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Priority Research Areas

Process automation and Industry 4.0

Part II

Gliwice 29/10/2020

POB5 - Process automation and Industry 4.0

Part II

- Digitization and information technologies (including the processing of large data set, cloud computing, cubersecurity, the Internet of Things, Industrial Internet of Things)

- **Simulation and modeling of processes (including industrial processes)**

POB5 - Process automation and Industry 4.0

Part II

B. Simulation and modeling of processes (including industrial processes)

Representative of the Research Team			Faculty
Prof.	Dariusz	Bismor	WAEiI
Prof.	Krzysztof	Gromysz	WB
Prof.	Tomasz	Krykowski	
Prof.	Jacek	Pieprzyca	WIM
Prof.	Damian	Krenczyk	WMT
PhD.	Arkadiusz	Kolka	
Prof.	Andrzej	Sokołowski	WMT
Prof.	Mariusz	Szczygieł	WEI

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SIMULATION AND MODELING OF PROCESSES (INCLUDING INDUSTRIAL PROCESSES)

MODELLING, SIMULATION AND CONTROL OF PROCESSES

Dariusz Bismor, Tomasz Grychowski, Karol Jabłoński

Faculty of Automatic Control, Electronics and Computer Science

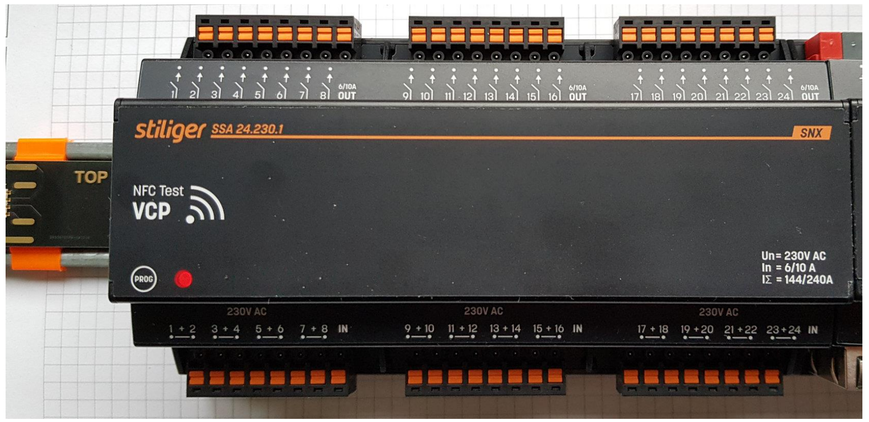
Ongoing tasks

- Matlab/Simulink simulations and control in teaching:
  - circular evaporator,
  - chemical reactor,
- Control system programming:
  - modelling of discrete plants,
  - programming, tuning and simulation of PID and MPC controllers,
  - object-oriented programming in C++ language,
- Heat pumps and floor systems control
- HVAC systems control
- The Stiliger project

The Stiliger project

- Project objective: design a line of devices for smart buildings
- Ordering institution: Stiliger Sp. z o.o. company, value: 325,000 PLN (part 1) + 195,000 PLN (part 2)
- Team task: design and create software for HVAC systems control, using the Node-RED environment, with implementation in dedicated microcontroller
- Implementation by: designing a building simulator in Matlab/Simulink, creating a GPC algorithm in C++, migration to a microcontroller, *hardware-in-the-loop* tests, and real environment tests in residential building

The Stiliger project



Cooperation:

- Stiliger Sp. z o.o.
- Intelis Sp. z o.o.
- Future Processing Instruments
- Spectrum Krzysztof Czyz

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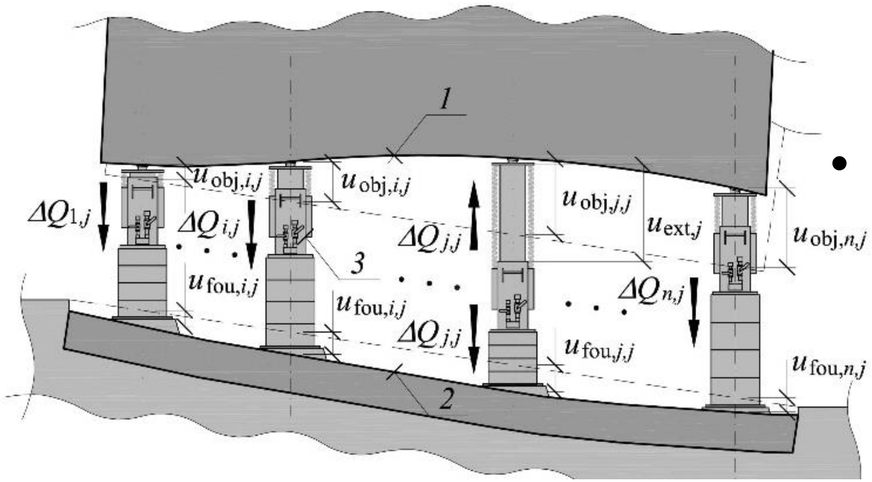
SIMULATION AND MODELING OF PROCESSES (INCLUDING INDUSTRIAL PROCESSES)

