CZECH INSTITUTE OF INFORMATICS ROBOTICS AND CYBERNETICS CTU IN PRAGUE

Department of Industrial Production and Automation

Department Introduction, Testbed Involvement and Research Topics

Prof. Michael Valášek, Dr. Petr Kolar

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CZECH TECHNICAL UNIVERSITY IN PRAGUE | CZECH INSTITUTE OF INFORMATICS, ROBOTICS AND CYBERNETICS
Department of Industrial Production and Automation | IPA
Jugoslávských partyzánů 1580/3 | 160 00 Prague 6, Dejvice | Czech Republic

Department of Industrial Production and Automation

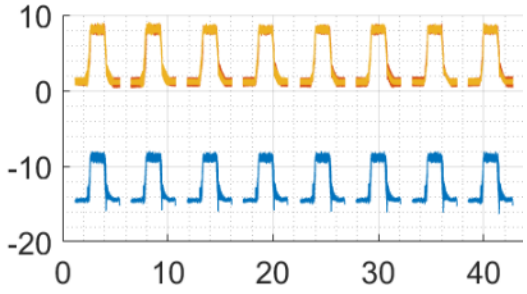
- Joint personal team with Faculty of Mechanical Engineering (FME CTU)
- Main research areas and topic leaders:

Advanced robotics

Prof. Michael Valášek

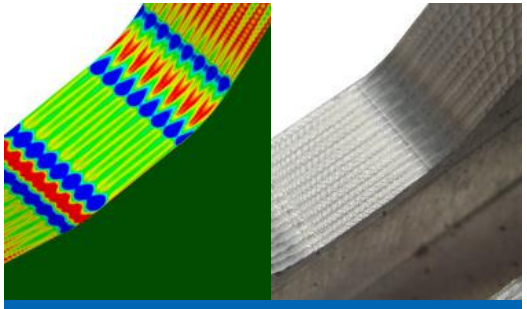
Industrial automation

Dr. Jiri Švéda



Smart machine tools

Dr. Petr Kolar

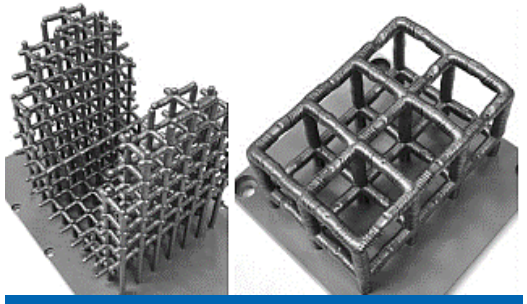


Digital twin and production process virtualization

Dr. Matej Sulitka

Machining and laser technologies

Dr. Pavel Zeman



Hybrid manufacturing technology

Dr. Jan Smolík

Department laboratories

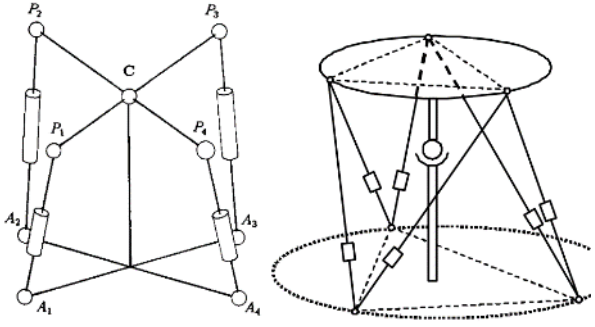
- The IPA department operates two laboratories:
  - Laboratory of robotics and manufacturing technology (LRMT)
  - Laboratory of advanced robotics (LAdR)
- Both labs are part of CIIRC Testbed for Industry 4.0

