MTA SZTAKI
Hungarian Academy of Sciences
Institute for Computer Science and Control

Industry 4.0 at MTA SZTAKI
research, development, education

Zsolt Kemény

Senior researcher at the Research Laboratory on Engineering & Management Intelligence of MTA SZTAKI
e-mail: zsolt.kemeny@sztaki.mta.hu

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MTA SZTAKI
Magyar Tudományos Akadémia
Számítástechnikai és Automatizálási Kutatóintézet

MTA SZTAKI at a glance

Hungarian Academy of Sciences, Institute for Computer Science and Control

- Established in 1964
- EU Centre of Excellence in IT, Computer Science and Control
- Basic and applied research
- Contract-based R&D&I activity mainly on complex systems, turnkey realizations
- Transferring up-to-date results to industry and universities

- Basic research
  - Computer science
  - Systems and control theory
  - Engineering and business intelligence
  - Machine perception and human–computer interaction
- Applied research and innovation
  - Vehicles and transportation systems
  - Production informatics and logistics
  - Energy and sustainable development
  - Security and surveillance
  - Networking systems and services, distributed computing

Key figures

- Budget
  - 13–14 M EUR/year
  - ~30% basic funding
- Scientific staff: 220
- Cost structure
  - Personnel 38%
  - Operational 51%
  - Investments 11%

Research Laboratory on Engineering and Management Intelligence (EMI)

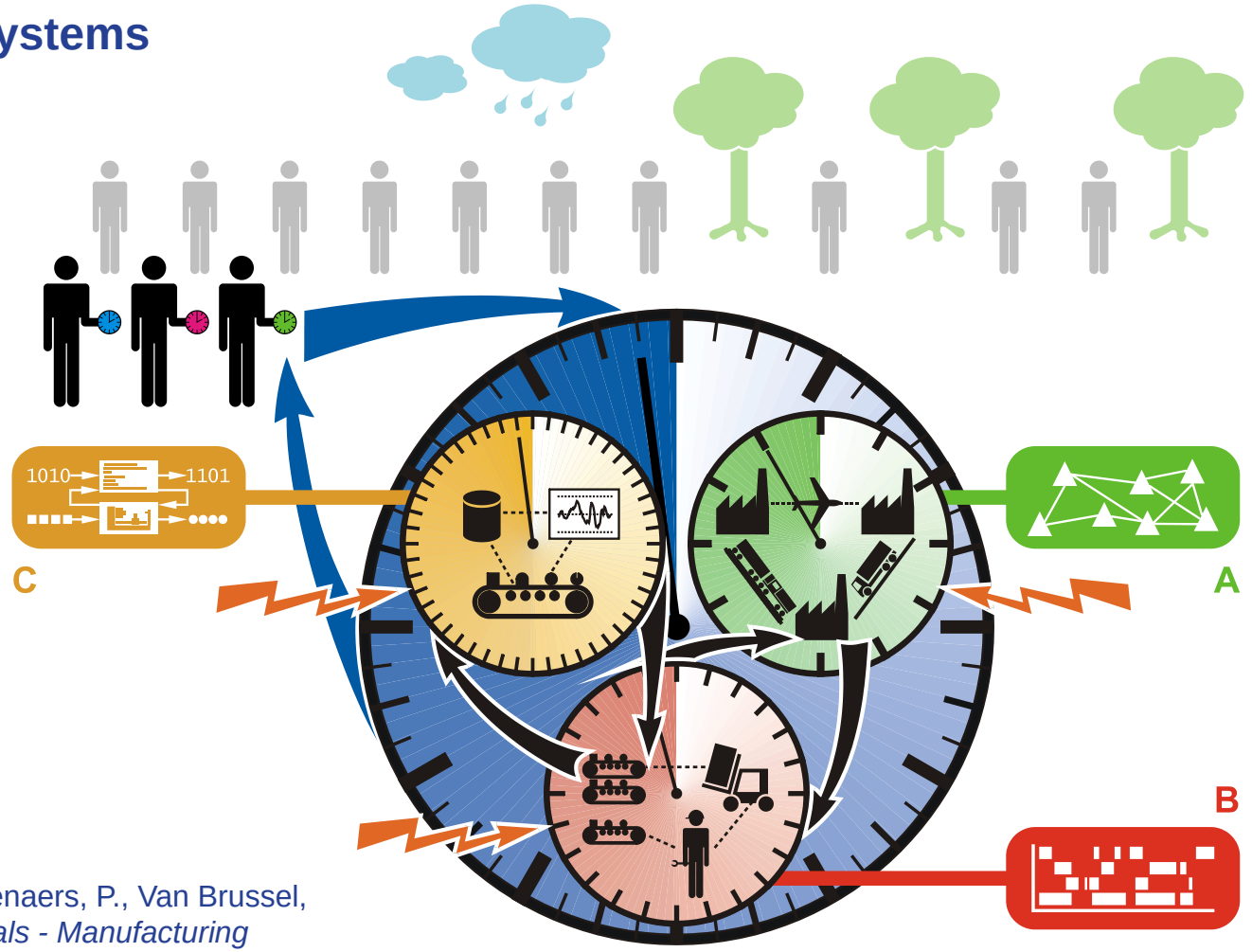
- **Head of Laboratory:** Dr. József Váncza
- **Location:** Budapest, MTA SZTAKI
- **Staff:** 45 FTE