Krzysztof Gromysz, Maciej Górski, Marcin Kozłowski, Tomasz Krykowski

Faculty of Civil Engineering

Control of rectification of building objects – RB2

dr hab. inż. Krzysztof Gromysz, prof. PŚ



- Building object rectification consists in placing a system of hydraulic jacks in the walls of the building. Then, with their help, the building is raised unevenly.
- The planned control of rectification will consist in setting the pistons stroke of the jacks, while taking into account the in the value of forces in these jacks.
- The first aim of the research is to identify the parameters describing building during rectification by formulating a mathematical model of the object.
- The next stage of the research is to develop a control method, taking into account the minimization of the necessary power of the hydraulic system and the deformations of the structure elements.

Robotic tools for diagnostics of structures with use of drones, robots and BIM technology - RB6

Marcin Górski, PhD; Rafał Białozor, MSc; Eryk Goldmann, MSc

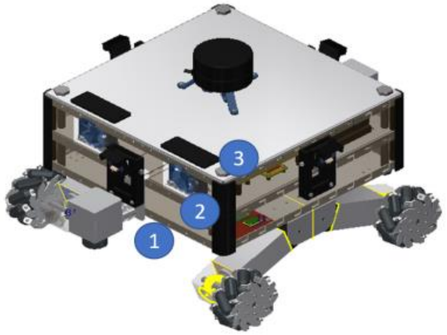
Projects *Inkubator Innowacyjności 2* and *POWER 3.5*

Patent

R. Czyba, R. Białecki, M. Górski, W. Adamczyk,
Z. Ostrowski, G. Przybyła

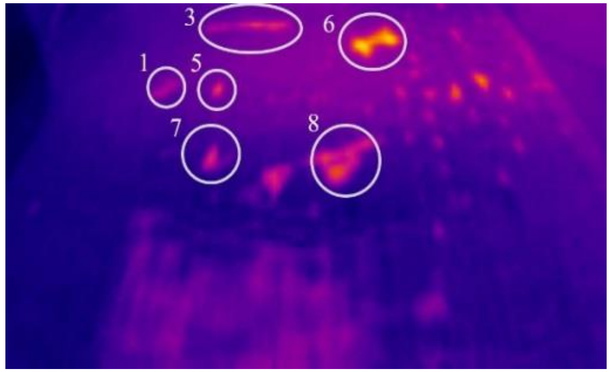
no: **P. 425878,** *no:* **P.425877,**

no: **P. 423709 (+ EP18000933)**



Mobile diagnostic platforms

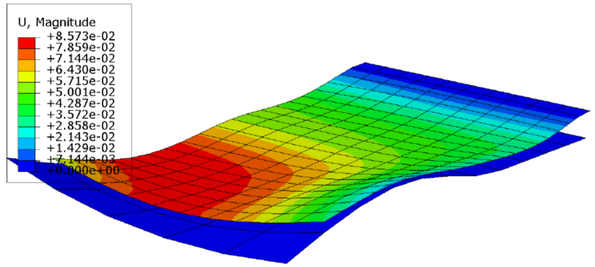
Adamczyk W., Górski M. et al. Application of numerical procedure for thermal diagnostics of the delamination of strengthening material at concrete construction. International Journal of Numerical Methods for Heat & Fluid Flow, 2019

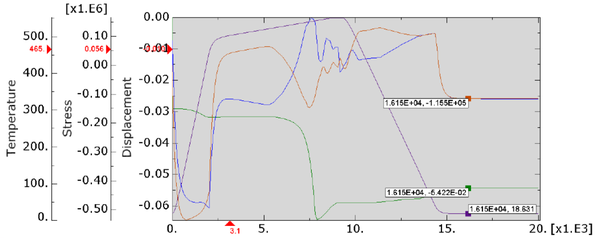


IR tests of RC elements strengthened with FRP

3D Glass slumping technology - RB6

Dr hab. inż. Marcin Kozłowski





Modification of the parameters of the slumping process in order to reduce thermal residual stresses and improve the final geometry of the 3D glass panes

- Basic research on glass (thermal and mechanical properties) in the temperature range from +20°C to + 550°C
- Experimental research and numerical simulations of 3D glass slumping technology

Cooperation with dr hab. inż. Wojciech Sumelka, prof. PP, MSc. Andrzej Malewski (PP) and PRESSGLASS S.A company.

