ACTIVITIES AT IMID 2018-2020

Krejčiřík Petr, Ing.

INSTITUTE OF MACHINE AND INDUSTRIAL DESIGN

FACULTY OF MECHANICAL ENGINEERING

BRNO UNIVERSITY OF TECHNOLOGY

Brno, 17.6.2020

ÚSTAV
KONSTRUOVÁNÍ

INTRODUCTION

Researcher at IMID since 2018

- Department of Reverse Engineering and Additive Technologies
- Robotic Aditive Fabrication
- A3/501, Petr.Krejcirik@vutbr.cz, +420 541 14**3 256**

RIAT

SLM

OPTICAL DIGITIZATION

ROBOTIC ADITIVE FABRICATION

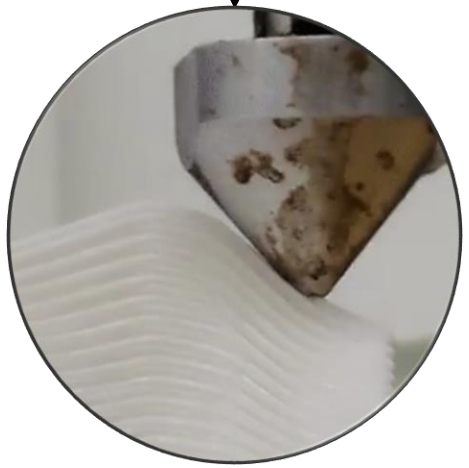
David ŠKAROUPKA, Ph.D.
Robotická aditivní výroba

Petr KREJČIŘÍK
VaV pracovník

Martin KRČMA
Ph.D. student

Arnošt VESPALEC
Ph.D. student

ROBOTIC ADIVITE FABRICATION



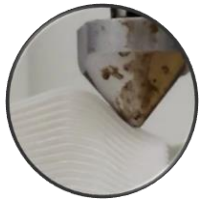
FDM/FFF

POLYBET

CONCRETE

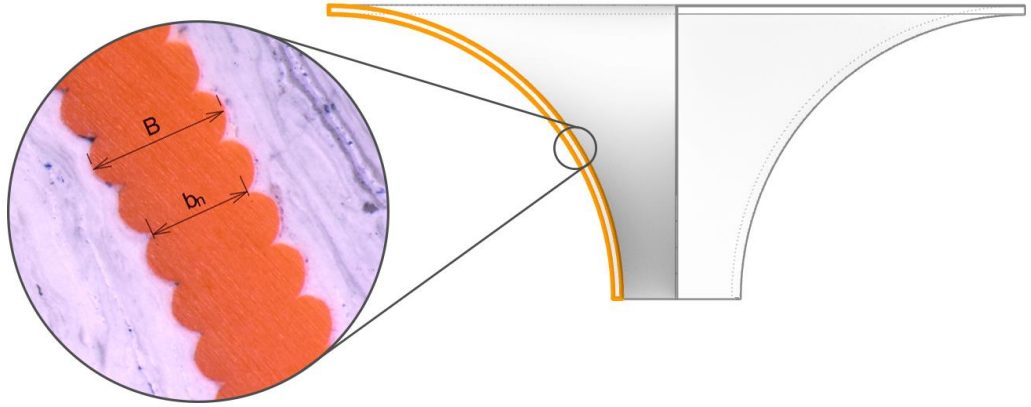
KUKA

RESEARCH ACTIVITIES

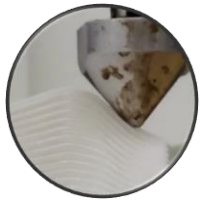


Supportless 3D FFF printing with 6-axis robotic arm

- 2018: 5-axis 3D printing, influence on the overhang printability
- Master thesis (supervisor: Ing. David Škaroupka, Ph.D.)
- Shell bodies, spiral vase mode, printable overhang angle 0-180° (standard FFF printer 0-45°)

