# NEW HORIZONS

## ANNUAL REPORT 2017


LUXEMBOURG
INSTITUTE OF SCIENCE
AND TECHNOLOGY

LIST

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# FOREWORD FROM THE CHAIRMAN OF THE BOARD OF DIRECTORS AND THE CEO A.I.

## TOWARDS NEW HORIZONS

2017 was without a doubt a year of decisive consolidation for LIST. Our research institute can finally face the challenges, projects and changes ahead with confidence. Since its creation more than three years ago, LIST has developed a strong foundation, giving it the non-negligible asset of being able to make progress without wavering.

This foundation materialized in particular with a solid performance contract signed in January 2018, after being prepared over a large part of the previous year with the government. It represents a great achievement for several reasons. Firstly, concerning the figures, as it envisages an increase of 18% in the funding allocated by our ministry over four years. Furthermore, in terms of content, the indicators were reformulated to better correspond to those of an RTO (Research and Technology Organization). Finally, its success also lies in the collaboration that was put in place with the directors and heads of unit or group, as well as with the Collaborative Council in order to define or refine the strategy that will guide LIST until 2021, with the aim of becoming a fully-fledged RTO by 2025.

As seen in 2017, Luxembourg's only RTO was able to maintain the course it had originally set itself and which was reconfirmed by the new performance contract.

Our Institute once again distinguished itself on the national and European research scene. In 2017, LIST rolled out numerous innovations and technologies benefitting both Luxembourgish industry and society, as well as others. LIST committed to important national and international collaborations, indisputably demonstrating the performance and quality of its work.

2017 began with the realization of LIST's commitments from the year before. As part of its flagship collaboration with the manufacturer Goodyear on sustainable mobility and materials of the future, LIST recruited a number of PhDs and post-docs from all over the world and launched more than ten projects. The collaboration with PM-International AG on innovative bio-supplements for health, fitness, well-being and beauty product lines also took shape, with LIST establishing shared laboratories at its premises to make operations and investments for extracting and transforming molecules of plant origin easier. Furthermore, LIST and PM-International AG launched the first LIST International Award in Bioinnovation (LIAB Award 2017) to reward research results and technologies particularly likely to be transferred to the market. 2017 was also distinguished by numerous industrial partnerships. Alongside CERATIZIT, LIST committed to developing new coatings efficient at high temperatures, even exceeding 850 degrees Celsius, for the high-speed machining technique. It also committed to developing a new generation of copper and a new generation of car windscreens with Circuit Foil and Carlex, respectively. Finally, LIST committed alongside SES to developing in particular commercial products and services in the area of innovative satellite communications (SATCOM). In total, 20 collaborative projects were signed with Luxembourgish and European industry during the year.

LIST joined forces with the Université catholique de Louvain as part of a research collaboration in the areas of life and environmental sciences and technologies, as well as in data processing, modelling and visualization. It also obtained the renewed confidence of the Ministry of Agriculture for its activities in the areas of agriculture, viticulture and consumer protection. Scientific excellence remains at the heart of LIST's ambitions, as proven by the 42 competitive projects accepted, the 11 publications with an impact factor greater than 10, the 17 theses defended and the 3 researchers appointed Adjunct Professor at the University of Luxembourg.

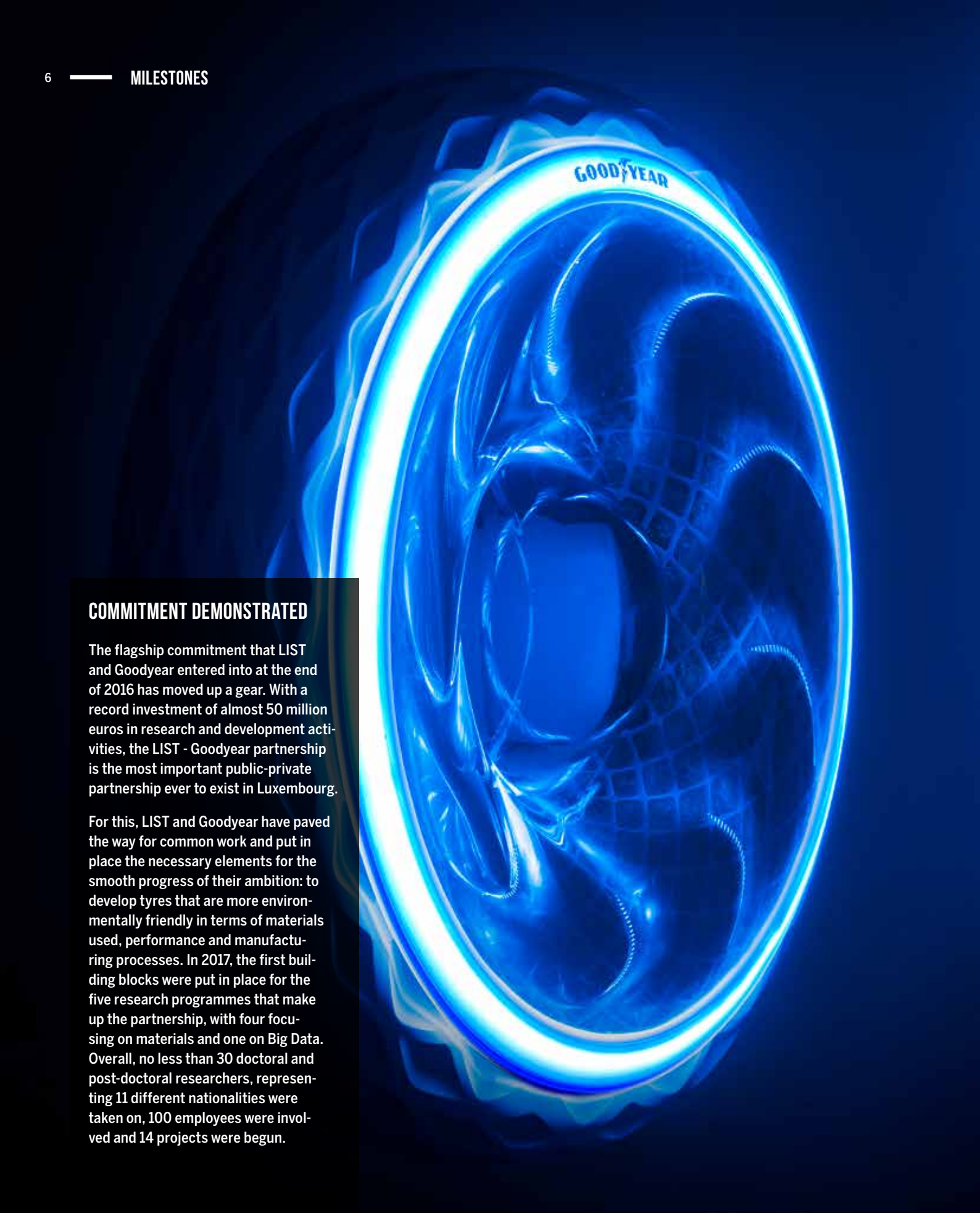
Finally, and in compliance with its mission of innovation transfer and the acceleration of the economic impact for industry, LIST created its Finance Innovation Technology and Systems Centre (FITS), an infrastructure concentrating on digital financial technologies as key accelerators in the transformation of the financial position of Luxembourg.

Boosted by all of its achievements, we consider the future of our institute with calm confidence, and are more than ready to face the challenges ahead.

Georges Bourscheid
Chairman of the Board of Directors

Dr Fernand Reinig
CEO a.i.

# MILESTONES




## COMMITMENT DEMONSTRATED

The flagship commitment that LIST and Goodyear entered into at the end of 2016 has moved up a gear. With a record investment of almost 50 million euros in research and development activities, the LIST - Goodyear partnership is the most important public-private partnership ever to exist in Luxembourg.

For this, LIST and Goodyear have paved the way for common work and put in place the necessary elements for the smooth progress of their ambition: to develop tyres that are more environmentally friendly in terms of materials used, performance and manufacturing processes. In 2017, the first building blocks were put in place for the five research programmes that make up the partnership, with four focusing on materials and one on Big Data. Overall, no less than 30 doctoral and post-doctoral researchers, representing 11 different nationalities were taken on, 100 employees were involved and 14 projects were begun.

## THE INFINITELY SMALL

As part of a large-scale project that LIST researchers were involved in for seven years, LIST developed a SIMS (Secondary Ion Mass Spectrometry) technology, which was both innovative and unique in the world, enabling the exploration of the infinitely small on scales that had never previously been achieved.

In combination with ionic microscopes such as the ORION NanoFab, marketed by LIST's partner for this project, the manufacturer ZEISS, the instrument developed in the LIST laboratories enables surface analysis with a record resolution of around 10 nanometres, that is, up to 10,000 times smaller than the diameter of a human hair.

This SIMS technology, called VECTOR$^{500}$, is now marketed by the Luxembourgish company Ion Optical Nano-Systems sàrl, a LIST spin-off launched for this purpose at the end of 2017.

