

AUTOMOTIVE INDUSTRY RELATED RESEARCH IN UNIVERSITY ENVIRONMENT JÁRMŰIPARI KUTATÁSOK EGYETEMI KÖRNYEZETBEN

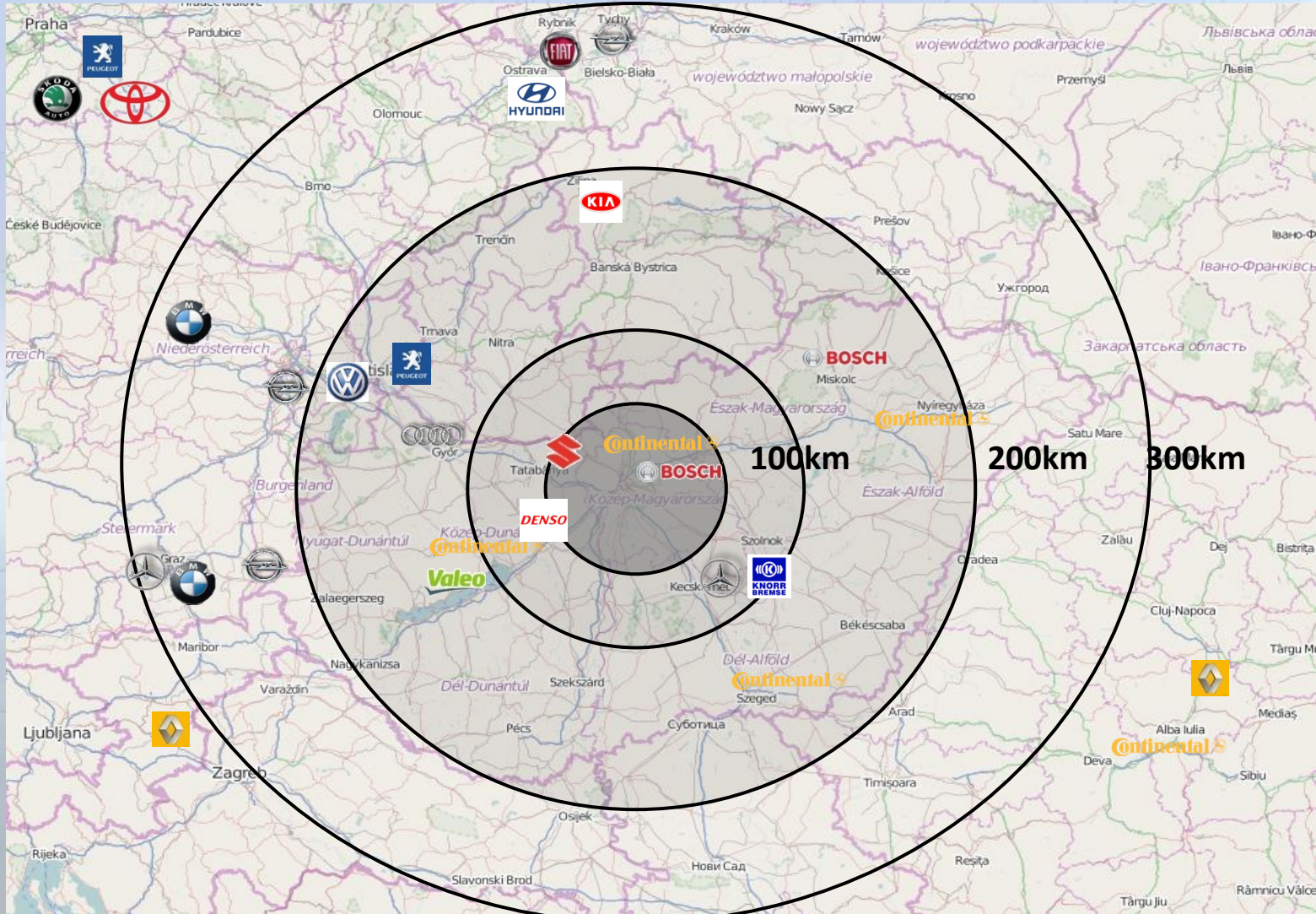
Dr. Dénes Fodor and Dr. László Czúni – University of Pannonia, Veszprém

Cooperation between higher education, research institutes and automotive industry
section

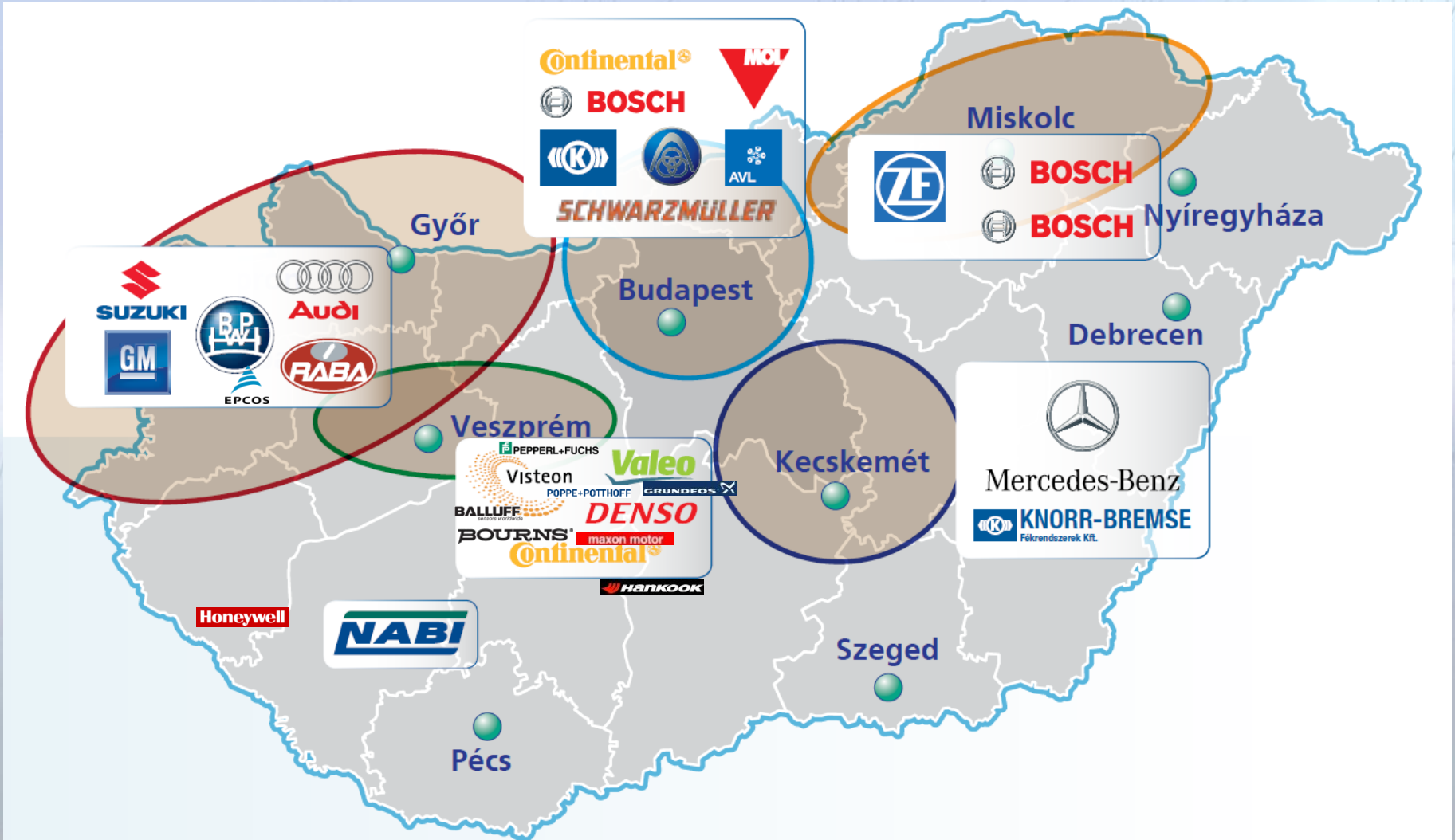
Contents

- Short automotive overview
- A global glimpse on R&D in the automotive field
- Life cycle of R&D
- Research & Development at the University of Pannonia
- Some Case Studies
- Known problems and ways to solve
- Conclusions

Middle-East European Automotive Situation



Concentration of Automotive OEM and TIER1 Industry in Hungary



What Manufacturing Means?

- “[Manufacturing in the US is] the vanguard of innovation ...
 - 9 percent of jobs,
 - 11 percent of GDP,
 - 35 percent of engineers,
 - **69 percent of private R&D**, and
 - 90 percent of our patents.”

Bruce Katz (a vice president at the Brookings Institution),
US Manufacturing: The Misunderstood Economic Powerhouse, Industry Week, January 15, 2013.

WORLDWIDE AUTOMOTIVE INDUSTRY

1200 USD for R&D per vehicle

16 % of total R&D for all industries

7 billion USD increase on R&D from 2012 to 2013

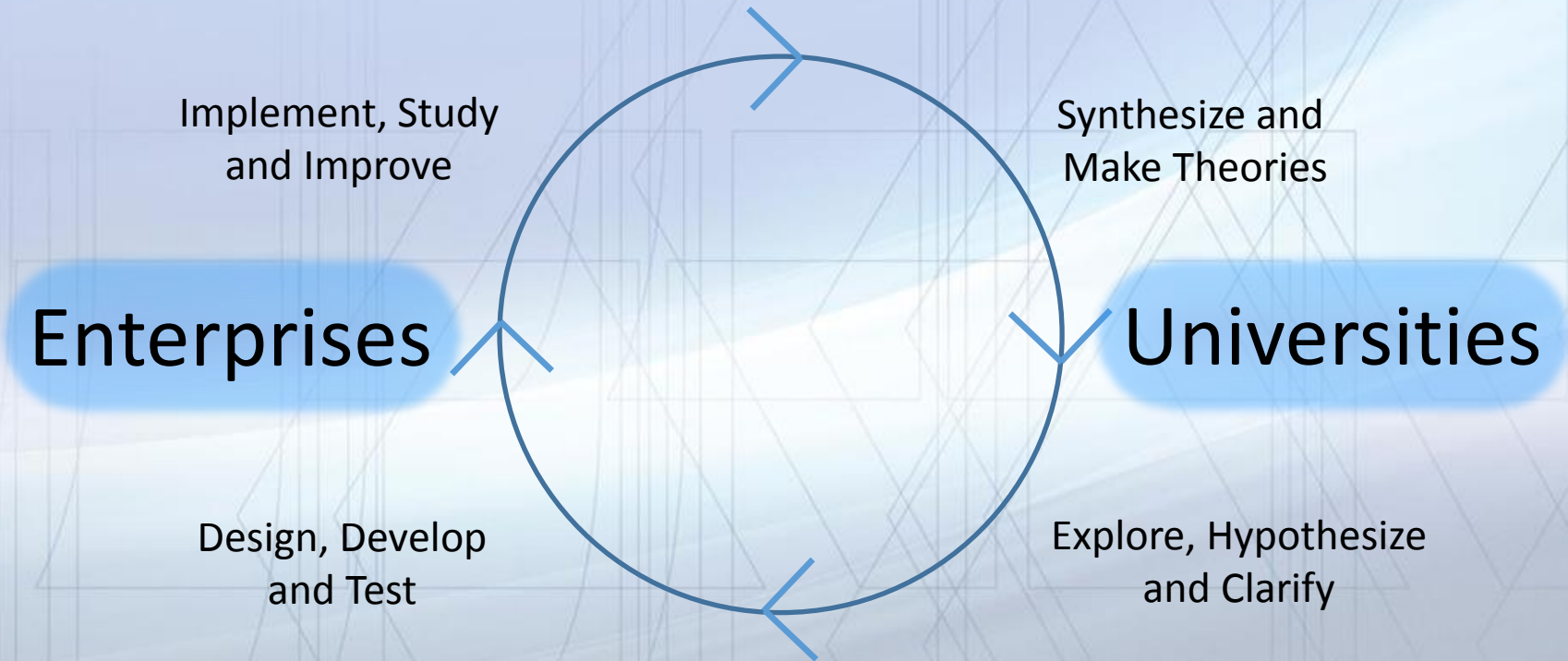
R&D expenditures of research sites at enterprises in Hungary (KSH 2012)

