V4 R&D institution to engage in EU Projects

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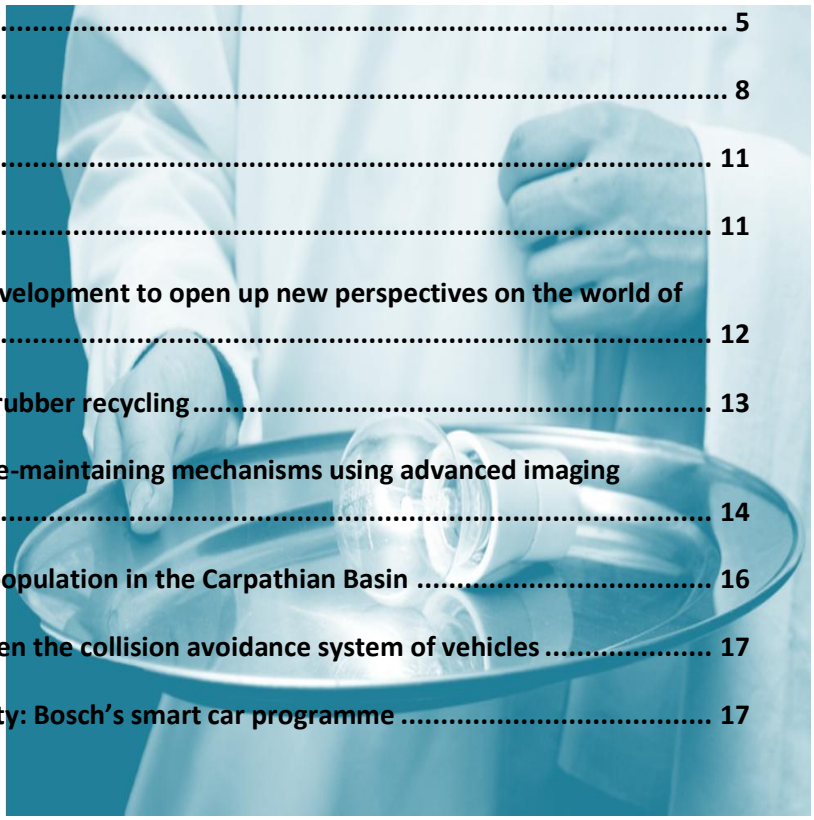
Content



Summary

The National Research, Development and Innovation Office (NKFIH or Office) is the government organ from 2015 responsible for the science and technology policy, and supervises and manages the implementation of the national smart specialization. The NRDI Office is the national strategic and funding agency for scientific research, development and innovation, the primary source of advice on RDI policy for the Hungarian government.

The RDI law (Act2014/LXXVI on scientific research, development and innovation) not only established the NRDI Office as a framework institution but also provided for the National Research, Development and Innovation Fund (NRDI Fund) to render state support for research, development and innovation.

NRDI Office also aims the efficient, transparent and purpose-oriented use of all available RDI resources i.e. both the domestic funds from the NRDI Fund and the funds provided from the European Union's Structural Funds. In order to ensure access to the latter, Hungary developed its National Smart Specialisation Strategy in 2014. These funds all have to serve the scientific and economic competitiveness of Hungary, the effective involvement of our country in the forefront European Research Area, and stimulate sustainable economic growth.

In the good practices we give seven examples of the EU funding schemes on R&D activities through universities and research institutions. The successful application for funding was partly due to these EU sources, but furthermore mainly the high-quality research activities of this research groups as well.

1. Research and innovation in Hungary

Hungary has always been proud of its outstanding researchers, inventors and innovators. Hungarian creativity is indeed a treasure that has been reflected through our past and present. It is generally acknowledged that the latest generations of Hungarian talent, scientists, inventors and innovators are the key to our future.

With that in mind, the National Research, Development and Innovation (NRDI) Office was launched as of 1 January 2015 to promote value creating innovation, in strong partnership with the researcher and innovation community. The NRDI Office is the national strategic and funding agency for scientific research, development and innovation, the primary source of advice on RDI policy for the Hungarian government.

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In order to enable the most efficient possible integration of European best practices into the National Innovation System and to facilitate Hungary's most successful possible participation in the European Research Area, the President of the NRDI Office seeks strategic advice from international experts who are not only world-class scientists in their respective field of expertise, but also have broad experience in science policy and research financing.