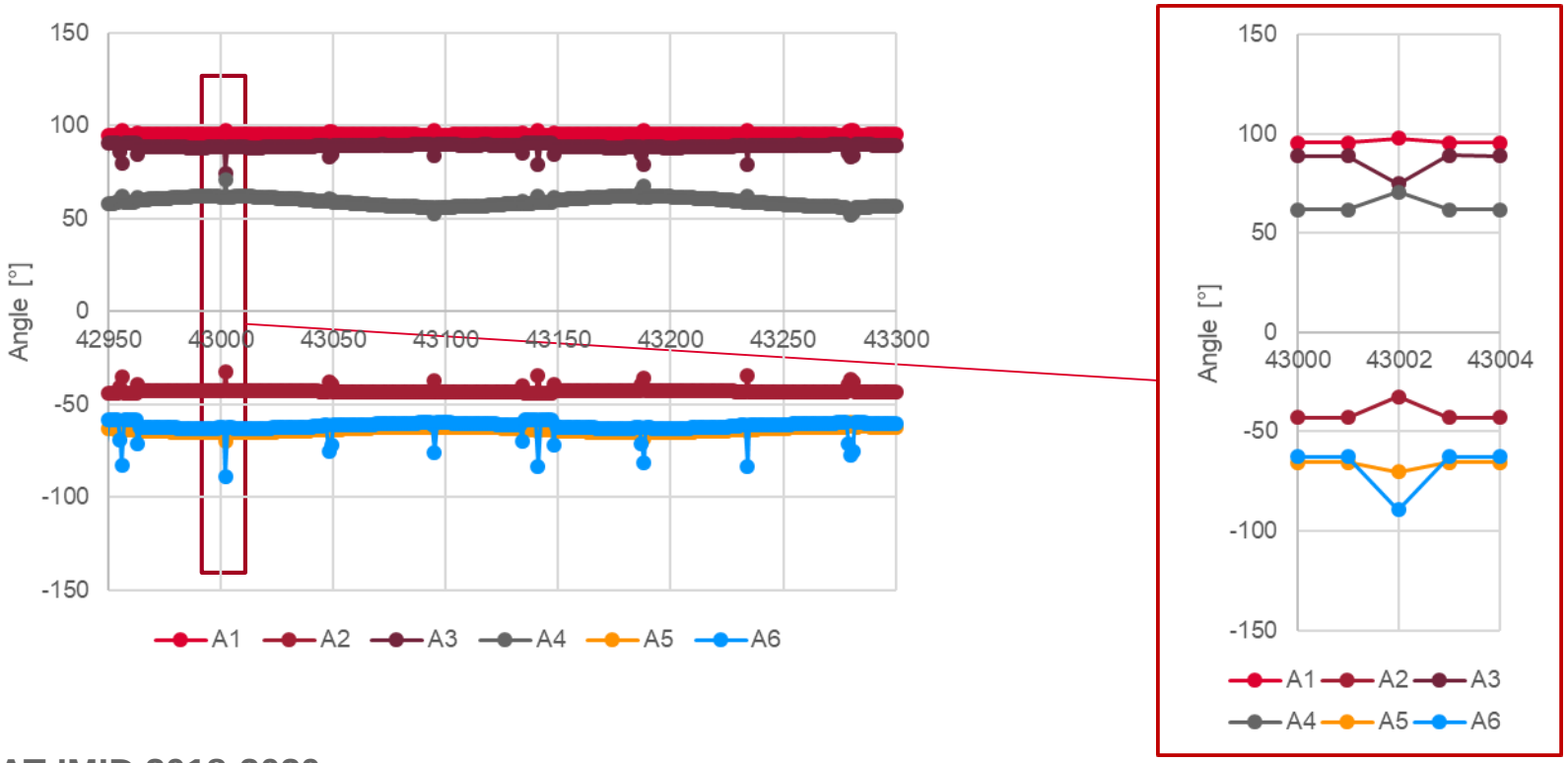


RESEARCH ACTIVITIES

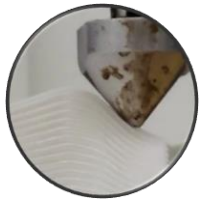


Supportless 3D FFF printing with 6-axis robotic arm

- 2018: 5-axis 3D printing, influence on the overhang printability
- Rapid printhead orientation change – fast robot axes angle change) – security risk, deterioration of surface quality



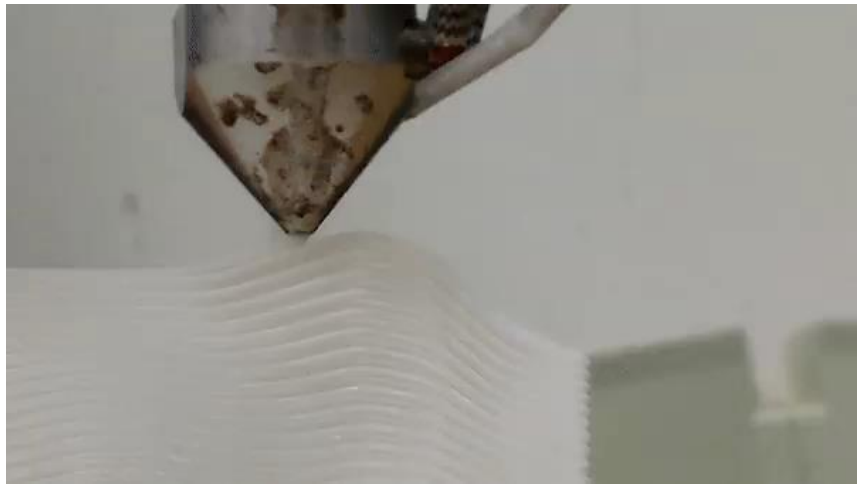
RESEARCH ACTIVITIES



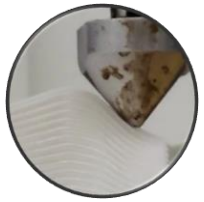
Supportless 3D FFF printing with 6-axis robotic arm

- 2019: 3D printing with usage of external axes
- Optimization of the robot kinematics by using external axes

- 2019: Non-plannar printing strategies
- Toolpath optimization (lower travel and retraction time, elimination of small skins, higher quality surface, deposition in suitable direction)



RESEARCH ACTIVITIES



Supportless 3D FFF printing with 6-axis robotic arm

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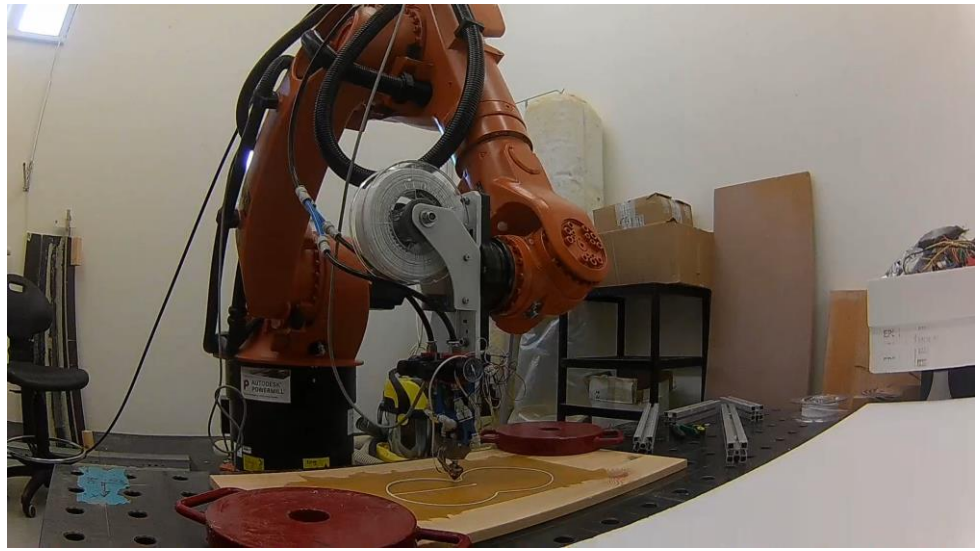
Computational time

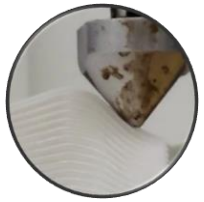
Parameters tuning

×

Printability (Overhang angles, dimensional limits)