Source: A. Malewski, PRESSGLASS

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SIMULATION AND MODELING OF PROCESSES (INCLUDING INDUSTRIAL PROCESSES)

Jacek Pieprzyca

Faculty of Materials Engineering

Laboratory of Modeling Research. There are conducted research in the field of physical modeling and numerical simulation of hydrodynamic phenomena occurring during industrial processes, in particular during smelting, secondary metallurgy and casting of liquid steel. The laboratory is equipped with water physical models of metallurgical reactors and an extensive control and measurement apparatus. Numerical simulations are carried out using the specialized ANSYS Fluent software.

Mariola Saternus
Tomasz Merder
Bogdan Panic
Jacek Pieprzyca

POiR.01.01.01-00-0610/18 pt „Development of a new technology of deep refining of steel in the process of secondary metallurgy and casting in a tundish, enabling an increase in the degree of steel purity "together with Cognor S.A. Ferrostal Łabędy.

MAJOR REALIZED RESEARCH PROJECTS

N N508 589839

Physical modeling of hydrodynamic phenomena occurring during the processes of blowing steel with inert gases and vacuum treatment

11/020/GEK15/0031-02 (GEK/2/RM2/2015/513)

Innovative technology of processing wire from used tires into a full-value product in the metallurgical process

PBS/A5/32/2013

Innovative and pro-ecological technology of secondary metallurgy, continuous casting and rolling of new types of high-carbon steel wire rod with increased plasticity for cold deformation in continuous rolling mills with multi-stage cooling.

AGH in Krakow,
Czestochowa University of Technology,
Łukasiewicz Research Network:
Institute of Ferrous Metallurgy
Institute of Refractory Materials,
VSB - Ostrava
VŠTE - Ceske Budejovice
ArcelorMittal
Ferrostal Łabędy

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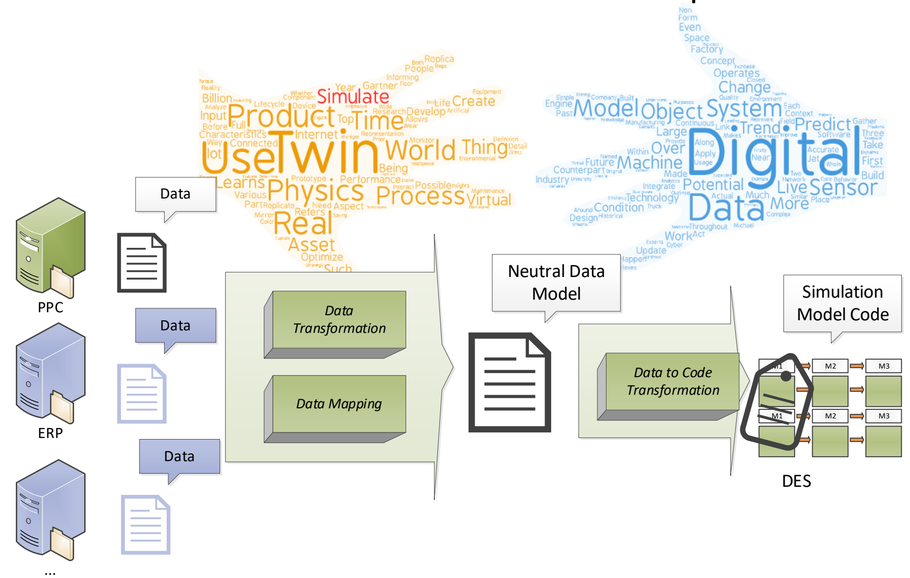
SIMULATION AND MODELING OF PROCESSES (INCLUDING INDUSTRIAL PROCESSES)