All the constituents of the previous institutional system have been transformed: development agencies (national and regional) were dissolved, and regional innovation agencies did not get any functions and roles from the national government in the new centralized national innovation system. The former managing authorities of the National Development Agency (NDA) and the Intermediary Bodies were merged into various ministries. Innovation related programmes belong to the authority of the Ministry for National Economy. Regional development is centralised under the Prime Minister's Office (PMO), but the chief decision-making body is the National Development Steering Committee (NDSC). NSDC's four members - the Prime Minister, the minister for national development, the minister of the economy and the minister of PMO - make decisions on all innovation related and all major regional development related programmes (their content and outcome).

Through the restructuring of the National Innovation Office (NIH), the National Research, Development and Innovation Office (NKFIH or Office) is the government organ from 2015 responsible for the science and technology policy, and supervises and manages the implementation of the national smart specialization.

In addition, the NKFIH ensures, in the framework and linked to the institutional system allocating the EU sources, the synergies in the fields of science, research and development and innovation by managing, inter alia, the domestic financial sources (Research and Technology Innovation Fund (KTIA)) and the National Scientific Research Fund (OTKA)).

1.1 The R&D institutions

The scope of activities and responsibilities of the NRDI Office include the following areas:

Competitive calls for RDI project proposals

- stimulating the implementation of well-designed R&D project plans and promising R&D programmes,
- the harmonisation of applicants' aims, strategic development directions and the institutional/organisational development ideas, and
- the preparation of solid budget plans that promote the successful and sustainable utilisation of R&D funds.

Researchers' thematic applications

Funding discovery research projects without thematic priorities

- funding promising basic research projects initiated by researchers with an aim to get a better understanding of natural and social phenomena, potentially resulting in the foundation of new methods and/or procedures
- strengthening workshops of scientific excellence through postdoctoral fellowship programmes for early career researchers

Research infrastructure

Providing appropriate tools and equipment for domestic research organisations

- strengthening the R&D capacity of state-operated knowledge centres of strategic importance
- development of research infrastructures with a view to build networks, supplementing regional research opportunities and leveraging existing infrastructures

Corporate RDI

Incentives for large enterprises, SMEs and innovative startup businesses to achieve their R&D objectives

- development of new marketable products, services and technologies with added value
- prototype development
- industrial property rights
- procurement of RDI services
- creation of startup incubator houses
- Knowledge transfer

Supporting the commercialisation of scientific results

- building cooperation with an aim to solve complex multi-disciplinary tasks with strategic importance

- establish the research infrastructure for industrial development projects which are based on actual market needs, in cooperation with excellent research institutions in the specific field;
- development of the domestic research infrastructure in the form of cooperation between the industrial and higher education sectors, where the created RDI capacity generates new competitive products and service.

International cooperation

Improving the competitiveness and ability to benefit from international funds of SMEs

- joining co-financed international cooperation
- promotion of consortium building activities
- supporting bilateral scientific and technological cooperation primarily through calls promoting project based cooperation
- supporting Hungarian discovery research projects ranked among the best but ultimately not selected for funding by the European Research Council (ERC)

(source: National Research, Development and Innovation (NRDI) Office)

The Hungarian Scientific Research Fund (OTKA)

The Research Fund has been the major funding agency of basic science and scholarship since 1986 when the transition to competitive research funding started in Hungary. Its "founding fathers" modelled the principles of operation on the practice of German (Deutsche Forschungsgemeinschaft) and American research funds (National Science Foundation, National Institutes of Health).

Upon a government decree, OTKA has been operating as an independent non-profit organisation since 1991. Its legal status and rules of operation were established in an act in 1993 and reinforced in 1997 by the Hungarian Parliament in order to provide independent support to scientific research activities and infrastructure, to promote scientific achievements of international standards, and to provide assistance to young researchers.

As an independent institution, OTKA reports to the Parliament and the Government of Hungary. With regards to the funds provided within the annual budget of the Republic of Hungary, the appropriations of OTKA are administered via the budget of the Hungarian Academy of Sciences. The administrative and financial tasks related to its operation are performed by the OTKA Office in Budapest.

The Hungarian Academy of Sciences – HAS (Magyar Tudományos Akadémia, MTA)

The Hungarian Academy of Sciences was founded by Count István Széchenyi in the middle of the 19th century, with the aim of developing the Hungarian language and contributing to scientific work to be performed through using the Hungarian language. (At that time the official language in Hungary was German.) Széchenyi also advocated the publishing of Hungarian scientific books and magazines. Since 1870 the Academy has evolved to become the centre of scientific activity in Hungary. 1946 saw an organizational restructuring of the Academy with the aim of excluding contemporary artists and writers. Reforms in the 1980s and 1990s led to the creation of the Széchenyi Academy of Art and Literature, meant to provide an elite platform for humanities.

