

Atlas Copco has 45% of the world market in rock drill equipment.
Atlas Copco: Rock drill Simulation
Angular position and reference position of the aircraft during an S-maneuver. 

The aircraft trajectory during an S-maneuver.

Integrated Aircraft System Simulation

The aircraft attitude during an S-maneuver.
KBE for system

Knowledge modelling of aircraft hydraulic System
Technical Rediness Level

Technology Readiness Level (TRL) is a measure used by some United States government agencies and many of the world's major companies (and agencies) to assess the maturity of evolving technologies (materials, components, devices, etc.) prior to incorporating that technology into a system or subsystem. Universities belong on the lower end of the scale. Industry belong to the upper levels. There must be an overlap.
Volvo CE projects

Jonas Larsson

Volvo

Kim Heybrook

Karl Pettersson

LiU
Cross Fertilisation
System Optimization

With a good network methods developed in one area can be transferred to other application areas.

Simulation based optimization was implemented for hydraulic system optimization in 1991 at LiU Flumes.

Simulation based optimization in Hopsan is heavily used by Atlas Copco for Rock drill development.

Simulation based optimization was introduced for pump design with Parker.

System optimization was introduced in projects with ABB for industrial robots.
Oil hydraulics in Sweden

Sweden is a leading nation in hydraulics. The proportion of Swedish industrial hydraulics are among the highest in the world, more than three times higher than for the United States and Germany.

Sweden's successful exploitation of hydraulics has resulted in the Swedish company has taken a leading role in several industrial sectors where hydraulics is a key technology in the products. Several world leading Swedish company that manufactures hydraulic components and systems.

Hydraulics is currently used in the automotive, mining, paper / pulp and machine tool industry for aircraft, U-boats, trucks, tracked vehicles, construction equipment and forestry equipment.

Commodity exports are estimated at 100 billion SEK or 10% of the commodity value of Swedish industrial exports. Swedish hydraulics manufacturers have a significant market share (~ 5%) of the world market for hydraulic system of over 200 billion SEK.
The Potential of Fluid Power

The importance of oil hydraulic is due to its unique ability to produce large forces, with great control, and the ability to efficiently store energy. The market for hydraulic components and systems are expected to triple turnover to 1000 billion in the next 15 year period. Few technologies today can compete with hydraulics. In the United States Department of Energy estimated that the hydraulics and pneumatics industries account for 2-3% of energy

Aviation is responsible for about 2% a CO2 footprint
The Potential of Fluid Power, cont

Approximately 79% are losses. Technically it is possible to reduce them to 10%. The commercial "upside" is gigantic. R & D investment can quickly be made profitable by a major product diversification across many industry sectors.

The new innovative hydraulic system has already fulfilled many expectations. Caterpillar launched this year a new hybrid excavator (336EH) that saves up to 25% fuel by hydraulic recovery of braking energy of the swing movement. It pays back within a year.
Bridgeing the gap

Jochen Pohl had a PhD at LiU/Flumes in 2001. He then worked for another ten years as 20% assistant professor and 80% in his company. Co-supervisor of PhD students. Access to university network for informal discussions. Did control system that is licensed for "Volvo Dynamic Steering".

*The Epic Split - most watched automotive commercial on Youtube ever!! >72 million downloads*
Pesquisa Aplicada para Geração de Engenheiros de Excelência

Universidade

Conhecimento

Ensino
Estudantes

Pesquisa
Pesquisadores
Pós-graduandos

Resultados de pesquisas

Domínio do conhecimento

Mestres e Doutores

Engenheiros

Indústria