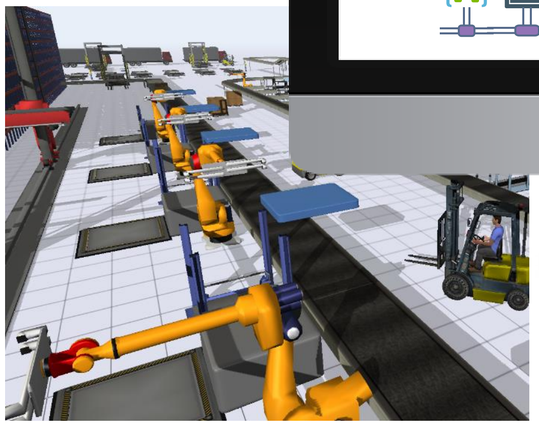
Bożena Skołud, Andrzej Sokołowski

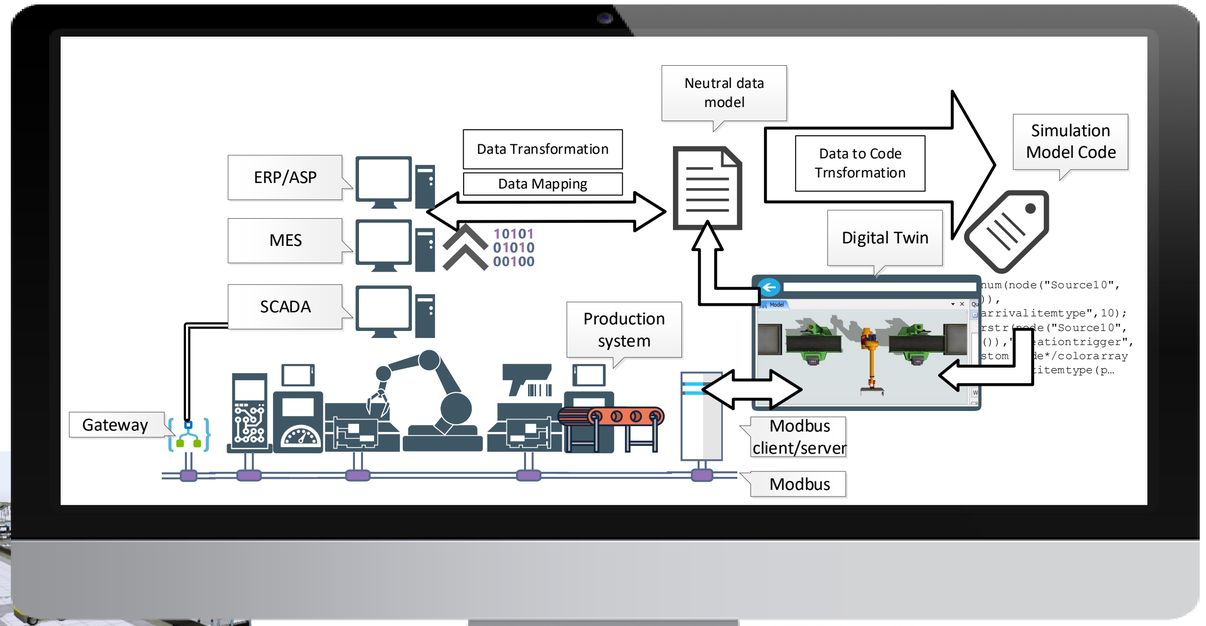
Faculty of Mechanical Engineering

Simulation models as digital twins of production systems based on data from multiple sources

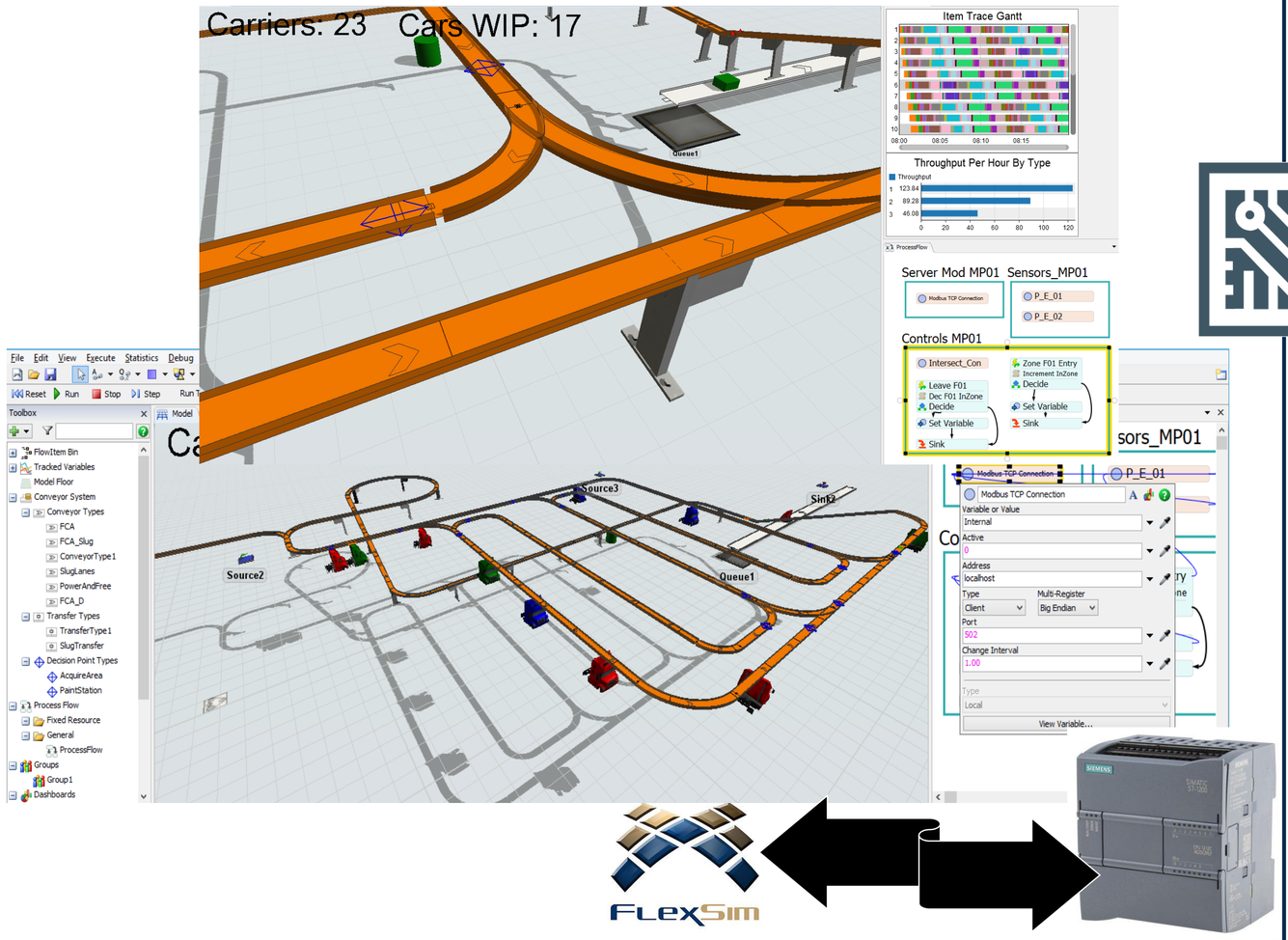
The conducted research activity focuses on the development of automatic generation methods of production system simulation models and the use of computer simulation systems in the implementation of a digital twin. In the context of simulation modeling, these methods allow increasing the level of data integration from the *Digital Model* level, through *Digital Shadow*, to *Digital Twin*. The developed method of creating and updating dynamic simulation models is based on a hybrid parametric approach that integrates data from multiple sources in order to automate the creation and update of simulation models.





