

## SPECIALIZATION

# MECHATRONICS of CONSTRUCTION MACHINERY

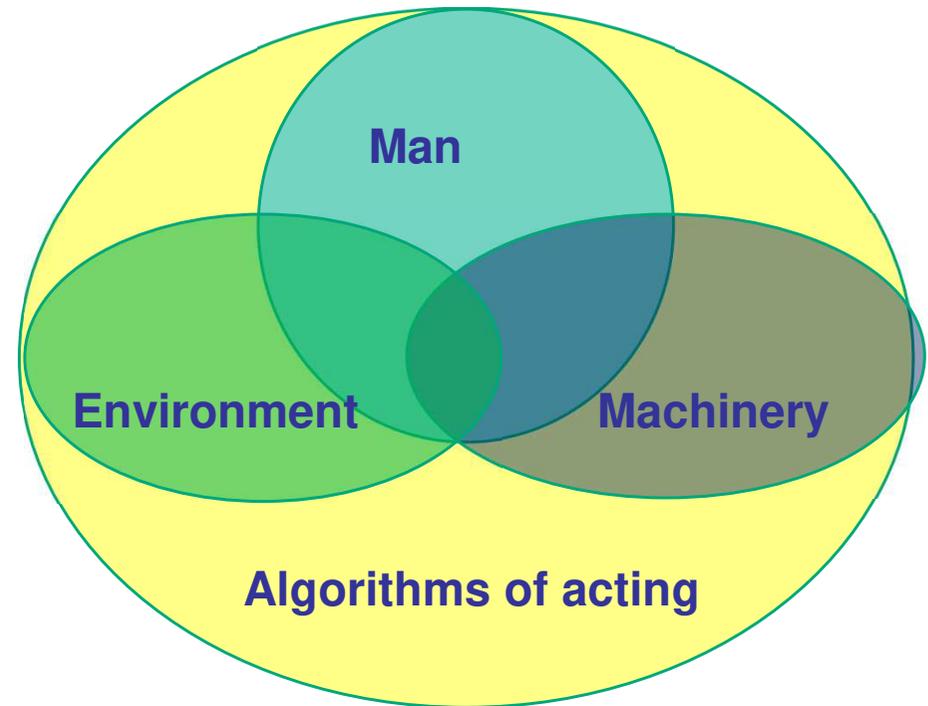
Tutor of the specialization: Tomasz Mirosław (Ph.D.)



# SPECIALIZATION – MECHATRONICS of CONSTRUCTION MACHINERY

## PROBLEMS of SPECIALITY:

- Objects – construction machinery
- Functional modelling
- Modelling of dynamic processes
- Deriving systems (hydraulic, pneumatic, electric, ICE, Hybrid)
- Control, and sensor systems
- Machineries Cooperation systems
- Human Machines Interfaces
- Operator support and training
  - Sensorics and communication systems
  - Machinery simulators
  - Virtual and augmented reality In HMI
- Remote control
- Automatisation of machineries



Mechatronics of construction machineries'  
The interdisciplinary (science) skill of  
environment, machinery and human  
integration

## **WHY SHOULD YOU CHOOSE THIS SPECIALITY?**

- The field of working /construction machines is one of the fastest growing industries (market value comparable to the "Automotive" market).
- Mechatronics of Working Machines covers a wide spectrum of problems: from the mechanical structure of the machine to biomechanical systems and the psychophysical system of the operator.
- Prepares you to solve a wide range of problems –which will be met in technology soon.
- Universal rules of conduct in the design and management of the operation of machines and other devices and systems.
- There is a shortage of specialists (market demand for specialists).

# SPECIALIZATION – MECHATRONICS of CONSTRUCTION MACHINERY

## specialization SUBJECTS

No	Sem	Subject	Lecturer
1	6	<b>Automation of Construction Machinery and Equipment (2hLec, 1hLab)</b>	Tomasz Mirosław (Ph.D)
2	6	<b>Construction Machinery (2hLec, 1hLab)</b>	Jan Maciejewski (D.Sc., Ph.D.)
3	6	<b>Passenger Lifts (1hLec, 1hLab)</b>	Artur Jankowiak (Ph.D.)
4	7	Basics of Electro-Mechanical Hybrid Drives (2hLec)	Piotr Piórkowski (Ph.D.)
5	7	Basics of Modeling and Control of Construction Machinery and Equipment (2hLec)	Tomasz Mirosław (Ph.D.) Dariusz Dąbrowski (M.Sc.)
6	7	Systems for Monitoring Construction Machinery and Equipment (2hLec)	Tomasz Mirosław (Ph.D.) Adam Zawadzki(Ph.D.)