Laboratory of robotics and manufacturing technology

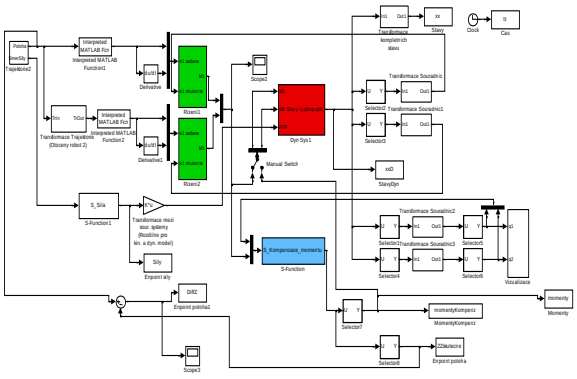
Laboratory of Advanced Robotics

Advanced robotics

- The focus is on research of non-traditional structures and control methods of robots. Combination of both approaches has potential to significantly improve properties of the traditional robotic systems. The research results can be implemented in wide task spectra of industrial production.
- Non-traditional robotic structures: e.g. parallel kinematic structures, inflated structures, rope structures, structures with redundant drives.
- Non-traditional control approaches: general problems of are controllability and observability, model identification and control robustness, special control approaches (sliding-mode control, state observer control)



Non-traditional robotic structures



Non-traditional control approaches

Innovative robotic applications

Industrial automation

- Industrial robots are the key instruments of the modern automated production.
- Industrial communication involves topic of monitoring of production machines and manufacturing processes and communication of production machines with the superior systems for production control.
- On the production system level, there is focus on horizontally and vertically integrated automated production systems. It includes industrial communication between various production machines combined with continuous monitoring of the production processes enable better effectivity, productivity and quality of the production.

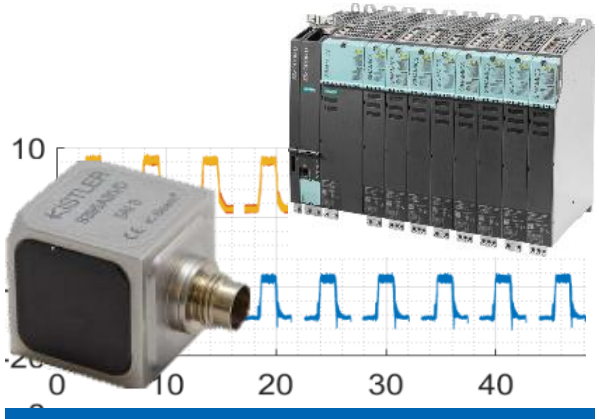
Industrial robotics

Industrial communication

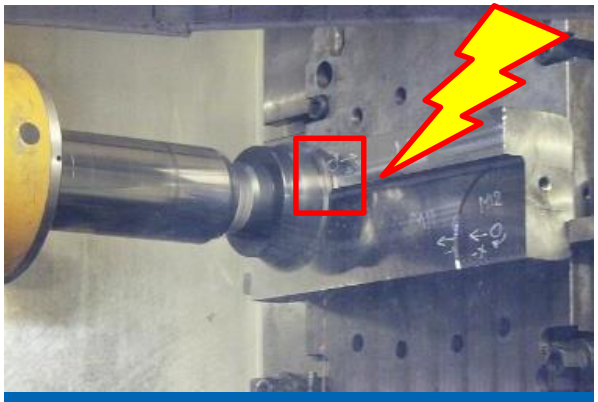
Data-driven production system control

Smart machine tools

- Our research goal is enhancing and maturing the concept of the smart machine tool.
- The smart machine tool is equipped by additional sources of inputs for feedback. The intelligence of the machine tool is based on predefined algorithms and current proces data. Autonomous reaction to unexpected situations is a current research goal.
- Research areas involves:
  - Physical and also virtual sensorics integrated in the machine tools and production, development of auxiliary measurement systems.
  - Process characterization using machine and process signals.
  - In-process collaboration of real machine tools with their digital twins.



