New automotive technologies from perspective of the ZalaZONE Proving Ground and its innovative eco-system

Dr. Andras Hary* - Leticia Pekk**

**ZalaZONE Ipari Park Zrt. (e-mail: andras.hary@apnb.hu)*
*** Zalaegerszegi Technológiai Centrum (e-mail: leticia.pekk@tc.org.hu)*

Abstract: The paper intends to give an outlook of the new technologies in the automotive sector through selected aspects which are based on experiences from the ZalaZONE Proving Ground project. First, an introduction is given on ZalaZONE Proving Ground project and its local environment, introducing the “world of ZalaZONE” on industrial park level. The typical technology features are analysed by research map technique, using key-word-based researches. The conclusions were set based on selected examples.

1. INTRODUCTION

The ZalaZONE Proving Ground at Zalaegerszeg, Hungary is a testing facility for classic vehicle function tests as well as it offers validation environment for automated, connected and autonomous vehicles. Even the classic modules were designed to support autonomous testing requirements, but there are also specific modules for driverless solutions. This kind of special combination of the modules is what makes ZalaZONE unique. (Szalay-Nyerges, 1997)

The first stage of the project included construction of the dynamic platform, the high-speed handling course, the first sections of the smart city zone, and they were launched for operation in May, 2019. The second project stage includes creation of smart city zone, highway section, rural roads by end of 2020. The final construction phase will be finished by early 2022, with completion of low-speed handling course, slopes, ADAS testing surface and noise measurement surface.

Fig. 1. Actual status of ZalaZONE Proving Ground

2. THE ZALAZONE AREA

The ZalaZONE Proving Ground is integrated into its environment through a complete industrial park concept. By this, relevant zones were established, beyond the “pure proving ground” project:

- Customer zone for those key clients who are constant users of the proving ground (called “SmartField program”),
- R&D&I campus for the research institutions and organizations, either as proving ground users or service providers.

The first players of both zones are already in place, next to the proving ground, as impact of its translational effect.

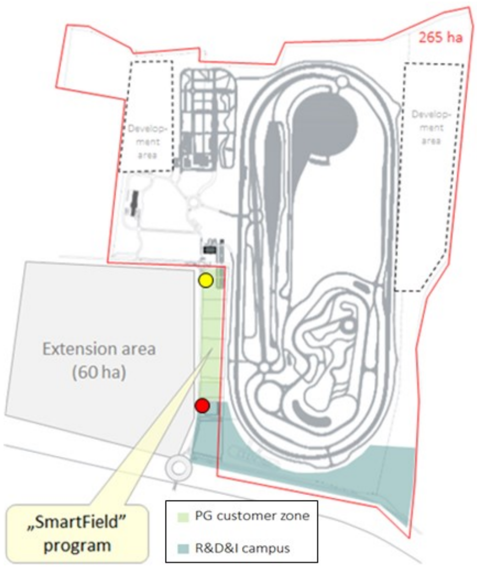

Fig. 2. Concept of ZalaZONE environment

The ZalaZONE environment is focused on leading industrial areas, with special attention to automotive industry and especially development-related fields. The relevant competence areas are: Vehicle development & testing, Simulations & ICT, Mechatronics, Manufacturing technologies, Advanced materials, Product design.

3. THE ZALAZONE SCIENCE PARK PROGRAM

The R&D&I campus of the ZalaZONE area is dedicated to growth of related competences and know-how. The first element of the infrastructure is ZalaZONE Research and Technology Center, which is a complex of interacting university groups and technical service providers.

Fig. 3. ZalaZONE Research & Technology Center

The Center is the first block of the ZalaZONE Science Park program that includes six basic pillars. They are built on the related industrial and scientific knowledge bases so as to serve industrial and scientific needs. The science park program is a special, know-how-oriented approach of the whole industrial zone development.

Fig. 4. Pillars of ZalaZONE Science Park program

4. TECHNOLOGY OUTLOOK

Today, at the global level, the world economy is undergoing significant changes due to the rapid development of technologies. At the same time, development is also driven by the depletion of energy resources which they also seek to optimize in terms of sustainability.

Global trends continue with the emergence of more and more technological innovations, but a trend reversal cannot be expected. The explanation for this, lies in the fact that the new dominant technologies do not necessarily replace the present technology, but instead develop and link the two, so that by cooperating further, the processes can be carried forward efficiently. Technological cooperation also covers vehicle development. It can also be said here that the trend change does not occur in transport alone due to the known changes (autonomous vehicle), but the trend change occurs in such a way that the effects of development reach wider layers. (Fleischer, 2018)

This paper examined relevant changes of the automotive industry in terms of sustainability, particularly in the following areas:

- Autonomous Driving,
- Connected Mobility,
- Hybrid Technology,
- Electric Vehicle.

