IMPACT OF DIGITAL TRANSFORMATION TO THE HUNGARIAN AUTOMOTIVE SECTOR
Automotive Background

Strong scientific community for autonomous vehicle technology research

„Hungary’s automotive sector quietly goes on growing” Financial Times*

- Annual revenues: 12.7 bn EUR
- 10% of the GDP, 20% of the export
- 600+ automotive companies and suppliers
- 100,000+ jobs

Automotive production and development figures

- 4 OEMs and 15 of the top 20 TIER1s are present in Hungary
- Continuous need for qualified engineers
- Currently almost 6,000+ engineers in the automotive R&D demand is beyond **10,000 qualified engineers**
- **Complex, interdisciplinary** domain specific knowledge
- New dedicated programs in higher education

Why Hungary?
## Mobility as social challenge

Inspirating factors for development

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<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td><strong>Zero Emission</strong></td>
<td>- Fuel-consumption reduction</td>
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<td></td>
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<td>- Reducing emission</td>
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<td>2</td>
<td><strong>Demographic pressure</strong></td>
<td>- Support of insecure leaders</td>
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<td></td>
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<td>- Increase the elderly mobility</td>
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<td>3</td>
<td><strong>Risk of accidents</strong></td>
<td>- Avoidance of the accidents by reducing the effect of human mistakes</td>
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<td>4</td>
<td><strong>Increasing traffic density</strong></td>
<td>- Management of transport process</td>
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<td></td>
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<td>- Comfortable, time-saving travel</td>
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<td>5</td>
<td><strong>Assistance systems</strong></td>
<td>- Intelligent sensors for appropriate process</td>
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<td>- Intelligent actuators (steering, brakes, etc.)</td>
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</table>

Source: VDA
RECAR Education program
Strong scientific community for autonomous vehicle technology research

**Long term competency in electronic vehicle control**
- Industrial partners (BOSCH and Knorr-Bremse)
- Academical background (BME, ELTE, MTA SZTAKI)

**Market demand**
- Global trends and actual developments in automotive
- 4 OEM’s and 15 TIER1 companies from Hungary
- Constant need for qualified engineers

**Strong government support**
- Higher added value compared to manufacturing
- ROI calculation at national economy level
- Special research funding programs

**Dedicated BSc/BEng and MSc courses**
- Autonomous Vehicle Control Engineer MSc in English, 2018, Budapest, BME
- Computer Science for Autonomous Driving MSc in English 2018, Budapest, ELTE
- Vehicle Test Engineer Beng in Hungarian 2018, Zalaegerszeg

**Why Hungary?**
### RECAR Education program

**Strong scientific community for autonomous vehicle technology research**

<table>
<thead>
<tr>
<th>Course</th>
<th>Code</th>
<th>Institute</th>
<th>Credits</th>
<th>Language</th>
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</thead>
<tbody>
<tr>
<td>Numerical mathematics</td>
<td></td>
<td>ELTE</td>
<td>4</td>
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<tr>
<td>Industrial image processing</td>
<td></td>
<td>BME</td>
<td>4</td>
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<tr>
<td>Automotive R&amp;D processes and quality systems</td>
<td></td>
<td>BME</td>
<td>4</td>
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<tr>
<td>Control theory and system dynamics</td>
<td></td>
<td>BME</td>
<td>4</td>
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<tr>
<td>High performance microcontrollers and interface</td>
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<td>VIK</td>
<td>4</td>
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<tr>
<td>Project management</td>
<td></td>
<td>BME</td>
<td>2</td>
<td></td>
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<tr>
<td>Machine vision</td>
<td></td>
<td>VIK</td>
<td>2</td>
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<tr>
<td>Human factors in traffic environment</td>
<td></td>
<td>ELTE</td>
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<tr>
<td>Legal framework of autonomous vehicles</td>
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<td>ELTE</td>
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<tr>
<td>Safety and security in vehicle industry</td>
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<td>BME</td>
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<td>Localization and mapping</td>
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<td>BME</td>
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<tr>
<td>Design and integration of embedded systems</td>
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<td>BME</td>
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<tr>
<td>Autonomous robots and vehicles</td>
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<td>BME</td>
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<tr>
<td>Traffic modelling, simulation and control</td>
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<td>BME</td>
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<tr>
<td>Automotive environment sensors</td>
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<td>BME</td>
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<tr>
<td>Automotive network and comm. systems</td>
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<td>BME</td>
<td>2</td>
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<tr>
<td>Automated vehicle design project</td>
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<td>BME</td>
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<tr>
<td>Vehicle dynamics</td>
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<td>BME</td>
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<tr>
<td>Automated driving systems</td>
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<td>BME</td>
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<tr>
<td>Vehicle testing and validation</td>
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<td>BME</td>
<td>2</td>
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<tr>
<td>Diploma thesis</td>
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**Why Hungary?**
RECAR Research program

- Basic and advanced research in **artificial intelligence**
- **Co-operative control** applications to vehicles
- **Redundant technologies** (sensors, actuators, energy and communication networks, software)
- **Insurance/reliability**: how can reliability be tested and improved?
- **Data acquisition/property rights**: how is it possible to make data access and management transparent? Personal data - how can the protection of personal data be guaranteed?
- **Cyber security**: how is it possible to avoid illegal use of intelligent functions?
- **Driverless technologies**: how can test and approval processes be improved to make autonomous vehicles safe and reliable?
- **Accident investigations** with involvement of automated vehicles

