

JOANNOVUM

The Magazine for Technological Innovation
Edition 01 / 2023

Focus on
Mobility



SMART MOBILITY WITH SMART TECHNOLOGIES



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EDITORIAL

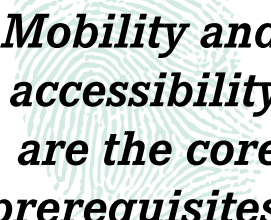
This edition of our scientific magazine is focussed on the socially important topic of mobility.



Photo: JOANNEUM RESEARCH

Mobility and accessibility are the central prerequisites for participation, economic exchange, occupation, and prosperity in our society. However, smart and sustainable mobility concepts are necessary in order to achieve the goals outlined in the Paris Climate Agreement. This challenging path towards sustainable mobility – the reduction of emissions as well as the lower use of resources – leads inexorably via innovative research and development.

Heinz Mayer
CEO
JOANNEUM RESEARCH



***Mobility and
accessibility
are the core
prerequisites
for participation,
economic
exchange,
occupation, and
prosperity.***

Together with its partners, JOANNEUM RESEARCH offers paths and solutions leading to sustainable mobility from innovative transportation concepts, lifecycle analyses in the transportation sector, and digital twins of transportation infrastructure and mobility, via biomimetic in aerospace and intelligent surfaces in vehicles, up to the optimisation of manufacturing processes.

JOANNEUM RESEARCH has established a new corporate strategy for the next five years that has been closely aligned with the owners and stakeholders of the company and is oriented along the lines of the European Union's missions. Alongside mobility, particular emphasis will be placed on the fields of digitalisation and green transformation, for example a circular economy and sustainability. The fields of health and care are and remain important topical areas for the future.

Together, we want to turn something good into something even better! Research and the development of technology provide answers to the burning issues of our time, particularly against a background of increasing energy costs and the competition for the best workforce.

Join us aboard for a journey towards the future of mobility!

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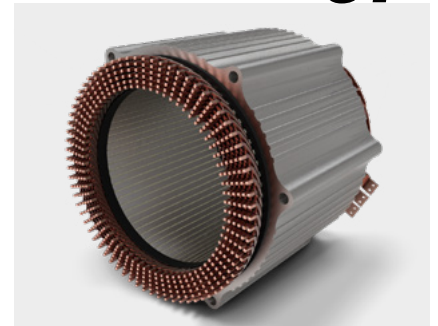
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About Drive, Transition and Responsibility

INTERVIEW: ELKE ZENZ

Matthias Rüter took up his new post as Director of DIGITAL, the largest institute at JOANNEUM RESEARCH, at the beginning of 2022. In an interview, he assesses the digital mobility transition and talks about the influence of the human factor on developments in the field of mobility.



Digital mobility transition: What trends do you see? The biggest trend lies in the term itself. Digitalisation is a crucial driver for the creation of a sustainable mobility trend. Digitalisation enables us to increasingly understand mobility as a service that brings us from A to B. It also opens up the possibility for new mobility providers to integrate themselves and occupy a niche. An illustrative example in recent years is the e-scooter.

Is society already where it could be in terms of technology? Technology can offer possibilities, but they need to address the concerns and needs of our society. It is currently becoming apparent that sustainable mobility concepts can be realised more easily in the form of centralised systems. This creates tensions between the need for individuality and the sustainability of mass transport systems. A country with Austria's geography in particular will need both at the end of the day, hopefully in seamless cooperation.

Where are the stumbling blocks that are preventing progress? Today, mobility is equivalent to multi-modal transportation. This is the combination of means of transport in such a way that our mobility needs are best served for certain routes. The trick lies in the collaboration of a range of different mobility providers without having to relinquish the principle of free competition. The challenges start with apparently simple topics such as the mutual exchange of information and reach up to the mutual invoicing of a transportation service. Work is ongoing at high speed on these and other organisational topics, which is also underlined by the "Action Plan for Digital Transformation in Mobility" from the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology.

What role does autonomous driving play in the mobility transition? Public transport will have even more problems in the future to offer transport connections

with good quality of connectivity due to the increasing lack of personnel. Autonomous shuttles could act as a useful extension for certain routes. Environmentally friendly and autonomous vehicles could also mitigate the parking problem in metropolitan areas if they are located far from their target location. This could create space for alternative means of transport.