## PROTECTED DATA

As part of its research and development activities with the National Commission for Data Protection (CNPD), LIST has developed an innovative and intuitive solution enabling the maturity level of organizations in terms of data protection to be verified.

Known as the GDPR Compliance Support Tool, this tool will help businesses become compliant with the new data protection regime that entered into force in Luxembourg in May 2018. It enables not only the management of a processing record, and of all other documents necessary to demonstrate their responsibility, but also the development of a way of monitoring the evolution of the maturity level of the organizations.

Designed and prototyped by a LIST team, by means of a complete database of 350 regulatory requirements, the tool has been transferred to eProseedRTC, a FinTech / RegTech software editor and supplier of IT services.


## SHARED LABORATORIES

For the very first time in its history, LIST has substantially opened up its bio-innovation technological research platform to one of its industrial partners.

LIST and PM-International AG now have shared laboratories at the LIST premises in Belvaux. Focused on innovative bioactive molecules, this common infrastructure makes operations and investments for extracting and transforming molecules of plant origin, among others, easier. In broader terms, this marks a big step forward in the partnership that has linked the two entities since 2016 and that focuses on innovative bio-supplements for the health, fitness, well-being and beauty product lines.

# KEY FIGURES

## HUMAN RESOURCES

employees | **592**

**65 %** men

**35 %** women

**40** nationalities

**74 %** innovation researchers or specialists

**114** | people hired

**79** | PhDs

## SCIENCE AND TRANSFER

**26** FILED R PATENTS

**13** paid licences

**200** Scientific articles published in 2106 with an impact ⩾ 2

**1** spin-off

# R&D PROJECTS

**114** competitive national projects

**55** large-scale contracts

**76** collaborative projects and similar

**17** Interreg, FEDER, Erasmus, Cost projects and foundations

**Σ 319** total of RDI projects and contracts

**32** self-funded projects

**25** competitive European projects

## TYPES OF RESEARCH CONTRACTS

- **Competitive projects** are research projects that have successfully passed an international scientific evaluation following a call for projects in the framework of national or international programmes.
- **Collaborative projects** are those that respond to the definition of collaborative projects in the sense of the Community framework for state aid. They include public projects that are part of the public benefit missions entrusted to LIST, as well as European Space Agency (ESA) projects or those co-funded by foundations.
- **Self-funded projects** are projects of strategic interest to LIST, financed by LIST's own funds.
- **Large-scale contracts** are those over €50,000 or those where it is considered necessary to monitor them more carefully.

# INTERNATIONAL COLLABORATION

## NUMBER OF AGREEMENTS PER COUNTRY

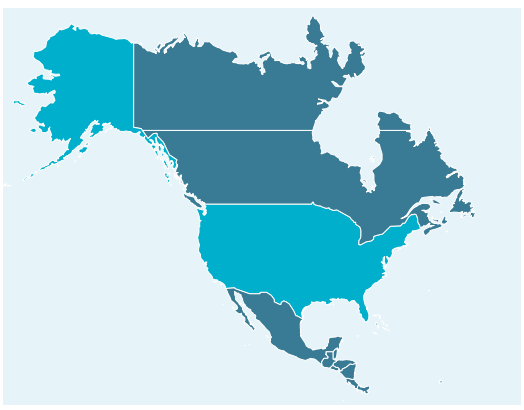
### EUROPE

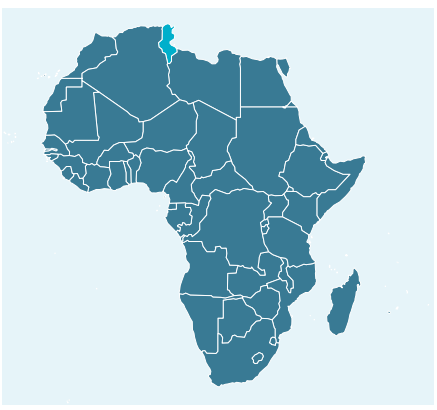
| | |
|---|---|
| Austria | 2 |
| Belgium | 9 |
| Croatia | 1 |
| Czech Republic | 1 |
| Denmark | 1 |
| Finland | 2 |
| France | 16 |
| Germany | 8 |
| United Kingdom | 6 |
| Greece | 3 |
| Italy | 5 |
| Malta | 1 |
| The Netherlands | 8 |
| Portugal | 2 |
| Romania | 1 |
| Spain | 5 |
| Sweden | 3 |
| Switzerland | 5 |

### WORLD

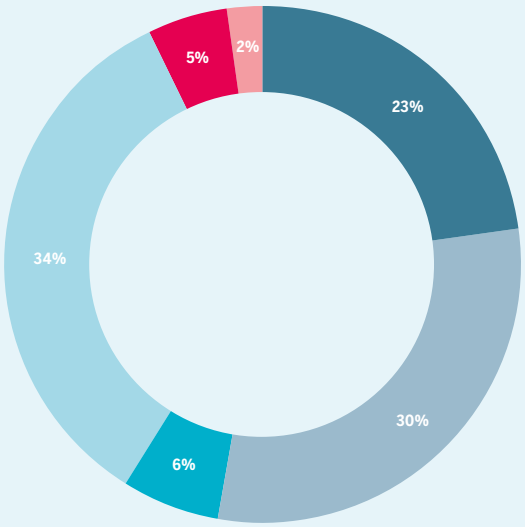
| | |
|---|---|
| United States | 1 |
| Tunisia | 1 |

## GEOGRAPHICAL BREAKDOWN OF AGREEMENTS SIGNED IN 2017





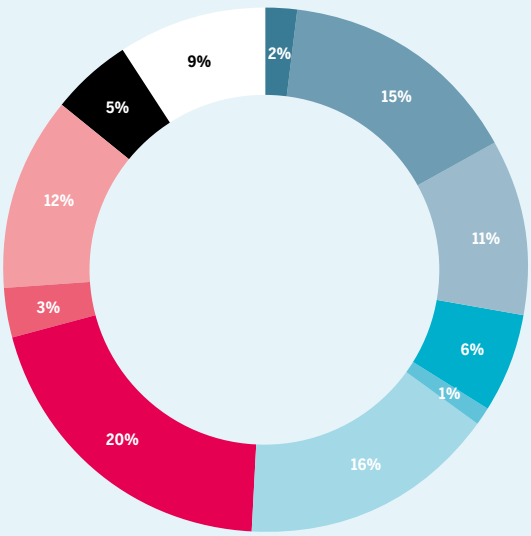
## BREAKDOWN OF PARTNERSHIPS SIGNED IN 2017 BY TYPE OF PARTNER




**Type of partner**

- Companies (30)
- Universities (38)
- Public institutions (8)
- Research centres (43)
- Federations and associations (7)
- Other (2)

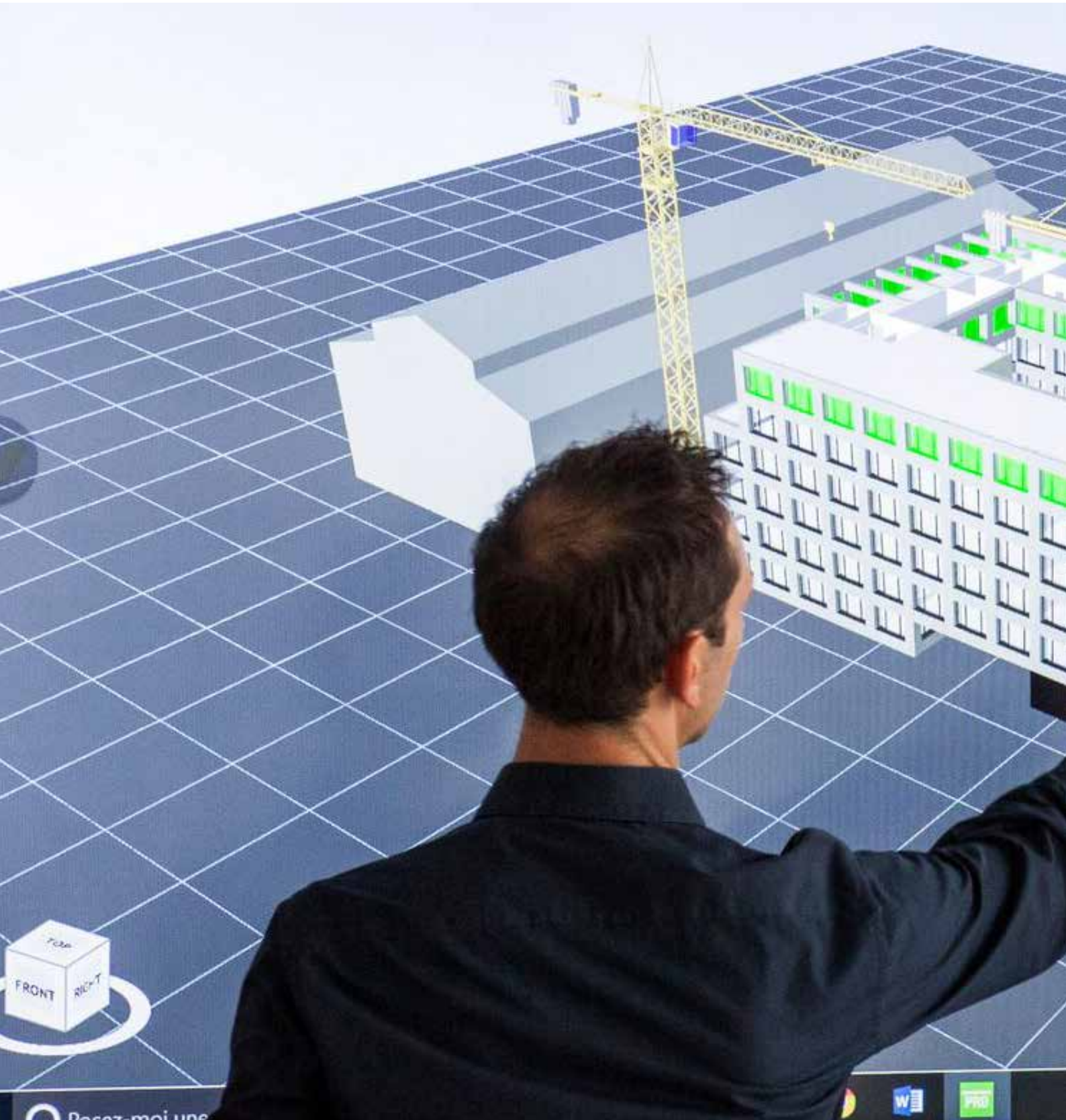
## PARTNERSHIPS SIGNED WITH COMPANIES IN 2017 PER SECTOR