http://www.emi.sztaki.hu

- **Mission:** Research and elaboration of techniques applicable for handling complex production and business systems working in an uncertain, changing environment, with special emphasis on manufacturing automation, production informatics, operation research, artificial intelligence ad machine learning approaches, balancing the aspects of optimisation, autonomy and cooperation.
- **Main research areas:**
  - modelling, control and optimization of technical and business processes
  - handling changes and disturbances in complex systems
  - distributed modelling of extended enterprises and production networks
  - modelling and simulation of large production and business systems, digital factories

Research Laboratory on Engineering and Management Intelligence (EMI)

- **Core field of application: manufacturing systems**
  - Real-time characteristics, responsiveness
  - Resilience, fault tolerance
  - Adaptivity
  - Efficiency
  - Process transparency
- These requirements have been identified on several layers of production hierarchy years or decades ago
- The set of expertise at EMI responds to challenges in all levels of hierarchy
- A large vertical span gives more insight into interdependencies
- Our continuous research has witnessed the evolution of industrial production

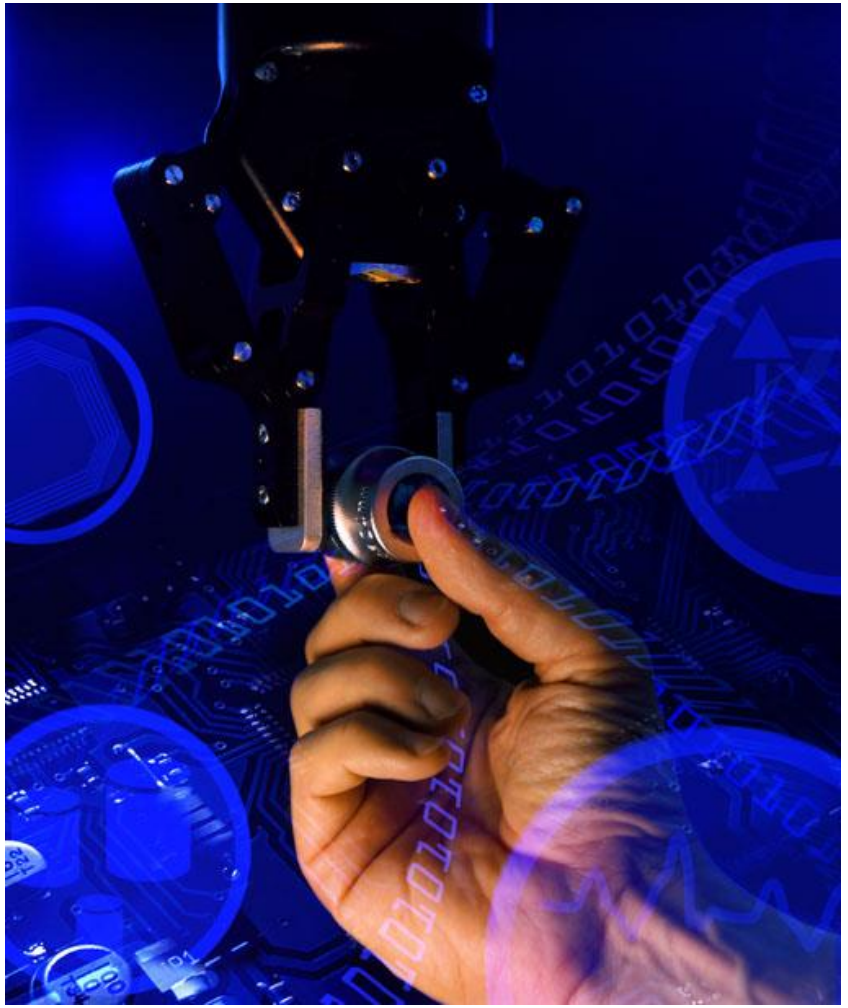


Váncza, J., Monostori, L., Lutters, D., Kumara, S.R., Tseng, M., Valckenaers, P., Van Brussel, H.: Cooperative and responsive manufacturing enterprises. *CIRP Annals - Manufacturing Technology* 60(2), 797-820, (2011)

Recent trends: Industry 4.0, CPPS

- Recent advances in
  - Technology (computational power, connectivity, sensing, etc.)
  - Scientific backgrounds (models, solution approaches)
- Changing demands in
  - Customer demands
  - Business environment
  - Regulatory environment
  - Labour conditions

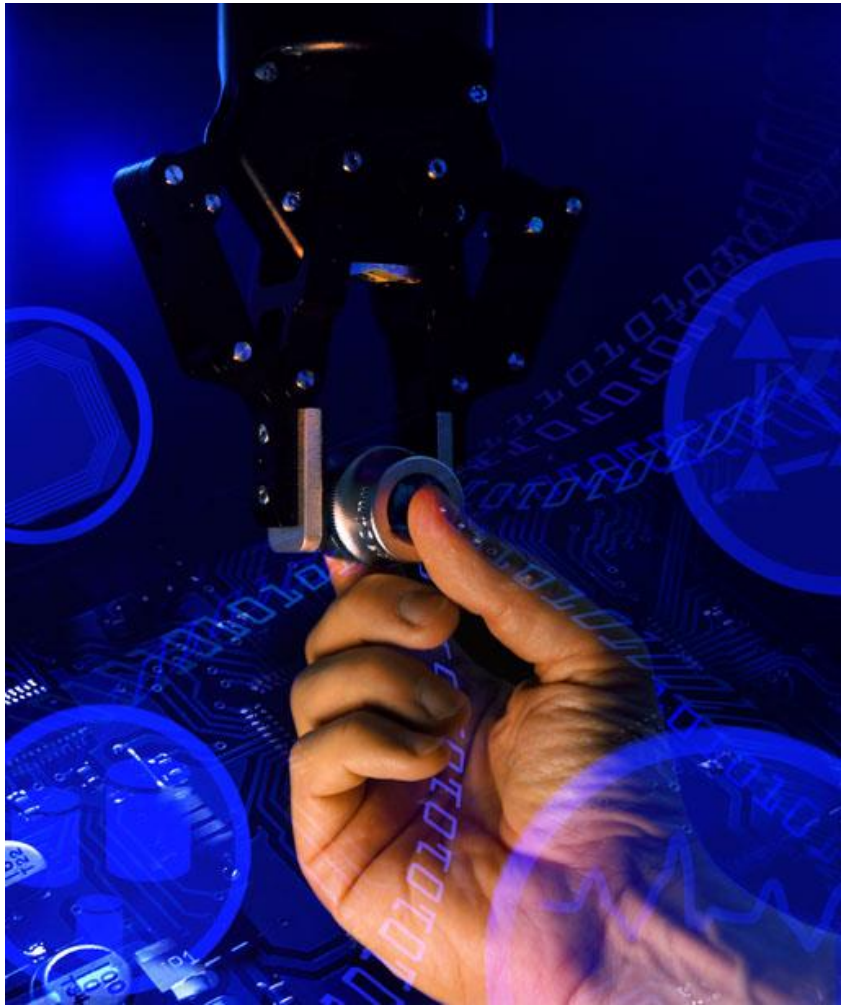
- Changes are expected to substantially transform the character of industrial production in the next decades, bringing about a **“4th industrial revolution”**
- The backbone of the new production paradigm is the combination of interconnected virtual and physical resources, resulting in **cyber-physical production systems**