Driverless vehicles are still seldomly seen. Why is that? Technically and legally validated functions are already widely available: Assistants for lane-keeping, distance-keeping, and emergency braking have already permeated the mass market. Parking and lane-changing assistants are on the rise. At the moment, digital assistants still dominate as in this case the final responsibility remains with the driver. The great hurdle is still the transfer of this responsibility to the supplier and in a suitable certification procedure that is internationally valid.

What is your forecast – when will we in Austria hand over control and sit in front of the steering wheel reading a book? Under certain circumstances, this is already possible in some vehicles. However, we will see this development arrive in commercial vehicles first. Even if reading in front of the steering wheel is comfortable, the huge benefit lies elsewhere. A fully autonomous vehicle can be more easily shared with others and can take on transportation tasks. Combined with environ-

mentally friendly powertrain technology, we will begin to see them more often on our roads in 10 years.

Which innovative and environmentally friendly transportation technologies would you bet on and for which services would you see the greatest opportunities on the mobility market? Personally, I would see the greatest opportunity in integrated mobility solutions that build upon existing infrastructure. Our transportation networks have developed over many decades in accordance with our mobility needs. At the moment, there is clearly a lot of effort going into increasing environmental compatibility: This is true for the rail, road, maritime and aerospace sectors. Digitalisation can build a bridge between the systems and raise mobility to a new level where the "container" used for the transport plays a subordinate role.

What are the research topics that play a major role in the digital mobility transition and where is DIGITAL in all of this? The overall vision is that of a completely integrated digital twin of all transportation systems, coupled with the complete representation of the infrastructures and real-time information about all means of transportation and their utilisation rates. This would provide the basis for a wide spectrum of digital services, as well as being able to simulate traffic scenarios and optimize systems. There is a long way to go until then, but Austria is on the right path, for example with "Traffic



The vision is the complete integration of a digital twin of all transportation systems.

Info Austria". This is where researchers are developing innovative solutions for the efficient acquisition of data. They are also driving forwards the use of this data in simulation and forecasting. The more complex the overall system, the more one will have to rely on automated analysis – for example via AI -, without compromising on safety. This will be extremely challenging.

What goals do you and your team at DIGITAL have to make tomorrow's mobility smarter and greener? Our focus is on the intelligent, localised data acquisition and the provision of data as digital twins. Transportation networks can contain thousands of kilometres and despite digitalisation, there is sometimes little information available regarding what is really happening on the route. In many areas, we can close this gap by measuring the status of the road to protect the road

surface or acquire and distribute real-time information about endangered traffic participants. We build warning systems for safe mobility and support traffic control measures for the smart cities of the future, for example by acquiring noise emissions with pinpoint accuracy and evaluating them objectively.

And finally: What would you relinquish to promote greener mobility? From your point of view, is there anything we need to give up or rethink? A sustainable lifestyle is important to me personally, which is why I use my e-bike the whole year round in the city. Apart from the environmental aspect, I actually even save a lot of time and am not limited by range, at least not in the city. My summary would be that it is always worth considering alternatives and to look for advantages instead of concentrating on limitations. ■

info

Digital Twin Lab in Carinthia

JOANNEUM RESEARCH's site in Klagenfurt is being given a massive boost: The construction of the laboratory is proceeding rapidly. The ramp-up phase up to March 2024 will see the establishment of a project team. The complete site with 10 employees, 100 square metres of laboratory and 130 square metres of office space will be finished by 2027. Plant and research equipment to the tune of 1.3 million Euros will be installed at the site. This initiative will further strengthen the Southern research axis Styria-Carinthia. ■

www.joanneum.at/digital

The specialist in telematics received his doctorate in 2009 in the field of 3D reconstruction and computer vision methods at the Technical University of Graz. He held lectures as a Senior Researcher at the Institute of Computer Graphics and Vision and founded the Robotic Vision Lab, which focussed on computer vision in conjunction with industrial robotics and automation. In 2013, he founded the company Holistic Imaging that specialised on the production, processing, and visualisation of big geodata. Armed with the experience of an entrepreneur and equipped with excellent competence in the fields of Information Technology and Image Processing, he joined DIGITAL and successfully led the research group "Image Processing and Measurement Systems". Since 2022, he has led the DIGITAL Institute.

Photo: JOANNEUM RESEARCH





Brake!