**Business sector**

- Automotive (3)
- Biotechnologies (19)
- Information Technology (14)
- Construction (8)
- Cosmetics (1)
- Materials (20)
- Energy and environment (25)
- Space (4)
- Mobility, Transport & Logistics (17)
- Instrumentation (6)
- Security (11)

# FEATURES


TOP
FRONT
RIGHT

# IMPROVE QUALITY OF LIFE IN A FAST-CHANGING SOCIETY


Although we are not always fully aware of it, technology, in all its forms, is an integral part of our daily lives. Beyond that, it influences and changes our behaviours and our perception of the world. Thanks to our expertise in this subject, our researchers accompany, support and anticipate changes in our modern society, whether these are a result of technology or require the contribution of new technologies. We try to make good use of the advantages of connected technologies, augmented reality and mixed technologies, or even smart technologies to construct the world of tomorrow, in tune with the needs of our society.

« Our research projects transform technologies into decision-making powers for the citizens of tomorrow

## CHANGING LIVES THROUGH GAMES

In certain areas, our research work focuses on the latest technologies, such as mobile applications, the cloud, and the blockchain, as well as on connected monitoring station networks. We want to change the way that we all, businesses, administrations and citizens, experience and see our world. For this, we are working on research projects that transform technologies into decision-making powers for the citizens of tomorrow.

With the European **MUV** project, we commit more precisely to putting in place an optimal use of technologies to contribute to local planning and decision-making processes as part of sustainable energy development in the urban environment. Our ambition is to **incite citizens to change their behaviour when they make trips**.

In this way, we hope to encourage people to adopt more sustainable and healthier lifestyles, thanks to a set of high-performing technological systems.

As part of the European **CrossCult** project, we cross-check substantial amounts of information in time and space, whether between nations, eras or collections of one or several cultural and heritage institutions (museums, historic buildings, etc.) in order to confront and analyse the points of view of European citizens concerning their own history. With CrossCult, we hope that the contribution of innovative ITC technologies will stimulate a change in the way European citizens understand History. In particular, we have developed a smart city application aiming to **disseminate cultural heritage thanks to new technologies** and help people to better understand, consider and debate culture and national and European history.

## AUGMENTED REALITY AS A FORM OF EDUCATION

Augmented and mixed reality technologies, allowing a simultaneous fusion of real and virtual worlds, are at the centre of some of our research work.

We are convinced that they provide multiple advantages, which are currently under-exploited. Therefore, we are particularly working on unveiling their potential in order to be able to respond to the difficulties encountered by our society. With the European project **TARGET**, we are committed to integrating these technologies into the training of professionals, whose jobs are in constant evolution and require highly realistic training environments. Indeed, the technologies offer a more flexible and profitable alternative for designing training scenarios. **Police forces, anti-terrorist units and emergency doctors** who are constantly confronted with changes in their working environment, could reap real benefits from such an innovation. It is our ambition that tomorrow, training organizations will be able to create their own personalized scenarios, not only more quickly, but also at a lower cost. We are therefore working on developing mixed reality environments bringing together different realities and enabling real-life objects to be linked to augmented and virtual reality headsets with geospatial systems.

## MAKE CLEAN TECHNOLOGIES POSSIBLE

With the contribution of smart technologies, such as those for storing and transmitting information, smart sensors and meters, network infrastructures, and 3D decision-making models, the way forward is now clear for a more environmentally friendly future.

These technologies prove to be very useful in the design and creation of future products and services with a limited environmental impact estimated in advance. At LIST, we are working on this approach, known as **life cycle assessment (LCA)**. We also use integrated simulation and optimization approaches allowing the best of the products to be defined and developed, and have already developed numerous environmental assessment tools that are used by Luxembourgish businesses. With our **ECOPACT** web application, small and medium-sized businesses in all sectors can carry out simplified LCAs to develop their future products. With our **OASIS** simulation tool, water management professionals, such as drinking water reservoir managers and administrations, can now design drinking water production stations that are more environmentally friendly.

Boosted by the success of our previous achievements, and our experience in this area, we are currently working on the application of such technologies in other sectors impacted by innovative environmental technologies. We are thus working on several projects that will enrich the existing LCA methodology. With the **VALUES** project, we are working on integrating the assessment of biodiversity and the ecosystemic services it creates into LCA in the best way possible. With **CONNECTING**, we are developing a new approach exclusive to multimodal electric mobility scenarios. The results of our research work will undoubtedly be adopted by businesses and researchers in their future considerations for launching products that are more environmentally friendly.

« We use integrated simulation and optimization approaches allowing the best of the products to be defined and developed.

# CREATE AN ECONOMIC IMPACT WITH NEW TECHNOLOGIES

New technologies play an important role in our economic environment. As sources of innovation, added value, evolution perspectives and new knowledge, they are essential to the proper economic development of our modern societies. In particular, we took up the challenge of supporting research into smart coatings, technologies related to space, remote sensing and data analysis technologies.

## A CLEAR VIEW OF THE ROAD

There is no question that smart coatings bring added value to classic day-to-day objects. With them, the ordinary becomes extraordinary. These latest coating technologies, consisting of a coating on the surface of a material or a part, to give it particular properties, provide new functionalities to the objects and things around us. By applying a smart coating to a standard object, it can react, as if by magic, to certain given interactions. Furthermore, manufacturers are also very interested in these coatings as they give them an inkling of the enormous development potential for the objects and materials of tomorrow.

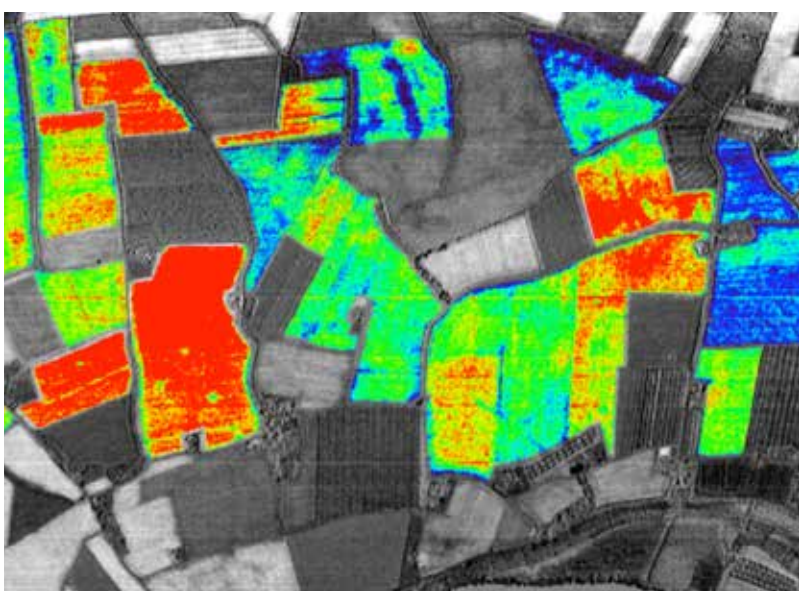
At LIST, we work in close collaboration with **Carlex**, a top-end American car glass manufacturer established in Luxembourg. Together, thanks to these smart coatings, we hope to develop a brand new generation of car windscreens that will prevent the passenger compartment overheating and the windows fogging up in the winter. Our ambition is simple: We want to reduce the ecological impact of the heating and cooling systems in cars. The windscreen is indeed a real weakness in terms of heat absorption and loss and is thus responsible for energy overconsumption. By improving its thermic insulation capabilities, we enable the cars of tomorrow to respond more effectively to future European regulations on vehicle emissions. But that is not all. When energy consumption decreases, the attractiveness and performance of electric vehicles will increase.

