CXI TUL

CXI TUL

- The Institute for Nanomaterials, Advanced Technologies and Innovations (CXI) is a research center of the Technical University of Liberec (TUL). Our goal is to contribute to the development of a region traditionally oriented towards technical industries.

- A total of 10 departments focus on solving questions not only in the macro world but also in a world a million times smaller than a millimetre, in which different physical rules apply. The one called the nanoworld.

- Every year, around 80 research projects employ more than 170 scientific, technical and administrative staff. Students also cooperate on research projects here.

RESEARCH DIRECTIONS

Nanomaterials in natural sciences focuse on the R&D, synthesis, behavioral description, and particularly application of advanced materials and nanomaterials, mostly in the field of water treatment, environmental protection and life sciences. This research direction ensures that the innovations contribute to a sustainable and healthier world.

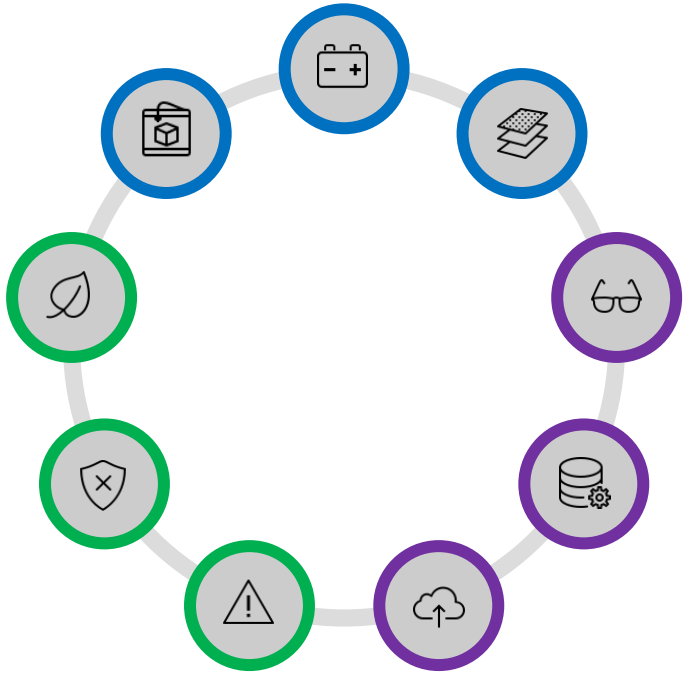
Competitive engineering focuses on the research, development, and application of cutting-edge engineering technologies and structures. We specialize in mechatronic systems, power units, and other machine and vehicle components in view of new approaches. We also excel in progressive methods for processing new materials, including additive technologies. Our innovative solutions are designed to drive progress and efficiency across various industries.

System integration deals with the development of state-of-the-art SW solutions, data processing and integration between systems, cybersecurity and architecture, communication protocols such as 5G, providing communication interfaces for industrial applications. Our expertise covers sensors and electronics, PLCs, robotics, including the use of collaborative robots, cloud application development, big data analytics, machine learning and AI, LLMs, industrial computer vision and others.

RESEARCH DIRECTIONS - COMPETENCES

Autonomous systems
autonomous and cooperative systems
autonomous utility electrovehicle

Additive manufacturing
3D printing including metallic prints and reinforcing by advanced materials



Advanced materials and machines design
the new light-weight and sustainable components, innovative design and systematic planning of technical systems innovations

Augmented reality
collaboration & remote assistance, mixed reality wearables

Green technologies, up-scaling
environmental friendly products, piloting of technologies