TEXT: ELKE ZENZ

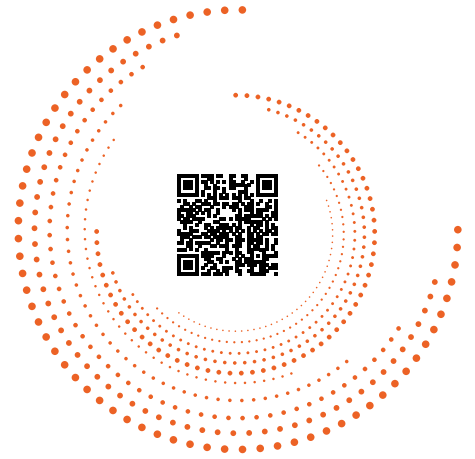
The fact that vehicles communicate with each other digitally is not new. The current European technology behind this is called DSRC, Dedicated Short Range Communication, and is located in the 5 GHz frequency range and is primarily used for digital toll management. There are still a few open questions in the field of vehicle-to-vehicle communications (V2V), in particular for autonomous driving. Research is also ongoing into 5G solutions. The challenges facing the research work are the premises of the shortest possible latency time, target compliance, and secure reception. Data transmission via light could provide a solution for this.

Andreas Weiss, Head of the Smart Connected Lighting research group at MATERIALS explains that “the wireless communication via visible light, called VLC, opens up interesting possibilities via the modulation of visible light in frequencies that are imperceptible for humans. This data communication could be built up on current vehicle lighting using LEDs. I am referring here to headlights or taillights that could transmit information to other vehicles. Reception would be possible by either

photodiodes or camera-based systems”. So, if one vehicle brakes, the brake lights could signal to the following vehicle that it, too, should brake.

The advantages of VLC are real-time transmission, targeted and ad-hoc communication. Apart from this, lighting and signalling could be combined, which would have a cost impact. It is also worth mentioning that VLC would not disturb the RF domain, however there are certain issues with bad weather conditions such as fog, rain, or snowfall. “The research topic is being widely discussed, from the hardware, via different modulation methods, up to the employed protocol, but the previously named challenges for different weather conditions and location of the systems on the vehicle are still inhibiting development”, Weiss continues. The telematics expert and his team can contribute a lot to the topic such as expertise in the field of LED control and the evaluation and processing of received light signals. The research group Light and Optical Technologies provides expertise in the field of light guidance and optics. ■

AI protects infrastructure



Vegetation is quite capable of damaging railways and roads.

The FloraMon project was launched in 2022 to maintain control of this process, in which AI “keeps an eye” on the growth of vegetation around railways and roads.

TEXT: ELKE ZENZ

Researchers from DIGITAL, the Institute for Digital Technologies at JOANNEUM RESEARCH, are working in a project together with ASFINAG and ÖBB to automatically recognise and manage the growth of vegetation on Austria's roads and railways. The team at JOANNEUM RESEARCH is able to bring their many years of technological expertise to the table in the fields of high-speed image acquisition, AI-based detection of vegetation and building structures, as well as GIS processing. This is important to provide more safety in traffic, to protect the transportation infrastructure, and to save on plant protection products.

Detailed image acquisition

Data acquisition has already started. “The mobile recording system was installed on ÖBB and ASFINAG vehicles. This system enables the extremely detailed image acquisition of vegetation along road and rail routes at very high travelling speeds. This ensures there are hardly any restrictions of normal traffic flow”, Peter Schallauer, the project manager for JOANNEUM RESEARCH explains.

Regions where vegetation has been detected are represented in the form of a superimposed mask. This information is intended to be used in the future by ÖBB to plan vegetation checks.

AI recognises neophytes

A research team is currently developing a system that can acquire vegetation growth on a large scale and which is also able to recognise relevant plant types. Plant types are captured that are capable of damaging roads or buildings or endanger the safety of traffic participants. In particular, the system is able to recognise neophytes, which are plants whose spread is to be prevented to protect domestic species. This is done at high speed and using artificial intelligence. “To do this, we train our specially developed neural networks with a comprehensive set of high-resolution plant examples. This is necessary to enable the recognition of small and easily mistaken plants”, Schallauer explains. Based on this information, the ÖBB and ASFINAG are able to plan and execute plant-specific vegetation management measures efficiently, which both reduces the in-

frastructure maintenance costs and also ensures the safety of traffic participants, while also protecting the environment.

FloraMon is financed from within the FFG program Mobility of the Future, subject area Transport Infrastructure Research, by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology and also by ÖBB Infrastruktur AG and ASFINAG. ■



Peter Schallauer has been with DIGITAL since 1995 and is an expert for audio-visual media with a focus on image quality and recognition of application relevant image content.