RESEARCH ACTIVITIES

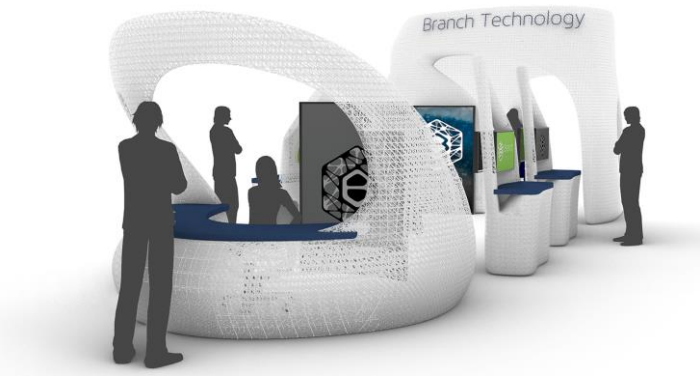


Supportless 3D FFF printing with 6-axis robotic arm

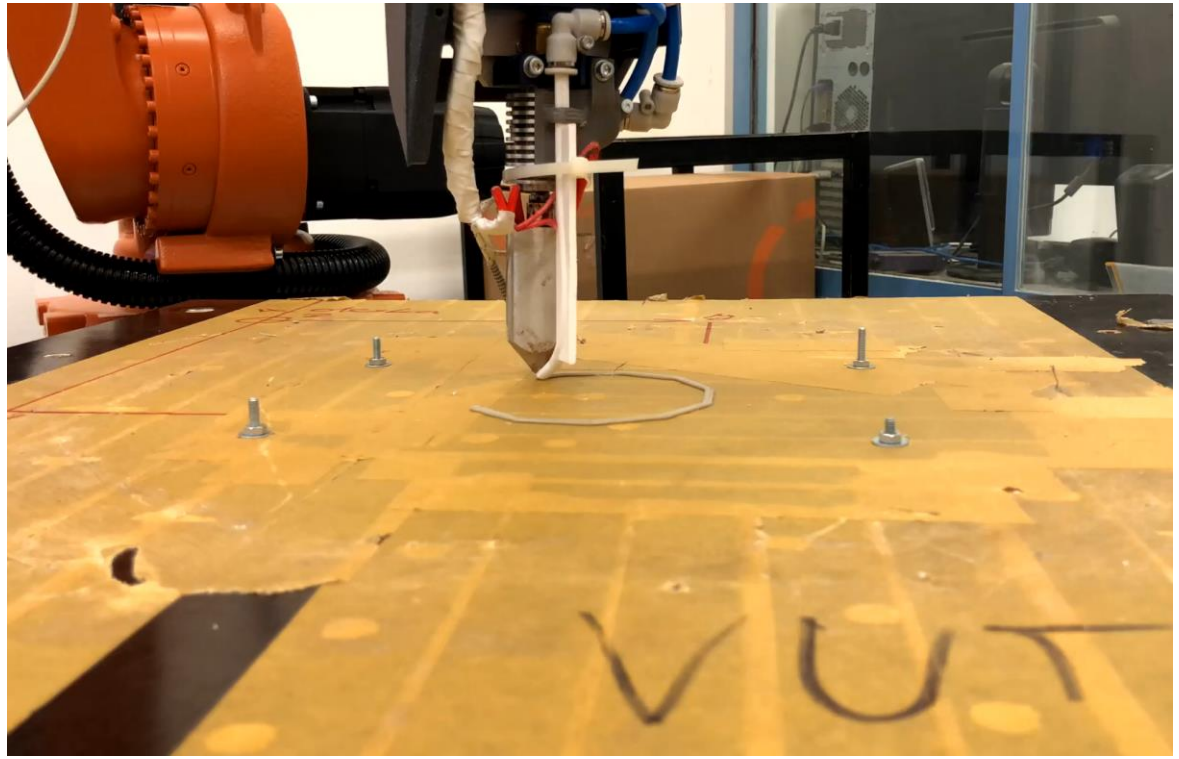
- 2020: 3D printing of the lattice structures
- Mass loss of the printed parts, faster production

PUBLICATIONS IN NEAR FUTURE

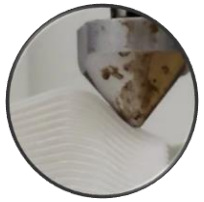
- Examination of bonding quality in nodes
- Trajectory compensation due to beam deformations



Branch technology EXPO booth (branch.technology)



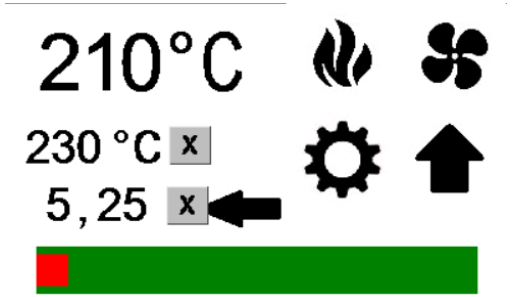
RESEARCH ACTIVITIES

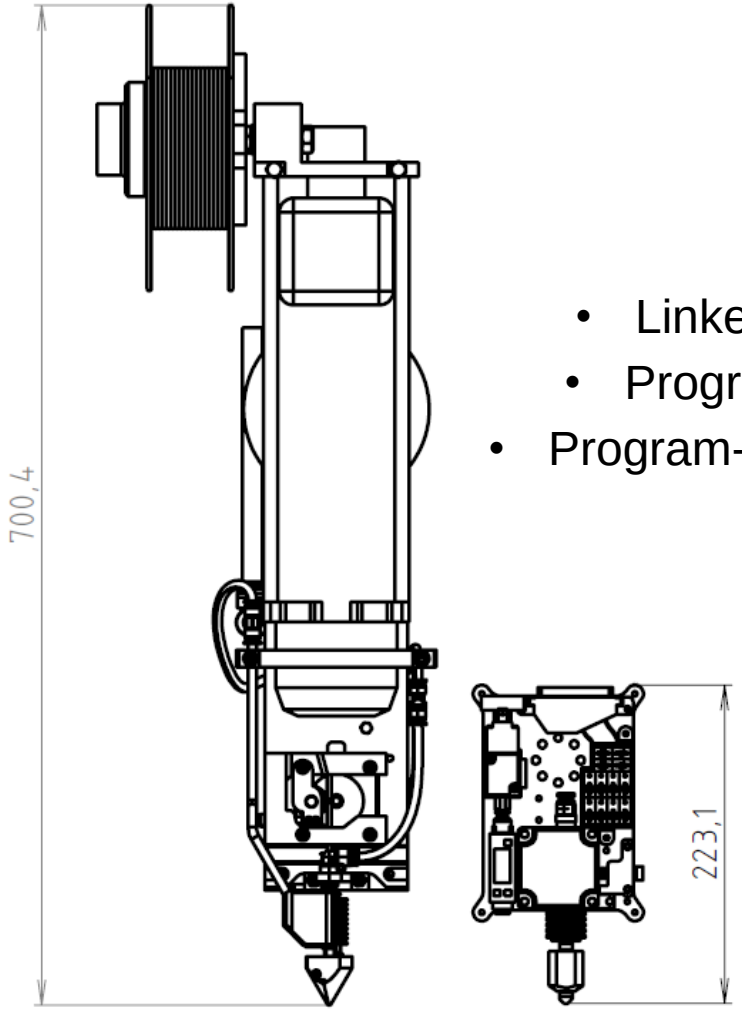


Evolution of the printhead

2018

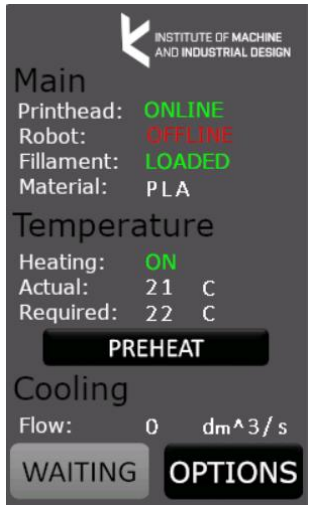
- Direct drive extruder
- Unlinked extrustion with robot movement
- Manually controlled extrusion feed rate
- Manually controlled air flow rate and switch



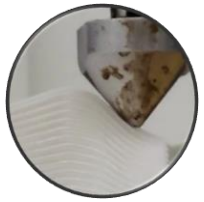


2020

- Bowden drive extruder
- Linked extrustion with robot movement
- Program-controlled extrustion feed rate
- Program-controlled air flow rate and switch