The HAS encompasses several scientific research institutes throughout the country. (See the list of research institutes of HAS below.) The Academy's share in the Hungarian research capacity in terms of the total number of other Hungarian R&D organisations is around 10%.

The HAS is an autonomous public body based on the principle of self-government. It is composed of members of the Academy and by active representatives of science, holding a scientific degree (Ph.D or D.Sc).

It is the responsibility of the Academy to

- support the development of sciences, scientific research and the publication of scientific books and journals;
- regularly evaluate scientific research results as well as encourage and assist publication, dissemination and utilisation thereof;
- represent, within its sphere of responsibilities, Hungarian science in Hungarian public life and at international scientific fora.

Research in the higher education sector

Considering the number of research units HEIs have a central role in the Hungarian research sector. Also, the most intensive research publication activity takes place in the HEIs: 2/3 of all publications were written by researchers in this sector.

Non-budgetary research establishments

The Bay Zoltán Foundation (BZF) is one of the most important among the research units of foundations and associations. The BZF is the largest research foundation in Hungary, founded in 1992; it consists of 3 research units: the Institute for Biotechnology, the Institute for Material Science and Technology and the Institute of Logistics and Production Engineering.

Universities

Most of the region's research centres are university-based. The key universities are: Széchenyi István University in Győr, University of West Hungary in Sopron and Mosonmagyaróvár, Pannon University in Keszthely). Industry-academia collaborations are concentrated in Széchenyi University which has several (automotive industry related) knowledge centres, and in the University of West Hungary (wood- and eco-industry related centres). Except for some key multinational actors, companies in WT innovate mostly by adopting technologies developed elsewhere.

National Agricultural Research and Innovation Centre

National Agricultural Research and Innovation Center, NARIC was founded by the governmental act 1476 (VII.24.), on January 1, 2014. An integrated, single legal entity was established from the fragmented and ill-proportioned sectoral governmental RDI capacities (13 research institutes in the field of agriculture and food science), where the institutes keep their professional autonomy as separate

organizational units and their financial management is carried out on a high level of independence.

The institutes integrated by NARIC conduct high-quality basic and applied research and development activities related to plant and animal biotechnology/genetics, animal breeding, reproduction and nutrition, aquaculture and fisheries, food and meat science, plant and vegetable production, viticulture and enology, forest research and management, climate change and biodiversity, agroenvironmental research and technologies, and agricultural engineering.

The organisation, by employing nearly 200 researchers, is of significant size even at international level. It is able to join the world's scientific circulation and increase the recognition of Hungarian agricultural research.

Hungarian Intellectual Property Office

The Hungarian Intellectual Property Office (hereinafter referred to as "HIPO"; former name: Hungarian Patent Office; change of name effective from 1 January 2011 pursuant to Article 265 of Act CXLVIII of 2010) is the government office responsible for the protection of intellectual property established in 1896 by virtue of Article 23 of Act XXXVII of 1895 on Patents for Inventions.

Detailed rules concerning the legal status, the financial management, the responsibilities and the competence of the HIPO are contained in Articles 115/D to 115/L of Act XXXIII of 1995 on the Protection of Inventions by Patents (hereinafter referred to as the "Patent Act") and in Act XLIII of 2010 on central state administrative organs and on the legal status of Government members and state secretaries (hereinafter referred to as the "CO Act").

Pursuant to the CO Act, the HIPO, as a government office, is directed by the Government. The Minister for National Economy designated by the Prime Minister exercises the rights of supervision over the government office as laid down by law.

The President of the HIPO is appointed and released by the Prime Minister. The President's two deputies are appointed and released by the Minister for National Economy on a proposal from the President. The employer's rights over the Director General for Economic Affairs, who is the head of the economic departments of the HIPO, are exercised by the President.

The HIPO covers its operational costs from its own incomes. The HIPO manages its incomes independently, and covers its operational costs out of its own revenue. The Hungarian Intellectual Property Office constitutes a separate budgetary title of the State Budget of Hungary.

1.2 The policy instrument

The Hungarian regional innovation system is characterised by 'façade regionalism': strategy design is bottom-up (since 2014 it is made at the national level), but implementation is centralised and bottom-up strategies are ignored. Following a

complete overhaul of the institutional system that managed EU co-financed regional development and regional innovation programmes, strategy implementation became separated from regional planning and programming and was completely centralised.

All the region experts prepared the RIS3 strategy that identified the main sectors, technologies and scientific disciplines bound to become the engines for innovation-based growth of the region. RIS3 and the additional county-level development strategies do not influence the content of the support measures that are launched, implemented, administered, and evaluated centrally. Innovation policy measures embodied in the Economic Development and Innovation Operational Programme are uniform across the Hungarian regions except for Central Hungary.