## ALL EYES ON SPACE

Mass spectrometry, a physics analysis technique for detecting and identifying molecules, is a real asset in the resolution, anticipation and analysis of our environment. Thanks to this incredible tool, it is possible to carry out numerous analyses on a very small scale. With it, we are capable of turning our attention to cells with a mass of one nanogram, that is, cells whose mass is 1 billion times lighter than a 1-gram object. This means that mass spectrometry enables us to see and analyse not only what is invisible to the naked eye, but also that which is sometimes even beyond our understanding.

At LIST, we have developed a **portable mass spectrometer**. We first designed the tool to answer questions inherent to hydrology, and then adapted it depending on needs and partnerships. Its compact size and high mass resolution make this technology a real asset. In the **MS-SPACE** project, we are working together with **NASA** to adapt it to spatial applications. Our ambition is that in the near future, our technology can be part of the next spatial missions and bring concrete responses to the still numerous mysteries of planetary exploration. Our innovation goes even further than our initial hopes: our innovative mass spectrometer was chosen by the Japanese lunar exploration company **ispace** to be taken to the surface of the moon. Up there, thousands of kilometres away from Earth, our technology will be used to exploit the elemental compositions of lunar ice and regolith, a fine dust covering the ground of the moon. Beyond this real recognition of our expertise, we are incredibly proud to be part of such a revolution.

> **« Thousands of kilometres away from Earth, our technology will be used to exploit the elemental compositions of lunar ice and regolith.**



## VIEW FROM ABOVE

The latest remote sensing technologies, which enable the acquisition of information on a specific object, even without coming into contact with it, are developing rapidly. They offer perspectives for the analysis and comprehension of natural phenomena that have never previously been achieved. Aerial images, from drones or aeroplanes, or from even further away from us, i.e. taken by satellites or hyperspectral cameras, offer enormous potential for monitoring and managing the environment, agriculture and natural risks.

As part of the **MOSQUITO** project, we are using new satellite observation technologies to improve flood management in urban areas. Heavy rain, melting snow, overflowing rivers or bursting dams and dykes are all potential causes of flooding, which, along with growing urbanization, are weakening urban zones, their inhabitants and their structures. We are therefore committed to developing new methods allowing the **precise, systematic and automated monitoring of flooding in urban areas**. We hope that tomorrow, public powers will have the necessary data to better identify vulnerable areas, better anticipate the onset of floods and better prepare searches, assistance, medical help, evacuations and managing population movement.

We also use **aerial and satellite imaging** in order to transmit crucial information to actors in the agricultural sector on the state of their crops. With **PLANTSENS**, we hope that farmers and horticulturalists will be able to take the necessary measures to guarantee a constant supply of water for their crops and plantations and thus avoid drought and dehydration. With **BIOSCOPE**, we hope that farmers will be able to accurately identify the problems with their crops and only use crop protection products where necessary, and not on all of their crops, as is currently the case. Our ambition is that tomorrow, the growth, yield and quality of the plants and crops, as well as agricultural operating costs, will be optimized, and at the same time, that consumers will find high-quality products available with a reduced environmental impact.

> « Data analysis technologies play a crucial role in the national economic development.

## LEARN TO SEE

In our connected world, we all leave considerable amounts of data in our wake. These data contain a lot of important information, which, when analysed and used correctly, allow businesses to remain competitive and even to win shares of the market. **Data analysis technologies**, which combine several analysis tools from the areas of operational research, artificial intelligence, and business intelligence, among others, play a crucial role for economic development. To this end, it is essential for us to accompany Luxembourgish businesses in this central issue and thus guarantee national competitiveness.

As part of the **FEDER-DAP** project, we are developing an efficient data analysis platform. At the cutting-edge of technology, this facility, unique in Luxembourg, will integrate a **high-performing calculation system** and high-level data analysis capabilities. It is our ambition that in the near future, businesses and industries will be able to benefit from the latest existing online analysis technologies that meet their needs to use, improve and predict operations and possibly even design new related commercial offerings.


WARD 2017
AWARD IN BIOINNOVATION
LIST AWARD 2017
Mr. Paul Spagnuolo
Winner of the 2017 LIST Internatio
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# BENEFIT FROM AN ATTRACTIVE RESEARCH SYSTEM


The innovative environment in which our research institute is evolving is a real opportunity, encouraging economic development and looking towards the future. We can be satisfied with the efforts made by the Luxembourgish government to make our country a real challenger on the international scene. More than that, we are committed to all of these policies and initiatives as we are convinced of their merit and their potential for our future.

## A SMART NATION

At LIST, we support the national effort to transform Luxembourg into a Smart Nation. Luxembourg aims to develop new research infrastructures with an international reputation. Such facilities, resources and services, used as much by our researchers as by our colleagues from other Luxembourgish research and innovation centres will enable research to be carried out in the best possible conditions, thus favouring innovation. However, this is not all; they may also serve as a reference for European research. Some of these large-scale infrastructures will be operated right at the heart of our research institute. For example, in our laboratories, we host the **National Composite Centre - Luxembourg** (NCC-L), which enables us to make the development and handling of innovative materials in Luxembourg even more dynamic.

Internet, smartphones and connected objects are many of the digital tools that have revolutionized our daily lives in just a short time. But this revolution is not without consequences for businesses, which are facing an unprecedented digital transformation. Integrating digital technologies into the heart of their activities has become more than invaluable; it is quite simply inevitable. In order to remain competitive, businesses have no other choice than to rethink, transform and adapt their whole organizations. This phenomenon is a crucial issue for which not all businesses are prepared, and it is therefore important to assist them. At LIST, we particularly support the financial services sector, which is not only one of the sectors most affected by the digital transformation, but also one of the pillars of the national economy today. We are working on **innovations allowing the digital transformation process of this sector to be accelerated** in order to position the Luxembourgish financial ecosystem among the best in the world.

> « By evolving from the linear to the circular, the idea is to make a real shift guaranteeing the longevity of the economy.

Furthermore, Luxembourg can boast excellent network connectivity. The country intends for the whole population to have broadband by 2020 and plans to equip all the country's economic activity areas with ultra-high-speed broadband. Both urban and rural areas have excellent connectivity, making Luxembourg one of the European leaders in ultra-high-speed and meaning our activities benefit entirely from this connectivity.

Luxembourg is constructing its future around innovation, essential for the successful diversification of its economy and sustainable growth. This means that Luxembourg is the first country to implement the third industrial revolution at the national level. This revolution, defined in 2011 by the American political and economic theorist **Jeremy Rifkin**, demonstrates that energy, mobility and digitalization will enable the course of the future to be changed. Inspired by this philosophy, our country is currently defining a new long-term economic model, based on technological progress in the information and communication technology, energy, and transport domains, and integrating them all into a smart network. At LIST, we completely support this initiative. Furthermore, we have aligned our research activities and our organization with the strategic axes the government adheres to.

## A PROMISING FUTURE

At LIST, we are confident about our future. Our activities and ambition benefit directly from the very healthy Luxembourgish economy, whose growth is higher than average in the eurozone, as well as being one of the most solid in the world. Furthermore, many years ago several credit rating agencies awarded Luxembourg the famous **triple A** or AAA rating and have since continued to renew it. This internationally recognized indicator corresponds to the maximum grading that a country may obtain to estimate its solvency in markets. Luxembourg is therefore part of the very exclusive club of countries with this rating, a pure and simple recognition of the solidity of its budget and more widely, the attractiveness of its territory.

We also support Luxembourg in the application and integration of circular economy principles by its businesses. Contrary to the "linear" economy on which the current society is broadly founded, the **circular economy** closes the lifecycle of a product, envisaging its recycling and the reabsorption of its raw materials by the technosphere and/or the biosphere right from the design stage. By evolving from the linear to the circular, the idea is not only to efficiently manage the natural resources of the country and more efficiently protect the environment and the climate, but also to make a real shift guaranteeing the durability of the economy. Furthermore, Luxembourg's diverse industrial fabric, and the numerous industrial SMEs and large international groups established on its territory, as well as its dependence on raw material and energy imports make the country an excellent testing ground for economic strategies and models that can be developed for the circular economy. With the support of new technologies and information technologies, we are working on different projects to help make Luxembourg a leader in this area. With the **PERSEPHONE** project, we want to make biomethanization play a regulatory role in the production of renewable electricity in the energy mix.