- All R&D expenditures
 - 239 B Ft
- Processing industry
 - 131 B Ft (55%)
- Vehicle production
 - 18 B Ft (8%)
- Machine production
 - 14 B Ft (6%)

63. A vállalkozási kutató-fejlesztő helyek K+F-ráfordításai gazdasági ágak szerint, 2012

Számjel	Gazdasági ág, ágazat	K+F-ráfordítás	(millió forint)	
			Ebből:	
			K+F-költség	K+F-beruházás
Mindegyeszesen		238 671,0	202 728,9	35 942,1
Ebből:				
A	Mezőgazdaság, erdőgazdálkodás, halászat	4 254,8	3 320,1	934,7
C	Feldolgozóipar	131 099,0	107 315,3	23 783,7
Ebből:				
CA	Élelmiszer, ital, dohánytermék gyártása	3 453,3	2 472,7	980,6
CE-CF	Vegyri anyag, termék gyártása és gyógyszergyártás	55 531,1	47 538,0	7 993,1
CG	Gumi-, műanyag és nemesfém ásványi termék gyártása	4 380,4	2 658,7	1 721,7
CH	Fémalapanyag és fémfeldolgozási termék gyártása	6 221,1	2 560,9	3 660,2
CI	Számítógép, elektronikai, optikai termék gyártása	14 398,3	12 763,3	1 635,0
CK	Gép, gépi berendezés gyártása	14 122,1	11 420,2	2 701,9
CL	Járműgyártás	18 297,0	16 143,2	2 153,8
CM	Egyéb feldolgozóipar; ipari gép, berendezés tüzembe helyezése, javítása	5 992,6	5 085,1	907,5
D-E	Villamosenergia-, gáz-, gőzellátás, légkondicionálás, valamint vízellátás; szennyvíz gyűjtése, kezelése, hulladékgyártás, szennyeződésmentesítés	442,5	370,0	72,5
F	Építőipar	1 065,5	844,4	221,1
G	Kereskedelem, gépjárműjavítás	28 054,2	24 710,3	3 343,9
J	Információ, kommunikáció	20 739,2	18 854,1	1 885,1
M	Szakmai, tudományos, műszaki tevékenység	49 686,4	44 620,1	5 066,3
Ebből:				
MB	Tudományos kutatás-fejlesztés	40 029,4	36 651,2	3 378,2
	7211 Biotechnológiai kutatás-fejlesztés	7 888,4	6 908,1	980,3
	7219 Egyéb természettudományi, műszaki kutatás-fejlesztés	31 096,8	28 716,3	2 380,5
	7220 Társadalomtudományi, humán kutatás-fejlesztés	1 044,2	1 026,8	17,4
P	Oktatás	18,4	12,1	6,3
Q	Humán-egészségügyi, szociális ellátás	651,8	280,6	371,2
S	Egyéb szolgáltatás	587,5	516,1	71,4

Cycle of Research and Development



What makes the cycle sustainable?

Main Areas of R&D in the Automotive Industry

Vehicle Development

- Safety systems (crashworthiness, restraints, active/passive safety devices)
- Customer interface

Energy and Environment

- Combustion
- Electrochemical
- Recycling

Systems and Electronics

- Sensors
- Vehicle controls
- Telematics/vehicle communication

Materials

- Advanced lightweight materials
- Biomaterials

Manufacturing Systems

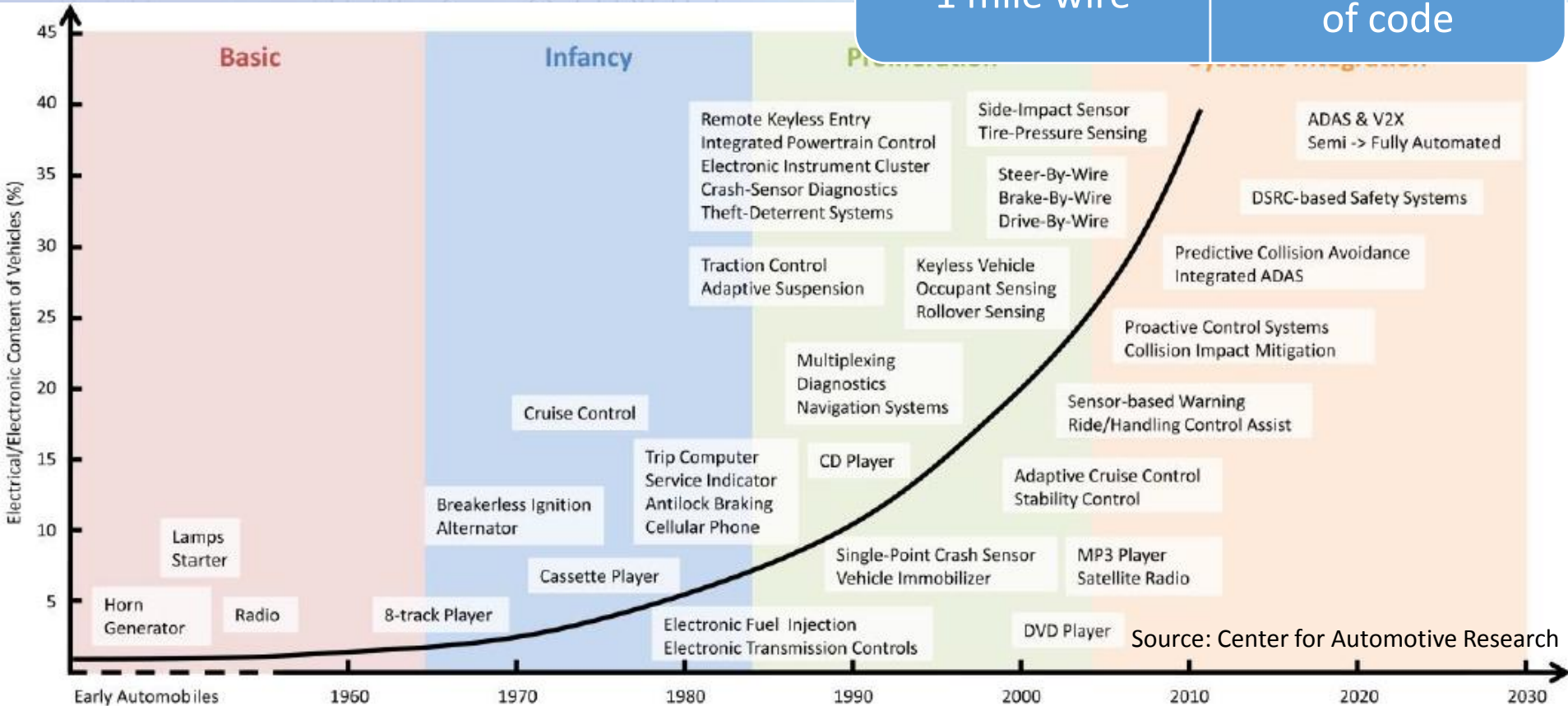
- Manufacturing processes
- Robotics
- Computer-Aided Engineering
- Nanotechnology

Becoming more interdisciplinary...

