cetop

The Voice of the European Fluid Power Industry

European Fluid Power – Digitalisation for Mobile and Industrial Applications

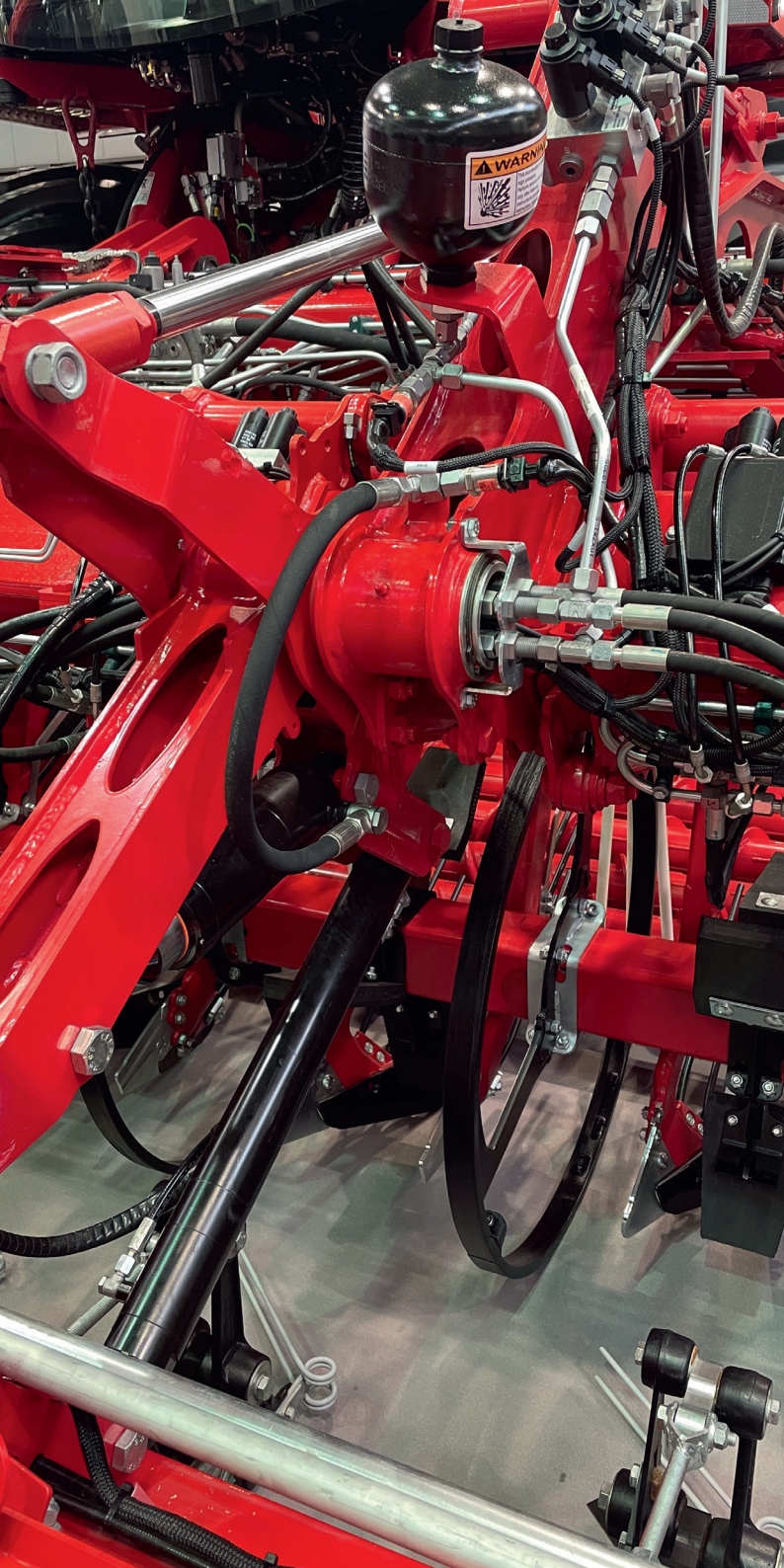
Fluid Power – Communicating in a Digital Network

Digitalized value chains require products and components that can communicate with each other reliably in all kinds of applications. This universal digital communication is a key task to successfully implementing Industrie 4.0.