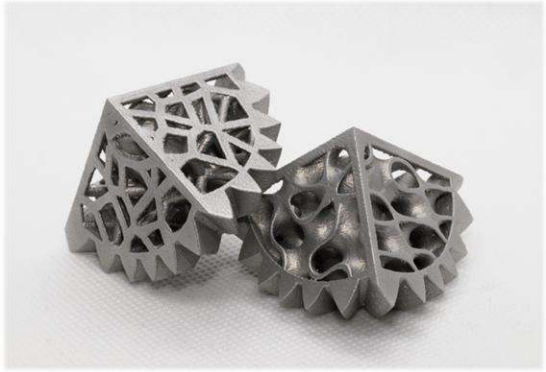
Environmental protection
(waste) water and groundwater treatment, waste disposal, air filtration

BIG DATA, artificial intelligence
big data storage and analysis, machine learning & AI, image and pattern recognition

Risk of nanomaterials, high-tech analysis
environmental risk of nanomaterials, advanced analytical techniques

Industrial IoT
advanced sensors, displays, edge and cloud computing, 5G and SigFox networks

CXI RESEARCH DIRECTIONS

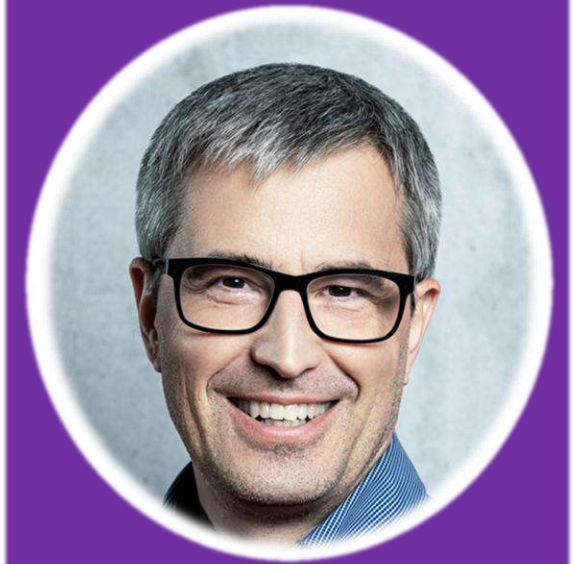


Nanomaterials in natural sciences

Competitive engineering

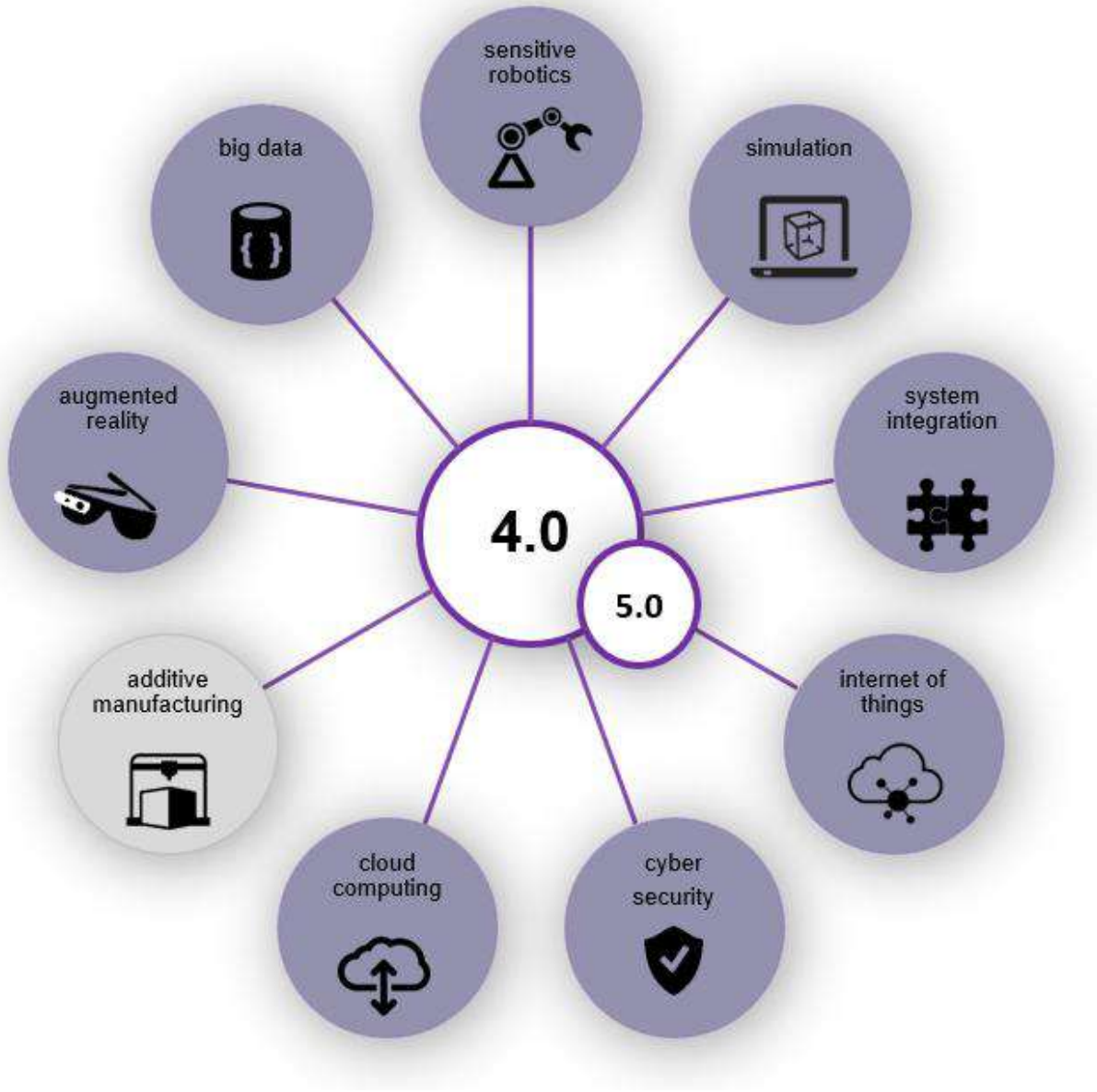
System integration

RESEARCH DIRECTION NO. 3

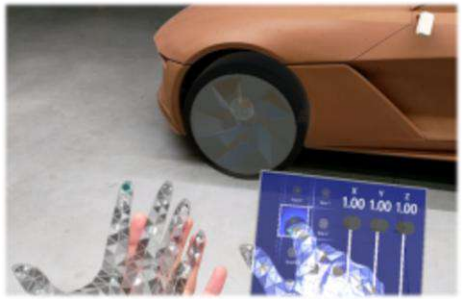


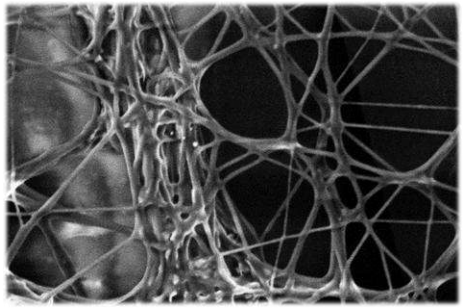
Ing. Jan Kočí