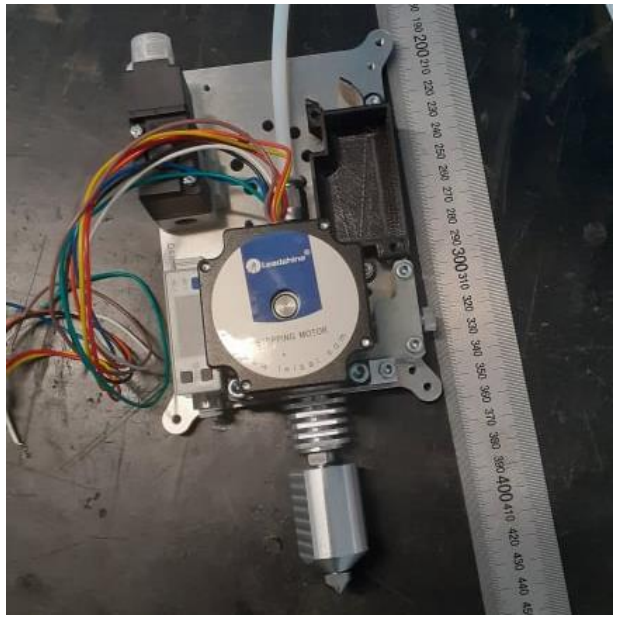
RESEARCH ACTIVITIES



Evolution of the printhead

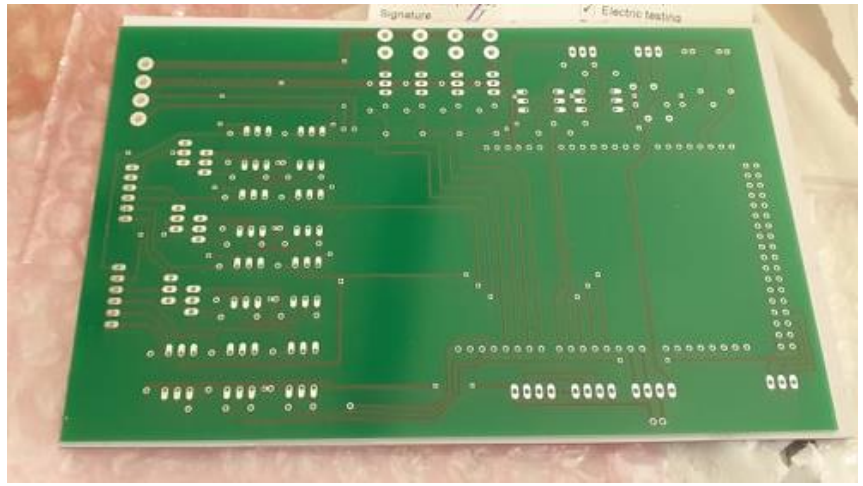
MECHANICAL

- Replaceable stainless steel nozzle
- Higher heat output of the hotend
- Better distribution and control of coolant on deposited material



ELECTRONICS

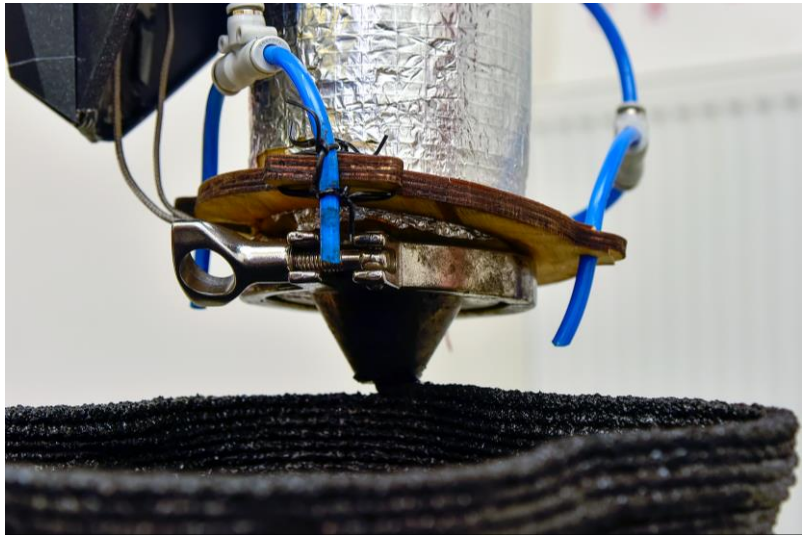
- Improved electrical circuit with new PCB
- Ensuring greater reliability of electronic systém
- Development of new printhead firmware
- Communication module with KUKA robotic arm



RESEARCH ACTIVITIES

Polybet TAČR ZETA (2018-2019)

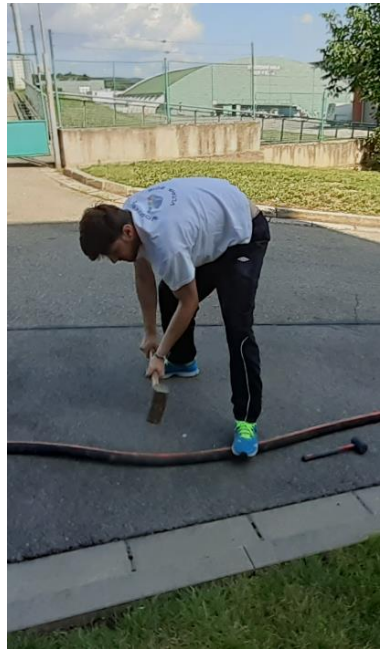
- Piston extruder (specialist supervisor for students project)
- Screw extruder (specialist supervisor for master thesis (Ing. Jiří Kočař)
- Pneumatic system (extrustion and cooling)
- Experimental 3D priting (initial tuning of process parameters)



RESEARCH ACTIVITIES

Concrete TAČR EPSILON (2018-2020)

- Large-scale 3D printer design
- Experiments with the concrete 3D printing (KUKA Robot trajectories)
- Large-scale 3D printer slicer development



RESEARCH ACTIVITIES IN NEAR FUTURE

Polybet TAČR TREND (2020-2022)

The aim of the project is the development of the PolyB3D production system, which will be implemented in production line POLYBET

- Increasing the value of Technology readiness level TRL4 » TRL6

Polybet TAČR ZÉTA (2020-2021)

The main objective is the technical solution enabling the additive manufacturing of framed structures from highly filled thermoplastics.

- Finding the technical solution and development of the structure, necessary for the implementation of additive production of rod structures from highly filled thermoplastics.
- Design of printing strategies with respect to case studies.