> **Within several metres of each other, the University of Luxembourg, the Luxembourgish research centres, the common laboratories, the start-ups and the national business incubator are all easily accessible.**

Luxembourg has been reaching for the stars for around 30 years. In this time, it has continuously followed an ambitious and effective spatial policy. Indeed, Luxembourg is the first European country to propose a legal framework guaranteeing private operators rights pertaining to the resources they extract in space. Very recently, Luxembourg launched the **SpaceResources.lu** initiative with the aim of supporting innovative projects using cutting-edge spatial technologies. The **Luxembourg National Research Fund (FNR)**, the main financial backer for public research in Luxembourg, joined this initiative at the same time by funding spatial exploration projects. There is therefore a whole ecosystem that has adapted to the needs and wishes to invest in and become an essential actor in spatial research. At LIST, we fully benefit from this initiative as part of our cooperation with **ispace**, a lunar exploration company for whom we have committed to developing its mass spectrometer in the coming years. ispace will use this instrument to characterize lunar water sampled and consider its future use. At the national level, we are also working in close collaboration with **Kleos Space** to make composite beams in space that are equipped with antennae, enabling the company to put latest-generation nanosatellites into orbit.

## INTENSIVE RESEARCH

We are situated on the Belval Innovation Campus, at the heart of an exceptional neighbourhood devised at the beginning of the 2000s. This location, with its rich past, is one of a kind. It is the result of the reconversion of an industrial site, which stopped a large part of its activities 20 years ago. Built on the past to shape the future, this **new research and innovation campus** houses all the actors in the innovation chain, from university training to innovation, by way of research. Within several metres of each other, the **University of Luxembourg**, the Luxembourgish research centres, the common laboratories, the start-ups and the national business incubator are all easily accessible. There is no doubt that such an organization makes discussions, decision-making and partnerships easier. Our activities benefit from this strong innovation potential and pooling of national scientific excellence on a daily basis.

The national business incubator, the **Technoport®**, located next to our headquarters, takes the spin-offs that have emerged from our research activities under its wing. Our latest spin-off to move to its premises was **Luxembourg Ion Optical Nano-Systems** sàrl, which marketed the VECTOR$^{500}$ SIMS, a technology both innovative and unique in the world enabling **the infinitely small to be explored at scales never previously attained**, and which was developed within our research laboratories. But this national incubator is not the only one to support young entrepreneurs in the realization of their projects. There are also numerous private incubators throughout the country, representing a real creative and innovative force for Luxembourg.

This comprehensive package for budding entrepreneurs is reinforced by the extensive presence of innovative business accelerators in Luxembourg.

# TRAIN THE NEXT GENERATION OF WORLD-RENOWNED RESEARCHERS

Welcoming more than 70 PhD students to our premises every year, we offer a real talent pool for future researchers, developers and industry specialists in a certain number of sought-after niches at the global level. The sustainable use of water resources and materials for autonomous sensors, energy sources and the next generation of tyres are some of the areas where we are at the forefront of knowledge and for which we propose budding researchers a wide range of opportunities. But that is not all. We give them the possibility to work in an international environment while at the same time benefitting from our very high-quality equipment.

> The sensors that the young researchers are working on will be found in the smartphones, cars and computers of tomorrow.

## BUILD ONE OF THE BEST HYDRO-CLIMATOLOGICAL OBSERVATORIES IN THE WORLD

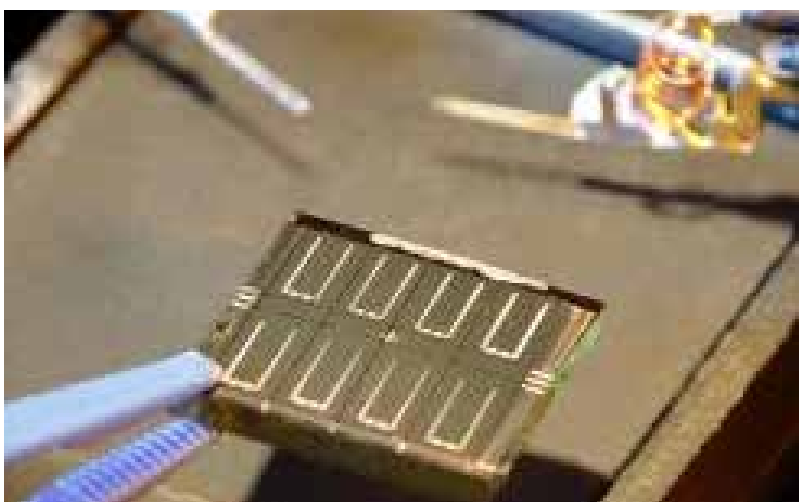
We cannot deny that that climate change has long-lasting impacts on our water resources. We can see the effects of this all around us: floods, heavy rainfall or even changes in the water levels of rivers. While we cannot overcome these impacts, at LIST we endeavour to understand, foresee and even anticipate the formation of natural catastrophes. To obtain such results, we have put in place a doctoral training unit in hydrological sciences, which has already welcomed around **15 doctoral researchers specializing in hydrology, remote sensing, soil erosion, hydrological modelling**, etc. To give ourselves the best chances, we have joined forces with the most renowned universities in this domain, the TU Wien in Austria, the Karlsruhe Institute of Technology in Germany, the University of Wageningen in the Netherlands and finally the University of Luxembourg. Together, we created **Hydro-CSI**, a dedicated research project, to not only encourage studies in the domain of water resources but also to better understand the fundamental hydrological functions of catchments, the areas of land where all the water run-off from them converges to the same outlet. The new generation of highly qualified experts, trained within our doctoral unit, is involved in the design, development, testing and marketing of innovative technological solutions, enabling more reliable predictions to be made. In partnership with this hotbed of young talents, we would like to carry out not only predictions over several hours but also projections for several decades relating to rising water levels and water channels.

Beyond the project itself, the competences and expertise of the young researchers that we welcome, associated with the tools that they will develop, are major milestones in guaranteeing a state-of-the-art national hydro-climatological observatory. We have already established this observatory, unique in Luxembourg, but above all, **one of the best-equipped research sites in the world**, in the hydrographic zone of the Alzette, one of the main rivers in Luxembourg, which crosses the country from south to north and is the source of numerous floods. Thanks to the observatory, our researchers have been continuously monitoring more than 80 sites for many years, relying on a very dense network of different sensors allowing them high quality spatial and temporal observation. The research developed by the doctoral students will enable us to ensure that our observatory remains at the cutting edge of the latest technologies and methodologies.

## DEVELOP MATERIALS FOR AUTONOMOUS SENSORS AND ENERGY RECUPERATION

In our daily lives, more and more autonomous connected devices monitor the parameters linked to the objects that surround us. Temperature, pressure, humidity, energy consumption, arterial tension and even glycemic index are some examples. But, the majority of these sensors are powered by batteries that we have to replace frequently. At LIST, we would like to respond to this problem by developing efficient sensors related to measures for the recuperation of renewable energy.

In order to **develop new materials for autonomous sensors and recover their energy**, we resort to the expertise of young researchers. We have thus developed a second doctoral unit in the physics and materials science research domains. Carried out in partnership with the University of Luxembourg, the aim of this activity, developed as part of the **MASSENA** project, is to improve understanding and performances of the materials used in the detection and recuperation of energy in order to develop new applications and to obtain better performances in the long-term. The sensors that the young researchers are working on will be found in the smartphones, cars and computers of tomorrow. More than 20 doctoral researchers specialized in physics, chemistry or materials science are working on this challenge, and further recruitment is necessary both at the national and international level to bring the ambition of this project to completion.



## DESIGN AND IMPROVE THE COMPONENTS OF TOMORROW'S RUBBER TYRES

At LIST, we are committed to a long-term partnership with the manufacturer **Goodyear**. Together, we want to develop the next generation of tyres, putting environmentally friendly materials, performance and production at the heart of the process. As part of this agreement, we have welcomed around 30 doctoral and post-doctoral researchers to LIST and Goodyear. Thanks to their activities focusing on new mechanistic knowledge, new materials concepts and the scalability of concepts and new processes dedicated to production, these young researchers are fully committed to the aim of the project, which is to **set new international norms by optimizing the materials used in tyres**.

The range of the work carried out by our researchers and young talents participating in this large-scale project has a non-negligible international influence. The results obtained will have an impact beyond our national borders and the Luxembourgish entity of Goodyear, Goodyear Dunlop Tires Operations SA, based in Colmar-Berg, which is actively participating in the project. The results we will obtain in the coming years will benefit more broadly the American tyre manufacturer, Goodyear Tire & Rubber Company, whose headquarters are in Ohio in the United States.

« The results obtained by our young talents will be disseminated far beyond the borders of Luxembourg.