Head of RD3

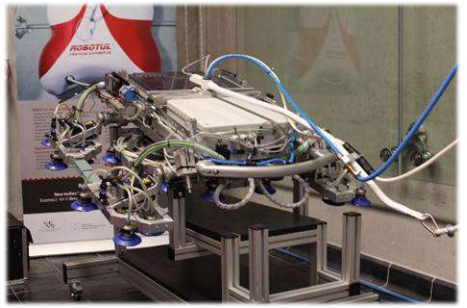
System integration

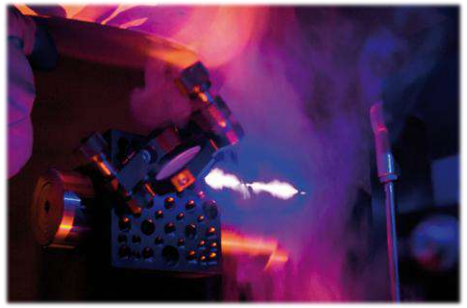


SYSTEM INTEGRATION









DEPARTMENT OF SOFTWARE AND ARTIFICIAL INTELLIGENCE

DEPARTMENT OF HARDWARE AND SENSORICS

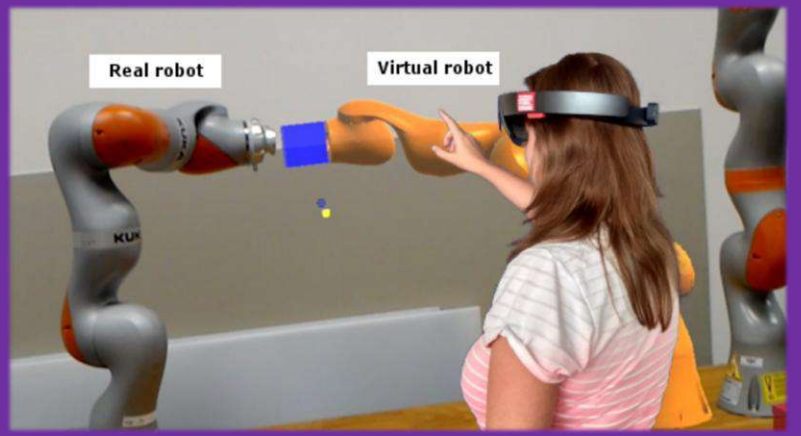
The research direction system integration focuses on research and development of modern software solutions, system solutions for data processing and integration between systems, and the provision of communication interfaces. An integral part of the direction is the field of robotics, including the use of collaborative or sensitive robots. The emphasis is being put on the introduction of state-of-the-art elements of visualization and projection of measured data, including the use of mixed / augmented reality.