Why Hungary?
RECAR Research program

Scientific Areas

- **Artificial Intelligence**
  - Knowledge representation
  - Intelligent Data Analytics
  - Machine Learning and Conclusions
  - Human-Machine-Interaction

- **Control Theory and Energy Management**
  - Autonomous, Distributed, Hierarchic and Cooperative Modeling and Control
  - Human-Machine-Interaction
  - Energy Management

- **Software and System Integration**
  - Platforms and Standards
  - Design, Testing and Validation
  - Reliability
  - Virtualization

- **Data Science and Communication Technologies**
  - Data Mining and Analytics
  - Cloud Technologies
  - Internet, IoT
  - Sensor Fusion
  - Mobile Technologies
  - Wired and Wireless Communication

- **Safety, Security, Privacy**
  - Functional Safety
  - Cyber Security
  - Data Ownership and Access Control
  - Privacy
  - Traffic Safety
  - Accident Reconstruction

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**Vehicle**
- Automated Vehicle Control (Level2-5)
- Drivetrain
- Human Factors
- Testing and Validation

**Vehicle-Environment Connection**
- Environment Sensing
- Cooperative Control
- V2X Communication

**Environment**
- Intelligent Transportation Systems
- Mobile Communication Systems
- Smart Infrastructure
- Electromobility

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Why Hungary?
Proving Ground - industrial background

Close co-operation with the industry – specification of requirements

**Automotive Working Group:** Almotive, AVL, BME GJT, Bosch, Commsignia, Knorr-Bremse, Continental, EVOPRO, NKH, NI, SZTAKI, ThyssenKrupp Presta, TÜV Rheinland, ZF

- Detailed technical specification of the classic elements of vehicle dynamics and physical structure of the automated vehicle tests
- Draft specification of the autonomous environment and related communication infrastructure
- Technical proposal for autonomous vehicle public road testing

**ICT Working Group:** BME HIT, BME KJIT, BPC, Ericsson, HUAWEI, Kapsch, Magyar Közút, Magyar Telekom, NFM, NMHH, Nokia, Oracle, RWE, Siemens, SWARCO, T-Systems, Vodafone

- Detailed specification of the autonomous vehicle environment and related communication infrastructure

Bounder less organizational approach

Why Hungary?
Multi-level testing environment

From computer to real traffic – essential for automated driving

What do we offer?

Public road
- Real public road environment

Limited public road
- Controlled public road tests

Proving ground
- Controlled system-test

Laboratory
- Component test, integration test

Simulation
- Conceptual and feasibility test
Multi-level testing environment

Not only a proving ground for automated driving but also a complex test environment for new info-communication technologies

Test track modules for controlled and repeatable tests in a safe environment

City environment for real-life testing
Proving Ground Concept plan - layout

Overview

Technical plans
Testing and Validation ZONE concept

Extended testing zone – test field to city to public roads

**Loop_1** Local roads (City Zalaegerszeg – being turned into “smart city”)

**Loop_2** Hungarian roads (Zalaegerszeg-Gyor-Budapest) – Actually designed R76 for automated driving, M7 with modified communication

**Loop_3** International roads (Graz-Zalaegerszeg-Sl zone)

**What do we offer?**
Commitment of the Hungarian Government

Investment into a European level RD infrastructure

**CONTROL**

- **Industry policy**
  - LEPSÉNYI I.

- **Coordination**
  - DR. PALKOVICS L.

- **Coordination**
  - DEUTSCH T.

**POLITICAL LAYER**

- **Strategic Partnerships**
- **Government Decisions**
- **Resources**

**Mobility Platform**

- **Tender / financial support**
- **Secretariat**
- **Communication / socialization**

**OPERATION LAYER**

- **RECAR**
  - Education
  - M.Sc. AVCE
  - M.Sc. CSAD
  - B.Eng Test Engineer
  - Dual Education
  - Research
  - RECAR Nr. 1-7
  - EFOP 3.6.2
  - EFOP 3.6.3

- **APZ system**
  - Proving Ground
  - Univ. Research C.
  - Industrial R&D C.
  - Technology Park
  - Next-door Services

- **External infrastructure**
  - Road
  - R76
  - Cross border
  - TÉN-T
  - Smart Test City
  - C-ROADS
  - CROCODILE

- **ICT infrastructure**
  - V2X – ITS G5
  - Cellular (4G/5G)
  - Data
  - Storage
  - Acces (Privacy)
  - Analytics
  - Okos város
  - C-ITS Platform

- **Legislation and standardization**
  - Automotive/Telco. International
  - WP.1
  - WP.29/ITS-AD
  - GEAR 2030
  - Euro NCAP
  - ISO
  - Hungarian
  - EKTB

- **Economic diplomacy**
  - Int’l promotion
  - Zone Concept
  - CAD Investment
  - International Acceptance
  - Int’l communicat
  - Press
  - Forums
  - Exhibitions / Fairs
  - Social Media

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**TECHNICAL ADVISORY BOARD**

- **Electrified**
  - Huba B.
  - Dr. Gáspár P.

- **Connected**
  - Dr. Bokor L.
  - Dr. Háry A.

- **Automated**
  - Erdős I.
  - Érsek I.
  - Dr. Charaf H.
  - Dr. Dávid A.
  - Ésik R.
Business model

On-board systems (OE, Tier1, etc.)

Communication partner (T, Vodafone, etc.)

System partner

PROVING GROUND ZALAEGERSZEG

Modules

Scenario simulation

Sensor cluster

Data management

Engineering Services

Project status
THANK YOU FOR YOUR ATTENTION