## specialization SUBJECTS

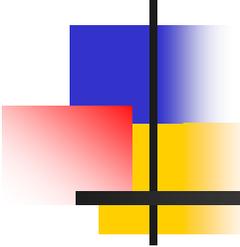
- **Automation of Construction Machinery and Equipment** (Lec. 30h, Lab. 15h)

### Lecture's topics:

- Aims and manifestations of construction machinery and equipment automation.
- Metodyka automatyzowania pracy MR.
- Rules for preparing functional models of construction machinery and equipment.
- Examples of building functional models: digger, loader, bulldozer, grader, scrapper, gantry crane, passenger lift, tower crane, tractor and forklift.
- Rules for dynamic modelling of construction machinery and equipment.
- Building digital models of control and supervision systems.
- Configuring measurement and control tracks.
- Rules for creating algorithms of digital control.
- Communication between operator and a machine.

### Laboratory's excercises:

- Adjusting systems – choice of parameters and frequency characteristics of dynamic systems.
- Didactic model of manipulator, trajectory, controllers, controller settings.
- PLC programming.
- Interface of construction machine operator.
- Automatic control of pull shovel equipment.



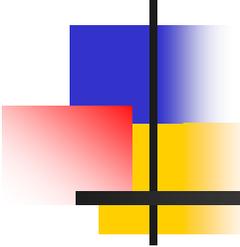
# SPECIALIZATION – MECHATRONICS of CONSTRUCTION MACHINERY

## specialization SUBJECTS

- **Construction Machinery** (Lecture 30h, Laboratory 15h)

### Lecture's topics:

- Presenting a group of construction machinery and discussing problems related to their influence on ground mediums and rocks. Classification of construction machinery. Production of machines for ground works. Statistical data.
  - Geomaterials as working environment for construction machinery. Physical and mechanical properties of ground and rocks. Laboratory methods of establishing strength of mediums. Methods of establishing strength of mediums within deposits. Analysis of chosen ground and rock mining processes. Methods of establishing mining resistances.
  - Machines for mining and transporting ground masses. Construction details of main systems. Kinematics of construction machinery operation – kinematic schemes of excavators, loaders. Work field of construction machinery. Stability of construction machinery. Determining available and restraining forces in the breakout process.
  - Designing equipment for construction machinery. Basics of design of mechanisms powered by hydraulic cylinders. Powering mechanisms of an excavator (extension arm, arm, bucket). Powering mechanisms of loader, bulldozer, grader, scrapper
  - Mechanisms of body rotation (construction of mechanisms of body rotation of excavators, the course of rotation process, movement equation, selection of mechanism parameters).
  - Chassis systems of construction machinery. Cooperation between road wheels and tire chassis system with ground medium. Cooperation of caterpillar and caterpillar systems with ground medium. Defining resistances of forces and towing power force. Chassis construction, power train transmission systems.
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# SPECIALIZATION – MECHATRONICS of CONSTRUCTION MACHINERY

## specialization SUBJECTS

- **Construction Machinery** (Lecture 30h, Laboratory 15h)

### Lecture's topics, c.d:

- Overview of construction solutions for basic construction machinery: - excavators (single-bucket hydraulic excavators, hydraulic mini-excavators, single-bucket cable excavators, multi-bucket excavators). - traction (caterpillar and wheel) machines for mining and transporting ground masses (graders, crushers, wheel loaders, bulldozers, rippers). - multi-function traction machines (excavator-loaders, excavator-bulldozers). - machines for compacting soil masses - machines for making holes and gaps - machines for paving and regenerating paved surfaces (concrete and asphalt). - materials for crushing construction materials - materials for handling ground mediums, rocks: dump trucks, conveyors (belt, bucket, vibrating).
- Automation of construction machinery. Operator support systems. Systems monitoring basic operation parameters and equipment location of a machine. Trends in construction machinery development.

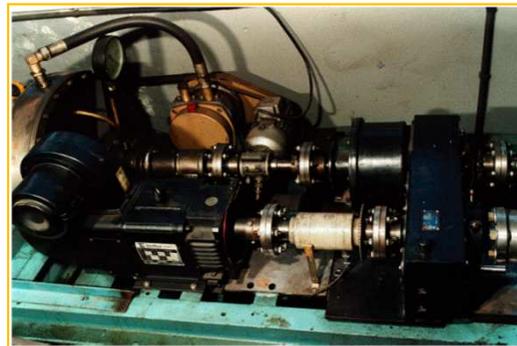
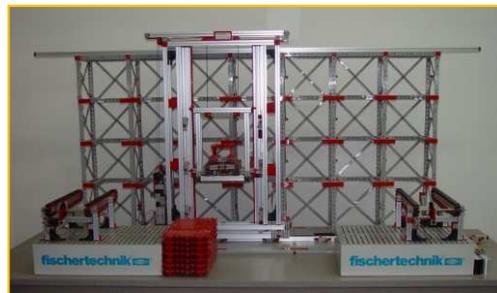
### Laboratory's exercises:

- Study of crushing processes in a model jaw crusher.
- Soil-Tool interaction,
- Excavator - digging process.
- Hydraulic cylinders in construction machinery, part 2.
- PLC controllers programming.
- Vibrating conveyor.