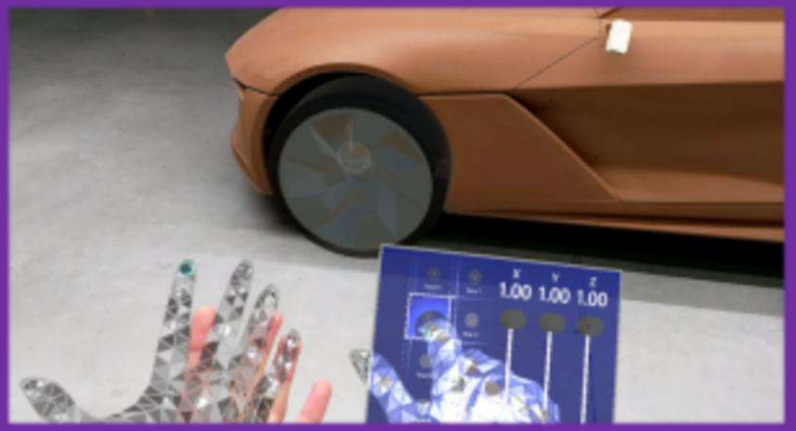
DEPARTMENT OF SOFTWARE AND AI

Ing. Jindřich Cýrus, Ph.D.
Head of OSAI

MAIN RESEARCH ACTIVITIES

- Research and development of modern SW solutions, system solutions for data processing and integration between systems and provision of communication interfaces
- Designing the architecture of SW and HW solutions in target processes using IoT devices, Cloud services and augmented reality
- Industry 4.0 pillars in product design and development
- Process modelling using mathematical, physical and numerical methods or machine learning and artificial intelligence principles
- Robot process automation
- Big data storage, processing and analysis
- Application of a data-driven approach to business/manufacturing processes