Recent trends: Industry 4.0, CPPS

- CPPSs consist of
  - **autonomous** and **cooperative** elements and subsystems
  - that are getting into **connection** with each other
  - in **situation dependent** ways,
  - on and **across all levels** of production,
  - from processes, through machines and production systems, up to production and logistics networks.
- CPPSs are characterized by their ability to
  - directly acquire physical data by using **sensors** and act on the physical world by using **actuators**,
  - **analyze and store** the acquired data and **interact both with the physical and the virtual world**,
  - are spontaneously **networked** amongst each other and with global information systems by wired or wireless communication means,
  - use **data and services available worldwide**,
  - have multi-modal human–machine interfaces—i.e., they are **smart**.

[Monostori, Kádar et al.; 2016]



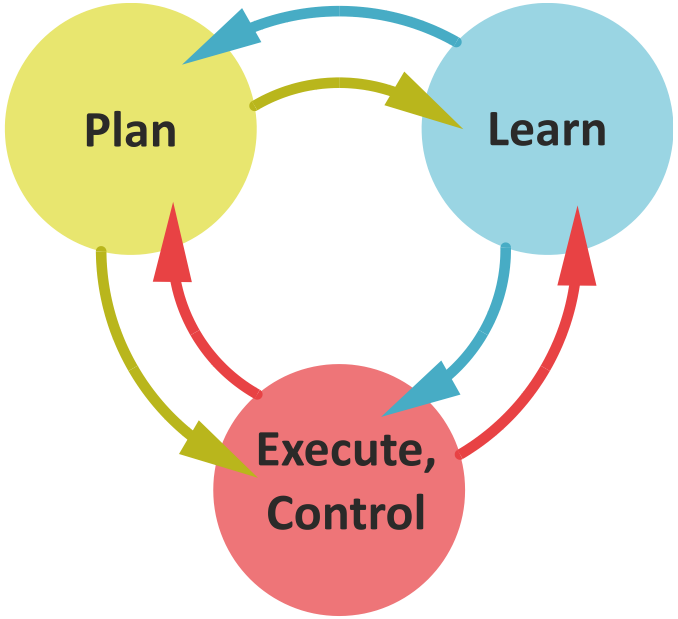
Our approach and competencies

Research areas

- Manufacturing process planning
- Process management and control
- Robotics and mechanisms
  - Including human-robot symbiosis
- System design
  - Reconfigurable manufacturing
- Production planning and scheduling
- Production and logistics networks
- Energy system management

General requirements

- Multi-objective optimization
- Adaptivity, robustness
- Handling complexity, efficiency
- Decentralization, collaboration, cooperation
- Safety and security
- Sustainability