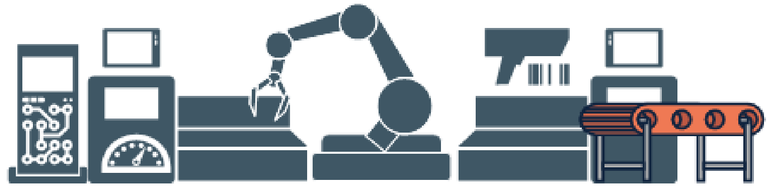


CURRENT RESEARCH:



RESEARCH WORKS:

- Analysis and optimization of the production line. Simulation studies.
- Analysis and optimization of the assembly line along with software generators for working time parameters of asynchronous stations. Simulation studies
- Analysis and evaluation of the possibility of introducing a new vehicle type along with adjusting the flow logic in simulation models..



RESEARCH DEPARTMENT:

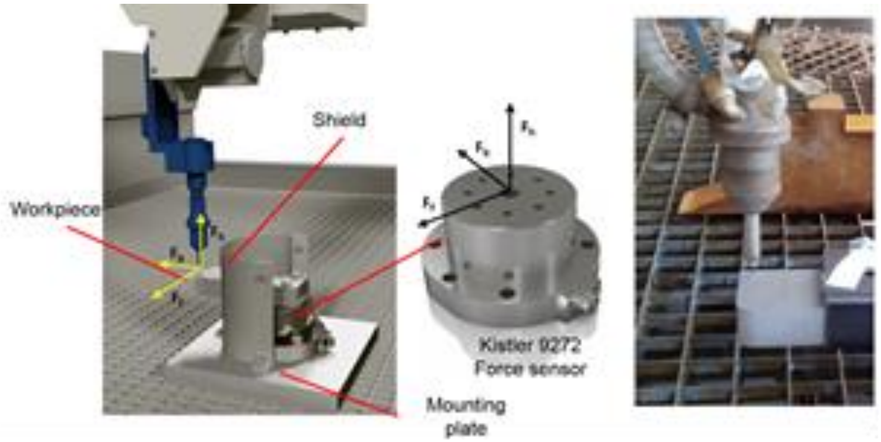
- Katedra Automatyzacji Procesów Technologicznych i Zintegrowanych Systemów Wytwarzania
  Wydział Mechaniczny Technologiczny

COORDINATOR:

- PhD, DSc, Eng Damian Krenczyk

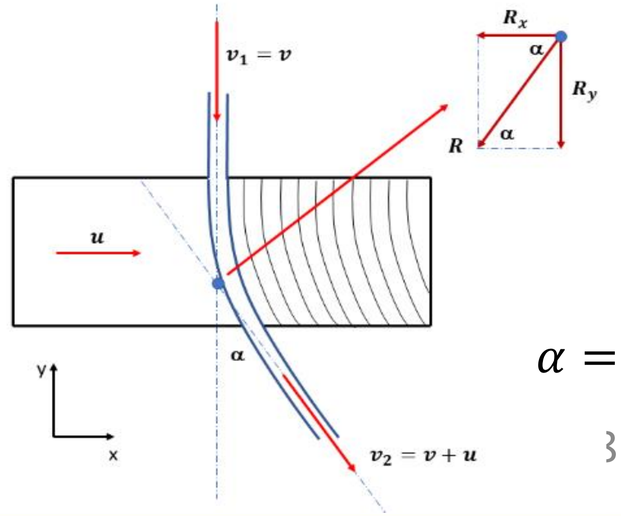
Model of forecasting the cutting jet deflection angle in the AWJM process

The registration of the value of force interactions during the cutting process allows to determine the value of the deflection angle of the abrasive water jet. Knowing the value of the deflection angle makes it possible to control the topography of the surface after cutting.