Fluid power is capable of communicating in a digital network and of generating, processing and sharing data. With intelligent data analysis, it is possible to better monitor and steer processes and to control and guarantee product quality. In this way, economic and ecological advantages arise which can be attributed to increased energy efficiency as well as the optimal and flexible utilization of machines and plants.

Fluid power products are known for their high reliability and great power density. With the help of innovative digital solutions, operating costs can be reduced and precision increased. In addition, digitized, connected and intelligently controlled fluid power products make it possible for new products and services to be developed in user industries.

Together with academic partners, the European fluid power industry designs efficient technologies for the future. Some innovative solutions are presented hereafter.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FLUID 4.0

Dr. Steffen Haack
Chairman of the Board Bosch Rexroth AG
Germany

“The joint research project Fluid 4.0 brings together manufacturers and users of fluid power components and systems and digitalizes the processes necessary for the industry. ”

Digitalization is the method of choice to increase efficiency and productivity. Thus, information on the product life cycle of fluid power products and systems has to be exchanged in a digital dataspace. This enables industry to speed up development, optimize processes in operation, improve productivity, and save resources overall.
However, to date there has been a lack of approaches for cross-industry, machine-readable data provision and data exchange. This requires, among other things, a higher-level system instance that builds on the already well-developed infrastructure at component level and links it intelligently.
Based on suitable interaction concepts and automated workflows between manufacturers and users as well as in product hierarchies, data-based business models - especially on the topic of sustainability - can be established.
The Fluid 4.0 project is funded by the European Union (NextGenerationEU) and supported by the German Federal Ministry for Economic Affairs and Climate Action to enable cross-industry information exchange along the product lifecycle of fluid power products and systems.
Fluid 4.0 brings fluid power manufacturers, universities and users together and digitalizes practical use cases for Industry 4.0. It aims at the automation of processes, the simplification of workflows, the digitalization of products and services and the use of data to increase productivity and efficiency and establish sustainability along the entire value chain. Learn more about the project on www.fluid40.de.

Dr. Marcus Fischer
CEO ARGO-HYTOS Group
Switzerland

“Our global digital production processes ensure on-time delivery of high-quality, customizable hydraulic solutions.”

Digitalization at ARGO-HYTOS: Empowering the Future

At ARGO-HYTOS the digitalization journey starts in engineering, where we develop innovative hardware and software, simulating various environments to optimize complete system solutions. AI-based expert systems support our teams in selecting the right products according to the customer needs. Our global digital production processes ensure on-time delivery of high-quality, customizable hydraulic solutions.

For longer than a decade, ARGO-HYTOS has utilized deep data analysis and machine learning. Our condition monitoring products (LubCos & OpCom series) predict necessary oil changes and prevent unplanned downtimes.
Our assistant systems (MHPS & SHC), integrating advanced hydraulic and electronic components with sophisticated algorithms, enhance machine performance, reduce operator workload, and improve overall comfort.
Our EL7 valve control sets benchmarks in control and data transfer via CAN, Bluetooth, or analog signals.

The Fluid 4.0 initiative provides a standardized digital twin structure based on the interdisciplinary “Asset Administration Shells”. Digital twins of ARGO-HYTOS solutions empower our customers to optimize processes, avoid design errors, automate workflows, and apply optimization algorithms, while addressing key topics like energy monitoring, CO2 emissions, and circular economy.

Dr. Alexander Flaig
CTO Mobile Hydraulics
Bosch Rexroth, Germany

“Bosch Rexroth is driving the digital transformation of hydraulics, unlocking value at both component and system levels. Our strategy focuses on optimizing hydraulic with smart control technology using digitalization, maximizing performance and efficiency.”