MAKE SPACE

for real
life!

TEXT: PETRA MRAVLAK

Christian Joachim Gruber leads the Urban Living Lab competence group. He is an expert in the field of traffic modelling and the design of infrastructural facilities.



Active Mobility, E-Scooter, and Carpools: Franz Prettenthaler, the Director of the LIFE Institute, and Christian Joachim Gruber from the Urban Living Lab competence group discuss future traffic concepts, private mobility, and the reclamation of public areas as living space.

The Life Institute deals with sustainable traffic concepts. How will we travel in the future?

PRETTENTHALER: The most climate-friendly and healthiest form of transportation is walking or cycling. This so-called active mobility has significantly grown in volume, particularly in cities, and has to gain further in importance regarding the transportation transition. An important trend in the area of individual mobility is intermobility. This describes a chain of different means of transportation leading to the target, such as bicycle, rail, and inner-city public transport or passenger car and public transport. The trend in motorised transportation is clearly in the direction of electromobility, and autonomous driving is becoming an important topic.

GRUBER: For example, autonomous driving could make journeys with a taxi cheaper because the taxi can be in use for seven days a week, round the clock. Carpools are gaining in importance, whether it is the use of a vehicle by several people, or ridesharing. All of this could increasingly question the benefit of owning one's own vehicle. We were able to simulate how these changes and the habits of individual traffic participants impact the overall system by employing an agent-based traffic model using individual actors, the so-called agents.

How will public space develop over the next few years?

PRETTENTHALER: The reclamation of public space and making it generally more attractive is a megatrend. Cars parked along roads are unattractive and detrimental to the living quality of an area. Park benches, public gardens, and availability on foot or by bicycle result in more turnover than parked cars in front of shops - this has been proven in numerous cities.

It is easier to use public transport in urban areas, so how is this transformation going to take place in rural areas and for commuters?

GRUBER: Rural areas represent a particular challenge as a result of the settlement structure in Austria. In order to also achieve the goals of climate-neutrality in rural areas with the focus 2040 in the mobility sector, there is a limited bandwidth of fields of action. But here too, individuals need to rethink. Public transport, cycling, and walking need to be made more attractive and, as an example, commuting by car into city centres more unattractive. This can be done on the one hand by improving public infrastructure and on the other by extending pedestrian zones and making parking more expensive in inner city areas so that public transport and park-and-ride services are used more often

instead of commuting into the cities by car. It would be beneficial to promote carsharing and ridesharing by connecting to existing digital platforms. Even regional planning measures can no longer be excluded in the future to prevent urban sprawl. Optimising regional planning could slow down urban sprawl and protect existing and functioning urban structures in order to make public transport more attractive in the future.

The corona pandemic accelerated certain developments such as online shopping and remote working. What has the impact been on transportation development?

PRETTENTHALER: Delivery services increased drastically during the corona pandemic, and this requires storage space. This has resulted in new forms of logistics that do not, in themselves, contribute to the quality of life, such as distribution centres for groceries and meal deliveries in inner city areas. When these unattractive areas and logistics are moved out, this results in the creation of unattractive cities, the so-called hub-cities. They cover production, transport, and logistics, but offer nothing regarding quality of life.

GRUBER: It has become quite normal in many professional groups to work from home for one or more days per week. On one hand, this represents an enormous opportunity to reduce CO₂ emissions: A daily commute of 30 kilometres would mean that one day remote working per week would be a saving of 2,700 km per year. On the other hand, there could be a rebound effect: If the saved energy or money then flows into long-distance travel or long-distance car journeys, then the CO₂ savings effect is reduced.

Does this mean that it will be difficult to lighten the load of one's CO₂-Rucksack without a change in awareness and lifestyle?

PRETTENTHALER: The largest item in the CO₂ footprint for the average person in Austria is mobility, which can be influenced by their own behaviour, ahead of diet and living. Mobility is responsible for an average of 3.2 tons CO₂-equivalent per capita per year. It is conspicuous that there are huge differences between people: The ten percent of the population with the highest emis-

sions are responsible for 18 times more emissions than the ten percent with the lowest emissions. Flying, driving large vehicles such as SUVs, and commuting are particularly significant.

So, do mobility habits mirror social differences?