Sensorics and signal processing

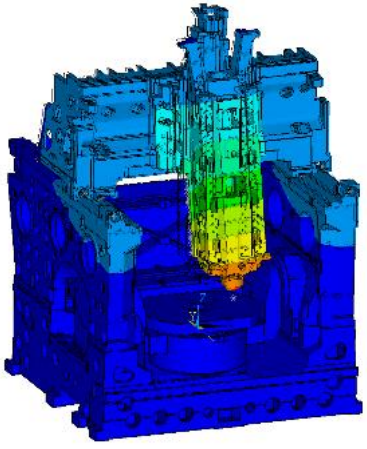


Data fusion
Edge computing

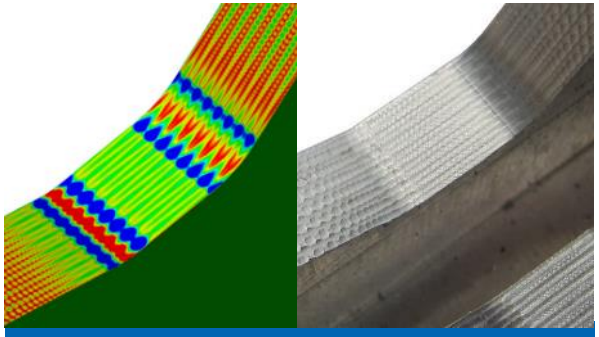
Data analyze
Cloud computing

Digital twin and production process virtualization

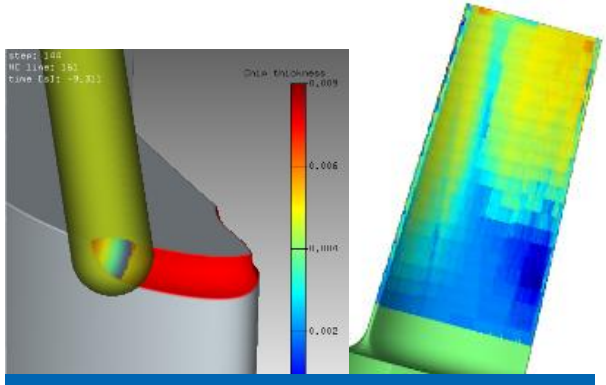
- Machine tool Digital Twin is an effective instrument for predicting and optimizing the results of machining process. Workpiece Digital Twin is a result of the complex simulation of the machine tool – process interaction, including the dynamic behavior of the machine tool and the workpiece and detailed visualization of the manufactured part.
- Digital Twin eliminates the uncertainties of NC machining processes, serves as a tool to identify and to eliminate machining errors.
- Our research goal is enhancing and mastering this concept for every-day practical implementation in the industrial production.



Physic-based
machine tool digital twin



Virtual machining
(workpiece digital twin)

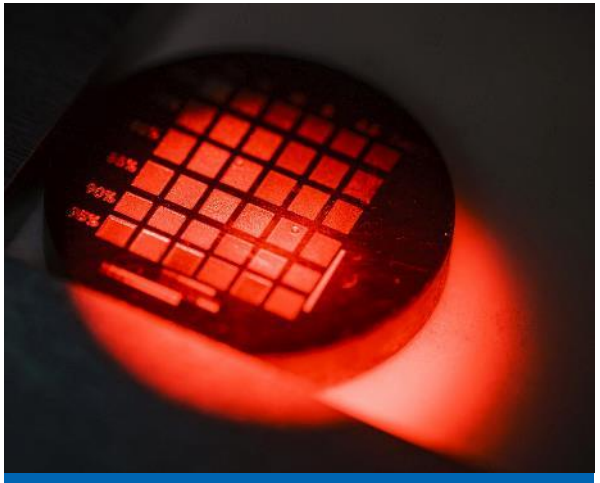


SW tool development
for process optimization

Machining and laser technologies

- The research scope is on fundamentals of the machining and laser processes used for additive or subtractive manufacturing processes. The key goal is to understand tool/laser beam interaction with the workpiece material and ability to characterize it using measurable parameters. This is a cornerstone for further process optimization and process-machine interaction control.
- High-power laser processes: heat treatment, laser cutting, LMD-wire, LMD-powder.
- Laser micro processing using nano-, pico- and femtosecond laser.
- Machining of difficult-to-cut materials with using cryogenic and MQL cooling.