4.1. Research map

Based on an internet database for specific areas, the common keywords in collected publications was examined. Keyword frequency was checked by using VOSviewer program. By the help of this, it was possible to identify areas that could be important for later analyzes and studies. In addition, it gives the connection of the selected areas to each other, including the nature of the connections between the clusters. The database contained 1000 publications per topic area.

The analysis was performed by using Network Visualization, which determines the size of keywords based on publications. The heavier the article, the greater the label and scope. The color of an element is determined by its cluster. The lines between the elements represent a connection: the closer two publications are to each other, the stronger their kinship is. Within this, it is also worth examining the connection between color clusters. (Eck & Waltman, 2018)

4.2. Autonomous Driving

Autonomous driving as a trend is an emerging and constantly evolving sector. With the proliferation of autonomous vehicles, a shift from stand-alone intelligent vehicles to cooperating intelligent vehicles is expected. In this model, several tools will work together independently of people or with human input. (Cearley et al., 2019)

PwC Autofacts assumes that demand for autonomous vehicles will be different in European market, compared to the United States and China. However, customers are generally positive about new technologies in these regions. Development is currently limited due to the lack of legal principles. From a technical point of view, more manufacturers and vehicles would be able to apply these levels, but the legal framework is still unclear. The current assumption is that vehicles with a level 4 rating will not be on the market until 2022-2023 at the earliest, although technically the functionalities may be available sooner. (Kuhnert et al., 2017)

It can be considered an important area for sustainability, as self-driving vehicles also generate parallel developments in the other areas examined: interconnected mobility and electric vehicles. In conclusion, the level of pollutant emissions improves, thus for example, energy utilization comes to the fore. In fact, self-driving vehicles appear to be an improved form of an existing device designed to facilitate certain activities. As a result, it only gradually becomes clear what other influential paths they are able to open.

A number of factors need to contribute to the implementation of autonomous driving, thus the three large clusters shown in the research map below, were defined as listed below:

- Physical elements of technology (blue)
- Technology software elements (green)
- Other aspects of technology (red)

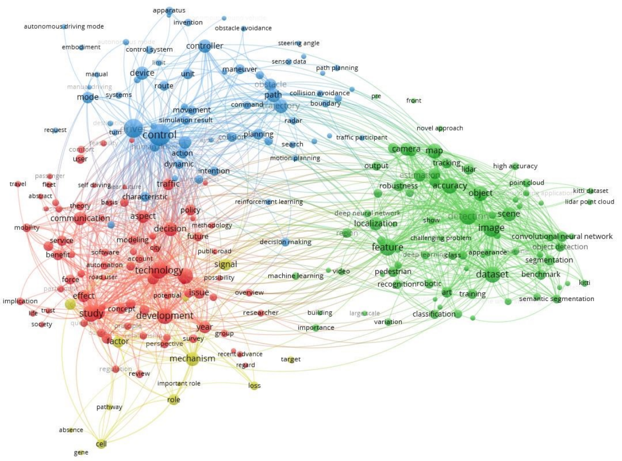

Fig. 5. Autonomous Driving research map – network visualization

Apparently, the physical elements and other aspects of autonomous driving are more closely related but technology software elements also form a larger cluster. Based on these, the following keywords are outstanding from a technical point of view, which can also serve as a kind of trend:

- Dataset,
- Detection,
- Feature,
- Image,
- Control.

The keywords highlighted can all be said to contribute to the implementation and operation of self-driving vehicles. Detection for self-driving vehicles is therefore nothing more than interacting with other devices in a physical space, through different channels, and using these to orient themselves. So, the other keywords, even control, imaging at this level contribute to the realization of self-management levels. It can be said that this also strengthens the mentioned areas. Companies try to use these technology trends by identifying and evaluating their trends and combining them.

4.3. Connected Mobility

Mobility is the movement of vehicles in a physical space from one point to another through some kind of drive, safely. Connected mobility will make a major contribution to increasing security. (Cearley et al., 2019) In fact, the term means two concepts at the same time. On the one hand, it applies to Car2Car and Car2X communication when network communication takes place between car-to-car or between car and infrastructure elements. On the other hand, the term also includes the person in the vehicle who is networked with the outside world. (Kuhnert et. al, 2017)

Technology is a challenge for automotive players, but it is an essential area for the implementation of self-driving vehicles. For the time being, it is also questionable what social impacts the interconnected mobility will have. It is hypothesized that connecting to a single network may reduce the number of vehicles and reinforce the trend of vehicle sharing.