The main tool for implementing national S3 strategy and R&D+I policy in Hungary is the Economic Development and Innovation Operational Programme for Hungary 2014-2020 (EDIOP). The addressed policy instrument is a part of the EDIOP. There are no regional operational programmes in Hungary between 2014 and 2020.

EDIOP is the largest operational programme in Hungary (8 813 million euro). The programme consists of eight priority axes, among them one of the largest amounts (1 1688 million euro) is allocated to Priority axis 2 – Research, technological development and innovation.

Main objectives of the EDIOP programme

The programme aims to stimulate the economies of the less developed regions in Hungary. Its most important priorities are the competitiveness of small-and medium sized enterprises, research and innovation, and employment. The programme also aims to develop the tourism industry, enterprises' energy efficiency, and information and communication technologies. Moreover it will stimulate the use of financial instruments to cover other objectives, like increasing renewable energy production and improving the energy efficiency of households and public buildings.

Funding priorities

The Programme focuses on different main priorities:

- Increasing the competitiveness and productivity of SMEs
- Research, technological development and innovation
- Infocommunication developments
- Energy
- Employment
- Competitive labour force
- Tourism
- Financial instruments

Expected impacts

Over 300,000 unemployed people – nearly half of them under-25 years old, will benefit from job creation initiatives, with 450,000 people set to participate in training to enhance employability;

Nearly 12,500 companies - including 1,500 start-ups to receive financial/advisory support, with 8,000 more assisted to enhance their use of e-services and ICT;

Some 1,400 to benefit from improved energy and resource efficiency, while the programme will install 240 MW renewable energy production capacities;

Nearly 3,000 research jobs to be created, giving a boost to SME innovation activities and Hungarian research institutes, while improving cooperation among private and public research centres;

A million households to be linked to the new generation broadband network, with high-speed internet coverage being rolled out country-wide; and

Some 1.6 million visitors expected to natural and cultural heritage sites as a result of investments in sustainable tourism – helping to grow local and remote economies.

In this period, two main institutions manage and decide upon the project applications: the Ministry for National Economy that manages the Economic Development and Innovation Operational Programme (final decision is made by National Development Steering Committee (NDSC)) and the National Research, Development and Innovation Office manage the funding of scientific research projects.

NDSC has four members: it is led by the Prime Minister and its members are the minister for national development, the minister of the economy and the state secretary in charge of the Prime Minister's Office. Government decree 140/2012 transferred the authority of deciding upon large-scale developmental projects and all innovation related programmes to NDSC. Note that by that time the Managing Authorities of the OPs have also become subordinated to the ministries steered by NDSC-members.

2. Good practices

2.1 iKOMP

The iKomp project ('Strengthening the regional research competencies related to future-oriented manufacturing technologies and products of strategic industries by a research and development programme carried out in comprehensive collaboration') is encompasses nine regional stakeholders: two universities (**Széchenyi University and the University of West Hungary**), a research institution of the Hungarian Academy of Sciences (SZTAKI) and six companies, including local subsidiaries of large blue chip global companies, subsidiaries of relatively smaller multinational corporations and Hungarian-owned companies.

The origin of the iKomp consortium can be traced back to a decade-long networking activity among a large number of stakeholders in the region of Zalaegerszeg (the capital of Zala county). The network comprises representatives of manufacturing firms: SMEs, large Hungarian-owned companies, subsidiaries of multinational corporations, innovation management and consultancy firms, NGOs, industry associations, a public foundation (for the tertiary education in Zalaegerszeg), universities and public research institutes.

The mission of this network is to contribute to the innovation-oriented development of the region, and enhance industry-university collaboration. Note that the boundaries of the region are loosely defined: the network comprises stakeholders also in Szombathely and Szentgotthárd: both in the neighbouring Vas county

Above and beyond a regular exchange of information about investment needs, future directions of regional development, or about domestic and international tenders, the main field of network members' collaboration is the organisation and provision of dual vocational training for both vocational school students and university students.

One commonality of network members' activity is that it is closely related to advanced manufacturing: either because they are manufacturing firms in automotive, electronics, machinery and metal processing industries, or they are specialised in advanced manufacturing-related research, or are engineering and technical education services providers, or they are simply interested in the innovation-based regional development of West Transdanubia.

Members of the network regularly participate in calls for tender of support measures that aim to promote innovation and technology development, investment in research infrastructure, or innovation collaboration. When the Hungarian government launched the EU co-financed 'R&D Contracts of Competitiveness and Excellence' (RDCCE) programme, several network members decided to form a consortium and apply for funding of their long-nurtured technological development plans and R&D programmes.