# HIGHLIGHTS

# REVIEW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## JANUARY

- Publication of a study in *Scientific Reports* on the food additive E171, led by the National Institute of Agronomic Research (INRA), in which LIST identified the undesirable effects of the additive on the immune system 1
- Welcome of the hydrologist Jeff McDonnell, UNESCO prize winner, to explore new research opportunities in the ecohydrology domain 2
- Collaboration with the European Space Agency (ESA) to bring a new dimension to the launch phases of spacecrafts 3

## FEBRUARY

- Commitment with SES to develop commercial solutions using innovative satellites
- Awarding of the FoodTechAward prize to the WikiFood® software in recognition of its technological expertise and innovative characte

## MARCH

- Partnership with Carlex to develop smart windscreens that can help respect future European regulations on vehicle emissions
- Partnership with ispace to bring an innovative mass spectrometer developed at LIST laboratories to the moon
- Collaboration with the Université catholique de Louvain leading to joint publications and staff exchanges

## APRIL

- Partnership with Circuit Foil to improve copper resistance to lightning
- Election of Aziz Zenasni, Director of Programs, to the Executive Board of the European Association of Research and Technology Organisations (EARTO) 4
- Highlighting of LIST's role in the Luxembourgish RDI ecosystem in a special issue of the *Scientific American* magazine 5

## MAY

- Creation of a new centre dedicated to financial innovation, the Finance Innovation Technology and Systems Centre (FITS)
- Signing of an agreement with the Institut fir Biologësch Landwirtschaft an Agrarkultur Luxemburg asbl (IBLA) in the framework of collaborative research focusing on biological agriculture 6

## JUNE

- Inauguration of the joint laboratories with PM-International AG 7

## JULY

- Visit of His Royal Highness the Grand Duke Henri, the Minister of the Environment, Carole Dieschbourg, the Minister of Agriculture, Viticulture and Consumer Protection, Fernand Etgen, and the Minister Delegate for Higher Education and Research, Marc Hansen, to the LIST stand at the Ettelbruck Agricultural Show 8
- Confirmation of the participation of Swiss adventurer Bertrand Piccard for the Life Cycle Management (LCM) conference in September 2017 9

## AUGUST

- Collaboration with Kleos to build robotic antennae in space
- Presentation of the Scientist Medal 2017 to Bianca Rita Pistillo by the International Association of Advanced Materials (IAAM)
- Welcoming of the German researcher Stan Schymanski as part of the National Research Fund's (FNR) ATTRACT programme 10

## SEPTEMBER

- Organization, together with the University of Luxembourg and ArcelorMittal, of the international Life Cycle Management (LCM) conference with the participation of over 730 international experts 11
- American authorities' use of flood maps for the management of hurricanes Harvey and Irma, extracted thanks to an algorithm developed by LIST 12
- Meeting with Goodyear S.A. to present the progress of different collaboration work in the domain of materials science and technology

## OCTOBER

- Presentation of project case studies concerning data analysis and carried out with LIST by Tetrapak, Goodyear, ArcelorMittal and Paul Wurth at a workshop on Industry 4.0 13
- Presentation of the 'Outstanding Promotion of Science to the Public Award' to Christian Penny at the FNR awards ceremony 2017

## NOVEMBER

- Organization of the research celebration evening on the occasion of the first LIST International Award in Bioinnovation (LIAB Award 2017), presented to Paul Spagnuolo, laboratory director at the University of Guelph in Canada 14
- Strengthening of the collaboration with the Ministry of Agriculture, Viticulture and Consumer Protection 15
- Participation in the Future of Materials Summit organized by The Economist Events in Luxembourg with more than 700 participants

## DECEMBER

- Collaboration with CERATIZIT to improve the high-speed machining technique
- Marketing of the Kniwwellino microcontroller, an information and communication technologies (ICT) learning device aimed at children, on electronic-shop.lu 16
- Organization of the PhD Day, an annual event bringing together LIST doctoral researchers and exploring the link between research, innovation and business 17


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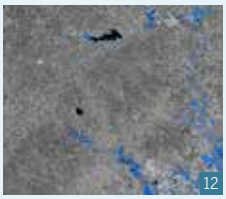
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# TECHNOLOGICAL RESEARCH

**LIST organizes its research and development activities in three main research departments focusing on the environment, IT and materials domains. These departments develop the expertise, know-how and technological foundations necessary for supporting the four sectoral and transdisciplinary activity portfolios dedicated to cities, space, finance and industry that were put in place at the same time.**


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## MATERIALS INNOVATION

The Materials Research and Technology (MRT) Department contributes to the emergence of generic technologies alongside the innovation processes of local and international industry. Its activities are coherent with three thematic pillars: nanomaterials and nanotechnology, sustainable composite materials, and production and procedures technologies, including scientific instrumentation.

### Highlights of 2017

- Support for Luxembourgish industrial research as part of the public-private partnership projects (PPP) carried out with Ceratizit, Circuit Foil, ArcelorMittal, etc.
- Implementation of the National Composite Centre - Luxembourg (NCC-L) with the creation of important infrastructures
- Increased activity in the domain of space technologies thanks to several projects with the European Space Agency and the national initiative SpaceResources.lu
- Preparation of the spin-off Luxembourg Ion Optical Nano-Systems aiming to market a mass spectrometry technology developed in the laboratories
- Filing of 15 patents with the European Patent Office, 12 of which are in nanomaterials-nanotechnologies
- Major publications in prestigious international journals: Nature Materials or Nature Communications
- Awards won by Bianca Rita Pistillo 1 for her research into the deposit of a transparent polymer conductor (Scientist Medal 2017 - International Association of Advanced Materials) and Mads Christof Weber 2 for his PhD thesis in materials physics (Prix Rolf Tarrach - University of Luxembourg)

## DIGITAL INNOVATION

The IT for Innovative Services (ITIS) Department focuses on the digital transformation operations taking place in organizations in traditional environments and digital ecosystems with the aim of improving their performance and their innovation capability. The common theme of ITIS is to develop a more efficient use of big data to ensure the most appropriate decision-making process.

### Highlights of 2017

- Creation of the Finance Innovation Technology and Systems Centre (FITS), a centre dedicated to financial innovation
- Transfer of the medical office management software Gecamed, the support software for conformity to the General Data Protection Regulation (GDPR) and the electronic platform Kniwwelino, to the Luxembourgish businesses, Abacus, eProseed and Electronic Shop, respectively, and the transfer of management software for the restoration of buildings to the French company, GTM-Vinci
- National prizes received for the WikiFood® software (FoodTech Award - Food Summit Luxembourg) 3 and the GDPR conformity support software in partnership with eProseed (RegTech Innovation of the Year - Luxembourg Finance Innovation Summit and IT Development Company of the Year - Gala IT One) 4
- Filing of 6 new patent requests in Luxembourg and granting of 9 commercial operations licences to local and international companies
- Launching and coordination of the Mobility Urban Values (MUV) project, funded by the Horizon 2020 programme, targeting the experimentation of an innovative mobility platform in six different European urban environments

## ECOLOGICAL INNOVATION

The Environmental Research and Innovation (ERIN) Department brings interdisciplinary knowledge, expertise and technologies to meet the major environmental challenges faced by society, such as the reduction in climate change, the resilience of ecosystems, sustainable energy systems, and the proper use of renewable energies, as well as the prevention and control of environmental pollution.

### Highlights of 2017

- Participation in 63 competitive projects (of which 12 were European) and in 15 collaboration projects, and acquisition of 2 collaborative projects and 2 projects from the European framework project and the European Space Agency
- Realization of policy support activities with public services as part of its support actions to policies in the areas of the environment, agriculture and health, such as Betriber & Emwelt or the Helpdesk REACH&CLP Luxembourg
- Filing of 5 priority patents, of which 3 inventions contribute to the development of new technological products
- Implementation of strategic collaborations with the Ministry of Agriculture, Viticulture and Consumer Protection, the Ministry of Defence, the Institut fir Biologësch Landwirtschaft an Agrarkultur Luxemburg (IBLA), SES and the Université catholique de Louvain (UCL)
- Organization of the first LIST International Award in Bioinnovation (LIAB Award 2017) 5 in partnership with PM-International AG
- Awards presented to Dr Christian Penny 6 for his numerous activities related to "microbiology for all" ('Outstanding Promotion of Science to the Public Award' - FNR Awards 2017) and to Barbara Glaser 7 for her article concerning a methodology on the way in which floods could be monitored with thermal imaging cameras (1st prize - Science Journalism Contest from science.lu)


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# INDUSTRIAL DEVELOPMENT

**LIST put in place four key activity portfolios thanks to which it offers a range of solutions that respond directly to the user experience and adapt perfectly to socioeconomic needs. As well as application-oriented technologies, these activity portfolios open up possibilities for LIST to offer integrated and multi-disciplinary solutions to its partners and clients, whether public or private.**

**By relying on the synergies and the complementary features of the existing assets developed by its three research departments, LIST seeks to plan, design and use its innovative and sustainable goods and services to face economic and societal challenges.**

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## SMART CITIES

LIST targets communities where technologies are a means of guaranteeing sustainable solutions and services, economic growth and an improvement in the living standards of its citizens. Its activities are focused on cleaner energy technologies, new logistics models, new types of secure water systems, innovation in the area of construction, and automated, environmentally friendly, soilless agriculture, as well as small-scale production (3D printing).