Overarching concepts for generating additional values by digitalization of hydraulics on component and system level

This involves four key advancements:

1. Mechatronic Integration: We‘re leveraging software-defined functionality and integrated sensors to simplify hydromechanical hardware, significantly reducing costs and enhancing control. This approach has already yielded an 80% reduction in machine commissioning time or overcoming performance limitations caused by environmental conditions.
2. Enhanced ECU Performance: Emerging applications demand faster reaction times and increased processing power from our Electronic Control Units (ECUs). The adoption of digital instead of analog interfaces addresses these needs, overcoming limitations of existing systems designed for electromechanical control. This requires a holistic approach to requirements engineering.
3. Advanced System Functionality: Meeting stringent legal requirements (e.g., the Cybersecurity Resilience Act) and evolving performance demands presents significant opportunities. We‘re developing innovative automation functions and energy-saving architectures, including advanced regeneration and recuperation, for reduced energy consumption and improved sustainability. This fundamentally enhances the capabilities of hydraulic systems.
4. Strategic Collaboration: Seamless integration of functionalities from diverse sources into our ECUs is paramount. We are committed to fostering collaboration and developing user-friendly tools to unlock the full potential of digitally enhanced hydraulic components and machine functions.

This comprehensive approach positions Bosch Rexroth at the forefront of the hydraulics revolution, delivering superior performance, efficiency, and sustainability to our customers.

Dr. Mark Krieg
CTO Industrial Hydraulics
Bosch Rexroth, Germany

“With the Hydraulic Hub from Bosch Rexroth, service becomes faster, smarter, and more digital.”

More Efficiency in Service and Maintenance

The online platform provides 24/7 access to service knowledge and processes for nearly half a million Rexroth industrial hydraulic components.

Increasing digitalization requires new and efficient solutions: The Hydraulic Hub provides comprehensive hydraulics and service expertise worldwide in real time - from fault detection and problem identification to solution finding and documentation through to maintenance planning. Service and maintenance teams have access to diagnostic tools, interactive assistants and preventive maintenance support, among other things.

Accessible via a web browser, the online platform offers a wide range of information, including datasheets, operating manuals, spare parts, and lifecycle details. AI-powered features like „Smart Diagnosis“ help quickly identify faults based on symptom descriptions or error codes. The „Smart Assistant“ provides targeted answers to product-related questions.

The Hydraulic Hub enables more efficient service planning, reduces downtime, and supports technicians, service managers, and maintenance leaders with practical solutions for seamless operations.

Frank Mühlon
Division President Bucher Hydraulics Germany

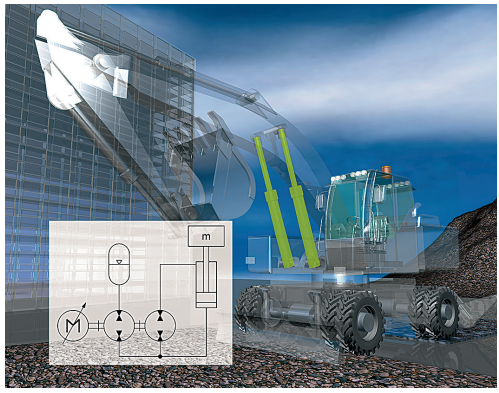
“The electrification of mobile machinery calls for significantly more efficient hydraulic systems.”

Future construction sites must be quieter, cleaner, and more efficient. One possibility is electrification, which is already well-advanced in smaller construction machines. However, in medium and large construction machines, the energy requirements are often too high to run a full working day on battery power. A starting point for improvement is the often-poor efficiency of hydraulic systems.