PLANNED PUBLICATIONS AND CONFERENCES

RobArch 2020 (postponed, expected in 2021)

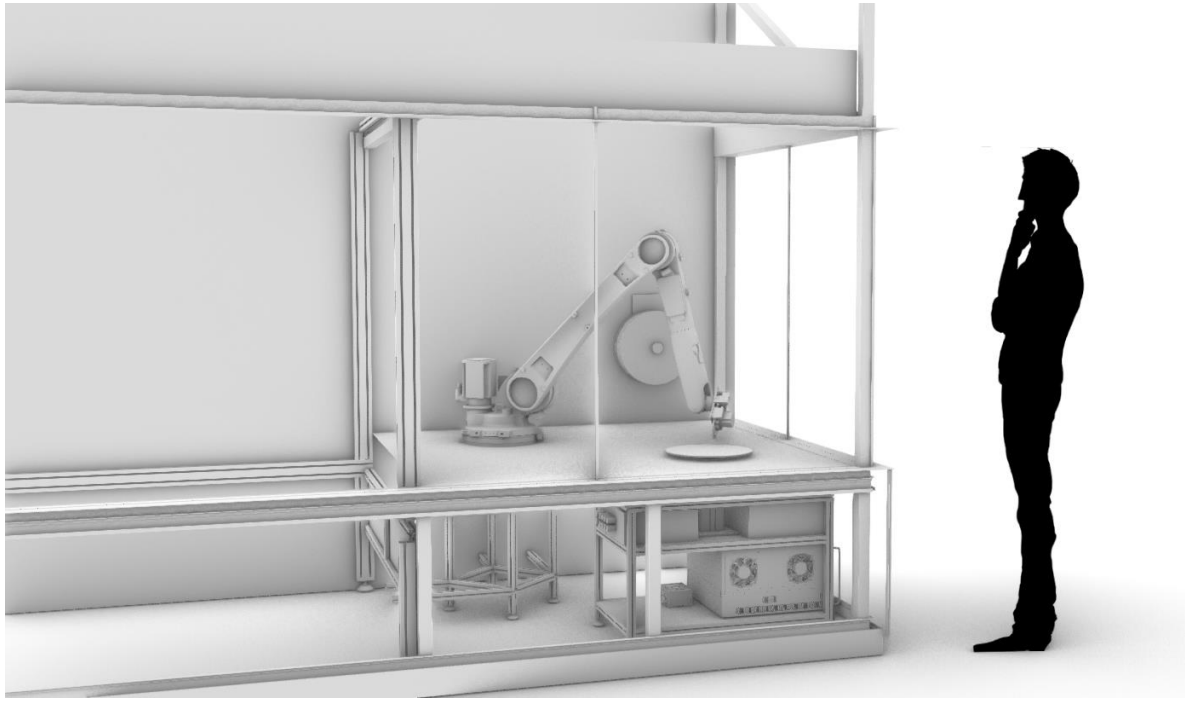
BE-AM 2020

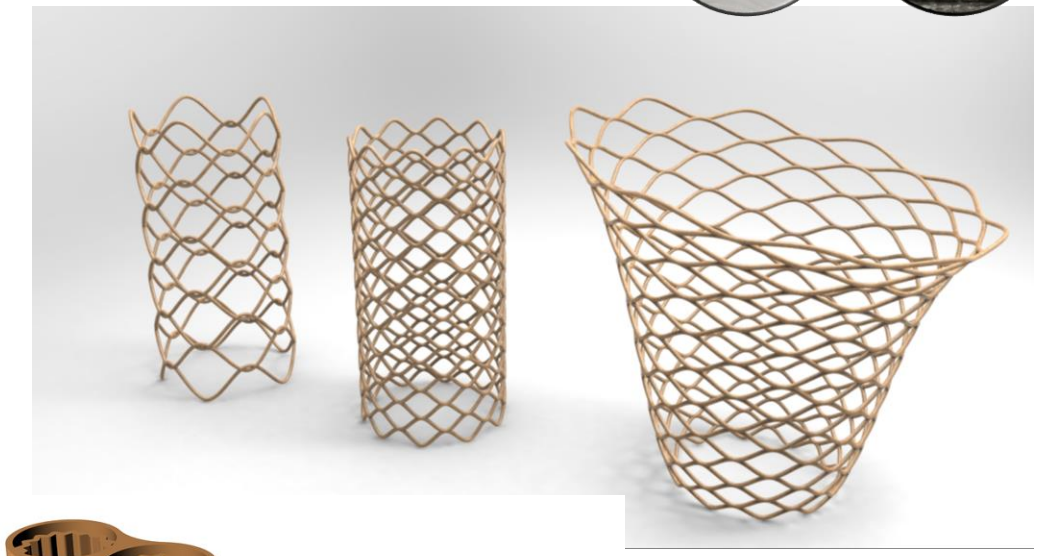
OTHER ACTIVITIES

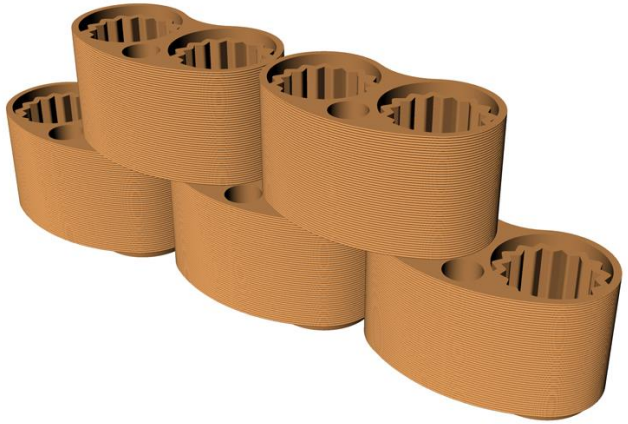
EXPO 2020 » EXPO 2021, DUBAI UAE

Fillamentum, UTB Zlín

- 3D FFF printing of lattice structures

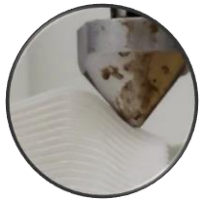






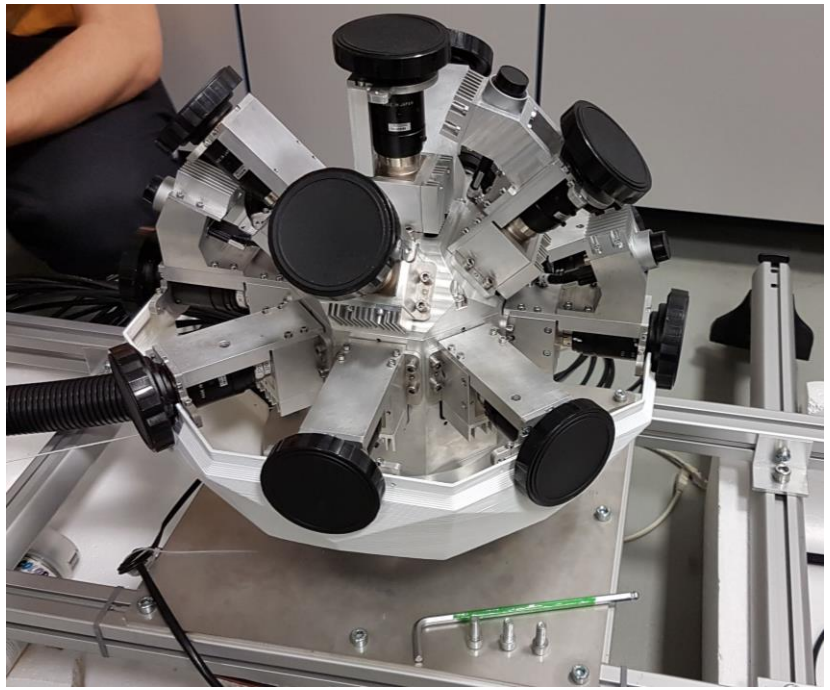
Design by: doc. MgA. Martin Surman, ArtD., UTB Zlín