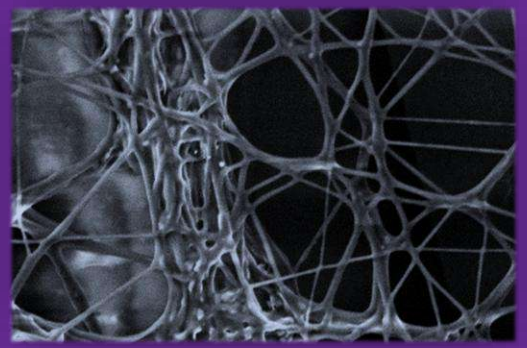




COOPERATION

- Design and application of IoT Technologies
- Use of augmented and mixed reality
- Design and implementation of artificial intelligence algorithms in processes
- Architecture of cloud solutions, image and pattern recognition
- Machine learning and prediction models, data storage, analysis, reporting
- Robotic process automation

DEPARTMENT OF SOFTWARE AND AI



Laboratory of Information Systems

P. Ječmen

- Architecture
- Security
- SW development
- AR development

Laboratory of Process Modelling and AI (LMAI)

V. Chumchal

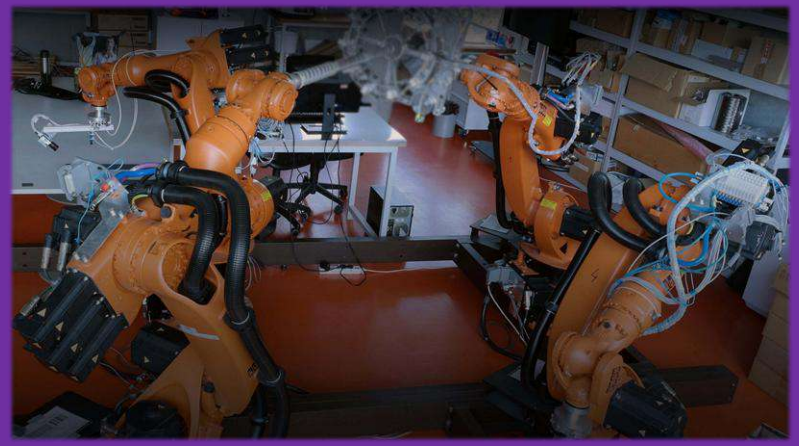
- Data stores
- Bigdata analysis
- ML/AI recognition of audio, video, LLM and chatbots

DEPARTMENT OF HARDWARE AND SENSORICS

doc. Ing. Tomáš Martinec, Ph.D.
Head of OHS

MAIN RESEARCH ACTIVITIES

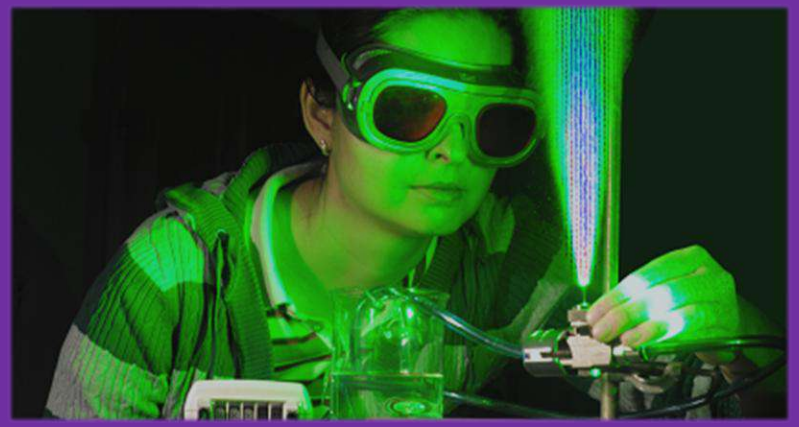
- Innovative research on autonomous service robots
- Development of robotic process workstation sub-assemblies and integration into production lines
- Solution of specific design nodes of industrial robots and their effectors, mechatronic elements of automation technology and peripherals of robotic workplaces
- R&D and use of means and methods for non-contact detection and measurement
- Measurement of physical quantities in industrial technological processes
- Experimental research in fluid mechanics
- Image information processing in the industry