For example, there is great potential for energy savings when heavy loads – such as an excavator boom – are raised and lowered frequently. In conventional systems, the lifting energy is lost when the boom is lowered. This is not the case with a HELAX from Bucher Hydraulics. The decentralized, electro-hydraulic axis recuperates almost all of the load‘s potential energy. Some of it is converted into electricity and used to recharge the battery, while the rest is stored hydraulically and used directly for the next lift. This reduces the excavator‘s energy consumption in the digging and loading cycle by 30%, making HELAX a key component for electric excavators in the 20-ton class.

In addition, the condition of HELAX is continuously monitored so that maintenance can be carried out proactively. This ensures planning reliability on the construction site 4.0.

The first production-ready models using HELAX will be presented at Bauma 2025, but we will continue to invest in smart and efficient hydraulic systems to electrify even bigger machine types that are unimaginable today.



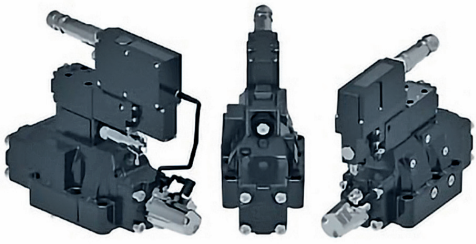
Dr. Andreas Schumacher
Head of Sustainability and Product Compliance
Danfoss Power Solutions, Germany

“Digitalization enables hydraulic systems to excel in efficiency, performance and sustainability and strengthens fluid power for the next decades.”

Mobile and industry hydraulic systems – digitalization mandatory

Fluid power systems have a very long tradition, but comparing the technology insights, the modern hydraulic components and systems advanced significantly in technology, leading to increased product efficiency, e.g. with Danfoss having the most efficient hydrostatic units with up to 96% of efficiency, with the DDP® also in part load situations. But, the requirements for mobile and industry hydraulic systems nowadays have reached a level, where digitalization is the main factor satisfying them. This starts in the design and layout phase with technical information and simulation models supply, alters during operation into data requirements for optimal machine performance and health/service functionality and in the future, load-life data plays a role for service- and recycling concepts for the components.

Taking an example from Danfoss’ industry portfolio, the AxisPro® is a hydraulic valve family with built-in digital capabilities through sensors, controller and connectivity, perfect for optimal and efficient machine control and diagnostics, both to reduce of the machine TCO. Real-time data enables real-time energy consumption and thus CO2-footprint determination and production process optimization. Like in the Fluid 4.0 project, the asset administration shell will also satisfy the need for digital product data in the design phase. Hence, AxisPro® is hereby a prime example for the numerous opportunities of the digital transformation with Danfoss products and engineer the tomorrow today.



Dr. Oliver Niese
Chairman of the Management Board
Festo Didactic & Head of Digital Business
Festo, Germany

“Predictive maintenance for pneumatic drives enables early detection of wear and malfunctions. Standardized industrial apps allow for an easy implementation without requiring extensive AI knowledge, making predictive maintenance accessible to many companies in industrial automation.”

The success of pneumatics in automation stems from its simplicity, robustness, and reliability. However, harsh environments, challenging air conditions, and extreme loads can lead to drive failures before their intended service life is reached. Predictive monitoring of pneumatic drives presents numerous advantages, notably the early detection of wear and malfunctions, which helps prevent costly downtimes.

Introducing the Festo AX Industrial Apps: Festo AX Motion Insights Pneumatic standardizes predictive maintenance for pneumatic drives. This industrial app operates flexibly on industrial PCs, virtual machines, or in the cloud, simplifying implementation and commissioning without requiring extensive AI expertise, by leveraging generalized AI models. Remarkably, it utilizes only limit switches, often already installed, as sensors.

This straightforward approach makes predictive maintenance accessible to many companies, paving the way for its adoption as a standard practice in industrial automation. The result is increased machine availability, optimized spare parts supply, and extended machinery service life.

Wolfgang Sochor
CEO HAWE Hydraulik, Germany

“As an innovation leader for hydraulic systems, digitalization plays a key role at HAWE along the entire process chain. We all benefit from the numerous advantages – component manufacturers, machine manufacturers and end users.”