OTHER ACTIVITIES

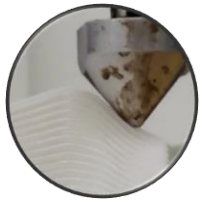


TopGis – mapy.cz Panorama scanning head (HS)

- Camera holder design
- 3D printing of the camera holder cover



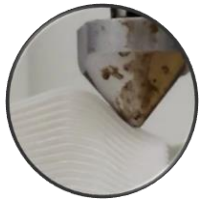
OTHER ACTIVITIES



ÚK FSI VUT + FaVU VUT + Fillamentum cooperation

- ÚK FSI VUT: 3D printing of sculptures
- FaVU VUT: Design of sculptures
- Fillamentum: Material supplier

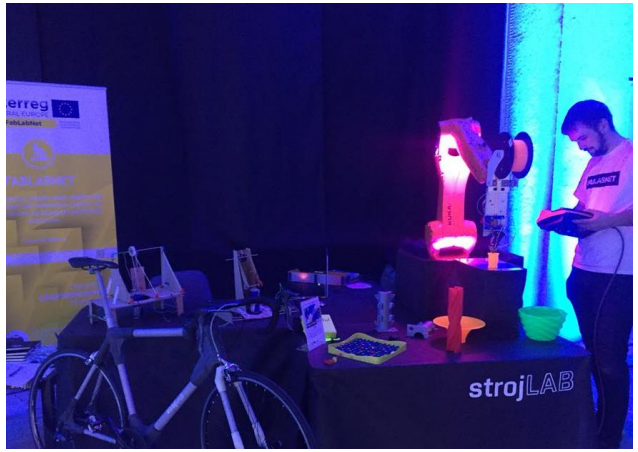
OTHER ACTIVITIES



MSV 2019

ABB Robotics 2019

Prototyp 2018



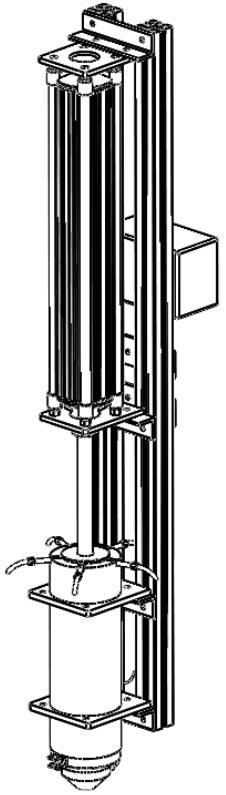
PUBLICATIONS AND PRODUCTS

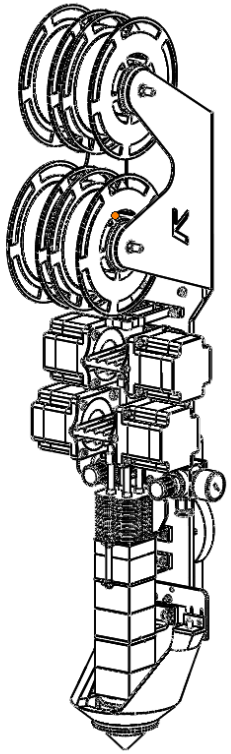
- KREJČIŘÍK, P.; ŠKAROUPKA, D.; PALOUŠEK, D. Free directional robotic deposition - influence on overhang printability. MM Science Journal, 2018, roč. 2018, č. 12, s. 2715-2721. ISSN: 1805-0476.

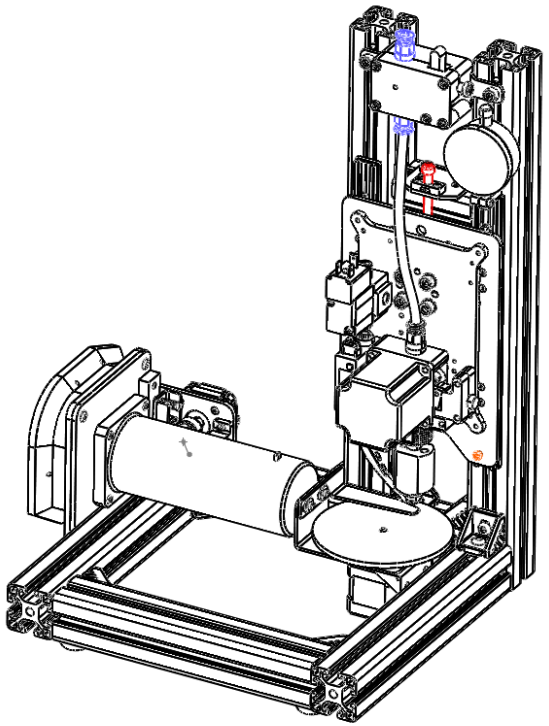
- ŠKAROUPKA, D.; KREJČIŘÍK, P.; Vysoké Učení Technické v Brně: 3D tisková hlava se šnekovým extruderem. 33807, užitný vzor. (2020)
- KREJČIŘÍK, P.; ŠKAROUPKA, D.: Robot Filament Printhead v01; 3D tisková hlava pro robotický tisk plastů ze strunového filamentu. FSI VUT v Brně Technická 2 Brno D5/121. (funkční vzorek)
- ŠKAROUPKA, D.; KREJČIŘÍK, P.; GURÁŇ, R.; JANDÁSEK, M.; HLOŽEK, J.; VODEHNAL, M.: PPE v01; Pneumatický pístový extruder vysoce plněných termoplastů. FSI VUT v Brně Technická 2 D5/121. (funkční vzorek)