The force measurements were made with a Kistler model 9272 force sensor with a Kistler 5020A piezoelectric amplifier and a PC computer equipped with a NI USB 6211 measurement card.

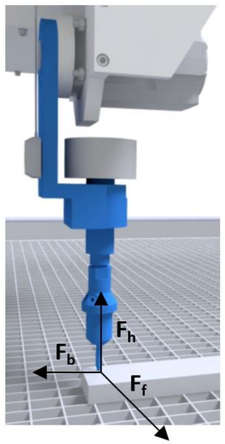
The method consists in measuring force interactions in real time and the developed mathematical model using selected components of cutting forces to determine the deflection angle of jet by abrasive waterjet method. The cutting waterjet angle directly relates to the deflection of marks after cutting porcess on the machined surface, i.e. the striation angle.



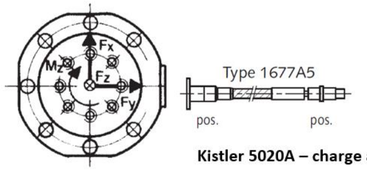
$$\alpha = arc\ sin \frac{\rho Q u + F_f}{\rho Q (v + u)}$$

$$\alpha = arc\ cos \frac{\rho Q u - F_h}{\rho Q (v + u)}$$

Model of forecasting the cutting jet deflection angle in the AWJM process



Kistler 9272 piezoelectric
4 axis force sensor

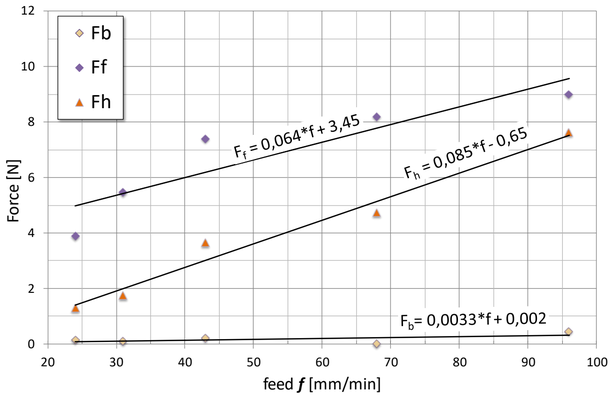


Kistler 5020A – charge amplifier

computer NI PXI + multi IO PXI-6230

Measurement path for recording force interactions

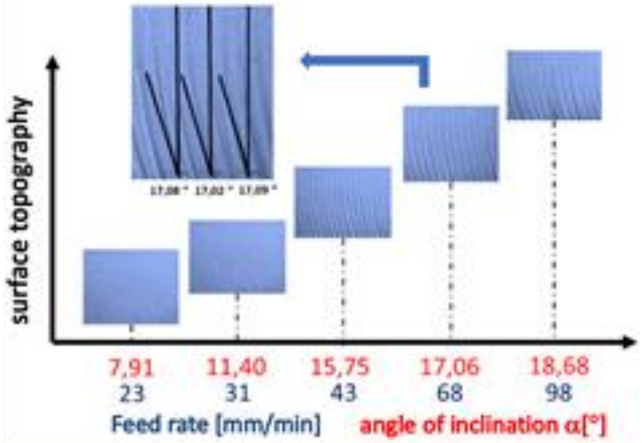
The function of changing the force interactions depending on the parameter of the cutter head feed speed



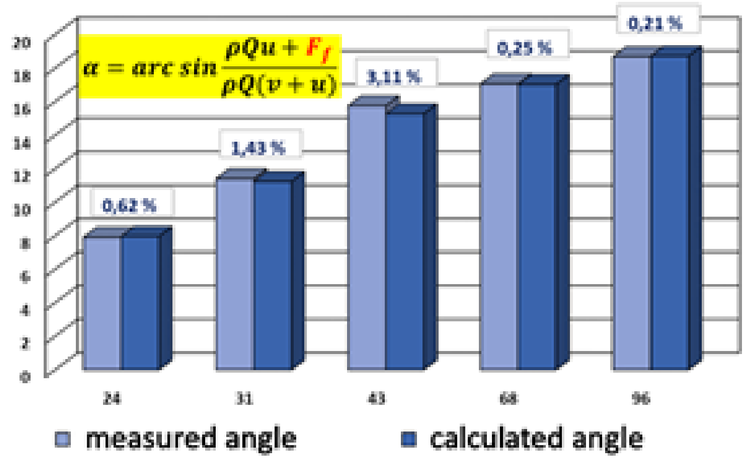
$$\alpha = arc\ sin \frac{\rho Q u + F_f}{\rho Q (v + u)}$$