With the help of modern digital simulation tools, potentials in the design of new products can be exploited at an early stage during product development. For example, the development engineers at HAWE Hydraulik were able to make significant progress in the areas of acoustics, thermals and strength even before the first prototype was built when developing the new INKA compact power unit.
Another interesting feature for the machine manufacturer during commissioning and for the end user during operation is the INKA’s modern sensor technology and directly attached communication box with integrated real-time operating system. These electronics enable the acquisition and storage of operating data, extensive diagnostic options and a self-test for all measuring functions. The measured values from the integrated multi-sensor, including the motor speed, can be transferred via an IO-Link interface to the higher-level machine controller or to the cloud for further processing – this is known as condition monitoring.
The integration of sensor technology and the increasing networking of hydraulic system components with the higher-level machine control system or with cloud solutions are making increasingly complex control systems easier to display and operate. This results in further advantages, which HAWE Hydraulik makes available to machine manufacturers with the new VIPR AI valve, for example. The valve unit combines four proportional seat valves, which are arranged in a so-called “independent metering” setup, with pressure sensors and a powerful electronic control system in a compact unit. The benefits include ease of operation, software-based flexibility and machine learning directly in the valve. The result is a robust, reliable and energy-efficient control system that adapts flexibly to changing working conditions.

Jörg Siering
Head of R&D, Axial Piston Pumps
InLine Hydraulik
Germany

“Thanks to digitalization, a digital twin of the pump is created in the shortest possible time according to the current state of research.”

Digital development – intelligent products

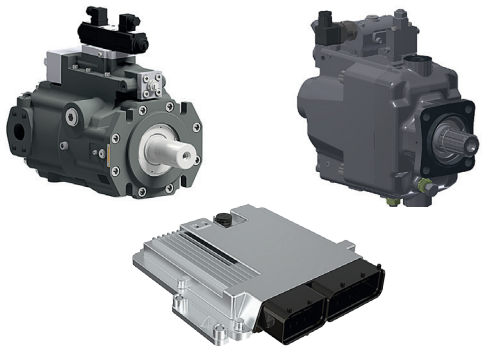
In the development of axial piston variable displacement pumps at InLine, all development steps in the digital field are carried out using familiar digital methods. Thanks to digitalization, a digital twin of the pump is created in the shortest possible time according to the current state of research. We make all of our component data available to our cooperation partners in order to enable and evaluate the overall system in terms of energy efficiency, noise emissions, sustainability and CO2 footprint as early as the product development stage. Together with excellent research institutions, we develop our products using the latest digital tools and methods and validate these prototypes in extensive test procedures.

Specifically, we have long been offering all of our high-pressure pumps with adjustment systems whose range of functions is implemented in the software. They have proven themselves in hydraulic systems in which only the pressure volume flow actually required is provided. The control card is available as a control cabinet version or directly onboard.

The V30D is used in industrial systems and the V30E and V60N up to 400 bar nominal pressure in mobile systems.

The customer can specifically influence the power distribution, the operating strategy, exceptional stability and the noise behavior of the component and thus the entire mobile machine.

With our expertise, we offer each customer a specific solution and are represented by leading manufacturers worldwide.



Gergely Csehi
Head of Product Development, Process Technic and Lab
nass magnet, Hungaria

“Digitalization of the last meters in valve technology supports energy efficiency and condition monitoring.”

At the 100-year-old nass magnet Group, innovation is rooted in tradition. We have combined our valve technology expertise with globally standardized IO-Link technology to introduce the “Smart Connector” product line. These intelligent valve connectors are suitable for pneumatic and hydraulic applications, including retrofitting options.

With IO-Link communication, our improved PWM (pulse width modulation) feature reduces power consumption by up to 10% when the valve is on. This helps lower the solenoid coil‘s operating temperature, extending the valve‘s lifespan.