The RDCEE support measure intended to support large-scale research development and innovation undertakings carried out in collaboration. Expected beneficiaries were consortia consisting of public research organisations and business enterprises. The minimum amount of funding to be applied for was €1.7m, and the maximum foreseen was €13.6m.

2.2 Pannon University based development to open up new perspectives on the world of particles

Establishment of an Electron Microscopy Laboratory at the University of Pannonia (SEM: scanning electron microscope, TEM: transmission electron microscope)

"Reinforcing the research infrastructure – internationalisation, networking" (GINOP-2.3.3-15) was among the first calls announced by the Ministry of National Economy on recommendation of the NRDI Office. The call with a total budget of HUF 20 billion (EUR 65.5 million) aims to strengthen domestic research infrastructure and facilitate Hungarian participation in international research infrastructures. It was also the first call in which the winners – from Debrecen, Keszthely, Pécs, Szeged and Veszprém– were announced in May 2016.

The **University of Pannonia** won nearly HUF 1 billion (EUR 3.2 million) to establish an electron microscopy laboratory. The technical leader of the project, Mihály Pósfai university professor, Member of the Hungarian Academy of Sciences and recipient of the Széchenyi Prize talked about the laboratory to be established in Veszprém, Hungary at a briefing in late November 2016. Scientists and experts who can benefit from the electron microscopes in the implementation of their research projects were also invited to the event.

The successful application for funding was partly due to the high-quality research activities of his research group.

The other project focuses on how carbonate minerals are formed in Lake Balaton. The Lake's mud is largely made of magnesium calcite which precipitates in the water. I have said that the two research projects are related because micro-organisms also play a part in mineral precipitation. The photosynthesis performed by algae creates suitable chemical conditions for the precipitation of magnesium calcite. Calcite does not only appear "in itself" in the solution, by the formation of homogeneous crystal germs, but it precipitates on a surface. Lake Balaton is shallow and its water is always full of tiny floating clay mineral particles providing a surface for calcite to crystallise. In winter, when the water freezes over, crystallisation sets in on the cells.

In the case of magnetic nanofibers the inorganic material is crystallised to mutagenic filaments to control its precipitation. In Lake Balaton natural control is ensured by clay minerals or suitable microalgae. Studying this process is interesting to science because it seems that apart from the long-established classical crystal germ formation mechanism; there are other processes in action as well. The new election microscopy laboratory will be a great help in monitoring them."

The funding will be spent on two microscopes: the old scanning electron microscope will be replaced with a new one, and a transmission electron microscope will be installed in a new separate building. The new building indicated in application is very important as the microscope located here can only be used in a noise-free environment.

Partly mechanical noise, vibration: the "standard vibration" of the city reaches the microscope through the rocks and the soil which frustrates the atomic resolution, the detection of individual atoms. These microscopes will not be installed in the first floor but in the basement, and even the environment of the new building will be adapted to the device. Electromagnetic noise will also have to be filtered: for example, have

to pay attention to what kind of devices are operating in the building and how wires run in the wall. Acoustic noises also cause disturbances but these modern microscopes mostly come in big boxes rather than on their own and even the operator controls the test from another room.

The electron microscope makes it possible to observe solid material in nanometre sizes or even "atom by atom". But such equipment are not only suitable for imaging but their accessories can be used for determining the composition of the examined material, and even 3D morphology and composition can be determined by "tilting" the sample (the 3D process is called electron tomography). Even biological samples can be studied but this requires special preparation. Part of the funding will be spent on two pieces of sample preparation equipment: an ultramicrotome for creating thin biological sections and an ion-beam thinner for the examination of "hard" samples."

The epoch-making change is the result of a new sample preparation method: the biological sample is immersed in liquid ethane and the sudden cooling (ethane melts at -182 °C) causes the water in the sample to solidify in an amorphous form rather than in a crystallised form which prevents cell organoids from changing. The accessories required for this are not included in the present funded project, but they are included in EDIOP project proposals pending decision.

The University completed an important work phase: the drafting of the public procurement notice in relation to the assets to be purchased. The scanning and transmission devices will enhance the competitiveness of Hungarian researchers in this field bringing them up to par with international research groups using cutting-edge technologies.

There are many research teams at the University of Pannonia who would have needed electron microscopy for their work, and there are many others who actually use electron microscopy by bringing their samples into another facility and paying for the examination – but work is ineffective this way.