PRETTENTHALER: Exactly. The really socially disadvantaged no longer travel by car. In this context, the social effects of the mobility transition and any

Franz Prettenthaler is the Director of the LIFE Institute and works in the subject areas of climate, energy, and society.



subsidies should therefore be examined carefully. At the LIFE Institute, we have developed a simulation model for this that can evaluate the targeting accuracy of transfer services such as the commuter's tax allowance.

GRUBER: It is also important to consider that the differing needs of different demographic groups are taken into account when planning charging infrastructure for e-mobility. In the FEMCharge project, we have worked out a criteria

catalogue for the positioning and equipping of charging stations for electric cars. If electro-mobility is to really reach all demographic groups, then the needs of women, older people, and other disadvantaged groups must be considered. ■

The Transition is Happening Now:

CLEANcultures – Initiatives from the neighbourhood

The international research project CLEANcultures declares war on climate change on the front doorstep. The idea is to confront local people with new perspectives regarding climate-relevant problems on a neighbourhood and local council level. To achieve this, new ways of communicating climatic information are being trialled such as the use of interactive and artistic impulses. The first exchange with interested parties took place in the market town Admont and in the Eggenberg and Jakomini districts of Graz. Apart from Austria, where the LIFE Institute is acting as coordinator, other research teams and councils are taking part in Norway, Finland, and Italy. The goal is to get people thinking and to animate them to actively involve themselves in the topic of climate change.



Learn more about this project

Real Traffic Data from the Kaiserfeldgasse in Graz

Bicycles, e-scooters, pedestrians, cars, and parking places – there is a lot going on in Graz's Kaiserfeldgasse. For more than six weeks, more than 20 Lidar, acoustic, and optical sensors supplied by the DIGITAL Institute and their partners were used to create a basis for the reworking of the traffic concept. For example, all movement by traffic participants was documented anonymously. This was then divided into different categories such as vehicle or bicycle so that they could serve as criteria in evaluations. The acoustic and emissions sensors also classified the noise background and measured the noise and emissions situation. The data was also used to determine whether critical encounters occurred and what type of traffic participant is involved the most frequently in which location.



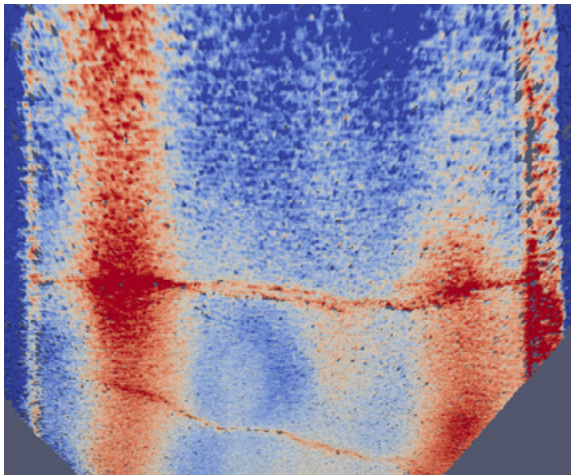
Learn more about this project

Klagenfurt: Agent-based traffic modelling

What would happen if an education facility no longer provided car parking spaces for employees and students who lived in the urban area? The Urban Living Lab at the LIFE Institute calculated a potential reduction in greenhouse gas emission of almost 28 percent in a simulated traffic scenario for the Lakeside Science & Technology Park and the University of Klagenfurt. However, the prerequisite is that the surrounding public parking spaces are included in the parking space management and are not available as alternative possibilities, otherwise the reduction falls to a meagre seven percent. The agent-based traffic modelling simulates the transportation habits of individuals in order to quantitatively represent the effects of a shift from passenger car towards more environmentally friendly means of transportation.



Learn more about this project



ESRIUM – Intelligent use and maintenance of roads

Road damage such as small cracks, ruts, or potholes are potential sources of safety risks and are the cause of high annual maintenance costs for road operators. Together with 8 European partners within the scope of ESRIUM, a Horizon 2020 project, experts from DIGITAL are developing a solution that is capable of recognising such damage at an early stage and promptly initiate appropriate measures.

The researchers are working on a system that combines data from a range of different sensors, cameras, and EGNSS-supported tracking devices. Over the course of the project work, the experts have developed a cost-effective sensor platform (Roadwear Mapping System) that is capable of measuring road surfaces with high precision. The result is image data together with an exact georeferenced location that serves as the basis for the detection and classification of road damage. The next step is to create a road status map and a comprehensive data management platform that forms the interface to all project sub-aspects.

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This project has received funding from the European Union Agency for the Space Programme under the European Union's Horizon 2020 research and innovation programme under grant agreement No 101004181.