Role of electronics in cars

Average car

- 60 microprocessors
- 100 sensors
- 1 mile wire
- 10 M lines of code

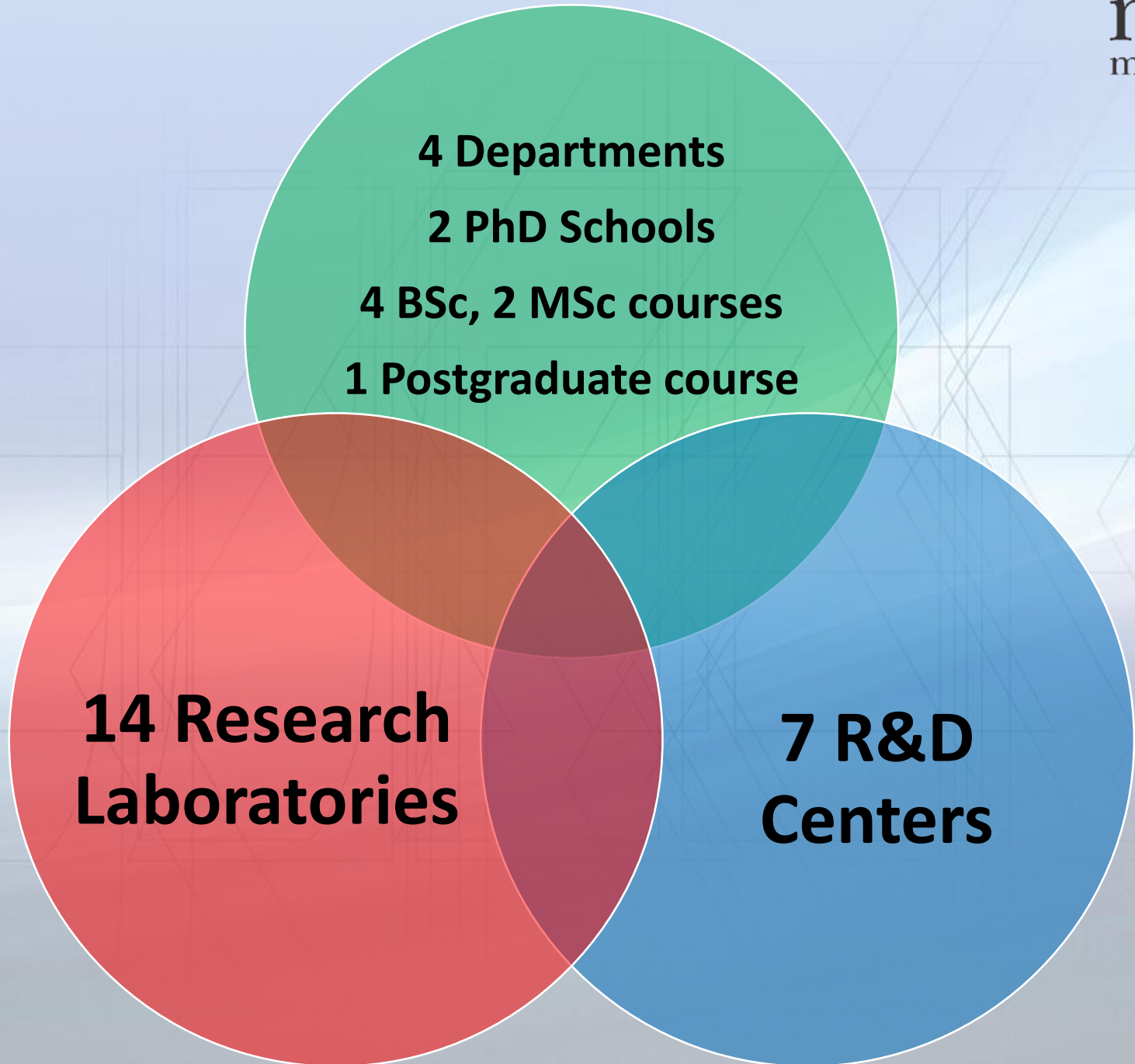


FACULTY OF INFORMATION TECHNOLOGY

Dr. László Czúni

University of Pannonia



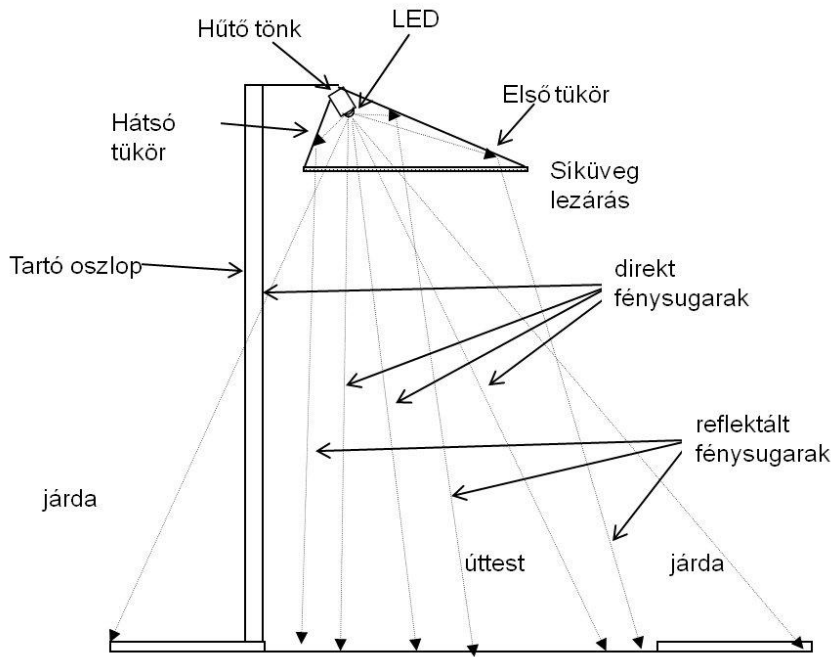


Let there be light ... and Vision

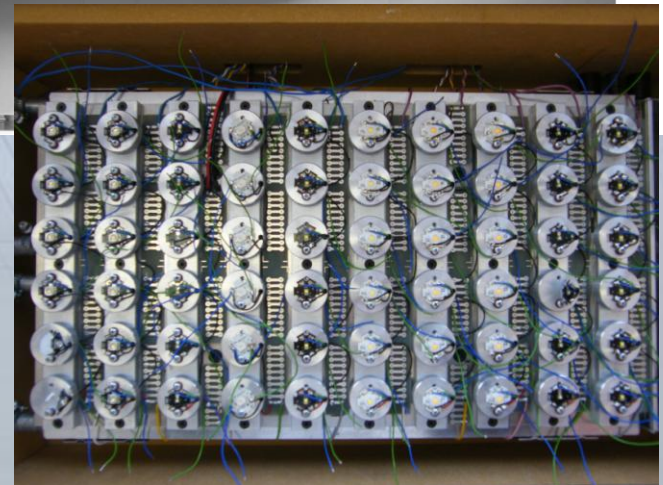
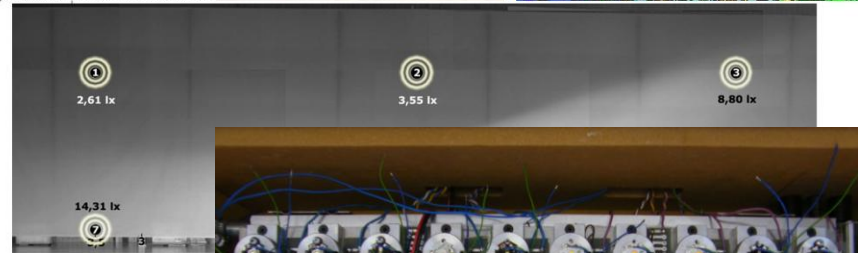
Virtual Environments and Imaging Technologies Research Laboratory

- Light production
- Sensing – Perception
- Measurement

Car projector measurements



Development of LED lamps



Artificial aging of LEDs

Sensing and Processing...

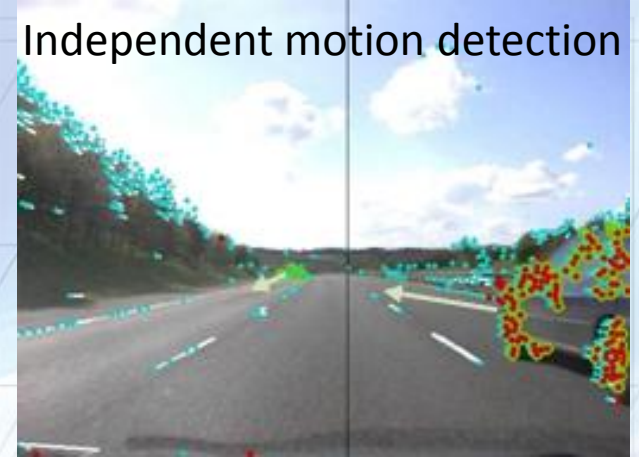
Sensor Networks Research Laboratory

- Noise source localization
- Vehicle classification
- Event detection with various sensors (accelerometers, gyros, microphones, PIRs, magnetometers, etc.)
- Optimal network communication protocols

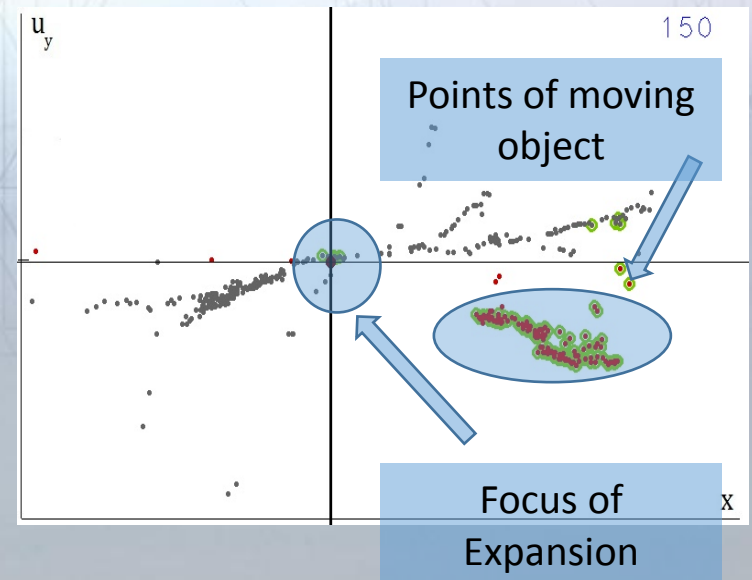
Image Processing Research Laboratory

- Motion detection
- Object recognition
- Data mining in image databases
- Video analysis

Independent motion detection



Feature point selection

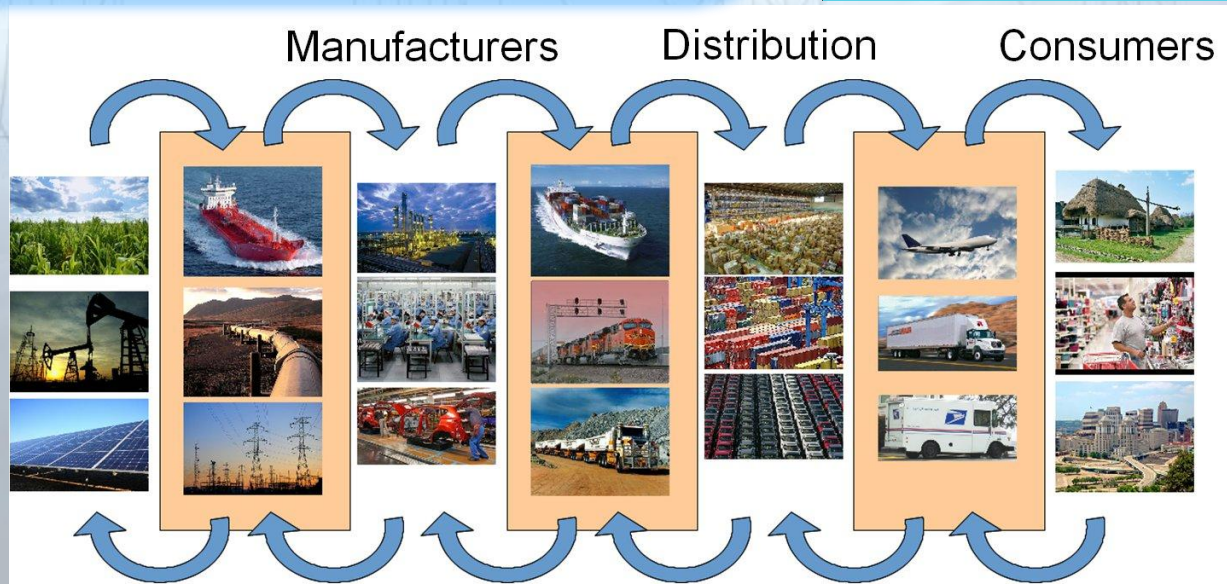
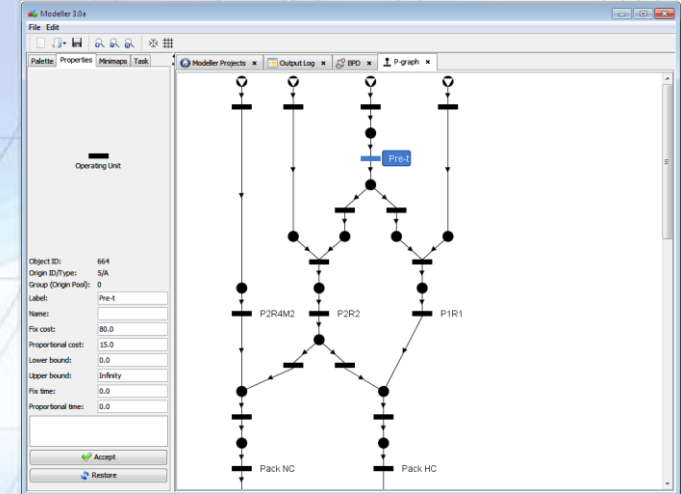


Analysis of optical flow

Optimization for production and logistics

Advanced Process Optimization Research Laboratory

- Strong mathematical background
(process synthesis, graph theories)
- Decision support systems for supply chains
- Scheduling Suppliers (e.g. for power plants)
- Supply chain simulations
- Optimal production planning