They want to create a laboratory which provides quality services to everyone, not only to the university but to a wider range of stakeholders. Institutions in the region include the University of West Hungary and the Széchenyi István University, a little further south the University of Pécs and the Balaton Limnological Institute, but we also expect industrial orders. So, we think that the laboratory will be suitable for the examination of various samples and scientific issues, and we want to operate it as efficiently as possible. Similar laboratories abroad not only give home to local staff but also to "outsiders" because the electron microscopy is very time consuming.

Their plan is that research groups wishing to use the equipment more frequently would delegate a colleague who would be trained by us to perform certain techniques and tasks. He or she would then be qualified to carry out such tasks and would be allowed to use the microscope independently. It is always more effective to allow researchers bringing the scientific issue to carry out the measurements as they the most familiar with the given problems.

2.3 Microwave improves scrap rubber recycling

The recycling of scrap rubber – such as scrap tyres – is a key environmental issue. It is, however, more challenging than you would think: due to its vulcanised matrix material with a stable cross-linked structure, scrap rubber can be "degraded" and reprocessed only to a limited extent. Researchers at the **Department of Polymer Engineering of Budapest University of Technology and Economics (BME)** have promising research results in the devulcanisation of the cross-linked structure which opens up new ways for the industrial recycling of crumb rubber.

Currently, the vast majority of scrap tyres are recycled to create crumb rubber which is primarily used for the coating of sports fields and playgrounds and for energy purposes, such as in the cement industry. Another form of high-volume application could be the so-called "rubber bitumen" but this technology is still in the experimental phase in Hungary. It would be another evident recycling opportunity to use crumb rubber as an additive in various natural rubber compounds in manufacturing processes, but the volume that can be utilised this way is limited: the amount of even the finest crumb rubber fractions (under 1 mm grain size) may not exceed 10 weight percent in any compound. Thus, new methods and application areas must be identified for recycling scrap rubber.

This is exactly in the focus of the project funded in the Researchers' Thematic Applications Programme financed from the NRDI Fund: researchers at the BME Department of Polymer Engineering assume that the microwave treatment of crumb rubber allows for the cleavage of the chemical (carbon-sulphur and sulphur-sulphur) bonds in its cross-linking structure. This enables the creation of mobile molecules that can attach to the matrix molecules to provide the necessary strength for the boundary formed between them. In this process, adding carbon black to rubber can promote efficient heating and the uniform distribution of heat in the material, even in the case of apolar rubbers.

A major challenge of the research team is to explore how the type of the rubber used as raw material in the experiments, i.e. the additives and fillers inside, influence the effectiveness of the microwave treatment. Their hope is that the innovative devulcanisation method will allow crumb rubber to be used in larger quantities in the rubber industry, while further experiments are needed to decide to what extent the amount of fresh natural rubber can be replaced in the manufacturing process.

The priority to provide useful recommendations to future industrial users of the method as to what types of rubber products (summer or winter tyres, motor-car or heavy duty truck tyres) are the most suitable for the microwave devulcanisation process.

Another goal of the project is to create a product with high added value, more specifically a thermoplastic elastomer which can be reprocessed multiple times through repeated smelting. The researchers plan to produce the thermoplastic elastomer – by partly or entirely replacing fresh natural rubber with microwave treated crumb rubber – with a new continuous manufacturing process while reaching optimal material properties (stretchability, elasticity).

As a practical result, the research project is expected to lay the foundations of and develop procedures which can be easily and quickly introduced to industrial processes and have the potential for mass production, with particular regard to the continuous production of thermoplastic elastomers.

3. Exploration of novel genome-maintaining mechanisms using advanced imaging technologies

DNA is the cornerstone of every living organism: our uniqueness, our whole existence is encoded in these miniature spirals. It was submitted his project proposal to the **European Research Council (ECR)** for funding but despite the positive professional evaluation the project was finally not selected for funding. With a bridge funding from the NRDI Fund, the excellent research biologist can continue his work under predictable conditions, preparing for another international competition with the promise of success on the horizon.

As long as your body functions properly, you never even consider how many things contribute inside to make it all work. They probably know what bones, muscles and blood vessels are for, but most of us are not so sure about what they are made of, why they grow, move, and more importantly, why they become defunct or deformed even from birth.

The genome is constantly exposed to damage but DNA maintaining enzymes – while continuously replicating DNA molecules – try to repair any physical damage and deficiencies. If the repair fails, the damaged DNA will be reproduced causing enormous damage with unpredictable consequences. If both strands in the double helix are severed, it can cause genetic instability that may lead to cancer for example.

However, a biological process called homologous recombination is able to fully restore broken DNA using the information of an intact copy of DNA. It is similar to backing up important family photos: if the files on the computer are damaged or lost we can use the backup copies to restore the photos so dear to us. Put simply, something very similar happens in our body as well.