High-power
laser processes



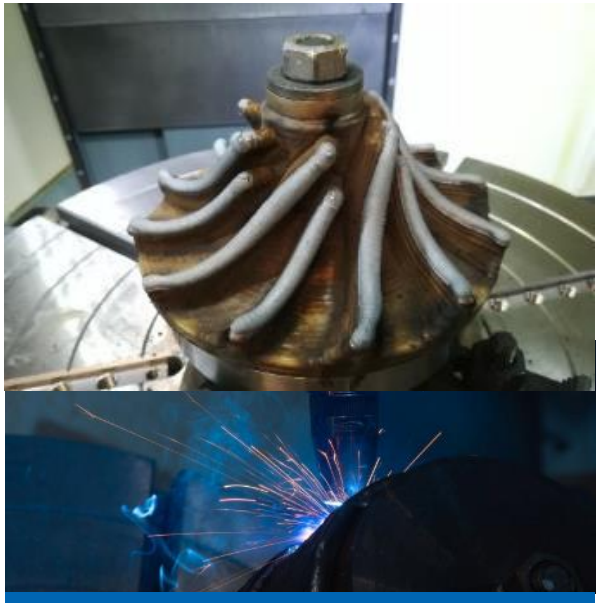
Short and ultrashort pulse
laser processes

Machining
of difficult-to-cut materials

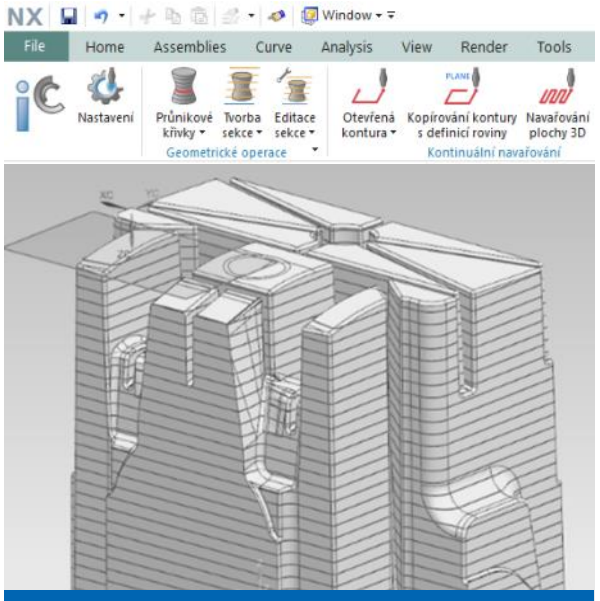
Hybrid manufacturing technology

- Hybrid manufacturing means combination of additive and subtractive production processes in one working space of the production machine. The research is focused on effective implementation of hybrid manufacturing.
- Applications include solution for production of new parts, partial material addition on the part and workpiece repair applications.

Design of machine tools for hybrid production



WAAM process monitoring and simulation



Strategies and tools for automatic tool path planning

References

ŠKODA

meopta

SIDAT AUTOMATION-INFORMATICS

VIVA CV

MAS KOVOSVIT MAS

LASER THERM LASERY PRO PRŮMYSLOVÉ TECHNOLOGIE

TAJMAC – ZPS ZPS

rotana

Contact

prof. Michael Valášek
Vice dean of FME
Head of IPA
E: michael.valasek@fs.cvut.cz
T: +420 723 461 600

Dr. Petr Kolar
Deputy head of RCMT
Deputy head of IPA
E: p.kolar@rcmt.cvut.cz
T: +420 605 205 926