### Highlights of 2017

- LIST organized the 8th international Life Cycle Management (LCM2017) conference, which brought together no less than 730 international scientists and practitioners working with the life cycle analysis approach (LCA).
- LIST is coordinating two new European projects based on the collaborative work process BIM (Building Information Modelling): 4D Collab and BIMEET. While the first aims to define innovative collaborative working practices in the construction domain, enabling multidisciplinary decision-making via innovative interaction techniques with BIM/4D models, the second aims to enlarge the BIM training programme intended to support the programme on the energetic efficiency of the European Union buildings

## SPATIAL SECTOR

LIST develops data analysis capabilities by relying on the use of Earth observation data (satellites, drones) and non-terrestrial observation (in situ data, crowdsourcing, social media, socio-economic data) to enable the large-scale use of data and generate a social-economic impact. It also develops services for businesses in terms of natural and industrial risks, agriculture, forestry and viticulture, transport and logistics, management of natural resources, energy, spatial resources, monitoring and safety. Finally, it is developing high-performance materials in a critical space environment and a unique set of equipment dedicated to space applications.

### Highlights of 2017

- LIST committed to working with SES, in particular to develop commercial products and services in the area of innovative satellite communications (SATCOM) 1
- LIST joined forces with the Université catholique de Louvain as part of a research collaboration in the areas of life and environmental sciences and technologies, as well as in data processing, modelling and visualization 2
- LIST came together with ispace Europe S.A. with a view to launching the “Roving Spectrometer”, a first common exploration mission dedicated to prospecting lunar resources

## INDUSTRY 4.0

LIST combines advanced manufacturing capabilities with opportunities opened up by the dissemination and adoption of information technologies in production industries, whether manufacturing or construction. In this way, it offers a panel of solutions relying not only on the development, use and coordination of information, calculations, software and modelling, but also on cutting-edge materials and the emerging capabilities stimulated by physical and biological sciences, such as nanotechnology, chemistry and biology.

### Highlights of 2017

- With CERATIZIT, LIST committed to developing new coatings with Physical Vapour Deposition (PVD) that perform efficiently at high temperatures of over 850 degrees Celsius, for the high-speed machining technique 3
- With Circuit Foil, LIST will develop a new generation of copper for the production of composite aircrafts resistant to lightning 4
- LIST joined forces with Carlex for the development of a new generation of car windscreens enabling the ecological impact of heating and cooling systems in cars to be reduced 5
- LIST hosted the "FEDIL meets LIST" event, organized by the Luxembourg Federation of manufacturers (FEDIL), which brought together around 20 participants from different Luxembourgish industries for a presentation of the services, activities and competences developed at LIST

## FINTECH AND REGTECH

LIST seeks to be an accelerator for the digital transformation of the financial sector by concentrating its research on two priority areas. On one hand, it aims to create a smart regulatory environment based on an innovative technology able to adapt to new risks related to the introduction of new technologies in real or almost real time. On the other hand, it is working on improving guidance within the departments working with businesses and users via the use of mass data.

### Highlights of 2017

- LIST created its Finance Innovation Technology and Systems Centre (FITS) 6, an infrastructure concentrating on digital financial technologies as key accelerators in the transformation of the financial position of Luxembourg
- LIST works with controllers, such as the national commission for data protection (CNPD) and the Luxembourg Institute of Regulation (ILR), in order to develop regulatory reporting tools contributing to a more business-friendly environment


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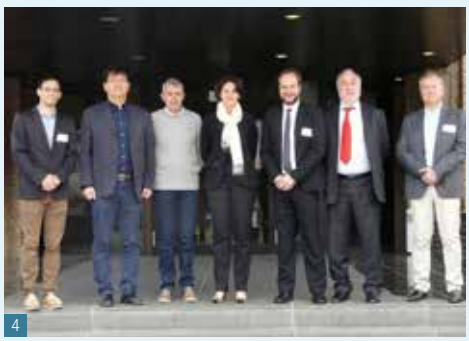
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# SCIENTIFIC EXCELLENCE

**LIST's ambition is to contribute to the diversification and strengthening of Luxembourg's economy. This wish goes hand-in-hand with a continual focus on high scientific standards. The role of an RTO, geared towards industrial applications, is therefore fully compatible with the transfer of expert scientific knowledge. This helps extend the international reach of Luxembourg-based research.**

## THESES DEFENDED

In 2017, LIST ensured, in partnership with the University of Luxembourg and foreign universities, the supervision of 79 PhD students, and 17 candidates successfully defended their theses

**M. WOOD**

"Improving hydraulic model parametisation using SAR data", University of Bristol, 24/01/2017

**Georgios PLATANIOTIS**

"EA Anamnesis - A Conceptual Framework for Enterprise Architecture Rationalization", Radboud University Nijmegen, 04/04/2017

**Anouk KAULMANN**

"Health beneficial effects of carotenoids and polyphenols from locally grown fruits and vegetables as determined by in-vitro assessment of Caco-2 cells following simulated gastro-intestinal digestion", Université Catholique de Louvain, 26/06/2017

**Alex GANSEN**

"Multiscale Modelling of Anisotropic Composite Media for EMC applications", Swansea University, 31/07/2017

**Anna SCAINI**

"Velocity and celerity in a forested headwater catchment: a combined experimental and modelling approach", Lancaster University, 05/09/2017

**Sunil Kumar CHANNAM VENKAT**

"Synthesis of strongly correlated oxides and investigation of their electrical and optical properties", University Toulouse, 14/09/2017

**Alexandre BERTRAND**

"Waste heat valorisation at multiple scales: focus on in-building waste water and regional heat recovery", Ecole Polytechnique Fédérale de Lausanne, 15/09/2017

**Nohora Lizeth CAICEDO PANQUEVA**

"Cycled growth and transport modelling of ZnO nanowires network towards room-temperature gas sensing", Université Catholique de Louvain, 19/09/2017

**Pietro BUONO**

"Chemical modification of lignin for the elaboration of novel bio-based aromatic polymers and additives", University of Strasbourg, 25/09/2017

**Berit BRÜSTER**

"Structure of Polylactide-Based Materials Obtained by Reactive Extrusion: Formation and Thermomechanical Transformations", Université de Lorraine, 02/10/2017

**Nicolas MEDOC**

"A Visual Analytics Approach for Multi-resolution and Multi-model Analysis of Text Corpora. Application to Investigative Journalism", Paris Descartes University, 16/10/2017

**Marina Sofia VERRUNO**

"Investigation of the enhancement of the performance of the SIMS instruments", Université Paris-Saclay, 06/11/2017

**Rodolphe MEYER**

"Development of time-dependent characterisation factors for life cycle impact assessment of road traffic noise on human health", University of Cergy-Pontoise, 10/11/2017

**Michael SCHWAB**

"Long-term, high-frequency analysis on the interplay between rainfall-runoff processes, discharge, DOC and nitrate", University of Fribourg, 20/11/2017

**Paulo DA SILVA CARVALHO**

"Visual platform for the integration of poorly structured and uncertain data", Université François Rabelais de Tours, 19/12/2017

**Gaëlle CORNE**

"Development of novel hybrid and multi layered nanoparticles for the delivery of active ingredients", University of Angers, 20/12/2017

**Kahina MEHENNAOUI**

"Understanding the impact of engineered nanoparticles – *Gammarus* sp. as a valuable non-vertebrate model?", Université de Lorraine, 20/12/2017

## SCIENTIFIC VISITORS

LIST welcomed almost ten scientific visitors within its different research departments, demonstrating the good momentum of its academic network

- Dr. Ingrid CANERO INFANTE, Ecole Centrale Paris (France)
- Prof. Jeffrey J. MCDONNELL, University of Saskatchewan (Canada)
- Dr. Emilie DIEUDÉ-FAUVEL, National Research Institute of Science and Technology for Environment and Agriculture (France)
- Prof. Eng CHEW, University of Technology Sydney (Australie)
- Prof. Keith SMETTEM, University of Western Australia (Australie)
- Dr. Brahim DKHIL, CentraleSupélec (France)
- Prof. Nicholas HARRIS, University of Southampton (Royaume-Uni)
- Prof. Carmelo RAPISARDA, Università degli Studi (Italie)
- Prof. Alexei GRUVERMANN, University of Nebraska-Lincoln (Etats-Unis)

## AFFILIATED PROFESSORS AT THE UNIVERSITY OF LUXEMBOURG

The University of Luxembourg's Board of Governors named three LIST researchers Adjunct Professors, allowing them to teach classes and supervise theses at the University.