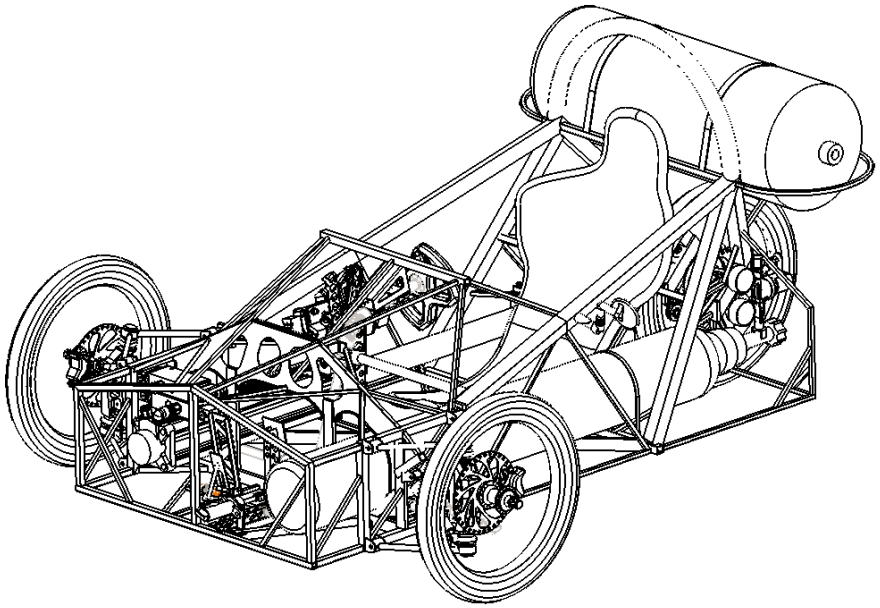
TEACHING

- 3CD (2018/2019)
- ZKP (2018/2019)
- ZIP (2017/2018, 2018/2019, 2019/2020)









INSTITUTE ACTIVITIES

3D Printing laboratory A3/513 + cloud 3DPrinterOS

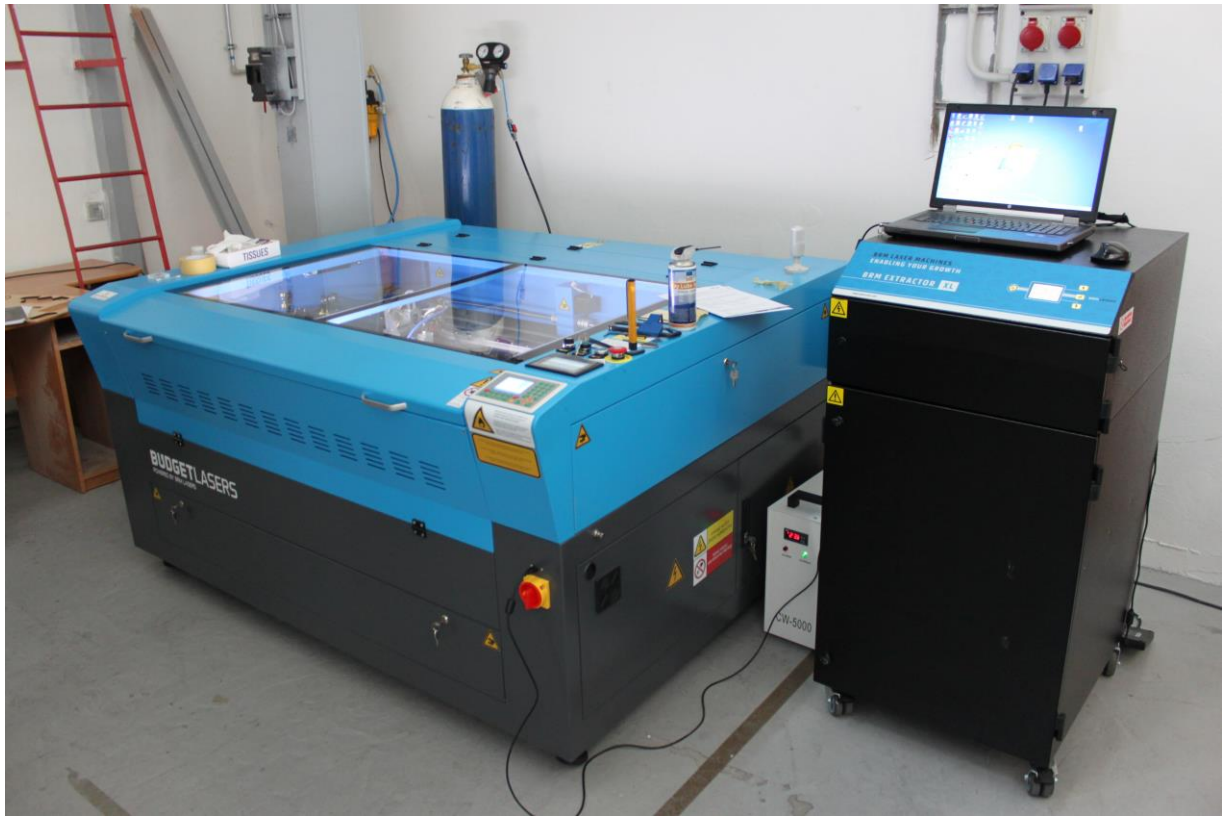
Machine	Ultimaker 3
Nozzle diameter	0,25 mm **0,4 mm** 0,8 mm
Work surface (WxD)	215x215x200 (single nozzle print) 197x215x200 (dual nozzle print)
Materials	**PLA, ABS** Nylon, CPE, CPE+, PC, TPU 95A, PP, PVA, Breakaway
Prices	Research and teaching: 1 Kč/g Private print: 1.46 Kč/g

INSTITUTE ACTIVITIES

Students workshop A3/104

CO2 laser C3/211

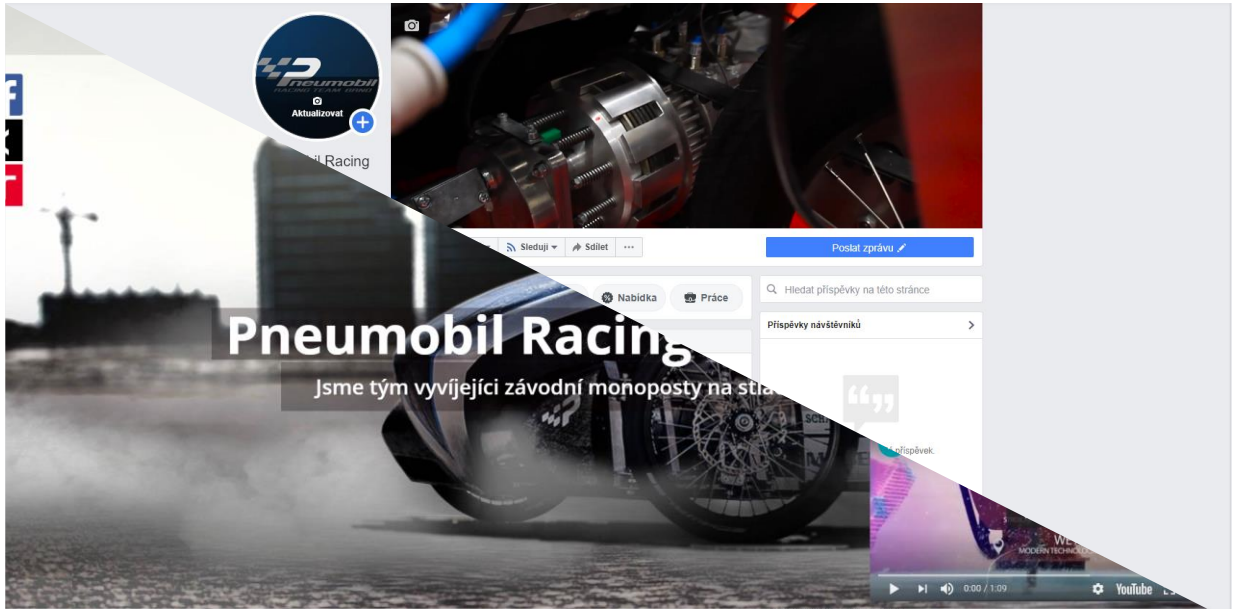
Machine	BRM 90130-X
Laser output	150 W
Work surface (WxD)	1300x900
Materials (metal)	Steel (T max. 1,5 mm) Stainless steel (T max. 1 mm)
Materials (plastics)	Acrylics, perspex, PMMA, Aramid, PETG, PA, PES, PE, PI, POM, PP, PUR, SAN, PS
Material (other non-metals)	Felt and foam, wood, cardboard, cork, leather, MDF, multiplex, packings, paper, textille)