The research project focuses on this repair mechanism, more specifically how the so-called BLM proteins can restore the structure of DNA molecules. On the one hand, the project aims to map the unknown biochemical mechanisms of DNA processing (using cutting-edge single-molecule manipulation experiments), on the other hand, it tries to explore how such mechanisms contribute to DNA repair in living organisms. Improving our understanding of DNA restoration processes will open vast horizons for humanity: it can help medical science discover new methods even enabling the "repair" of cancer cells.

Recording a DNA repair process requires equipment and technology worth millions of forints. In addition, as it is a dynamic process, the repair process can only be properly followed by "video-recording". This was the weak point of the original project proposal submitted for ERC funding: no matter that the project was among the top 10 percent of the proposals, no matter how highly the research results were assessed by the evaluators, the research group still had insufficient experience in using advanced imaging technologies. This is a typical case where the NRDI Fund can help through a special funding scheme: it provides bridge funding to researchers who narrowly missed out on the ERC grant. The funding makes it possible for the most outstanding Hungarian researchers to continue working on promising discovery research projects without being forced to abandon their work or continue it abroad.

The host institution **Eötvös Loránd University, Budapest** will also benefit from the new equipment, as they will be integrated in the education system giving university students an unprecedented opportunity to gain practical experience in this field.

This project also involves two predoctors: participation in such a research project is not only an excellent dissertation topic for PhD students but it can also lay the foundations of their future research career.

In consideration of the NRDI Fund grant the beneficiaries have to undertake that at the end of the grant period they will reapply for funding under the international ERC call. The team already use the bridge funding to develop their research project, they have good chances to win the ERC grant of EUR 2-3 million within the framework of the call to be announced in two years. This amount equals to their total budget in the past 10 years. This would allow the team to buy even more advanced equipment, introduce more modern methods and could potentially reach a breakthrough in the field of repairing DNA strains, bringing them to forefront of global scientific research.

3.1 Mobility and transforming population in the Carpathian Basin

Institute of **Archaeological Sciences, Faculty of Humanities, Eötvös Loránd University, Budapest**

In relation to the ethnic and cultural change of the Carpathian Basin in the Early Middle Ages, not much attention has been paid to how settlers and local inhabitants co-existed and created a shared culture. Recent migration trends in Europe, however, have made it a hot topic to learn more about the migration wave that occurred 1500 years ago. Although history rarely provides clear guidelines to be followed, the unbiased observation of historical processes can broaden your perspective and help find better solutions.

The complex multidisciplinary research project funded under the Researchers' Thematic Applications Programme of the NRDI Fund combines traditional and new methods to present a more accurate picture about how the population of the Carpathian Basin, including the territory of present-day Hungary, changed in the 5th to 7th centuries A.D., and how changes in lifestyle relate to the constant ethnic and cultural changes. However, artefacts found in tombs and the evolution of funeral and settlement traditions can supply us with not much of new information if we use traditional archaeological and anthropological methods.

This is why the joint Hungarian–German bio-archaeological project seeks to find new ways of interpreting remains with the involvement of modern scientific procedures still less applied in Hungarian archaeology practices of the great migration period. This approach does not only help learn more about our cultural heritage from the era before the Hungarian Conquest and provide additional information to the self-concept of the population living in Hungary today, but it also helps better understand the permanent and timeless nature of migration. Who, when and why decide to leave? Who, why and how decide to stay?

The isotope diagnostics help map the origins and mobility of individuals by analysing the strontium content of teeth and bones. The proportion of this element always characterises a certain geographical environment and, as it gets into waters and plants, leaves its traces in the bone tissues of locals consuming such food. At a young age, strontium is conserved in the dental enamel where it indicates the individual's place of origin throughout his or her life. In other types of bones, however, the bone tissue is continuously changing, therefore the proportion of strontium isotopes reflects the place of living during the years before his or her death.

This method enables us to clearly distinguish between locals and first generation immigrants in a given environment, to reveal the relationship between persons moving together, and to identifiy whether non-locals came from the same place of origin. The route of migration can also be tracked by reconstructing the lifestyle and staple diet of individuals of different social status. This is indicated by the analysis of the stable carbon and nitrogen isotopes since they integrate into the bones and thus conserve the composition of trace elements of regularly consumed food. The proportion of carbon isotopes is determined by the type of photosynthesis of plants, enabling a clear distinction between the food of terrestrial and aquatic origin for instance, or the consumption of millet as a peculiarity. Presence of nitrogen in the organs implies the consumption of more meat and a higher level of social status accordingly.