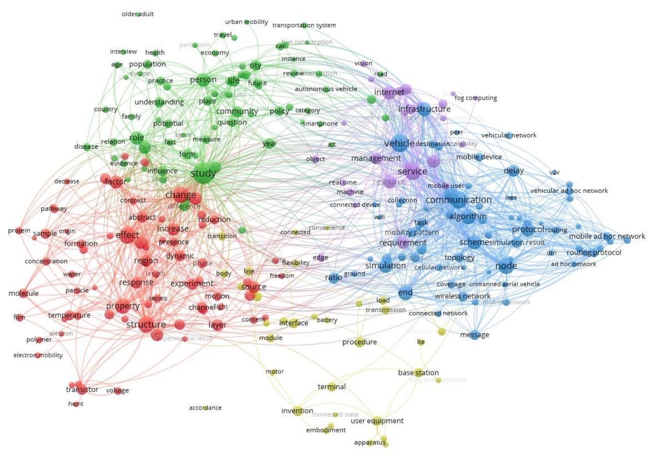

Fig. 6. Connected Mobility research map - network visualization

In the study, four clusters were analysed as follows:

- Other aspects of technology (green),
- Technology other effects, elements (red),
- Technology network elements (purple),
- Physical elements of technology (blue).

Apparently, the clusters of network and physical elements are more closely related to each other compared to the other two clusters. The examined labels can also be considered less diversified within clusters. Keywords were also identified during the analysis:

- Communication,
- Infrastructure,
- Internet,
- Algorithm.

It can be stated that these areas are important for the implementation of interconnected mobility. In terms of sustainability, interconnected mobility as a trend predicts the construction of smart cities, which can make a major contribution to improving the lives of inhabitants. The trend also points to other areas that are gaining strength, such as accurate recognition of the traffic situation and data recording, smart infrastructure developments, etc., all of which can contribute to the safe transport.

4.4. Hybrid Vehicles

In fact, hybrid powertrain technology is not considered as a brand-new trend, but it is important to mention it in the study as it forms a bridge between electric vehicles and vehicles with conventional powertrain.

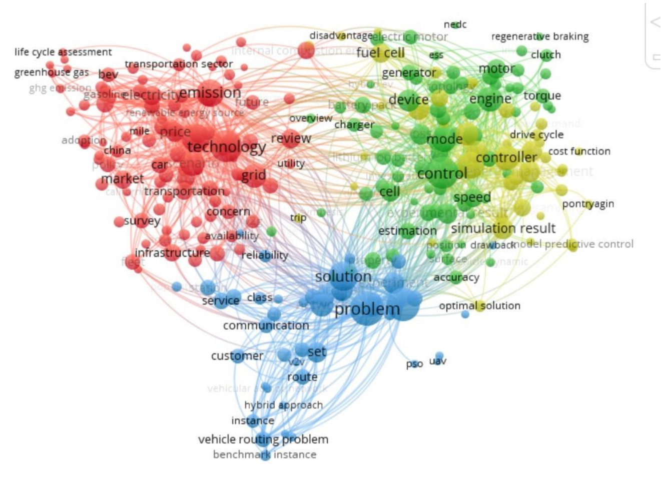

Fig. 7. Hybrid Vehicles research map - network visualization

In the process of the analysis, the connection of four areas have been identified:

- Other aspects of technology (red),
- Technology concept (blue),
- Physical elements of technology (green),
- Technological know-how (yellow).

Compared to the previous areas, it can be considered as a more limited topic area, so the proximity of clusters and their connection is also stronger. The following keywords were found:

- Speed,
- Control,
- Engine, motor,
- Controller,
- Simulation.

These earlier statements were confirmed by the fact that hybrid technology is not a new trend, but a technology that is still widely used today. As automated and electric vehicle solutions will grow primarily in defined areas such as highways and downtowns, as well as in geographically limited areas, hybrid powertrain vehicles will continue to be present widely and being part of transition to sustainable self-driving electric vehicles. Thus, automakers will certainly continue to apply hybrid propulsion technology to their new vehicles. (Kuhnert et. al, 2017)

4.5. Electric Vehicle

As highlighted earlier, the technological trends examined are mutually complementary. It is especially fulfilled in the concept of the connected-electric-autonomous vehicles. Autonomous vehicles used in limited areas (downtown) amplify the development of the electric drive chain. It might lead to a reduction in CO_2 emissions, which can support the efforts due to climate change. In addition, the energy-producing sectors also need to be strengthened, as charging electric vehicles, operating infrastructure elements etc. need to be addressed by building a sustainable energy source. To do this, the energy-producing sectors must also switch to decarbonisation processes.