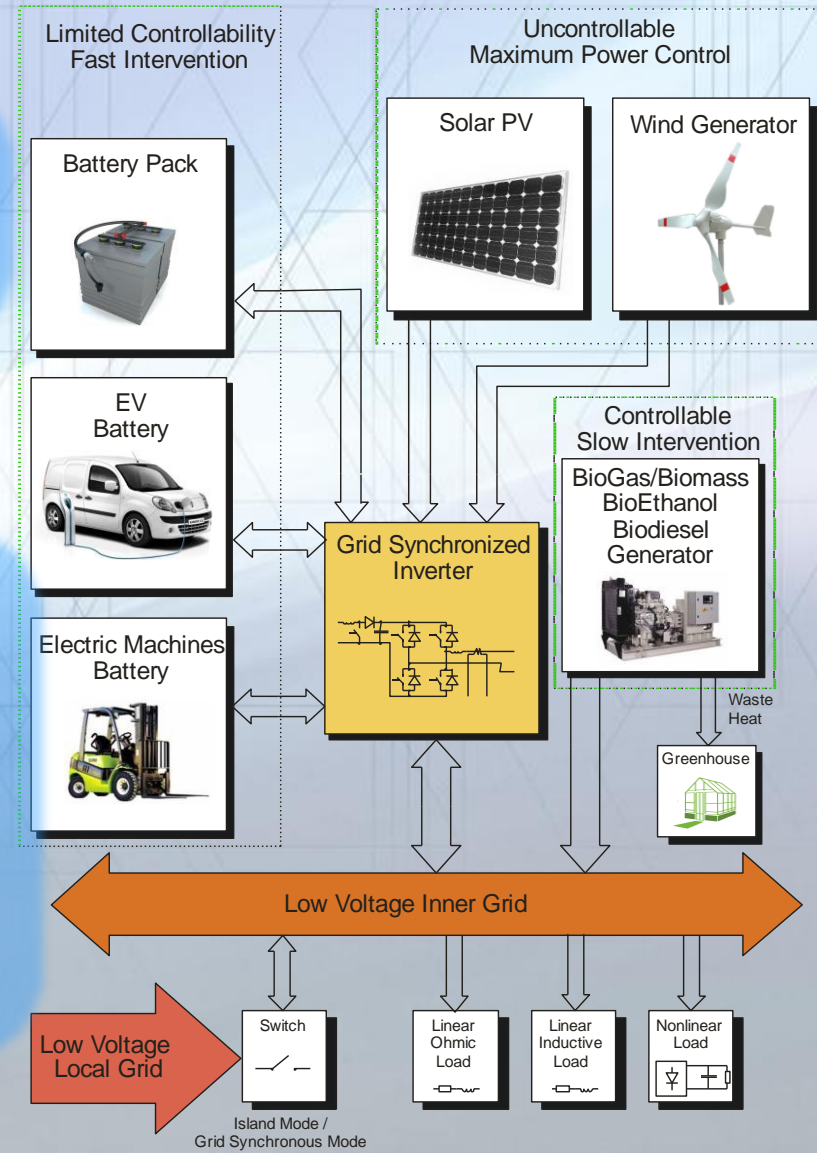
Optimal Energy Systems – Energy Systems Integration

Intelligent Control Systems Research Laboratory

- Energy systems integration
- Energy systems control
- LiFePO₄ battery modeling

Process Integration and Intensification Research Laboratory

- Life cycle analysis of energy systems
- CO₂ emissions reduction and mitigation exploiting IT tools
- Integration of Renewable sources of Energy into Energy Supply Chains



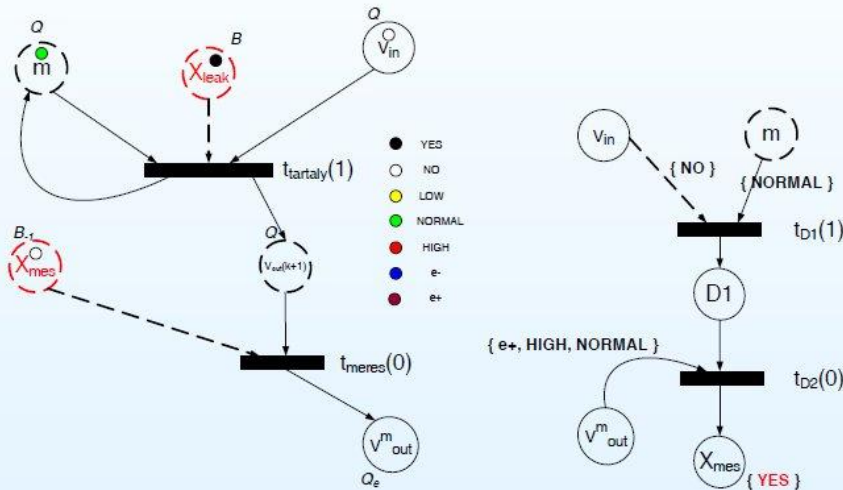
Discrete Diagnostics for the Industry

Intelligent Control Systems Research Laboratory

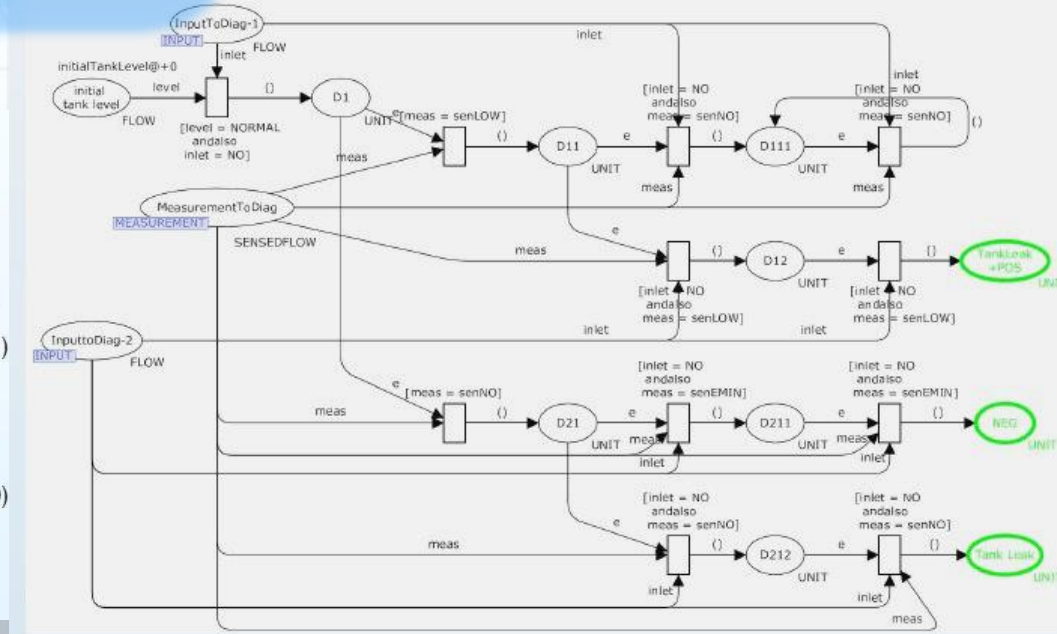
- Fault Mode and Effect Analysis (FMEA)
- Hazard and Operability Analysis (HAZOP)
- Process mining



New fine scale measurement methods



Coloured Petri Nets Models



Process mining to diagnose

FACULTY OF ENGINEERING

Dr. Dénes Fodor

University of Pannonia



Faculty of Engineering – Education

8 BSc courses

- Materials engineering
- Bioengineering
- Mechanical engineering
- Environmental eng.
- Mechatronics
- Chemical engineering
- Chemistry
- Environmental science

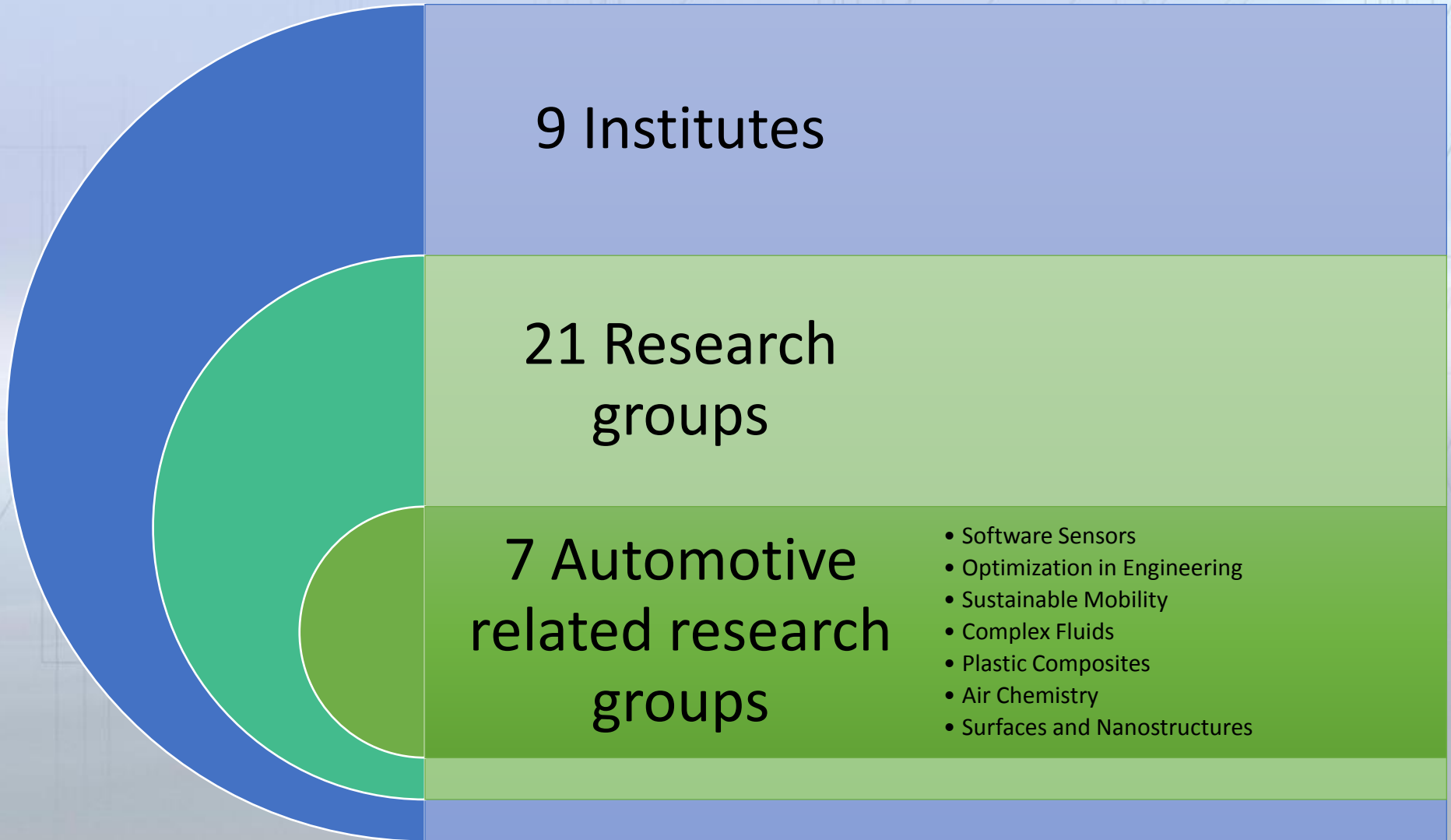
6 MSc courses

- Materials engineering
- Environmental eng.
- Mechatronics
- Chemical engineering
- Chemistry
- Environmental science

2 PhD Schools

- Chemical Engineering and Material Sciences
- Chemistry and Environmental Sciences