Model forecasting the value of the abrasive waterjet deflection angle

Model verification - experimental measurements of the angle of striation on the machined surfaces



Comparison of test results

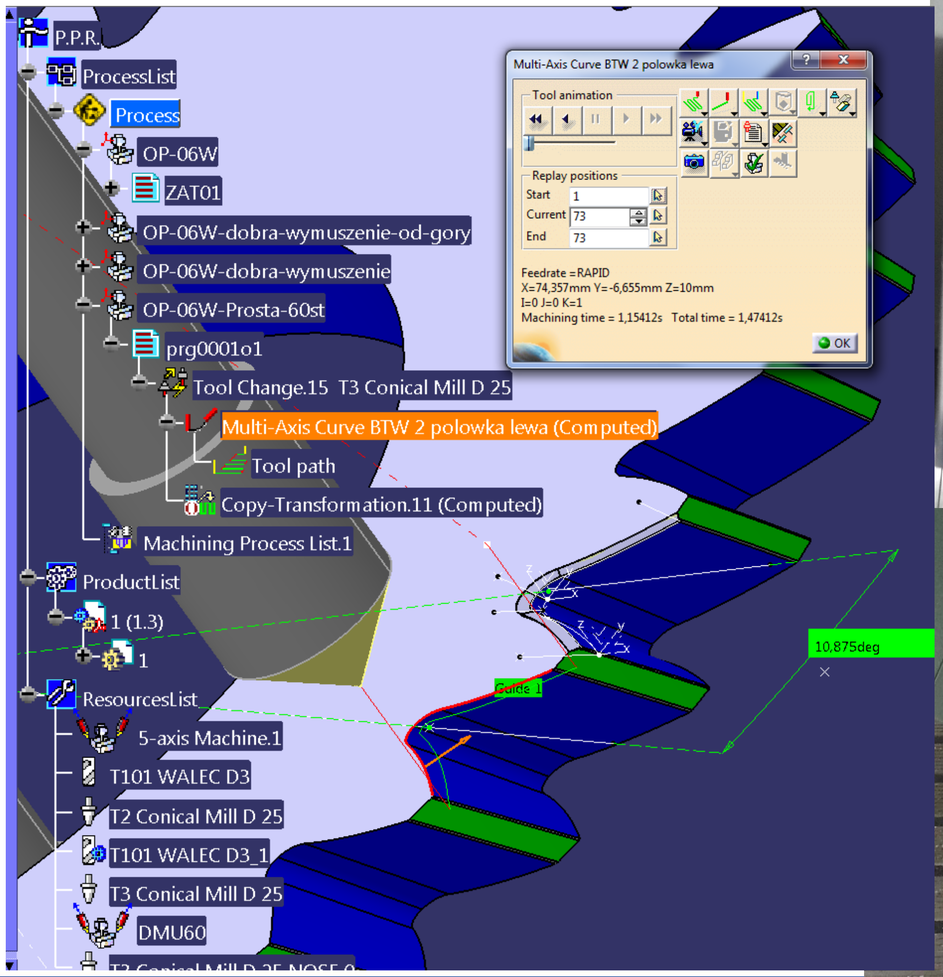


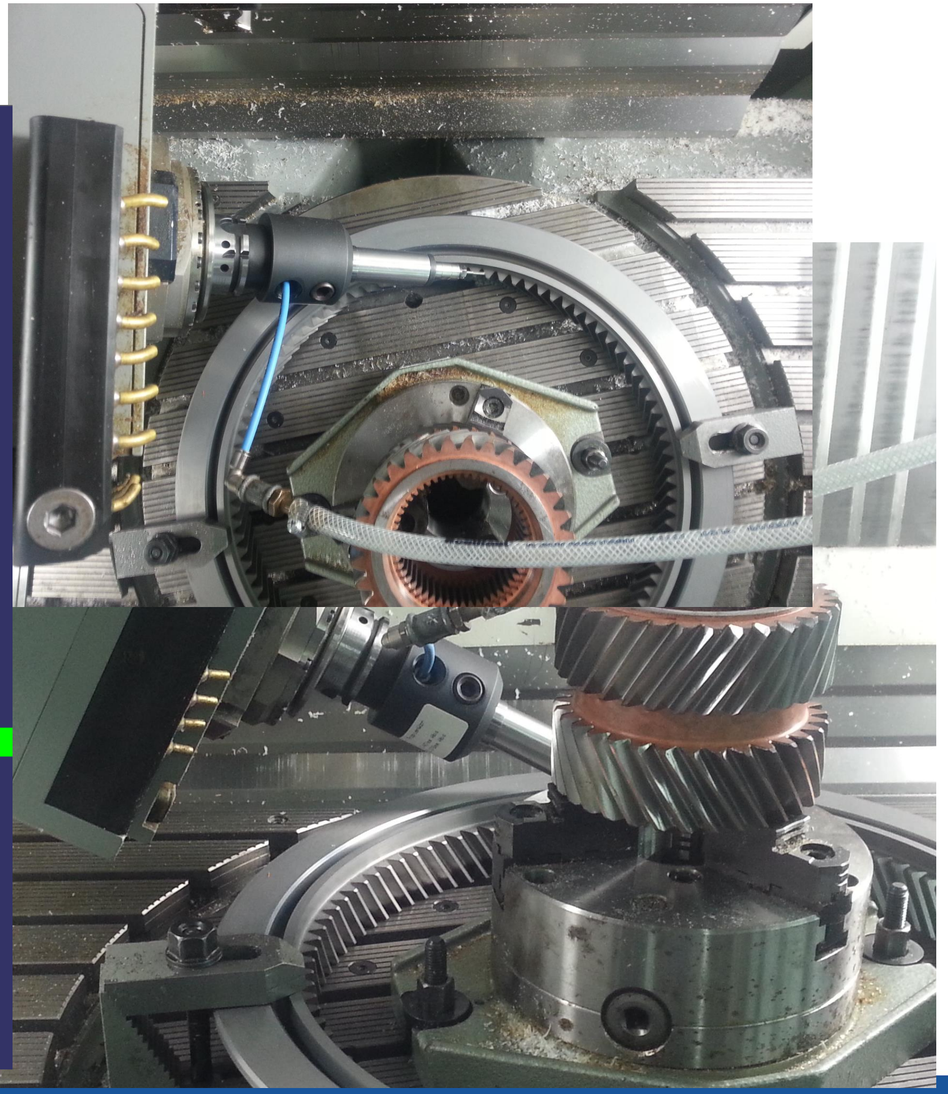
Chamfering of tooth gears for airspace industry

Process designing:
CATIA – Dassault Systems.

Specialized postprocessor preparation

Machning:
Department of Machine Technology (RMT7)





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SIMULATION AND MODELING OF PROCESSES (INCLUDING INDUSTRIAL PROCESSES)

Marcin Szczygieł