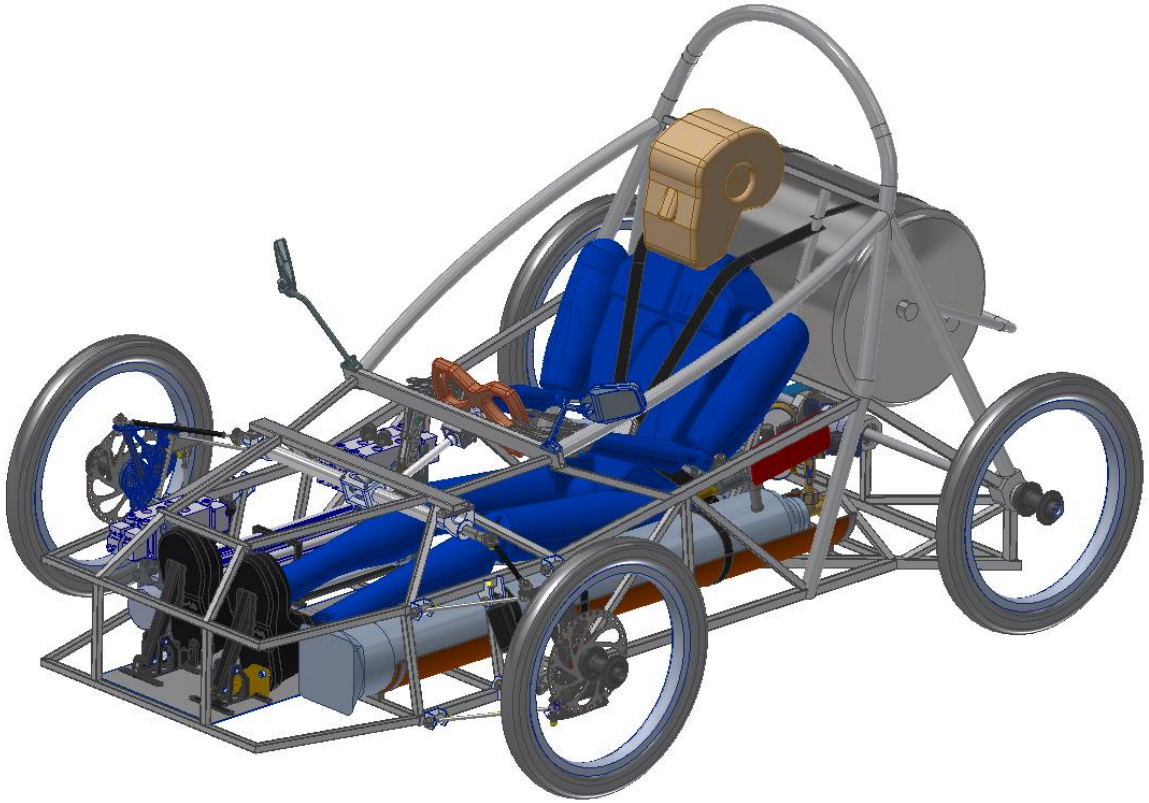


INSTITUTE ACTIVITIES

Pneumobil racing team Brno

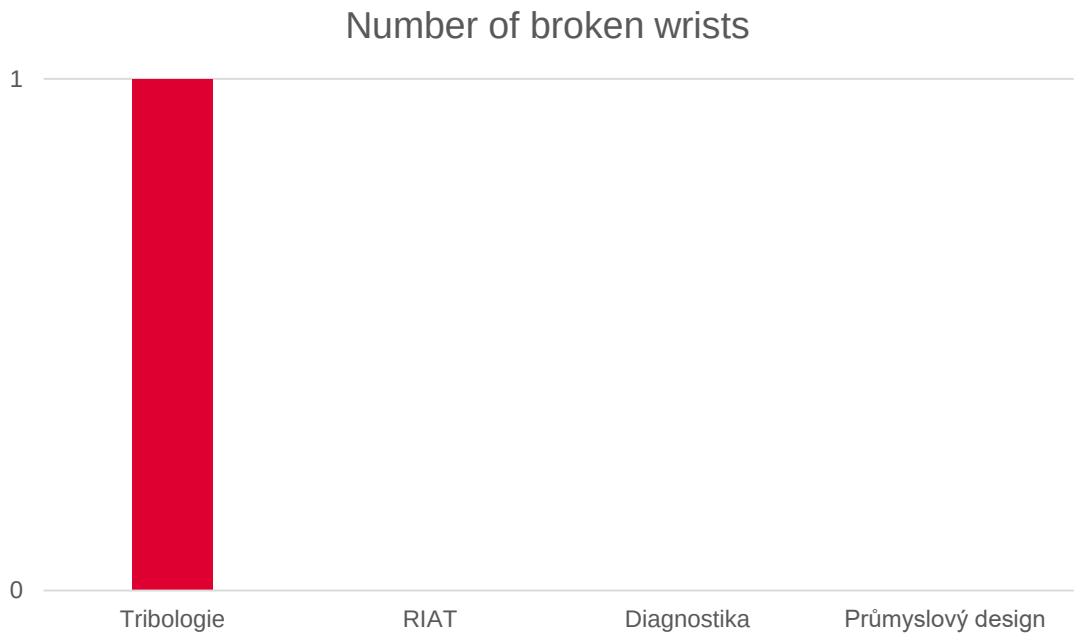
- Website and FB page management
- Vehicles CAD data management
- Communication with race event organizers





INSTITUTE ACTIVITIES

- ÚK football/hockey/floorball



THANK YOU FOR YOUR ATTENTION

Krejčiřík Petr

Petr.Krejcirik@vutbr.cz

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KONSTRUOVÁNÍ

www.**ustavkonstruovani**.cz