Faculty of Engineering – Research groups



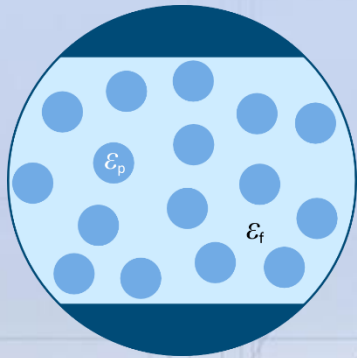
MAGNETORHEOLOGICAL AND ELECTRORHEOLOGICAL FLUIDS

Complex Liquids Research Group

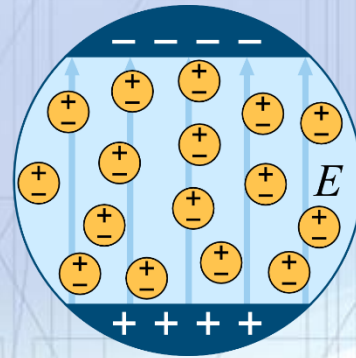
Head of Research Group: **Dr. István Szalai**

Institute of Physics and Mechatronics

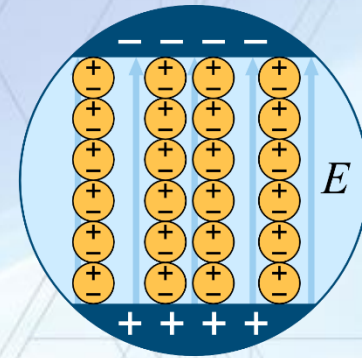
Electro- (ER) and magnetorheological (MR) effect



liquid + solid particles



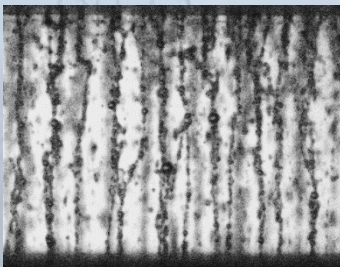
induced dipoles



structure formation
 (chains, columns)

magnetic analogue: MR fluid (μm sized particles)
 ferrofluid (nm sized particles)

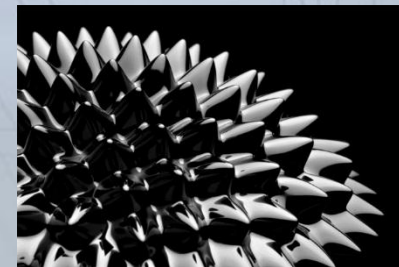
change in properties:
**rheological (viscosity),
 dielectric, optical, ...**



ER fluid



MR fluid



ferrofluid

smart materials: various properties can be controlled with external fields

MR or ER based applications

- Dampers (ER, MR)
 - **bridges:** China, Croatia, Netherlands
 - (Maurer Söhne GmbH)
 - **buildings** (seismic application, wind)
- Suspensions (MR)
 - **shock absorber:**
 - commercial: MagneRide
 - Audi, BMW, Ferrari, Cadillac, Chevrolet
 - military: Humvee (LORD corporation)
 - **engine mount** (Porsche)
 - **seat suspensions** (trucks)



MR or ER based applications

- Clutches (MR)
 - trucks, SUVs (General Motors)
 - hybrid vehicle for public transportation: AutoTram (Fraunhofer IVI)
- Brakes (ER, MR)
 - human prosthetic limb: Rheo Knee (Össur)
 - aerobic machines
- Ferrofluid applications
 - Liquid seals (hard disks)
 - Heat transfer
 - Magnetic hyperthermia (cancer treatment)
 - MRI contrast agent



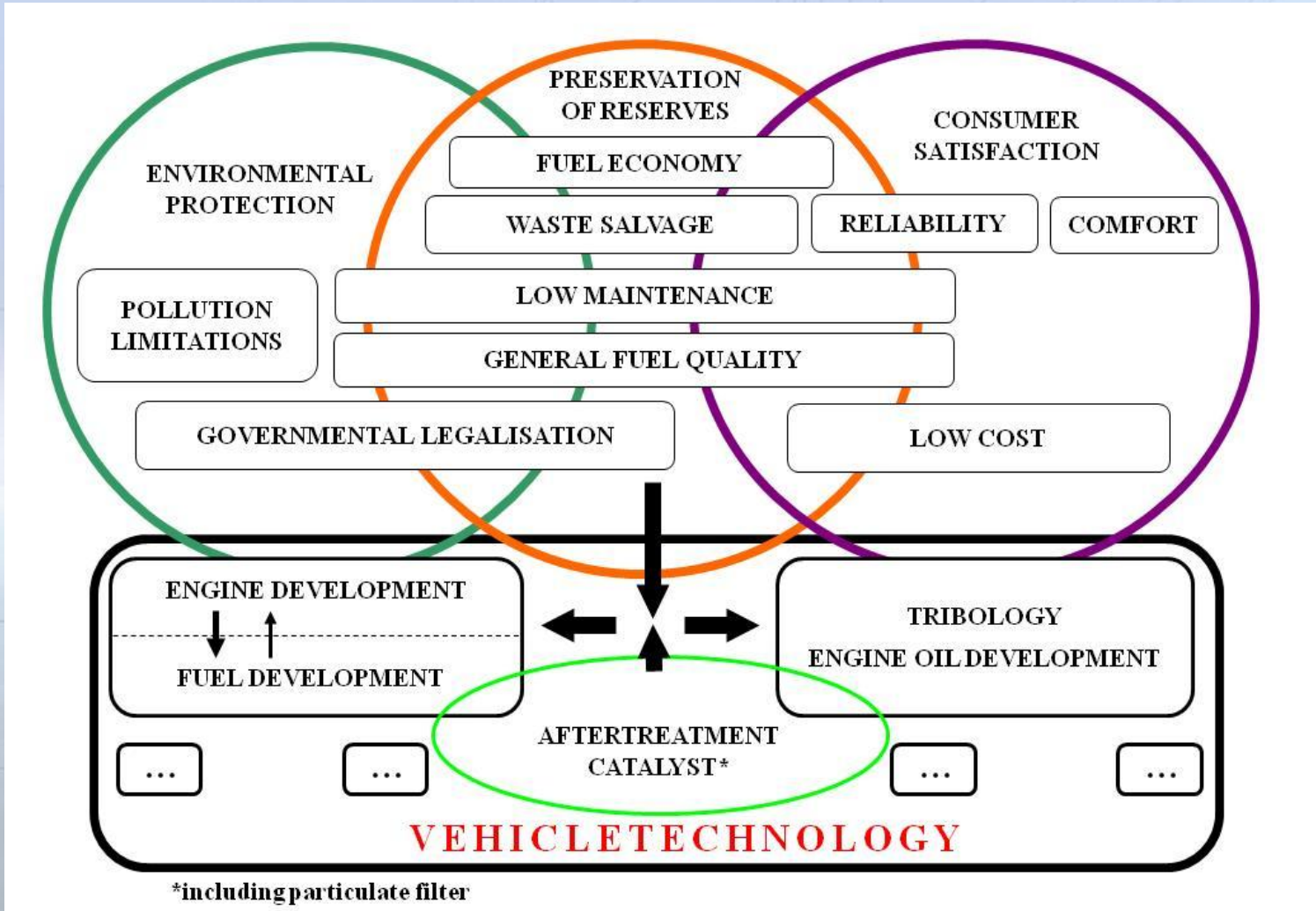
FUELS AND LUBRICANTS

Sustainable Mobility Research Group

Head of research Group: **Dr. Jenő Hancsók**

Department of MOL Hydrocarbon and Coal Processing

Development of fuels, lubricants & system elements



Quality improving of fuels and lubricants

- Hydrocarbon products with high hydrogen content
 - (*methane from alternative sources, gasolines or diesel fuels rich in isoparaffins from crude oil and different wastes*)
 - Wide raw material range, economic production
 - Very high octane or cetane number
 - Clean burning → environment friendly
 - Operating experience, known safety aspects
- Fuel/energy saving engine oils and gear oils
 - High isoparaffin content base oils (80-85% of engine oils)
 - Based on crude oil, including isomerization
 - Based on biosynthetic gas (isomerization hydrocracking of heavy Fischer-Tropsch bioparaffins)
 - Performance additive packages with high efficiency
 - (→ longer oil drain interval, environment friendly, friction and wear reducing)
- Partners:

MOL Plc. – MOL-LUB Ltd. – Hungrana Ltd. – Rossi Biofuel Ltd.

Own results for the future

Selected properties of biogasoils from waste tryglicerides and bio synthetic gas (bioparaffins)

Property	Bioparaffins		EN 14214:2012 biodiesel (winter grade)	EN 590:2012 Diesel gasoil (winter grade)	CEN CWA 15940:2009 Paraffinic diesel from synthesis or hydrotreatment
	Biogasoil	Synthetic biogasoil*			
Density, kg/m ³	775-785	770-785	860-900	820-845	770-800
Cetane number	75-90	66-81	appr. 51	min. 51	min. 70
Cold Filter Plugging Point (CFPP), °C	appr. (-15)- (-35)	appr. 0 – (-35)	< -5	< -20	< -20
Heating value, MJ/kg	appr. 44	appr. 43	appr. 38	appr. 43	n.a.
Heating value, MJ/dm ³	appr. 34	appr. 34	appr. 34	appr. 36	n.a.
Polycyclic aromatic content, %	0	0	0	max. 8	max. 0.1
Sulphur content, mg/kg	< 1	< 10	< 10	< 10	< 5