Mobility – Dare we look forwards?

GEORG LIST

The mobility industry is not in the throes, as is often discussed, of one but three fundamental transformations: Digitalisation, the transformation of mobility technologies, and – not to be forgotten – the transformation of energy systems. Mobility affects us all and we experience it in both our daily and professional lives. If, as is often asserted, Austria has 9 million football trainers, then the world has several 100 million politicians, industrial activists, experts, and self-proclaimed philosophers who all know the direction mobility ought to take.

However, the automotive industry paints a very different picture to the one that is “burnt” on society’s retina, and it is worth taking a step back to reflect. What is happening in front and behind the stage curtains is equivalent to starting in a new age: The future is already apparent in reality. Mobility and transport are indeed both major drivers of industrial and sustainable value creation as well as of applied sciences and entrepreneurial activity in completely different ways to before.

- A huge wave of development activity around new, networked, and climate-neutral technologies is currently causing the all-round renewal of product portfolios.
- Enabled by an acceleration of development cycles (amongst other things due to virtualisation and new digital methods) that has cut the duration in

half.

- An increasing share of software with hyperscaling solutions for Cloud, data, and AI that is unparalleled in other domains is significantly changing job descriptions.
- The automation of driving has raised traffic safety and comfort to new levels.
- All this has nurtured an industrial structure in which start-ups and tech-giants collaborate and also compete with incumbent players.

Many opportunities are presenting themselves, whether we are engaged in research, development, production, repairing, or recycling, where we can contribute to the mastering of the huge societal challenges of our time: Climate, energy, raw materials, poverty, and even cybersecurity. And yet the fruits of change have not yet penetrated our daily lives, because:

- New mobility technologies are not yet in the majority of consumer use.
- Sufficiently sustainable energy systems and their infrastructures are lagging behind the possibilities and remain a huge social and economic challenge.
- The geopolitically secured development of new raw materials, the sustainability of production and recycling are still in their infancy.

- Finally, although consumer acceptance is growing slowly, it is mainly present where it is affordable either in terms of money or application profile.

Alongside the resolution of these topics, it is worth it to continue researching, developing, and investing for a mobility that serves our society and environment and solves the challenges. Sustainability can be achieved the quickest if we implement all the possible and meaningful levers and technologies. Affordable mobility that connects people and global economic collaboration secures peace and create jobs. Industry and research are on it! Today. “Full speed ahead!” Or even “Maximum voltage!” Should we or are we even able to determine what the result should look like? Counter question: Are we underestimating the creative power of researchers, scientists, and engineers? Let’s give a free rein to creativity, the will to shape, and entrepreneurship and therefore yes, let’s dare to look forwards!



Georg List is Vice President at AVL List GmbH and is responsible for corporate strategic development. He is also a member of numerous committees.

WE ARE RESEARCHING TOMORROW'S TECHNOLOGIES TODAY

TEXT: ELKE ZENZ

The first Future Conference (Zukunftskonferenz) under Heinz Mayer's lead took place on the 20th of September 2022 at the Congress Centre in Graz. After a two-year Corona break, around 500 technology and research experts enjoyed 2 keynotes, 6 fascinating sessions, project poster sessions and an informative exhibition. There was enough space for networking, discussing, gathering ideas, and building the future. ■

Digital Review:
zukunftskonferenz.
joanneum.at



CONFERENCE

Below: The owner representatives, the directors, the management board, and interested members of the press met at the pre-opening event prior to the Future Conference (Zukunftskonferenz).

The guided tour through the exhibition by CEO Heinz Mayer was well received. f.l.t.r: COREMED director Lars-Peter Kamolz, Member of the Styrian Government Barbara Eibinger- Miedl, JR CEO Heinz Mayer, Deputy Governor of Carinthia Gaby Schaunig and Member of the Burgenland Government Leonhard Schneemann



In their keynotes, Henriette Spyra, Head of Section III "Innovation and Technologies" at the BMK (r. top.), and Infineon chairman of the board Sabine Herlitschka (r.) provided inspiring changes of perspective on the part of funding agencies and industry.



Procurist and strategist Helmut Wiedenhofer presented the highlights of 2022.

ROBOTICS director Michael Hofbauer with Carinthia's Deputy Governor Gaby Schaunig at the ROBOTICS Institute's booth.