The Smart Connector range offers real-time valve condition monitoring, enabling continuous checks on electrical and mechanical conditions, which aids maintenance planning, minimizes downtime, and maximizes OEE.

We also prioritize environmental protection in our design, utilizing an integrated seal with an injection-molded sealing surface to minimize environmental impact.

Our IO-Link Smart Connectors meet international standards and are available in Form A and Form B Industry. They are compatible with all available IO-Link Masters, with varying Class A (500 mA) and Class B (2 A) load ratings depending on the model.

Dr. Dirk Lewke
Head of Research and Development
RAPA Healthcare and Industry
Germany

“Digital networking enhances precision and efficiency.”

Digitalization in Products and Manufacturing of Fluid Technology

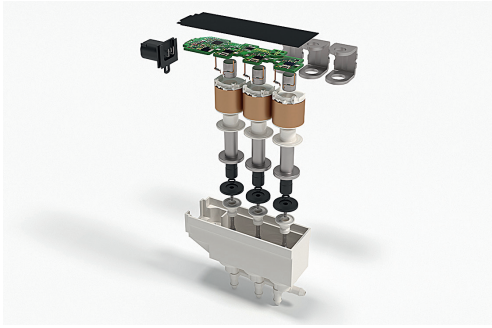
RAPA is a leading manufacturer in fluid technology, specializing in pneumatics and oil/water hydraulics. The company focuses on electromagnetically and mechanically driven valves as well as specialized pump technology, positioning itself as a system provider rather than just a component supplier with digitalization in both its products and manufacturing.

Digitalization in Products

RAPA develops all components in-house, including mechanics, electronics, and software, ensuring compliance with customer-specific safety standards. The Fluid Control Unit exemplifies this approach, integrating solenoid valves for hydraulics or pneumatics within a valve block, combined with power and control electronics. Communication is standard via LIN bus, with other bus systems available upon request. This digital networking enhances precision and efficiency.

Digitalization in Manufacturing

RAPA also develops its assembly lines and end-of-line testing stations in-house. Proprietary control software ensures seamless process data acquisition and usage. Each product is 100% end-of-line tested and receives an unique ID, enabling full traceability and continuous quality optimization.
By integrating digital technology into both development and production, RAPA advances intelligent fluid technology solutions.



Dr. Matthias Wandfluh
CEO Wandfluh Group
Switzerland

“Learn it once, learn it for all.”

In today‘s rapidly evolving world of fluid power applications the shift toward electrification and embedded electro-hydraulic solutions is accelerating. While this transition presents exciting opportunities to expand our technical expertise, it also raises a critical challenge: Do we have the time and resources to master multiple software tools while ensuring safe and efficient interactions between hydraulic systems and human operators?

Every new product with proprietary software introduces a steep and costly learning curve. The process of calibrating, configuring, and confidently operating these systems demands significant time, effort, and rigorous testing. Navigating the complexities of various software platforms can slow development, increase risk, and hinder productivity.

Wandfluh’s freely available PASO software addresses these challenges by offering a comprehensive PC program that consolidates configuration, simulation, bench testing, and local control with integrated data logging for multiple formats of open and closed-loop drivers. Its guiding principle, „Learn it once, learn it for all,“ powerfully conveys this advantage, significantly reducing risk and configuration time. This allows system designers to implement solutions swiftly and confidently, ensuring safety and efficiency in every machine build and faster times to market.

Univ.-Prof. Dr.-Ing. Katharina Schmitz
RWTH Aachen University
Germany

"Data and its smart use will enable the next step of sustainable and energy efficient fluid power"

Fluid Power systems are robust and allow with high power density and good controllability the precise movement of large forces and torques. Nevertheless, these systems are often complex, and it is challenging to overlook, understand or predict their behaviour as they need to be considered as systems composed of many smaller systems. Anyhow, fluid power is a crucial enabler and stakeholder in the Green Transition of our society and industry. The digitalisation and especially the collection and holistic use of data is a prerequisite for allowing the exploitation of the full potential of fluid power drives and systems.

