



Aalto University
School of Engineering

Electromechanical steering on frame-steered machine



Articulated vehicles: Frame-steering

Traction and maneuverability

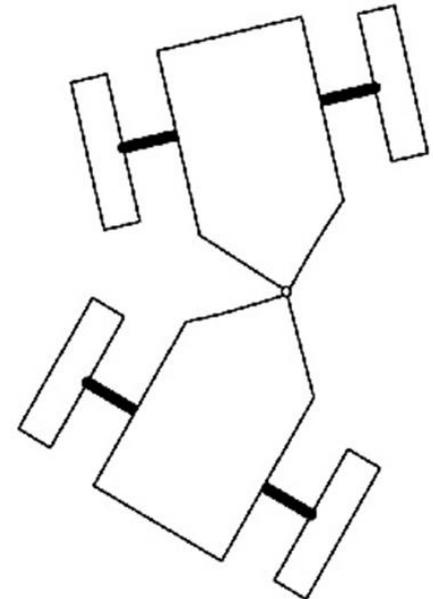
- ✓ Possibility to use large tires
- ✓ Tires track better
- ✓ High steer angles
- ✓ Vehicle control

Simple construction

- ✓ Cost effective
- ✓ Reliable
- ✓ More available space, e.g. hub transmission
- ✓ Orientation of attachments

Challenges

- ✓ Directional instability (jack-knifing) especially on higher speeds
- ✓ Risk of falling over



Electromechanical actuation: Motivation

Controllability & accuracy & sensitivity

- ✓ Very soft and slow movements are also possible for drivers demand or tasks
- ✓ Self straightening is to be implemented in all loadings and driving situations
- ✓ Steering degrees can be adapted by driving speed and direction
- ✓ Steering speed can be adapted as function of turning angle

Construction

- ✓ Perhaps more flexibility by programming vs. valve blocks
- ✓ Lower maintenance requirements
- ✓ Environmentally friendly, less local emissions
- ✓ Build in self diagnostics, beside can analyze and provide other parameters based on steering forces
- ✓ Higher operational safety, for example dangerous steering actions preventing

Engineering parameters

Original one hydraulic cylinder

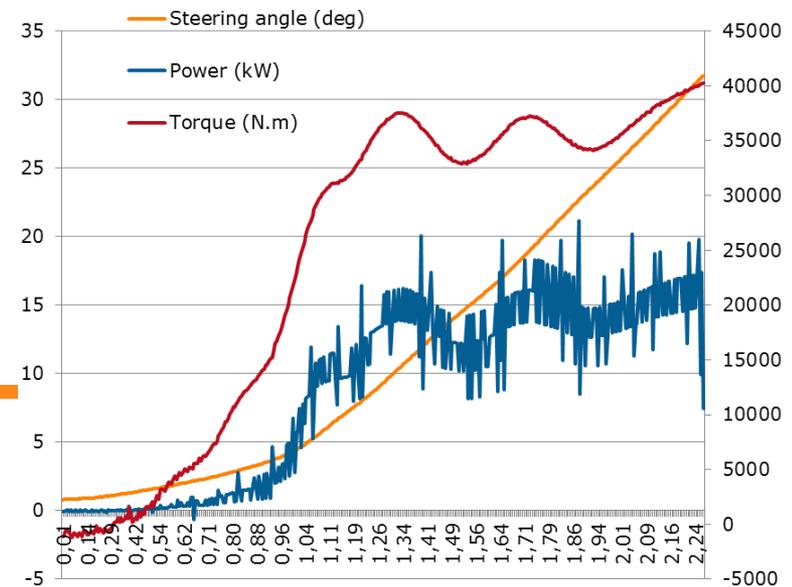
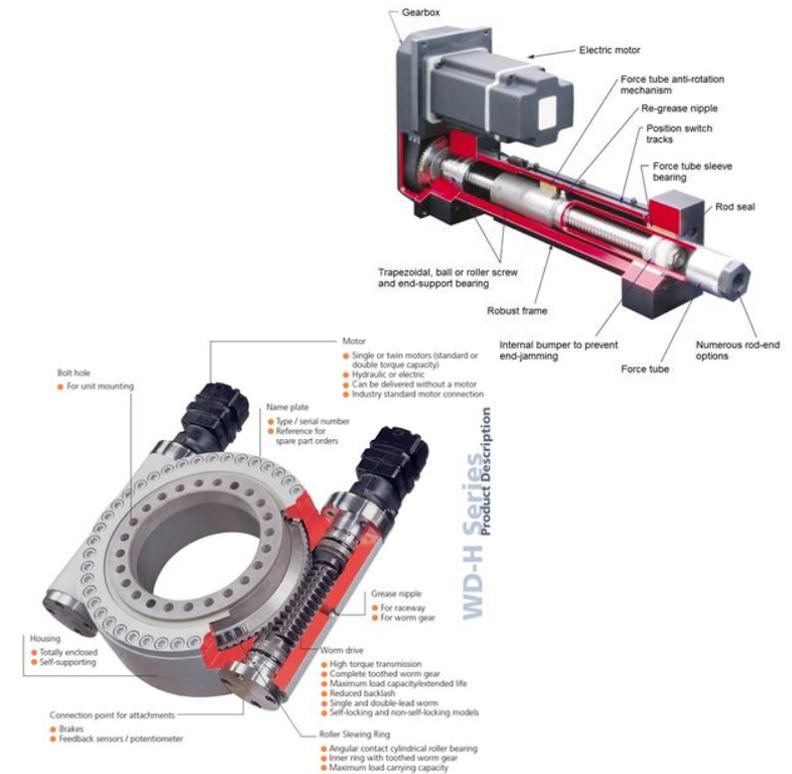
- ✓ Max power 20Kw and average 15Kw
- ✓ Max torque: 43kNm (as force 170kN)
- ✓ Max steer speed: 140mm/s = 2,3s