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## LABORATORIES of:

- Mechatronics
- Construction machinery
- Passenger lifts
- Logistics and transport systems
- Digital control of hydraulic systems



## **Examples of engineering/master thesis topics**

- Apple harvesting robot design
- Robot project for evacuating people from collapses
- Excavator simulator project of a municipal
- A machine with a hybrid drive
- Design of a didactic and laboratory station for traffic programming
- Modernization of the sorting robot station Crane software interface design
- Preliminary design of the drive system of a licensed vehicle weighing up to 180 kg
- Initial project crawler robot with three manipulators
- Project of accessories for a walking excavator
- Project of a machine for transporting trees from the forest
- Project of a machine for transporting large-size elements
- Conceptual design of a machine for transporting containers in mountainous terrain

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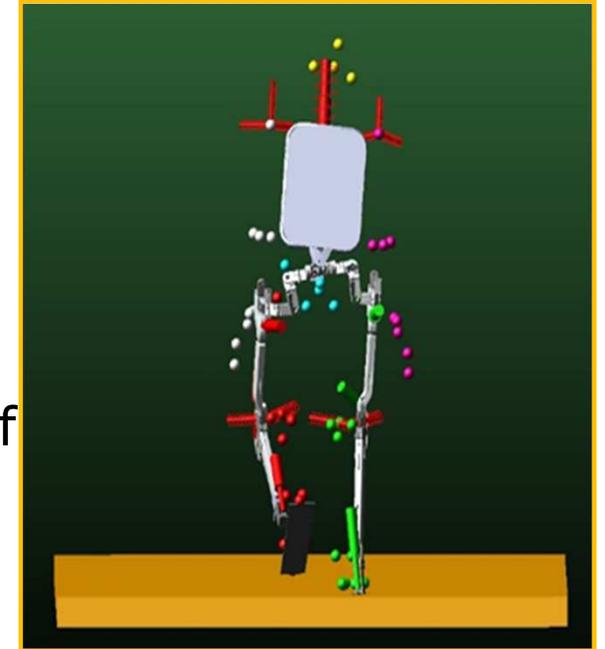
## Examples of engineering/master thesis topics cont.

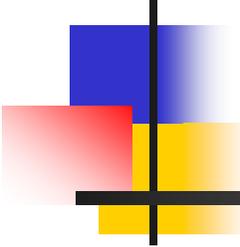
- Concept of Backhoe excavator simulator
- Control of hydraulic systems in the CAN network
- Design of an automated material handling line, e.g. in a fruit sorting plant
- Design of a pneumatic vehicle test stand
- Design of a laboratory stand for programming PLC controllers as part of a mechatronics laboratory
- Initial design of the exoskeleton (e.g. shoulder girdle)
- Examination of the exoskeleton system
- Initial design of the exoskeleton supporting the mobility of a person with lower limb dysfunction
- Design of a station for rehabilitation exercises of the upper / lower limbs



## Examples of engineering/master thesis topics cont

- Research on the control algorithms of active exoskeletons
- Construction of a teaching station for examining exoskeletons
- Initial design of the exoskeleton (e.g. shoulder girdle)
- Examination of the exoskeleton system
- Initial design of the exoskeleton supporting the mobility of a person with lower limb dysfunction.
- Design of a station for rehabilitation exercises of the upper / lower limbs
- Design of a device for compression and packaging of raw material waste
- Folding city bike design
- Design of the stand for disassembly of end-of-life vehicles