The Winners

Best Performance Award

DIGITAL: Michael Schmidt

W-Cube: New bandwidths in satellite technologies or how the “Cubesat” will facilitate communication

MATERIALS: Anne Linhardt

R2R Microfluidic Meters: Tiny foil chips enables medical quick tests and rapid analysis of different medical parameters

ROBOTICS: Chris Torkar

RoLH: Robot-based intermediate batters and squared timber handling for automated magazine-filling in a wood-processing company

COREMED: Elisabeth Hofmann

BurnSkin: Investigations into the local processes of wound healing after burns

HEALTH: Thomas Birngruber

Substance P Challenge: How to test allergy medication

LIFE: Judith Köberl/Franz Prettenthaler

PROSNOW: Real-time forecasting and snow management for ski areas

POLICIES: Hermann Katz

BUMIS: Information system for soil test monitoring



All Photos: JOANNEUM RESEARCH



Provincial councillor for science Barbara Eibinger-Miedl (below), Burgenland's Landesrat Leonhard Schneemann (below left and BABEG CEO Markus Honrböck (above) opened the pioneering conference together with JR CEO Heinz Mayer (left).



CONFERENCE



The owner representatives next to the main speakers and the management team at JOANNEUM RESEARCH



Digital Review:
[zukunftskonferenz.joanneum.at](https://www.zukunftskonferenz.joanneum.at)



Top-class speakers contributed visions and solutions for the challenges of our time in 6 sessions. The speakers included Bente Knoll (Office for Sustainable Competence), Renato Sarc (Leoben University of Mining), Werner Gruber, Gernot Pagger (IV), Josef Anton Moser (Infineon) und Georg List (AVL).



All Photos: JOANNEUM RESEARCH



Will we see you at the FIFTEEN SECONDS FESTIVAL 2023?



JOANNEUM RESEARCH is again taking part in the Fifteen Seconds Festival from the 15th to 16th of June 2023. This is directed at people who enjoy further personal development and learning and who wish to help shape the future. Just as we do. Shaping the future, together.

Lars-Peter Kamolz at Fifteen Seconds Festival 2022

More about Fifteen Seconds at: <https://fifteenseconds.co/festival>

Our research activities have an impact on the further development of society. Let's meet at our booth where you can learn more about your entrance possibilities into JOANNEUM RESEARCH. Two of our researchers will provide insights into our research work in their talks. We are looking forward to an exciting festival.



Save the date

15.11.2023

Future Conference



More info at
futureconference.joanneum.at

#zuko23

Innovative Technology is the Key for Successful, Green, and Digital Mobility

JOST BERNASCH

Energy, transportation, construction, and agriculture: These five largest greenhouse gas emitters in the EU are the key factors to achieve a successful link between a green and a digital transition. Green and digital technologies over the entire value creation chain will therefore play a key role in achieving climate-neutrality, increasing competitiveness, and reducing the dependence on supply chains.

Technologies such as robotics, digital partnerships, and the Internet of Things will improve the efficiency of resource exploitation and strengthen the flexibility of systems and networks.

Energy-efficient e-mobility, battery technology and data management over the entire life cycle, and the value creation chain of products and services can accelerate progress towards a stronger, circular economy and competitive sustainability. Comprehensive system simulation, virtual testing, and an increase in confidence in simulation via defined quality measures and processes (credible simulation) will lead to a reduction in the hardware required and also save valuable energy.

With regard to transport and mobility, VIRTUAL VEHICLE has been driving green and digital technologies forwards

in conjunction with its international industrial and research partners for almost two decades and has picked up early on many of the current trends. As early as in 2008, VIRTUAL VEHICLE started the research program “Sustainable Vehicle Technologies” that today focusses on five columns for climate-neutral mobility with up-to-date technology: Passenger rail transport, goods rail transport, cooperative and automated mobility, e-mobility and infrastructure, and safety for active mobility. As one of the owners and a research partner, JOANNEUM RESEARCH has accompanied VIRTUAL VEHICLE on this path since the very beginning.

Overall, green, and digital technologies can contribute to the creation of a climate-neutral and resource-efficient economy and society if they are developed and implemented the right way. And this is far more than just a “green” buzzword: The bottom line is that these technologies are key to the further strengthening of European competitiveness and the innovative power of the economy of the future.



Jost Bernasch is
CEO of the Virtual
Vehicle Research
GmbH.