Challenges for electromechanical

- ✓ Shock/impact loading is a problem
- ✓ Force and power density
- ✓ Higher cost of acquisition
- ✓ High voltage on board

Concept evaluation solution purchased

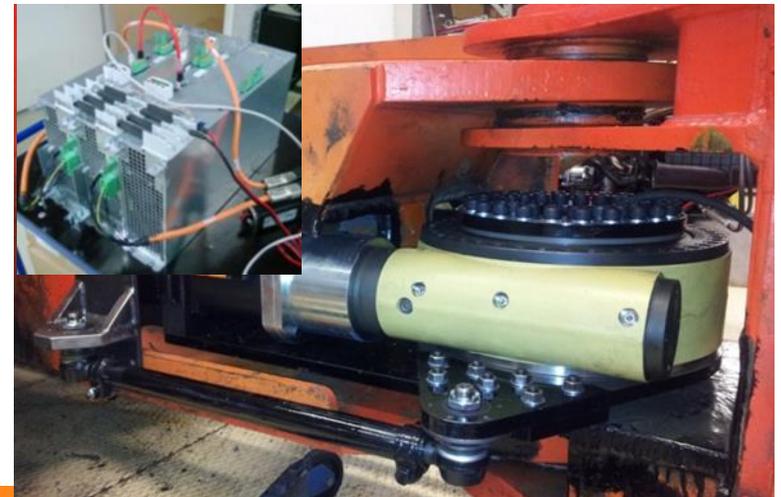
- ✓ Max torque 42kNm @ 4,92 rpm (2,6s)
- ✓ Weight of electromechanical unit 270 kg



Hardware

”Research by engineering”

- Electromechanical steering for the hybridization, Internship report, Pierre Cournout, 2010
- Electromechanical steering for an articulated mobile work machine, M.Sc. thesis Tuukka Lehtinen, 2013
- Retrofitting electromechanical steering on frame-steered non-road mobile machine, M.Sc. thesis Juha Muhli, 2013
- Control Strategy work, Ferdý Kusumach
- Instruction and guidance work by Teemu Lehmuspelto and Panu Sainio supported by Aalto mechanics



Summary and future opportunities

Key findings of the research

- ✓ Electromechanical steering for frame steered machine might work out
- ✓ It even fits to existing frames with performance very close to on market solutions

How can these results benefit participating companies?

- ✓ This helps to reduce energy used today for hydraulics and amount of oil on board
- ✓ This enables hydraulics to be used only for bucket movements, i.e. no need for constant oil flow for steering → less cooling because hydraulic could be used more like on demand bases

What could be the application areas or new businesses arising from this research?

- ✓ Automation and remote control of machines will become much more common. Electromechanical steering is one technology to enable no-driver-on-board or even robotized work machines