COOPERATION

- Implementation of high-intelligence elements and new materials in robotic and mechatronic systems with multiple degrees of freedom
- Rehabilitation robotics (exercise bikes, medical beds, etc.)
- Development and application of non-contact measurements in industrial applications
  Applications of "Global Imaging Methods" (LDA, PIV, micro PIV, PLIF, IPI)

DEPARTMENT OF HARDWARE AND SENSORICS



Laboratory of Physical Measurements (LFM)

M. Kotek

- Optics and lasers
- Acoustics
- Currents

Laboratory of Mechatronics and Robotics

T. Buchta

- Robotics
- Sensorics
- Electronics
- Communication

PROJECT SOLUTIONS (E.G.)

EDIH

Ing. Jan Kočí

e-mail: jan.koci@tul.cz
tel.: +420 485 353 606

EDIH Northern and Eastern Bohemia

The European Digital Innovation Hub - North and East Bohemia builds on the existing networking of the professional and technological know-how of progressive digitalization activities of its partners, who have long provided services in the field of digital transformation of SMEs and public institutions, innovation, technical education and basic and applied research - all in connection with artificial intelligence and cybersecurity.

Spolufinancováno Evropskou unií

NÁRODNÍ PLÁN OBNOVY

Financováno Evropskou unií NextGenerationEU

PROJEKT **LasApp**

Průlomové laserové technologie pro chytrou výrobu, vesmírné a biotechnologické aplikace

je spolufinancován **Evropskou unií.**

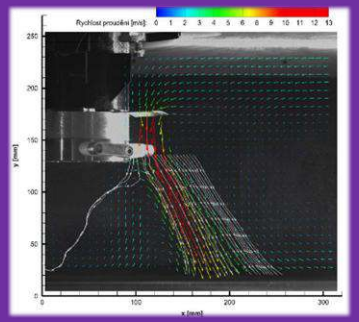
Rozvoj centra vědecké excelence a kompetence v **laserové** technice se zaměřením na vláknové a tenkodiskové lasery a jejich potenciální **aplikace**.

Spolufinancováno Evropskou unií

MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

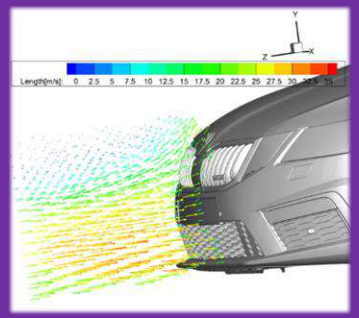
Více projektů podpořených Evropskou unií na **www.mapaprojektu.cz**

PROJECT SOLUTIONS



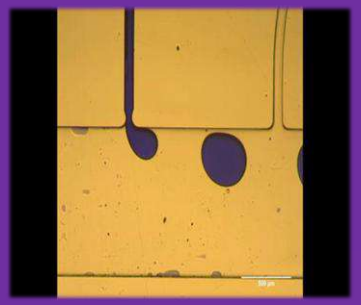
Nano4fibers, Roudnice nad Labem

Micro and nano fibers production – monitoring of the fiber production, investigation of the flow field in the production machine, fiber decomposition, CFD verification



ŠKODA AUTO, Mladá Boleslav

Characterization of the water droplet spray coming to the car front and engine’s air suction inlet



Grade Medical, Praha

Development of fluidic micro-chips for drug delivery, controlled droplet production, measurement and suspension analysis

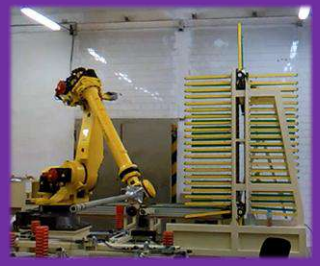
Aveton, Praha

Design and measurement of acoustic elements and structures, application of nanofiber membrane resonator, development of specific acoustical elements, acoustic measurements