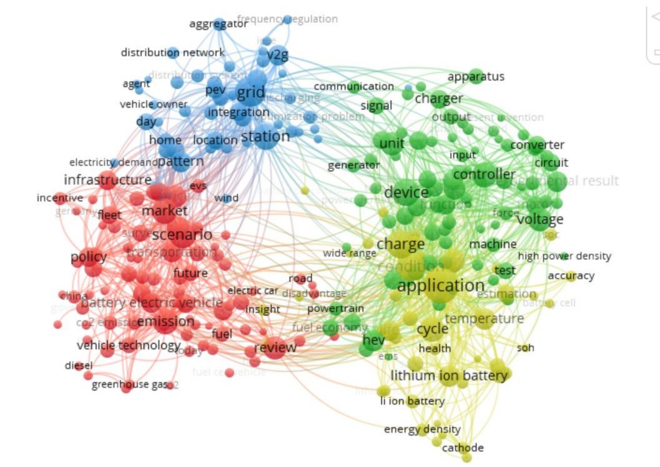

Fig. 8. Electric Vehicle research map - network visualization

Using the program, the following clusters were identified:

- Technology conditions (blue),
- Other aspects of technology (red),
- Physical elements of technology (green),
- Technology application issues (yellow).

Clusters also refer to a rather clear topic area, as cluster groups are located close to each other. The physical elements of the technology and the labels within the field of technological application suggest an even closer connection. The keywords defined for these are:

- Charger,
- Controller,
- Application,
- Cycle,
- Battery.

The importance of charging electrical devices discussed earlier is also reflected in keywords such as battery development. It can be said that the field of technology is critical and constantly undergoing innovation, even in terms of sustainability.

The transport sector is one of the largest consumers of energy and its source of energy seems to be remained mainly fossil fuels. In the United States, for example, 98% of transportation energy comes from petroleum, but much of it is wasted due to the low efficiency of vehicles with conventional internal combustion engines (ICEs). As a result, the automotive industry is still one of the largest sources of greenhouse gases. (Bilgin & Emadi, 2014)

4.6. Conclusions of the studied areas

- Autonomous Driving and Connected Mobility are comprehensive technology changes that induce system-wide changes.
- In the case of all four examined technologies, in addition to the technical elements, the research focus area is also the examination of other social aspects.
- The Hybrid Vehicle area is already in the application phase (know-how), while in the case of the Electric Vehicle area, the sustainability of the application is still under research.
- Key research directions in each field:
    - Autonomous Driving: detection as a key challenge.
    - Connected Mobility: new service areas.
    - Hybrid Vehicle: technology competitiveness.
    - Electric Vehicle: what and where do we use it?

5. CHALLENGES OF THE NEW TECHNOLOGIES

5.1. Self-driving vs. traditional vehicles

Figure 9 shows the well-known five levels of the self-driving technologies. The red-dotted line is not only a legal breakthrough in the development process, but also a change of technology approach. The mix of the traditional vehicles and driverless vehicles generates crucial challenges in testing, both on facility level and competence/know-how level. ZalaZONE, as a testing- and development-focused zone, is facing with these challenges which need to be embedded into the whole technology competence development roadmap of the park.

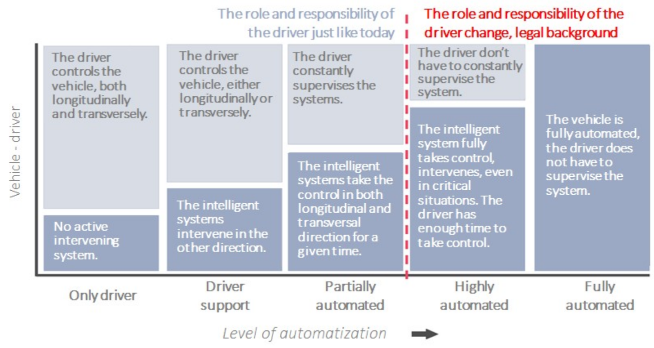

Fig. 9. Levels toward autonomous vehicles

5.2. ADAS systems, as intermediate stage toward autonomous systems

ADAS (Advanced Driver-Assistance Systems) are extensively developing area in automotive industry. These type of systems and devices are available in all cars today, contributing to the safer and more comfortable driving. ADAS tests are usually realizable in classic physical testing environment, but the nature of the tests (e.g. dynamics, no. of safe users, etc.) completely differs from features of vehicle-dynamic tests, resulting in challenges not only in technical point of view, but also in perspective of the testing facility business model, too.