AUTOMOTIVE RESEARCH

Software Sensors Research Group

Head of Research Group: **Dr. Dénes Fodor**

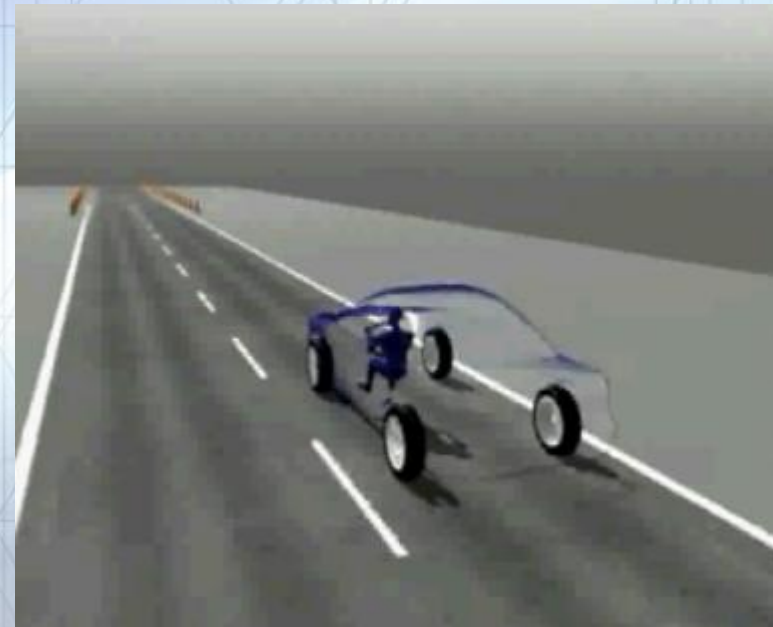
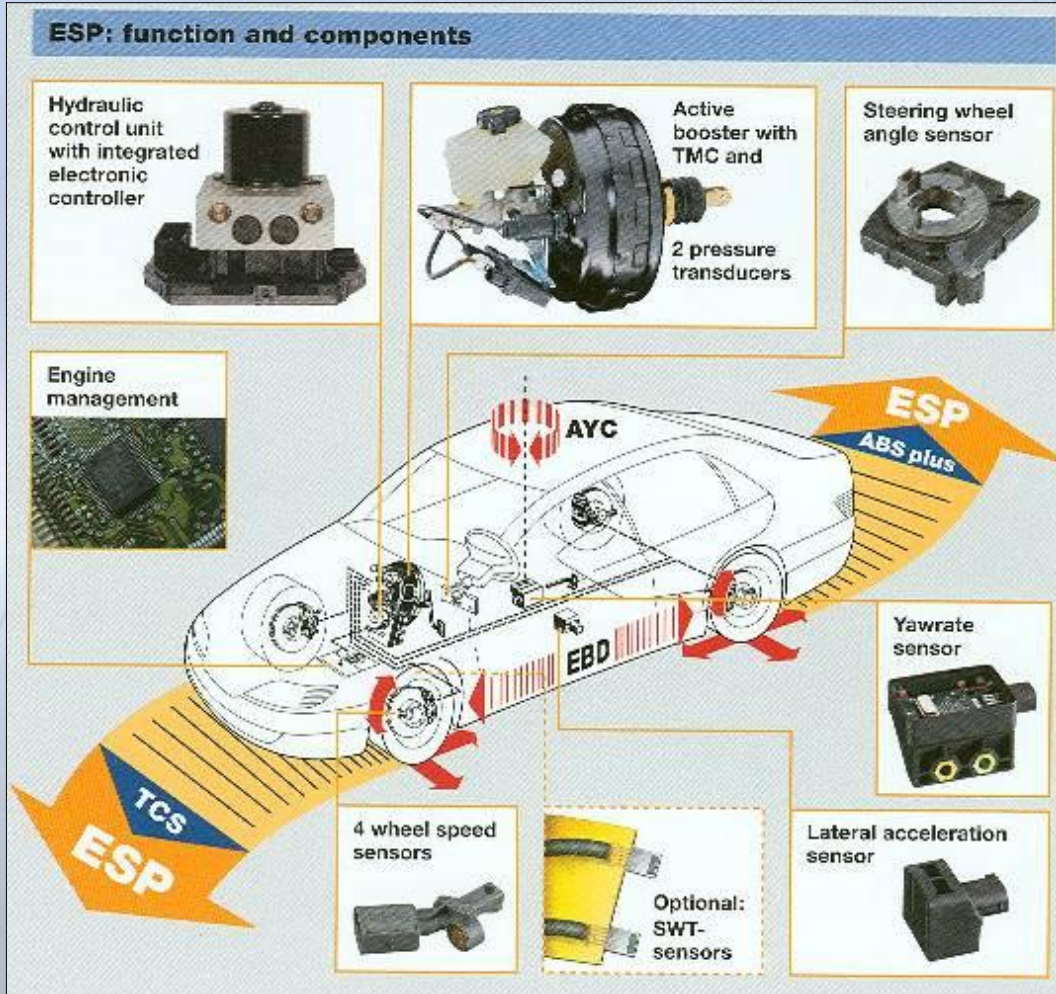
Institute of Mechanical Engineering

Continental-University Cooperation

- Automotive system engineering education (MSc level) beginning from 2010 September with the strong support from Continental Automotive Systems (for BSc graduates in mechanical, electrical, technical informatics and mechatronic engineering).
- Establishment of a new department called „Automotive Mechatronic Systems” inside the Mechanical Engineering Institute to support the education and research activity of the Continental AES school
- **Research and development projects:**
 - Vehicle-Dynamics-Based **Tire-Road Friction Coefficient Estimation**
 - Development of a **Bike ABS** Prototype
 - **Sensorless** Rotor Position Detection of PMSM
 - Deflation Detection System (DDS)
 - Side Slip Angle Estimation
 - Conti-Uni Verification Project (HIL testing of ECUs)
- **Till 2013 second semester 23 graduates from which 14 are today Continental employee**

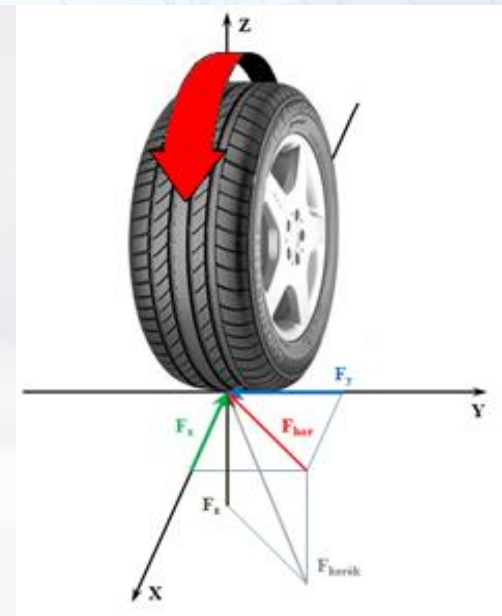
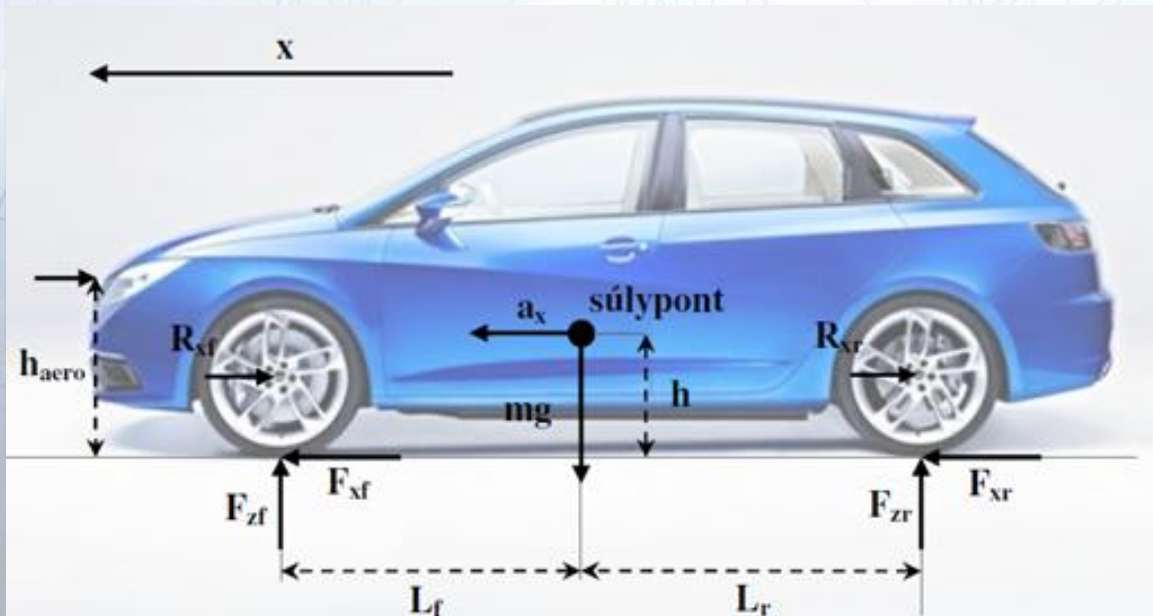
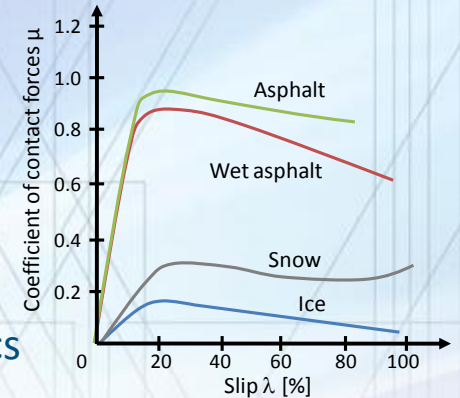
Continental-University Projects

Active Safety Systems



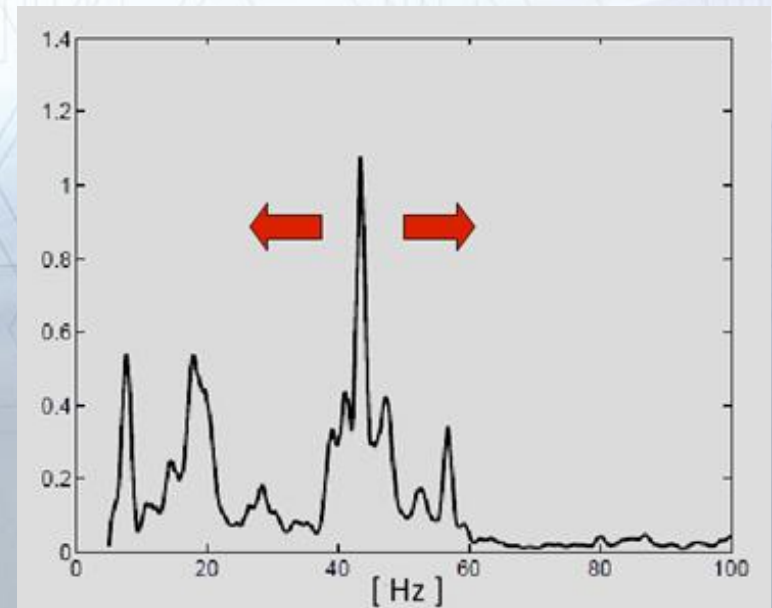
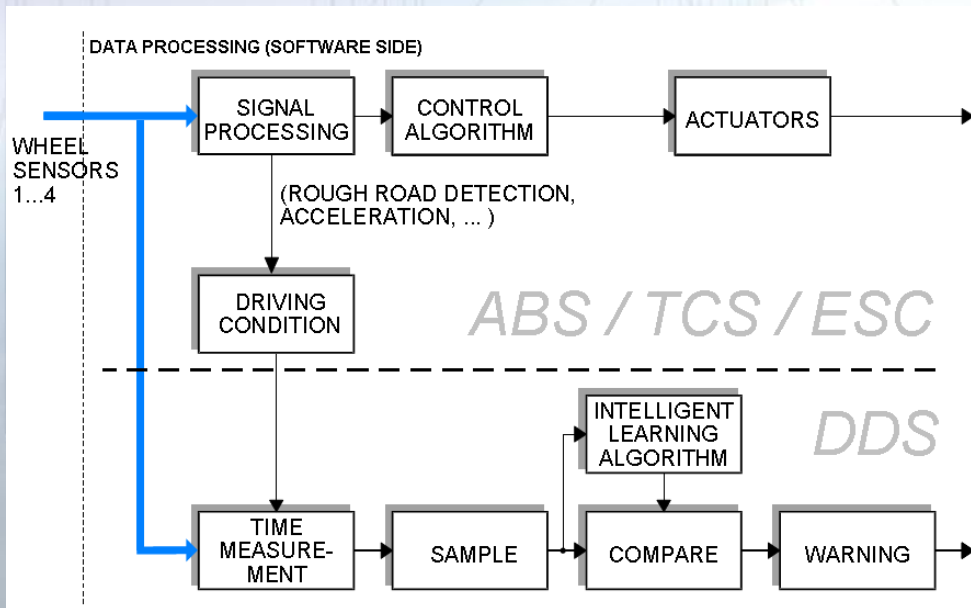
Tire-Road Friction Coefficient Estimation

- Improve active safety systems
 - Anti-lock Braking System
 - Electronic Stability Program
 - Traction Control System
- Real-time estimation algorithms
 - Slip-slope method based on longitudinal vehicle dynamics
 - Cornering stiffness method based on lateral vehicle dynamics
 - Burckhardt method based on wheel dynamics