PROJECT SOLUTIONS

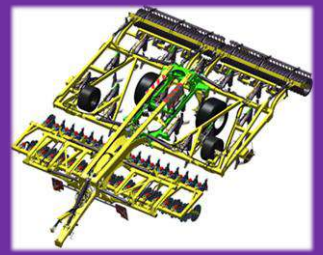
Kanfit Ltd., Israel

Development of robotic winding technology for the production of composite frames for the aviation industry



Carlex Glass Luxembourg S.A., Grevenmacher

Robotic production line for glass finishing with automatic quality check using IoT sensors, robot vision, 2D vision and 3D vision



BEDNAR FMT, Rychnov nad Kněžnou

Autonomous IoT unit including energy havesting for remote supervision of trailed agricultural machinery, monitoring the current state of the machine and evaluating possible critical conditions during its use

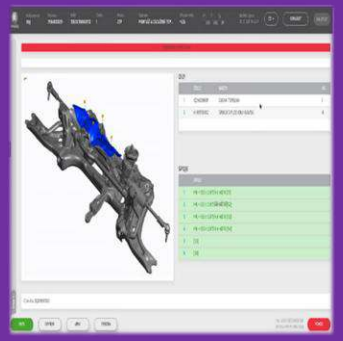
Saint-Gobain Sekurit, Hořovice

Measuring station for quality control of the production of 2D and 3D glasses for the automotive industry, sensors and data control

PROJECT SOLUTIONS

SVOTT, Mladá Boleslav

Product design optimization using AR techniques.
Programming apps for HoloLens.

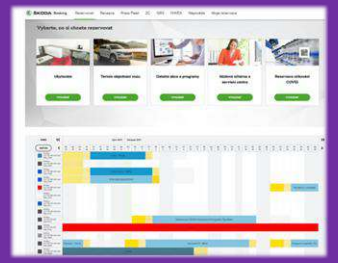


ŠKODA AUTO, Mladá Boleslav

Design and implementation of a modular system for visualization on an automotive assembly line.
Development, integration and management of IIoT-based hardware and sensors.

Systematic, Praha

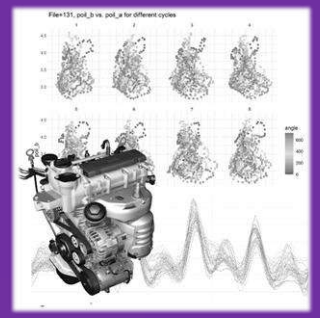
Development of the management and IoT sensors, control system for the fully automated robotic warehouse with planning, visualisation and simulation modules for capacity and throughput testing using AI algorithms



ŠKODA AUTO, Mladá Boleslav

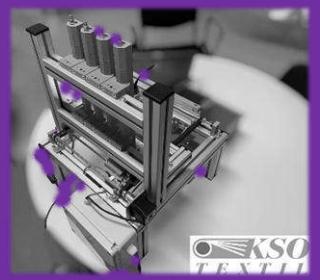
Universal reservation system development and management for a customer centre, meeting reservations, training, health and prevention programs, personal agenda, accountancy, and personal car management for journalists

PROJECT SOLUTIONS



ŠKODA AUTO, Mladá Boleslav

Data-driven design, preparation of digital-twin using AI for combustion engine oil management and its optimization



KSO Textil, Zittau, DE

Industrial vision and AI based automated quality check of textile machine device, replace manual work, increase productivity

DREVOPLAST Ludvík, Všelibice

Advanced raw material planning using ML and AI for plastics injection molding automotive SME company

ŠKODA AUTO, Mladá Boleslav

AI driven expert system for online analysis of the vibrodiagnostics data, PoC for integration platform and maintenance GUI

INSTITUTE FOR NANOMATERIALS,
ADVANCED TECHNOLOGIES
AND INNOVATION TUL

RESEARCH ON THE TOP

Studentská 1402/2 | 461 17 Liberec | e-mail: cxi@tul.cz | web: https://cxi.tul.cz