Methods and tools

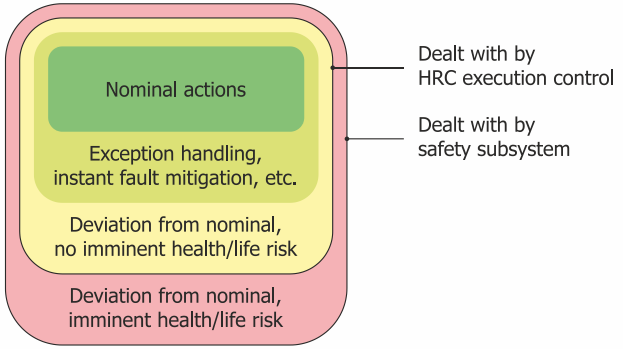
- Mathematical (and constraint) programming
- Statistical machine learning
- Geometric reasoning
- Scheduling theory
- Game theory, mechanism design
- Discrete-event simulation
- Agent-based simulation
- Digital twin
- Sensor networks
- IoT, cloud computing

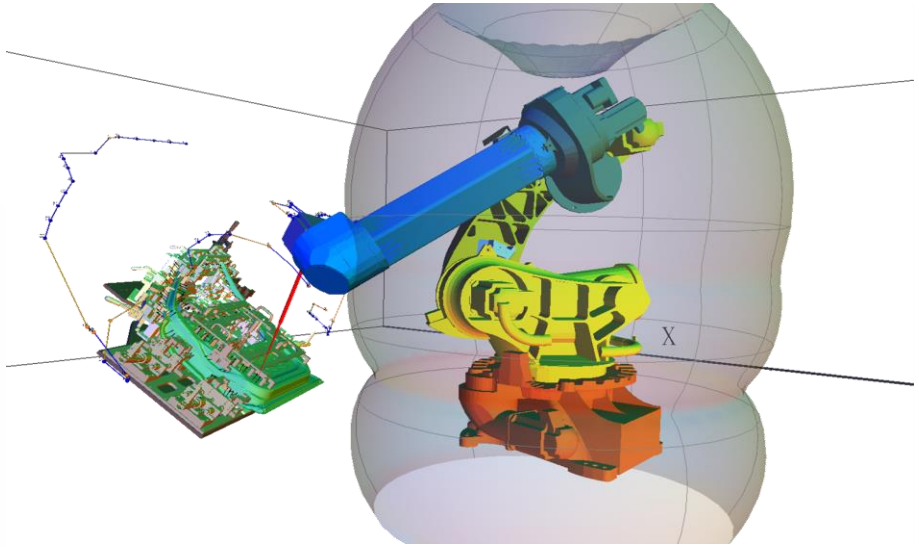
- Targeted technology readiness levels:

  TRL1 – TRL6 […TRL9]