Future of the digitized traffic systems, is still a running and active research area, with special view on the challenges of the mixed (classic and automated/autonomous) traffic. This opens research questions in several fields like traffic automation, data management, mapping, etc.

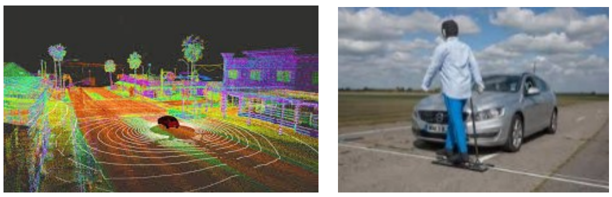

Fig. 10. Examples of ADAS illustration

5.3. Real vs. simulated environment

Scenario-in-the-Loop, as a testing approach and architecture offers the combination of real and virtual objects in order to maximize variable testing environment of autonomous solutions. The Sc-i-L concept was published by research team of Budapest University of Technology and Economics, in co-operation with ZalaZONE Proving Ground. (Németh et.al., 2018).

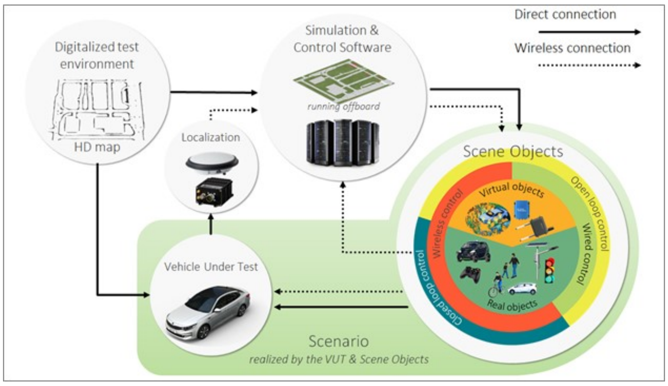

Fig. 11. Scenario-in-the-Loop concept

5.4. New communication technologies

Development of the communication technologies is one of the most extensive area in technology revolution. There are various concepts and trends in competition so as to become the leading technology. Nevertheless, the largest automotive companies typically follow a multi-optional way of development, keeping more key technologies on the table. Currently, mostly the mix of technologies is characteristic instead of having any technology as the only leading one.

The various V2X technologies are apparently widely expanding, with various fields of application. 5G, as the new technology is also dynamically developing, despite the still unclear breakthrough in the automotive industry. It is rather evident that the connected systems and devices are becoming more and more dominant, requiring a really complex testing and development environment.

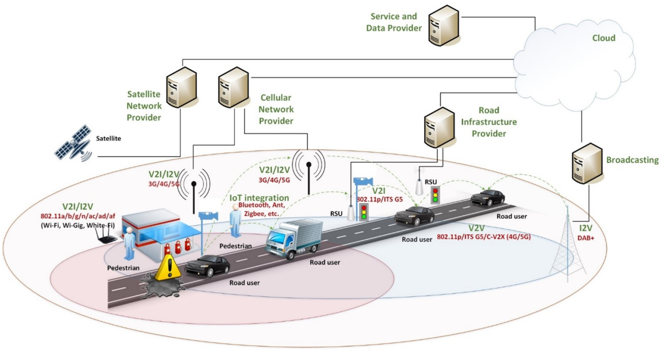

Fig.12. Overview of communication technologies, by Ericsson (EXAMPLE)

6. CONCLUSIONS

The conclusions of the paper are related to the considerations of the new technologies in the automotive industry.

A technology change (and even if it is a revolutionary transition) is always an opportunity to pilot and implement new ways of working.

Due to the fact that nowadays the technology change is wide and deep, it is a must for the companies to evaluate, interpret and understand the technology why's.

Significance of the soft know-how (knowledge, competences, etc.) are more important then ever before. Additionally, the interfering technology trends and impact result in complex technology systems, which need very high level of knowledge to develop and operate.

After the introductory part, the paper gave an outlook on the relevant technology trends and their key features. The challenges of the new technologies were discussed through selected examples.

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