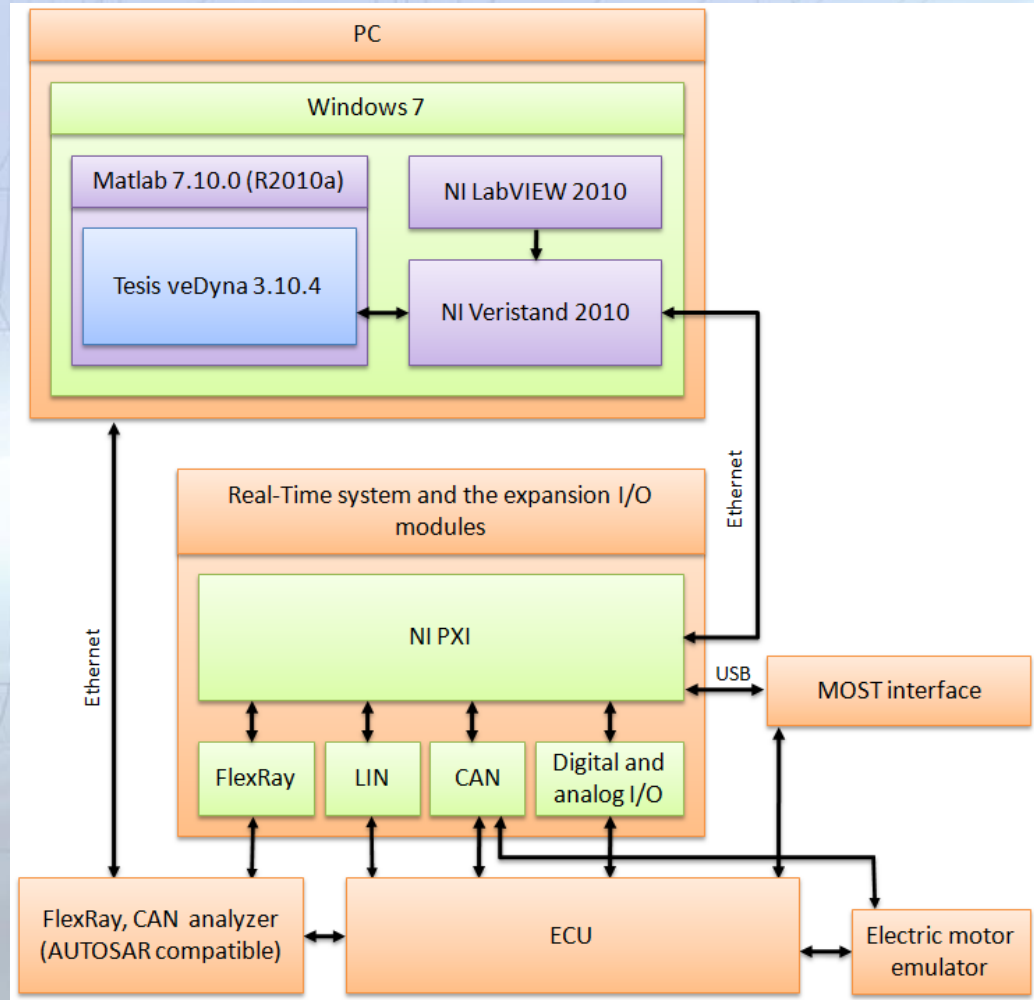


Tire pressure monitoring (deflation detection)

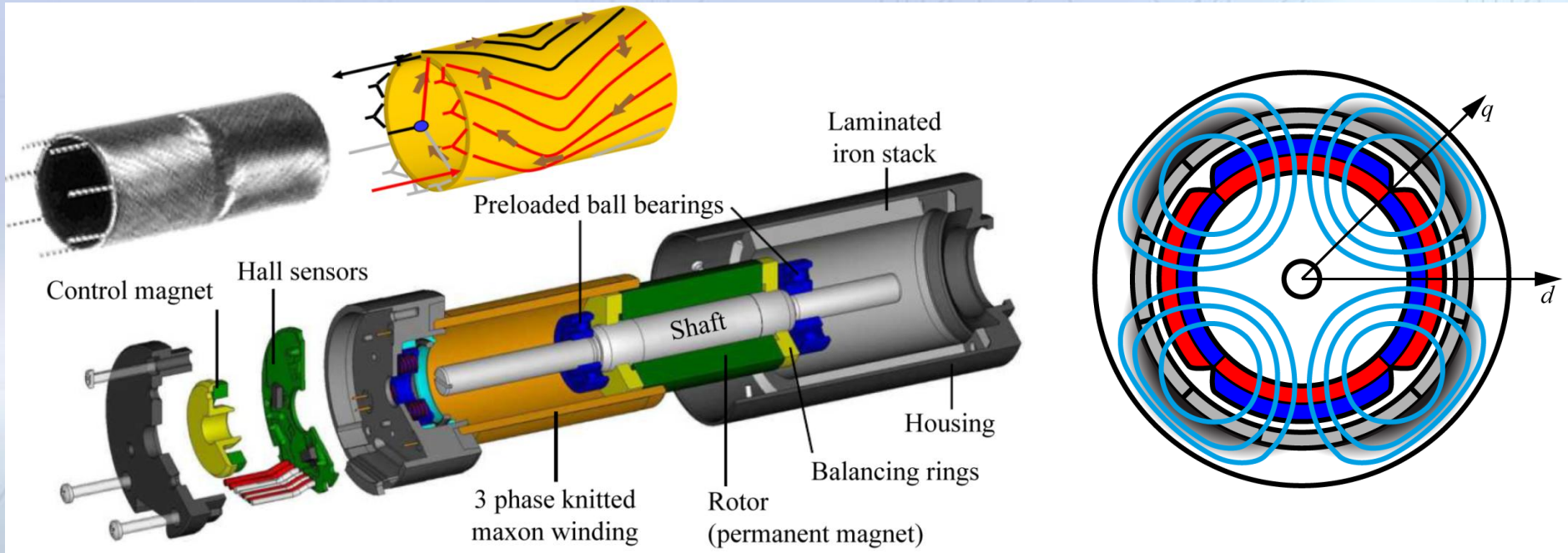
- Nearly 30% of traffic accidents caused by flat tires
 - Lower tire pressure increases fuel consumption and can lead to loss of traction
 - Tire pressure monitoring became mandatory equipment
- Indirect deflation detection



Hardware-In-the-Loop simulator



Sensorless control of PM synchronous motors

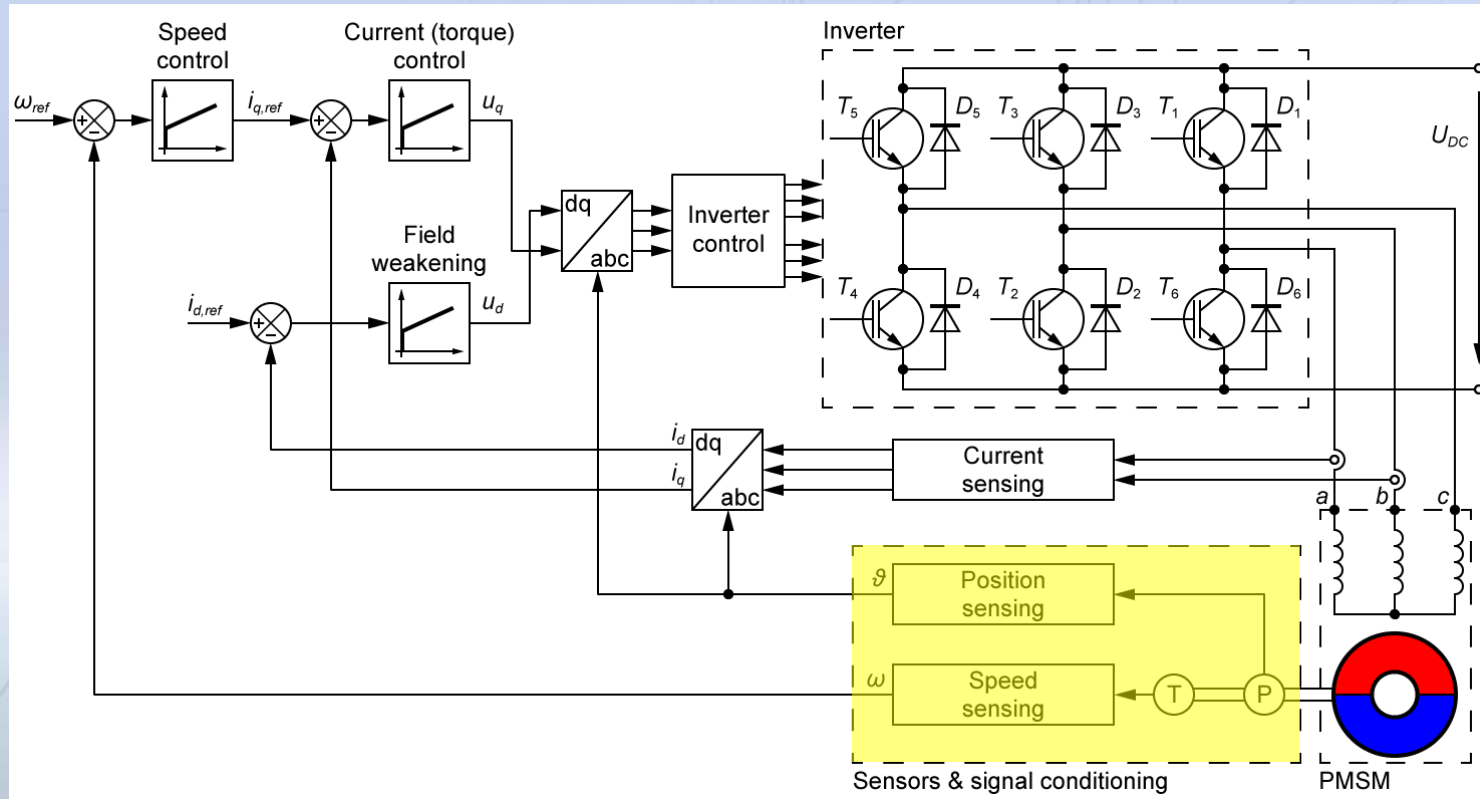


- Slotless PMSM – aircore winding
- Magnetic anisotropies caused by rotor magnets