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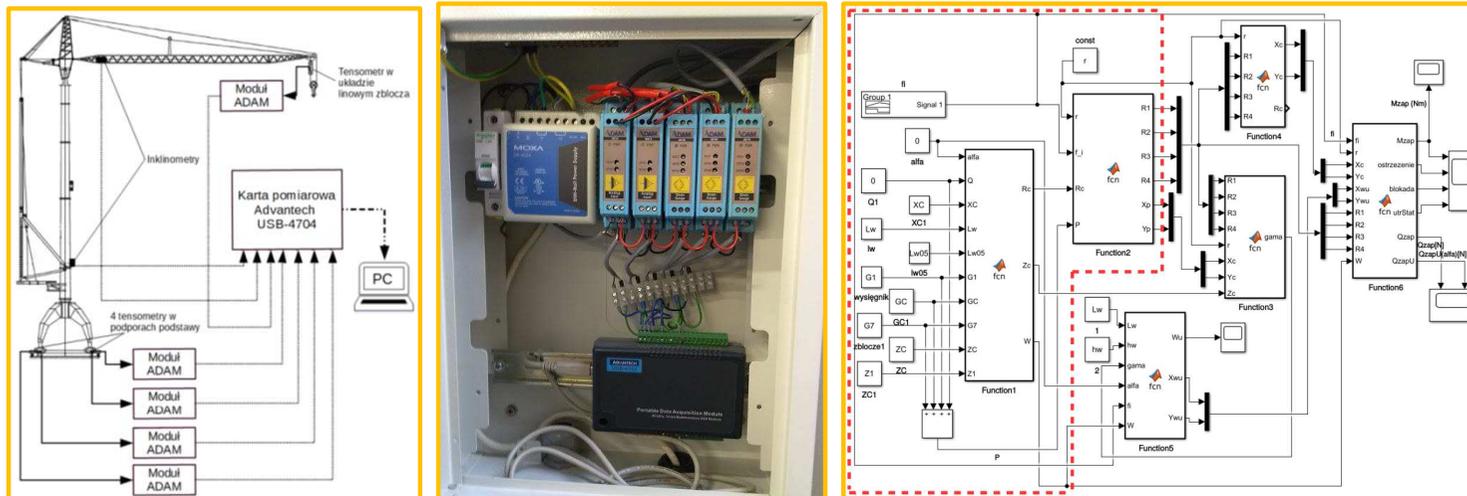
## **Examples of engineering/master thesis topics cont.**

- Concept / design of an automated multi-level car park
  - Project of a mixing unit dosing unit for a mobile concrete plant
  - Design of a ready-mix collection station for a mobile concrete production plant
  - Design of a dosing and weighing device for loose materials
  - Project of an electronically controlled aggregate drying unit for a mobile concrete plant
  - Design of machinery / equipment for specialized earthwork / agricultural machinery
  - Design of an automated transport cart
  - Design of a charging mechanism for a waste collection vehicle
  - Design of the drive system of the street sweeper equipment
  - Design adaptation of the working machine / agricultural tractor operator's station for a mobility disabled person
  - Agricultural tractor cabin design
  - Design of a car body / frame straightening station
  - Modernization of the teaching post (electrohydraulic position servo - design and construction of the pressure and position measuring system)
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## Examples of engineering/master thesis topics cont

- Design of a sensory system for an autonomous vehicle
- Model of the sensory system for robots operating in a swarm
- Model of a remote-controlled robot complex
- Preliminary design of a hydraulic truck crane
- Stand operational tests of chain hoists
- Research on stranded lifting ropes of cranes and cranes
- Tests of lifting belts for electric lifts
- Design of a system protecting against loss of crane stability



## **PRZYKŁADOWE MIEJSCA ZATRUDNIENIA ABSOLWENTÓW (W-WA)**

**AMMANN Polska Sp. z o.o.**  
**DEMAG CRANES & COMPONENTS Sp. z o.o.**  
**Wydawnictwa Komunikacji i Łączności Sp. z o.o.**  
**BOSCH-REXROTH Sp. z o.o.**  
**Parker Hannifin Sp. z o.o.**  
**HYDAC Sp. z o.o. Biuro Warszawa**  
**IOW Sp. z o.o.**  
**TEREX Polska Sp. z o.o.**  
**Wojskowy Instytut Techniki Panczernej i Samochodowej**  
**PIT-RADWAR S.A.**  
**GE Company Polska - Engineering Design Center**  
**Urząd Dozoru Technicznego**  
**Instytut Maszyn Budownictwa i Górnictwa Skalnego**  
**Przemysłowy Instytut Maszyn Budowlanych Sp. z o.o.**  
**WARYŃSKI Trade Sp. z o.o.**  
**STREIF Baulegistyk Polska Sp. z o.o.**  
**SCHINDLER POLSKA Sp. z o.o.**  
**DrlrenaEris SA**  
**Agrex-Arcon Sp. z o.o.**  
**AEBI SCHMIDT POLSKA Sp. z o.o.**  
**BERGERAT MONNAYER CAT Sp. z o.o.**  
**HARSCO INFRASTRUCTURE Polska Sp. z o.o.**

**VOLVO CONSTRUCTION EQUIPMENT**  
**SIEMENS Sp. z o.o.**  
**WAMEX Sp. z o.o.**  
**PCO SA**  
**PONAR WADOWICE ODDZIAŁ W-WA**  
**SCANIA POWER POLSKA Sp. z o.o.**  
**BAUER MASCHINEN GmbH Sp. z o.o.**  
**OTIS Sp. z o.o.**  
**ZEPPELIN POLSKA Sp. z o.o.**  
**TRUCK STORE Warszawa**  
**KOMATSU POLAND Sp. z o.o.**  
**INTERHANDLER Sp. z o.o.**  
**INTRAC POLSKA Sp. z o.o.**  
**FAYAT BOMAG POLSKA Sp. z o.o.**