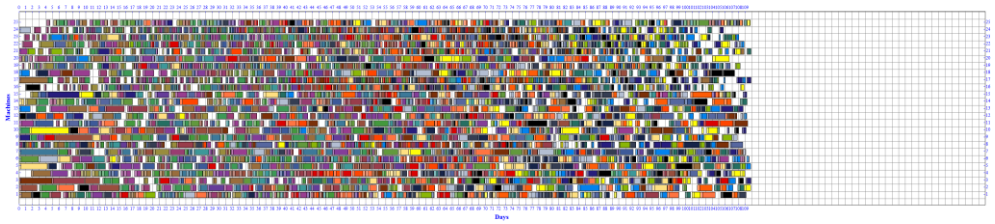
Our activities—research and development

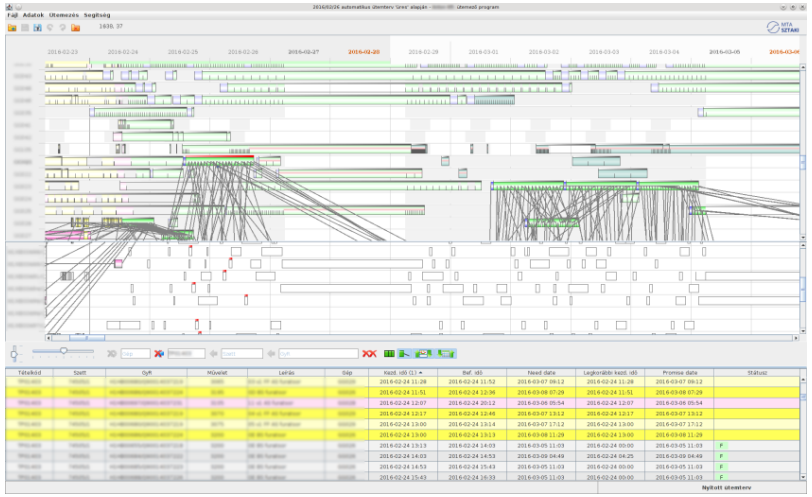
- **RLW Navigator:** planning and optimisation of robotic remote laser welding
- **SYMBIO-TIC:** work environments with human–robot collaboration





- Several industrial development projects in production planning and control, forecasting, scheduling