- Erik Proper, ITIS Department, was named Adjunct Professor in Computer Science
- Jens Kreisel, MRT Department, was named Adjunct Professor in Materials Science and Physics
- Laurent Pfister, ERIN Department, was named Adjunct Professor in Environmental Sciences

# GOVERNANCE

# LIST AT A GLANCE

## BOARD OF DIRECTORS

Photo from left to right: Diane Wolter, Etienne Jacqué, Gaston Schmit, Georges Bourscheid, Nicolas Gengler, Isabelle Kolber, Eva Kremer. (Absent: Hubert Jacobs Van Merlen, Amal Choury, Marie-Christine Mariani)

**Georges Bourscheid**
Chairman of the Board of Directors

**Hubert Jacobs Van Merlen**
Vice-Chairman of the Board of Directors

**Amal Choury**
Member, CEO of eKenz

**Nicolas Gengler**
Member, Professor at the University of Liège

**Etienne Jacqué**
Member, Corporate R&D Manager at CEBI International S.A.

**Isabelle Kolber**
Member, Head of Laboratory at SEBES

**Eva Kremer**
Member, Deputy Director of SNCI

**Marie-Christine Mariani**
Member, Founder and CEO of MCM Steel

**Diane Wolter**
Member, former philanthropy advisor at the Banque de Luxembourg

**Gaston Schmit**
Government Commissioner, Principal Government Counsellor at the Ministry of Higher Education and Research

## MANAGEMENT

**Dr Fernand Reinig**
Chief Executive Officer a.i.

## HUMAN RESOURCES

**Isabelle Hernalsteen**
Director of Human Resources

## PROGRAMMES

**Dr Aziz Zenasni**
Director of Programmes

## DEPARTMENTS

**Prof. Dr Lucien Hoffmann**
Director, Environmental Research and Innovation (ERIN)

**Prof. Dr Eric Dubois**
Director, IT for Innovative Services (ITIS)

**Prof. Dr Jens Kreisel**
Director, Materials Research and Technology (MRT)

# ACCOUNTS & BALANCE SHEET

# BALANCE SHEET AS AT 31 DECEMBER 2017

## APPROVAL OF ACCOUNTS

**The accounts were audited by statutory auditors PricewaterhouseCoopers and approved by the Board of Directors during their meeting of 27 April 2018.**

**The full financial report is available at www.list.lu**

| **Assets** (in euros) | 2017 | 2016 |
|---|---|---|
| **Fixed assets** | | |
| Intangible fixed assets | 707.384,91 | 178.701,21 |
| Concessions, patents, licences, trademarks and similar rights and assets | 707.384,91 | 178.701,21 |
| Tangible fixed assets | 20.154.723,31 | 14.815.945,11 |
| Land and buildings | 1.570.931,80 | 2.021.156,61 |
| Plant and machinery | 15.243.340,35 | 10.438.969,89 |
| Other fixtures and fittings, tools and equipment | 1.468.103,00 | 680.299,57 |
| Payments on account and tangible assets under development | 1.872.348,16 | 1.675.519,04 |
| Financial fixed assets | 763.542,81 | 872.716,17 |
| Shares in affiliated undertakings | 404.377,09 | 513.550,45 |
| Amounts owed by affiliated undertakings | 359.165,72 | 359.165,72 |
| **Total fixed assets** | **21.625.651,03** | **15.867.362,49** |
| **Current assets** | | |
| Inventories | 234.410,18 | - |
| Raw materials and consumables | 234.410,18 | - |
| Receivables | 26.499.297,70 | 25.223.202,11 |
| Trade receivables | 5.443.475,06 | 4.028.928,35 |
| Other receivables | 21.055.822,64 | 21.194.273,76 |
| Transferable securities | - | - |
| Cash at bank and in hand | 58.940.593,09 | 63.731.616,91 |
| **Total current assets** | **85.674.300,97** | **88.954.819,02** |
| Accruals | 520.692,52 | 511.169,10 |
| **Balance sheet total (assets)** | **107.820.644,52** | **105.333.350,61** |

| **Equity & Liabilities** (in euros) | 2017 | 2016 |
|---|---|---|
| Equity | 77.100.175,77 | 71.647.297,21 |
| Capital contribution | 28.044.521,26 | 25.196.617,51 |
| Reserves | 43.602.775,95 | - |
| Profit or loss brought forward | - | 40.554.778,48 |
| Profit or loss for the financial year | 5.452.878,56 | 5.895.901,22 |
| Provisions | 416.494,60 | 748.378,25 |
| Provisions for tax | 299.574,35 | 523.859,25 |
| Other provisions | 116.920,25 | 224.519,00 |
| Liabilities | 29.244.588,68 | 32.207.344,81 |
| Payments received on account of orders where not separately deducted from inventories | 20.504.490,39 | 23.867.014,77 |
| Debt on acquisitions and provision of services | 3.743.677,76 | 3.883.619,75 |
| Other debt | 4.996.420,53 | 4.456.710,29 |
| Accruals | 1.059.385,47 | 730.330,34 |
| **Balance sheet total (equity & liabilities)** | **107.820.644,52** | **105.333.350,61** |

# PROFIT AND LOSS ACCOUNT FOR FY 2017



| | 2017 | 2016 |
|---|---|---|
| **Net turnover** | **6.358.589,72** | **5.752.102,91** |
| **Other operating income** | **59.890.542,58** | **56.660.075,33** |
| **Raw materials and consumables and other external expenses** | **-13.046.561,33** | **-13.774.679,82** |
| Raw materials and consumables | -4.328.031,81 | -5.380.390,76 |
| Other external expenses | -8.718.529,52 | -8.394.289,06 |
| **Staff costs** | **-42.495.459,07** | **-38.053.884,43** |
| Salaries and wages | -37.425.637,94 | -33.640.344,66 |
| Social security expenses | -5.024.175,57 | -4.400.336,67 |
| covering pensions | -2.923.885,97 | -2.558.139,77 |
| other social expenses | -2.100.289,60 | -1.842.196,90 |
| Other staff costs | -45.645,56 | -13.203,10 |
| **Value adjustments** | **-4.409.996,78** | **-3.582.496,62** |
| on formation expenses and intangible and tangible assets | -4.250.069,78 | -3.589.416,85 |
| on current assets | -159.927,00 | 6.920,23 |
| **Other operating expenses** | **-752.394,19** | **-1.160.432,09** |
| **Other interest and financial income** | **24.264,23** | **79.856,11** |
| derived from affiliated undertakings | - | - |
| other interest and financial income | 24.264,23 | 79.856,11 |
| **Value adjustments in respect of financial fixed assets and in respect of transferable securities held as current assets** | **-109.173,36** | **-** |
| **Interest and other financial expenses** | **-6.933,24** | **-24.640,17** |
| concerning affiliated undertakings | - | - |
| other interest and financial charges | -6.933,24 | -24.640,17 |
| **Profit after income taxes** | **5.452.878,56** | **5.895.901,22** |
| **Profit for the financial year** | **5.452.878,56** | **5.895.901,22** |

## REFERENCED PROJECTS:

- 4DCollab: "Usage and interaction of synchronous 4D simulation for collaborative decision support in Architecture, Engineering and Construction", project co-funded by the French National Research Agency and the Luxembourg National Research Fund
- BIOSCOPE: "Biodiversity and Agriculture Multiscale Observation Performance Enhancer", project funded by the European Space Agency (ESA)
- BIMEET: "BIM-based EU-wide Standardized Qualification Framework for achieving Energy Efficiency Training", project funded by the European Commission's Horizon2020 programme
- CONNECTING: "Consequential Life Cycle Assessment of multi-modal mobility policies - The case of Luxembourg", project funded by the Luxembourg National Research Fund
- CrossCult: "Empowering reuse of digital cultural heritage in context-aware cross-cuts of European history", project funded by the European Commission's Horizon2020 programme
- FEDER-DAP: "Data Analytics Platform", project funded by the European Regional Development Fund
- HYDRO-CSI: "Doctoral Education unit in hydrological sciences", project funded by the Luxembourg National Research Fund
- MASSENA: "Materials for Sensing and Energy harvesting", project funded by the Luxembourg National Research Fund
- MOSQUITO: "MOnitoring and predicting urban floods using Sar InTerferometric Observations", project funded by the Luxembourg National Research Fund
- MS-SPACE: "Development and benchmarking of a compact mass spectrometer for space applications", project funded by the Luxembourg National Research Fund
- MUV: "Mobility Urban Values", project funded by the European Commission's Horizon2020 programme
- OASIS: "Optimization based integrated process modelling-LCA: application to potable water production", project funded by the Luxembourg National Research Fund
- PERSEPHONE: "Integration of Biogas into the new Bioeconomy", project funded by the INTERREG IV-A "Grande Région" programme
- PLANTSENS: "Detection of plant stress using advanced thermal and spectral remote sensing techniques for improved crop management", project funded by the Luxembourg National Research Fund
- TARGET: "Training Augmented Reality Generalised Environment Toolkit", project funded by the European Commission's Horizon2020 programme
- VALUES: "VALUing Ecosystem Services for environmental assessment", project funded by the Luxembourg National Research Fund

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