Even though digitalisation has been a topic of awareness and in the scope of development for some years, several aspects are still to be investigated, researched and overcome. More data needs to be collected in fluid power systems throughout the whole lifecycle of the products and systems and this data needs to be transferred from one phase of lifecycle to another, e.g., from product design stage to product manufacturing stage to product utilization stage. It is important to involve relevant stakeholders (component manufacturers, system manufacturers, operators etc.) to ensure that this data transfer process and, thus, better data availability create added value. However, this leads to various challenges, e.g., due to different data interfaces or specific data security requirements. Here, frameworks based on the Asset Administration Shell (AAS) provide good solutions but need to be developed further regarding data consistency, disposability of data and proprietary issues. Together with a virtual representation of components and systems as in digital twins and in combination with algorithms (physically based, data-driven, etc.), data can provide more knowledge about the current status of a system than ever before. Developing virtual sensors and soft-sensors will play a significant role in future systems analysis. However, the most important is finally the use of consistent, all-encompassing data. Solely by further using this data for systems analysis, parameterisation / optimisation, prediction and scenario calculations, machines using fluid power can exploit their full potential and be more energy efficient, more robust, long-lasting and more sustainable.

Prof. Dr.-Ing. Tatiana Minav
Tampere University
Finland

“Future Off-road machinery must be intelligent and energy-efficient.”

In order to achieve the Paris objectives to limit global warming to 1.5 degrees Celsius, strict and all-encompassing legislation on reduction of greenhouse gas emissions are required for all economic sectors. However, this legislation is only enforced in a limited number of countries worldwide and often fails to set out concrete and feasible targets and pathways for all economic sectors. One of the sectors that is impacted by this legislation, but not on track to achieve the EU‘s climate objectives, concern heavy-duty vehicles. Currently, this sector contributes to 6% of total EU GHG emissions.

That is why new and more ambitious solutions are required and must come from companies and universities. Innovative Hydraulics and Automation (IHA) laboratory in Tampere University concentrates on novel solutions combining fluid power and electrical systems for powertrain and implement systems, where automation brings boost in functional safety, reliability, controllability and energy efficiency. Due to the variety of heavy-duty machinery and their low production volume the research strategy of IHA is made up with the ambition to develop new fluid power automation technology from system level and application specific perspective, which minimizes the environmental impact in all aspects. Future Off-road machinery must be intelligent and energy-efficient.

Prof. Dr.-Ing. Jürgen Weber
Technische Universität Dresden
Germany

“Through interdisciplinary collaboration and digital standards, the fluid technology sector will drive innovation.”

Digitalisation has been a central topic in fluid technology research and industry for several years. Numerous solutions have been developed to address specific challenges. For instance, many manufacturers of fluid components provide digitised product information in the form of AAS, facilitating integration into digital ecosystems. Additionally, mobile machines and stationary systems increasingly offer real-time data via cloud-based platforms or middleware interfaces.

However, to fully leverage the potential of digitalisation, it is essential to establish interoperability across different technological domains. This requires a cross-sectoral exchange of information that spans the entire product lifecycle of fluid power components and systems. Such an integrated approach will accelerate innovation cycles, enhance operational efficiency, and contribute to more sustainable resource management.

A key prerequisite for achieving this goal is the semantic description of information. Standardised data models enable transparency and ensure that diverse digital solutions can interact effectively. Therefore, the adoption and further development of open, technology-independent data standards are of paramount importance, to which initiatives such as MiC 4.0 and ECLASS have committed themselves.

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Switzerland

Sweden

Germany

CETOP is the European Fluid Power Committee. Through its 19 member associations, all renowned companies, leading manufacturers together with many small and medium-sized enterprises, in Europe are represented in CETOP. Thus, CETOP stands for a market value of about 16 billion EURO.

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