Faculty of Electrical Engineering

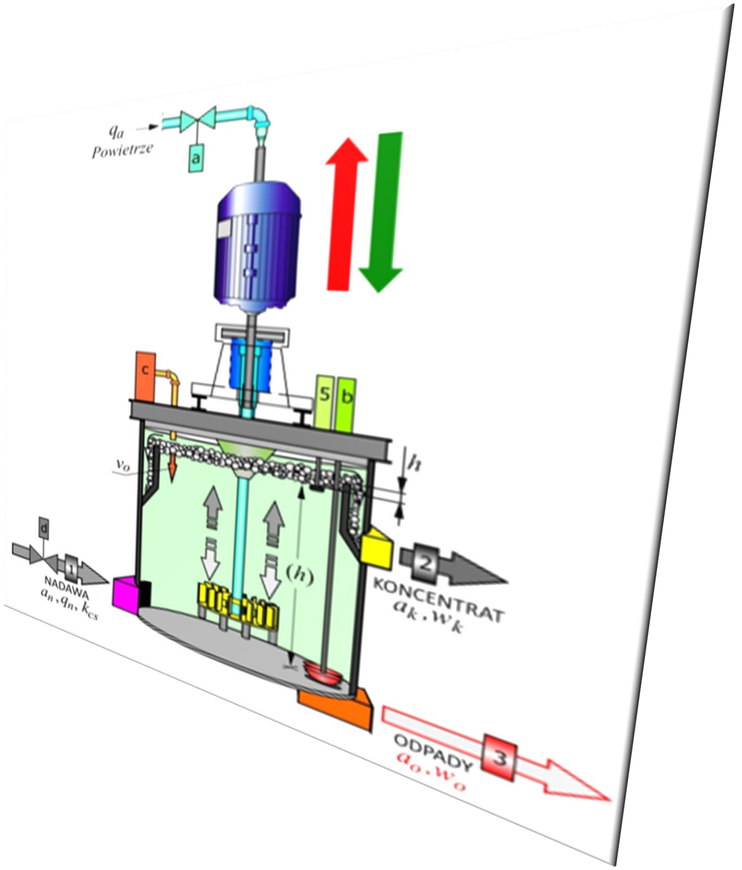
- **INCREASING THE EFFICIENCY OF THE MINE FLOTATION PROCESS THROUGH THE APPLICATION OF A ROTARY-LINEAR MOTOR**

Project goals:
Research related to increasing the efficiency of the flotation process through new solutions of drive systems

Issues:
- **Introduction of the rotational-linear motion of the aerator**
- **Determination of the control algorithm**

Research team:

Department of Mechatronics RE
Department of Electrical Engineering and Automation RGIBiAP

Patents:
Patent - Device for flotation of minerals

Beneficiary:
Coal and metal ore mining companies