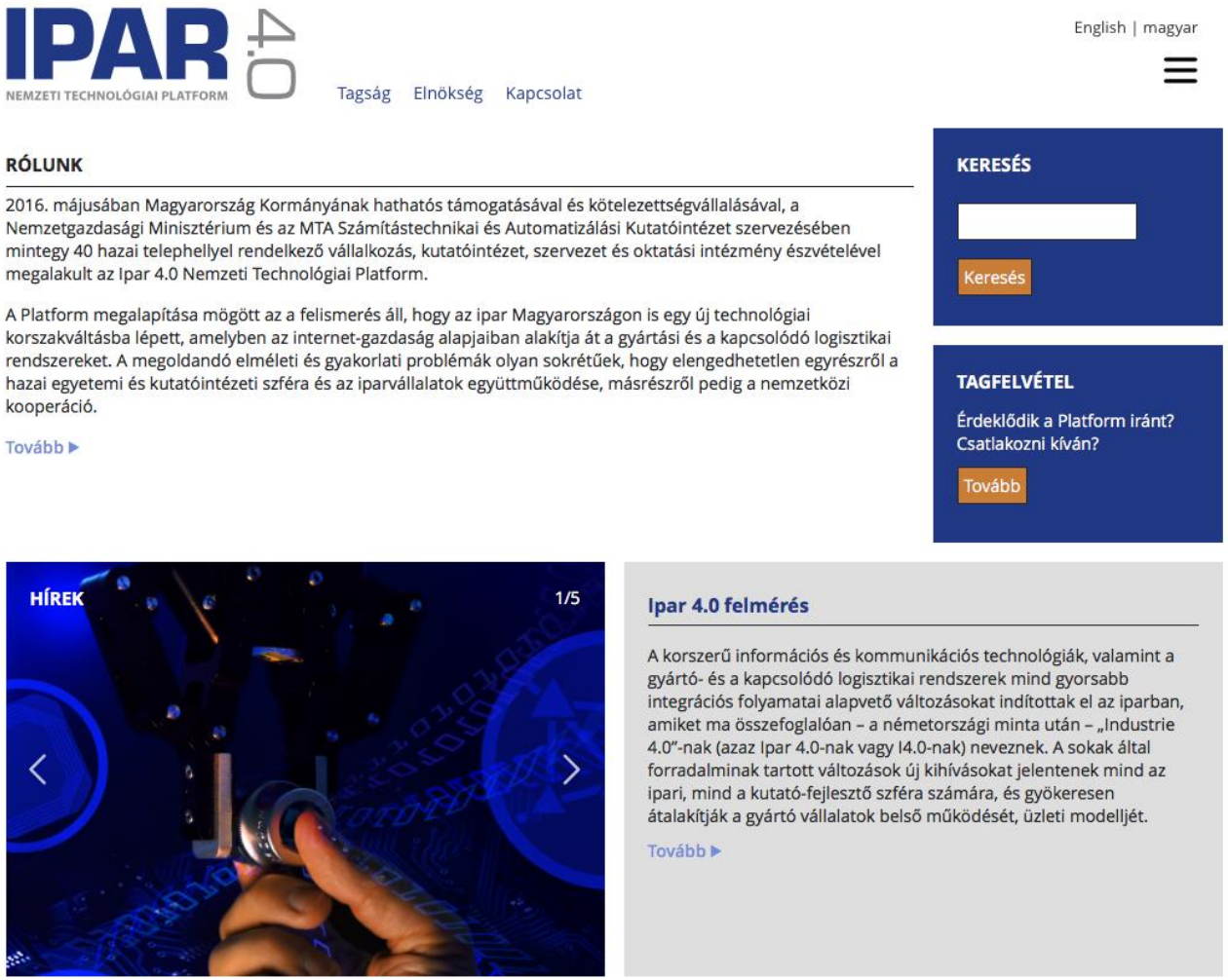




Our activities—contribution to clusters, platforms

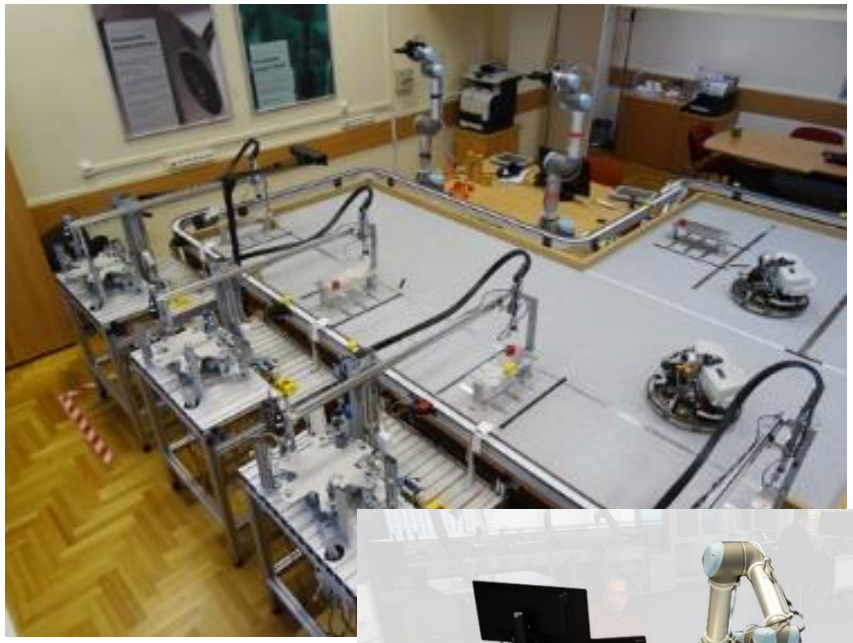
- **EPIC**: Centre of Excellence in Production Informatics and Control
- Consortium members from Hungary, Austria and Germany

- **“IPAR 4.0” National Technological Platform**
- National-level support
- MTA SZTAKI is a key driver
- Currently ca. 40 members from industry, research and education



Our activities—physical pilot systems

- **Smart Factory**
  at the premises of MTA SZTAKI in Budapest
  - Compact, simplified but functional model of a complete production facility
  - Functional planning, execution infrastructure
  - “Digital twin”, connection to remote and virtual subsystems supported
  - Main focus on demonstration and research
  - Secondary focus on education (BME)
- **MTA SZTAKI Learning Factory**
  in Győr (premises of Széchenyi University)
  - Open shop-floor with collaborative workstations and robots
  - “Digital twin” and advanced human–machine interfaces under development
  - Main focus on eucation
  - Fully functional by September 2018



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Takk for deres oppmerksomhet!