The multidisciplinary evaluation of the results of different examinations gives rise to a new interpretation of history; the diversity of methods paves the way for a comprehensive reinterpretation of the archaeological finds of the migration period and the known phenomena. An international team with members from various generations of researchers cooperates combining the new aspects of related social sciences and modern disciplines.

3.2 Cognitive methods strengthen the collision avoidance system of vehicles

Drones nowadays are applied for an increasing number of tasks in the course of which they face the complex mathematical and technological challenge to identify objects appearing unexpectedly and their likely trajectory during such missions. Collision avoidance is essential to prevent substantial material damage and personal injuries, however, targeted solutions of intentional collisions are used more and more frequently for security and defence purposes, marking a new field of applications for the project results.

The new system developed by the Hungarian consortium combines complex signal and image processing with a new method to drastically improve the collision avoidance system of robot vehicles: the drone – or the anti-drone interceptor respectively – processes information collected from various sources by "thinking and becoming smarter". The BHE Bonn Hungary Elektronikai Kft. in cooperation with the Institute of Technical Physics and Materials Science, Centre for Energy Research of the Hungarian Academy of Sciences, three departments of the **Budapest University of Technology and Economics** and the ASTRON Informatikai Kft developed an integrated solution using radar, video and telecommunications technologies which enables drones not only to map their environment but also to interpret and use the collected information based on cognitive mechanisms and feedback. At the same time, reversing this process enables to detect and avoid "unwelcome" drones and even to force a controlled landing, if necessary.

As a result of the experimental development, the navigation and content generating capabilities of the drones have drastically improved. Collision avoidance tests combined with learning have proven that the environmental analysis of radar-based video navigation (featuring a range of several hundred meters and an accuracy of one centimetre) has contributed to the creation of an efficient system which can be used for various purposes of drone missions. This is an important milestone in the development of unmanned aerial vehicles. By reducing the reaction time of drones, they become capable of solving complex and difficult tasks, such as flying in formation, mutually supporting each other.

There is also further potential in the utilisation of the present intelligence system as a powerful long-range interference system or a modern combination of universal sensor and management system which can be successfully down- and up-scaled within the frequency range.

3.3 From science fiction to reality: Bosch's smart car programme

Those who have a car, almost certainly use something that was manufactured by Bosch. The German company has been present in Hungary for 117 years now and

has always been at the cutting edge of innovation and scientific research. Launched in 2013, the company's development programme was implemented in cooperation with the Institute for Computer Science and Control of the Hungarian Academy of Sciences, the Budapest University of Technology and Economics, and the **University of Miskolc**, in search of solutions to the changing needs of the automotive industry.

ABS, ESP, ESC we know these acronyms, though their meaning may be less clear to us. It is, however, clear to everyone that they were all invented for us, drivers and passengers. Bearing in mind the importance of safety systems, Bosch has spent almost HUF 7 billion (EUR 22.2 million) on research and development in the field of transportation technologies.

The camera system developed by Bosch not only increases comfort, but also driving safety. Probably all drivers have experienced distraction when their attention was drawn away from the road for a few seconds. In such cases the driver may not perceive the stop sign or the indications of speed limits. The Bosch system recognizes and interprets road signs and, if the driver fails to respect them, sends a warning. In addition, the system always functions according to the real-life situation and not on the basis of previously uploaded and perhaps already outdated GPS data.

The radar sensors can see through fog, rain and heavy snowfall. If all cars were equipped with a radar emergency braking system, never again would we see TV news about pile-ups of 50-60 cars on the motorway, as the sensor would detect any obstacle ahead on the road and would immediately activate the braking system. It would do the same when seeing a pedestrian in front of the car. The average driver reaction time is 0.5 second. During this period of time, a car going at 30 mph will travel 23 feet. Even 7 inches can mean life or death, let alone 23 feet. The radar system's electronic brain, however, takes action without delay.

Bosch engineers think that the protection of human lives comes first, the mitigation of damage is only a bonus. Parking assistance radars, cameras and ultrasonic sensors help drivers to park in smaller places without damaging the paintwork or, more importantly, the bodywork.

It would be fair to ask: what is new in these technologies, as we have already seen most of the above-mentioned features on the roads as convenience or safety add-ons. Well, a separate unit may increase driving safety, but in addition to developing sensors further and bringing down their prices, the real forward-looking solution is to integrate them into a single system. Bosch's innovations are forward-looking; a step on the road to a world where built-in car safety systems no longer function as separate units but let vehicles to communicate with each other. If, say, on a frosty winter morning, a car's electronic system detects ice on the road, it warns nearby cars of the danger, so that they can slow down in time and avoid any accident.

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