maxon motor

driven by precision

Sensorless PMSM drive



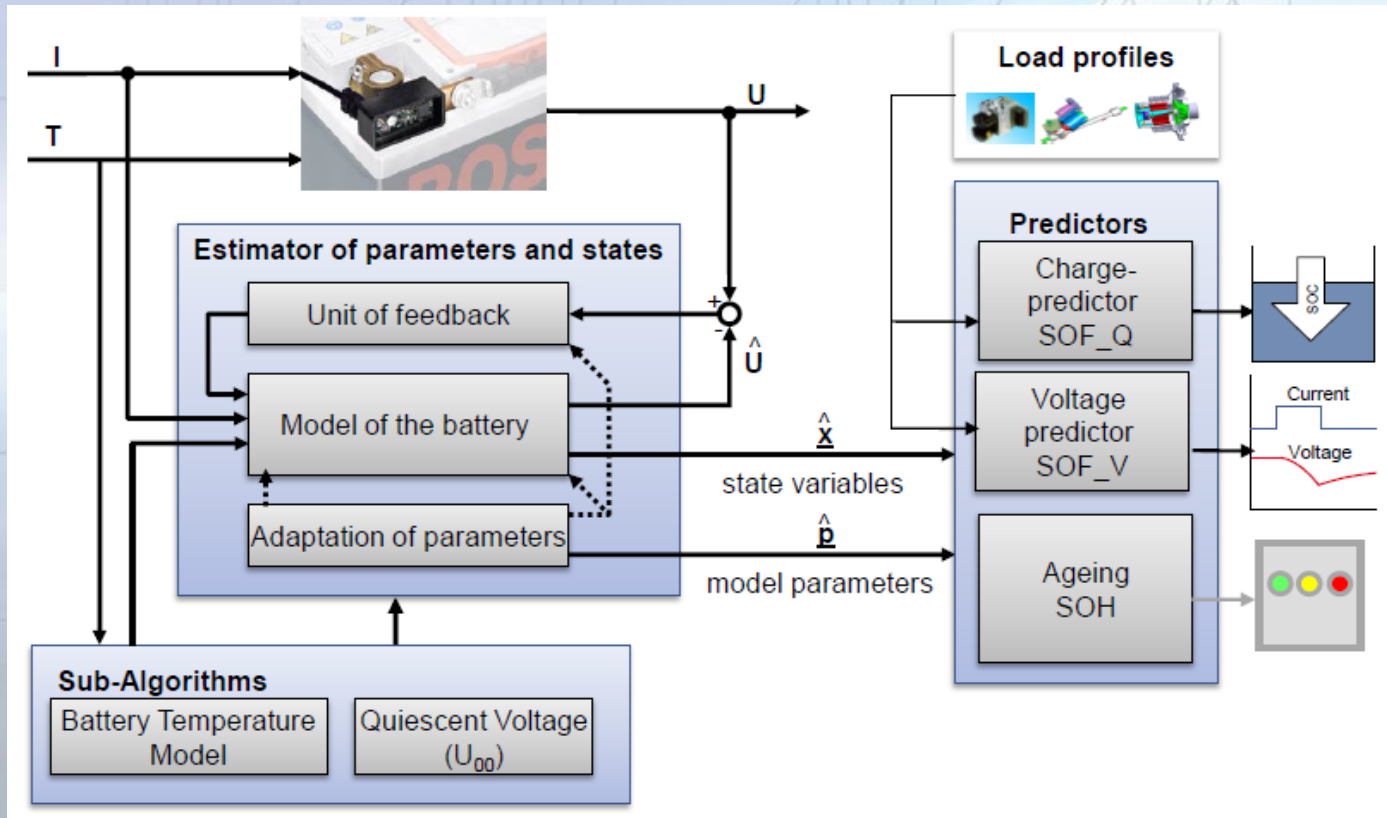
- Replace position and speed sensors with a „software sensor”
- In cooperation with Maxon Motors

maxon motor

driven by precision

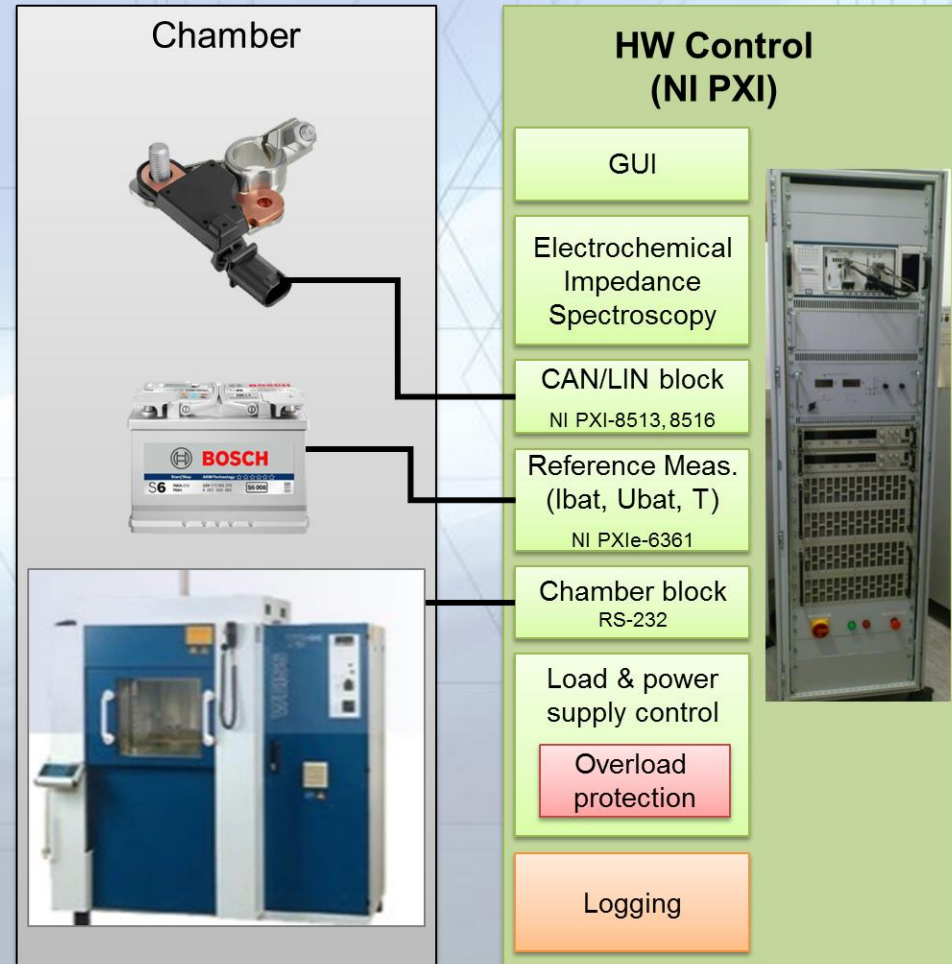
Bosch-University cooperation

- Battery Sensor Testbench
- Electronic Battery Sensor Tests



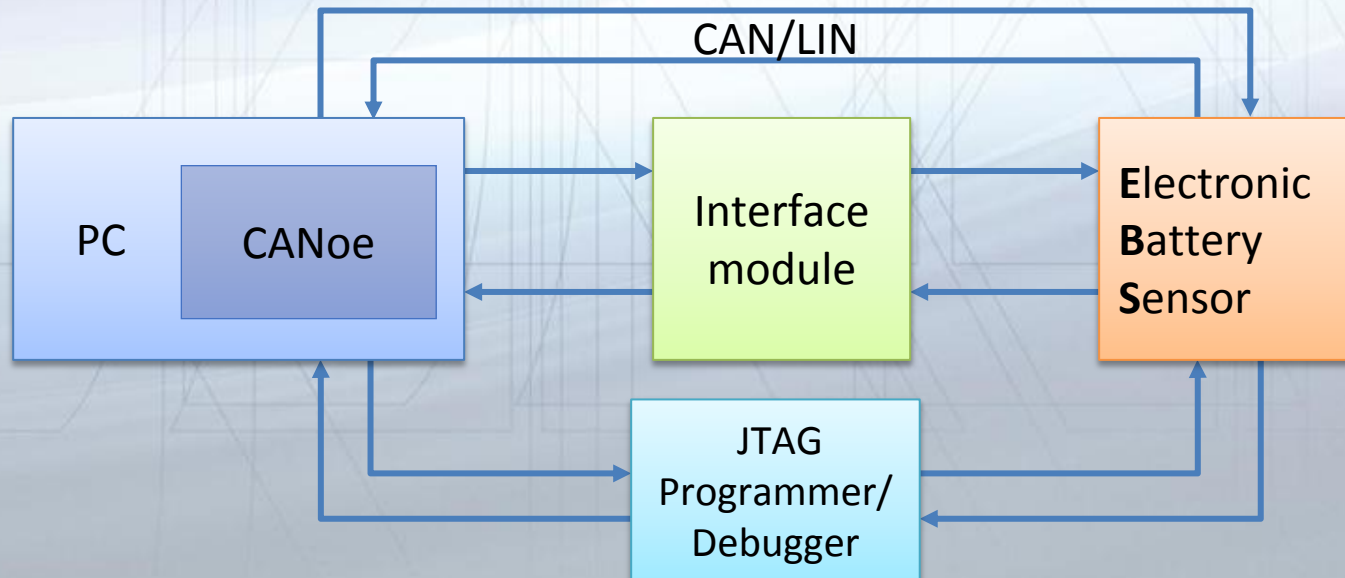
Battery Sensor Testbench Development

- Automated testing of batteries and Electronic Battery Sensors
- Precision battery measurement
- Sensor testing:
 - Automated flashing
 - Voltage, current & temperature setting with programmable load
 - Automatic test execution (NI TestStand integration)
- Security module
 - Overload protection
 - Overheat protection
 - Explosion protection



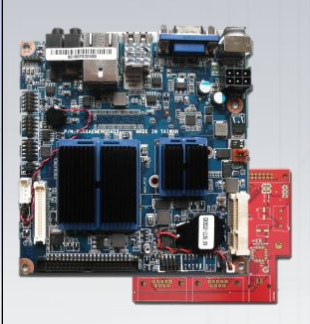
Battery Sensor Software Integration Test

- Automated software integration testing of EBS
 - Test environment construction
 - Specification and implementation of integration tests
 - Switch to new development environment and compiler

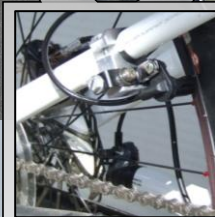
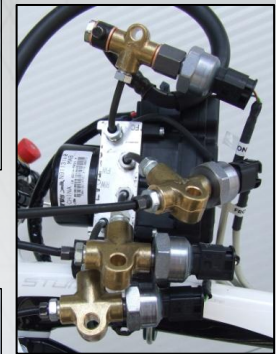


Bicycle ABS prototype development

Controller Computer
and A/D Converter



HECU and
Pressure Sensors



Wheel Speed
Sensors

Known Issues in R&D (Cooperations)

- Interdisciplinary aspect of automotive research
- Universities can contribute with strong theoretical background
- Problems to be solved
 - Small sites, big projects, distribution of tasks
 - Attraction of young engineers
 - Migration
 - Cultural diversity (enterprise, university)
- Sustainable R&D

Solutions by TÁMOP

- Identify knowledge potential and infrastructure
- Form networks of research sites
- Reach the critical mass for handling effort-intensive industrial challenges
- Harmonization of bachelor, master and doctoral educational system
- Cooperation in recruitments of young people

Conclusions

- In the 20th century the scientific problems were generated by scientists, our believe is that in the 21st century the scientific problems will be generated by customers
- University challenge:
 - Provide a problem-rich environment, where the individuals decide on which topic they would like to work
- Goal:
 - Establish such an R&D atmosphere where industrial research takes place in a university environment and the topics present industrial interests.

THANK YOU FOR YOUR ATTENTION.

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COOPERATION BETWEEN HIGHER EDUCATION, RESEARCH INSTITUTES AND AUTOMOTIVE INDUSTRY

TÁMOP-4.1.1.C-12/1/KONV-2012-0002

BASIC RESEARCH FOR THE DEVELOPMENT OF HYBRID AND ELECTRIC VEHICLES

TÁMOP-4.2.2.A-11/1/KONV-2012-0012

"SMARTER TRANSPORT" - IT FOR CO-OPERATIVE TRANSPORT SYSTEM

TÁMOP-4.2.2.C-11/1/KONV-2012-0012

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HUNGARY'S RENEWAL



The projects are supported by the European Union
and co-financed by the European Social Fund.