



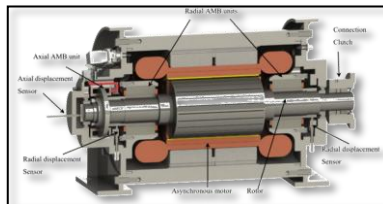
ORGANISATION PROFILE

University of Oulu – Machine and Vehicle Design (MVD), Finland

Personnel / size: Machine Design team led by Prof. Emil Kurvinen (17 persons), part of the MVD research unit.

Technical areas: Systematic multidisciplinary machine design; digital twins; CAD, FEM and flexible multibody dynamics; hydraulic valve modelling (PVG32, 4WRPEH directional control valves); physics-informed ML; state and parameter estimation (Kalman filters); fatigue estimation and structural optimisation.

Applications: heavy mobile machinery and rotating machines.



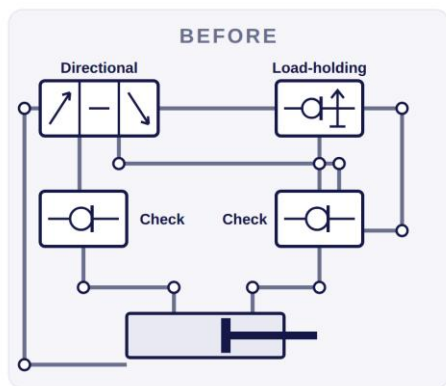
R&D project expertise: 5x Business Finland, 1 EUREKA (Xecs), 1 Horizon Europe and 5 ERDF projects

PROPOSAL INTRODUCTION (I)

Vision: A universal hydraulic valve for mobile working machines that adapts to the load cycle and replaces several separate valves. It is designed, simulated, 3D-printed, tested and cost-assessed in one framework.

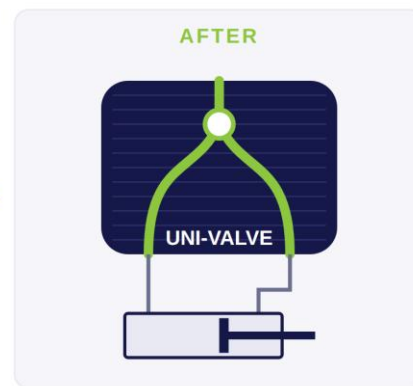
Motivation: Each hydraulic machine needs its own set of separate valves. This means more parts, cost, leak points, energy loss and spare parts. Traditional machining also limits the internal flow channels.

Content: From load-cycle requirements to a 3D-printed prototype tested on LEMMI **research platform for mobile machinery**



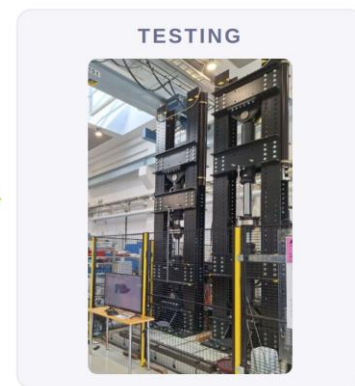
Conventional

Separate directional, check and load-holding valves



Proposed

Design, simulate and 3D-print (UOULU)



Validation

LEMMI research platform (Aalto)

PROPOSAL INTRODUCTION (II)

Expected outcome:

- A UNI-VALVE prototype, validated on an experimental test setup
- A digital twin-based design and simulation framework for 3D-printed hydraulic valves
- A cost model for manufacturing, operation and maintenance

Impacts:

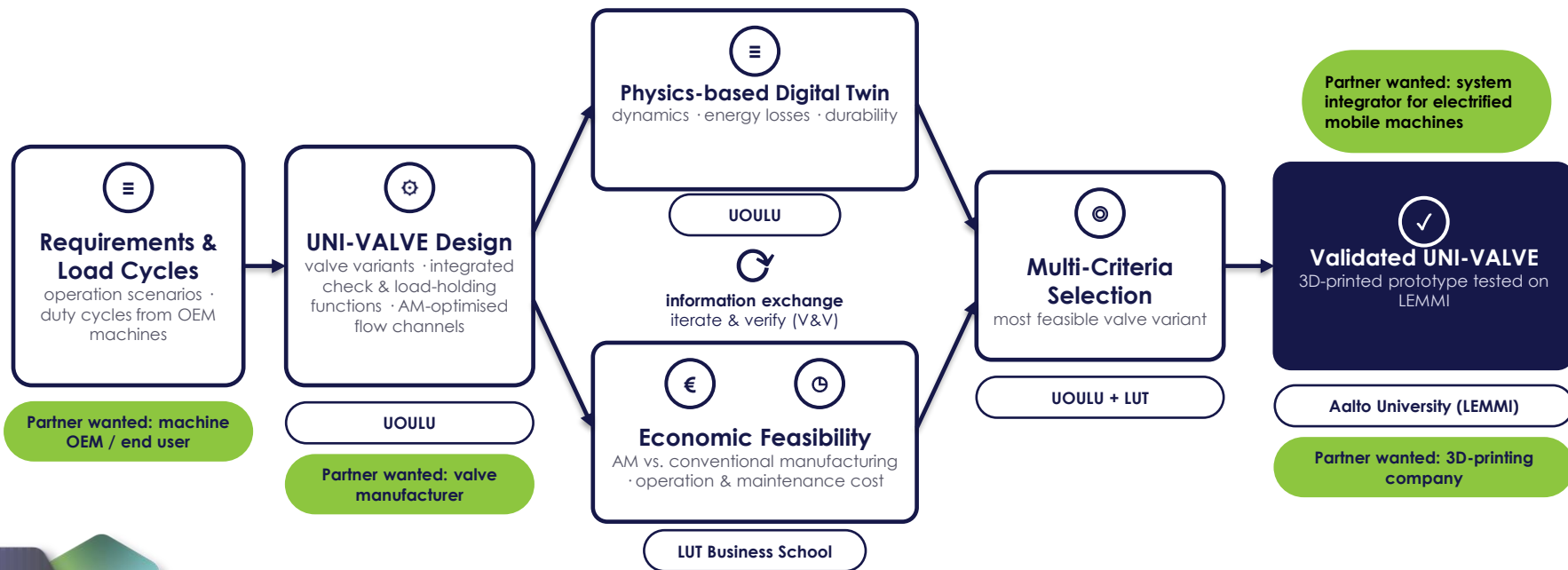
- One valve replaces several separate valves, such as check and load-holding valves
- Fewer parts, fewer leak points and simpler assembly
- Lower manufacturing cost and faster customisation with 3D printing.
- Lower energy use in mobile work machines.
- Physics-based digital twin, combined with AI, enables intelligent valves and self-adaptive control
- New business opportunities for valve manufacturers, 3D-printing companies and machine OEMs
- The method can be used for other hydraulic components and industries.

Schedule:

Proposed duration 36 months; target start Q3 2027.



VALUE CHAIN & COOPERATION



PARTNERS

Current Consortium:

- University of Oulu (Coordinator) – Faculty of Technology, Machine and Vehicle Design (MVD) research group
 - Valve design based on load-cycle requirements
 - Physics-based and surrogate modelling; simulation of valve and machine dynamics (digital twin)
 - Additive manufacturing of valve prototypes

Proposed:

- Aalto University – Department of Energy and Mechanical Engineering, Mechatronics
 - Valve testing and experimental validation on LEMMI (Large-scale Electric Mobile Machine Infrastructure)
 - Assessment of energy efficiency, controllability and performance under real-world work cycles
- LUT Business School
 - Cost comparison of additive vs. conventional valve manufacturing
 - Calculation of operation, maintenance and life-cycle costs; business case

Partner search: All Eureka SMART member countries

- *Hydraulic valve and component manufacturers*: UNI-VALVE design and industrialisation
- *Metal additive manufacturing companies and service providers*: 3D printing of valve prototypes
- *OEMs of mobile work machines* (forestry, cranes, mining, construction, agricultural, material handling): use cases and load cycles
- *Electrification, control or system integration partners*: intelligent control and machine integration

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