VIRTUAL VEHICLE: Full of Energy for Green and Digital Mobility

TEXT: JOST BERNASCH

An international success story is celebrating its birthday: VIRTUAL VEHICLE in Graz has developed over 20 years into a key European player for green and digital mobility. As one of the owners and a research partner, JOANNEUM RESEARCH has accompanied VIRTUAL VEHICLE from the very beginning. In the meantime, VIRTUAL VEHICLE is Europe's largest research centre for virtual vehicle development in the automotive and rail domains.

The ambitious goal: Austria is to be climate-neutral by 2040. Jost Bernasch, CEO of VIRTUAL VEHICLE, explains that “the mobility transition is one of the key factors to achieve the climate goals. If implemented correctly, it can turn into a huge economic motor for Austria. The focal points of our research fit perfectly to the future goals of the Federal Ministry for Climate Protection, Energy,

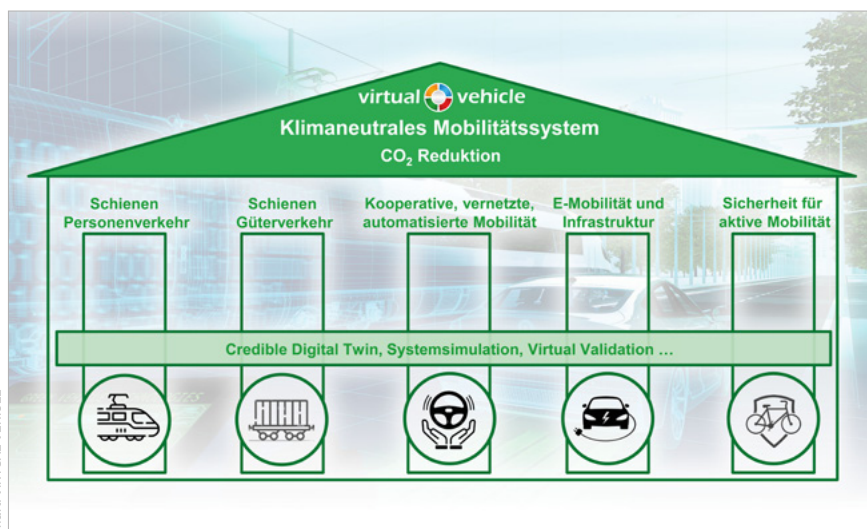
Mobility, Innovation, and Technology”. A climate-neutral mobility system has been VIRTUAL VEHICLE's core focus for years and is built upon the following five columns:

The research field “**Rail and Passenger Transportation**” bundles simulation with the design and optimisation of components for vehicles and infrastructure,

as well as the intelligent maintenance of rail and switch systems. A particular success story in the research activities of “**Rail and Goods Transportation**” is the “Digital Automatic Coupler”, or DAC, which increases efficiency in goods transportation by using automation technology.

Since 2015, **Collaborative, Networked, and Automated Mobility** has focussed on automated vehicles. The current use-case for the EU project SHOW provides a premiere with an electric, autonomous, on-demand shuttle in Graz. Together with JOANNEUM RESEARCH and within the scope of ALP-Lab, which manages Austrian test regions for automated driving, VIRTUAL VEHICLE is researching into new concepts for the safe testing and use of technologies for automated driving (AD) and advanced driver assistance systems (ADAS)

The focus of **E-Mobility and Infrastructure** is on the optimisation of e-charging and e-feed-in cycles of the 30 to 40 million e-vehicles expected in Europe as an overall energy system (“giga-battery”). In one of the currently most



VIRTUAL VEHICLE develops key technologies in these five areas and thus contributes to the goal of climate-neutrality 2040.

exciting projects, a Styrian consortium under the lead of VIRTUAL VEHICLE is developing powerful and sustainable lithium-ion battery technology (project OpMoSi).

The last column is **Safety for Active Mobility**, which deals with the increase in safety of non-motorised traffic participants through the use of cooperative, networked, and automated technologies. The project SINUS, for example, combines existing data sources (traffic volumes, location of accidents, etc.) with wearables (e.g., smartwatches) to increase the safety of cyclists.

A subject area currently displaying strong growth deals with a network of digital twins, so-called **Digital Twin Networks**. These enable the continuous alignment with real systems and hence a continuously updated basis for the evaluation of a range of component states and operational processes. VIRTUAL VEHICLE is also currently working together with large rail operators in a strong partner network on the goal

of building a digital representation of the entire rail network. Apart from the potential for optimisation and maintenance of mechanical components, this technology is a major contributor to goals such as the implementation of the planned doubling of rail capacity, the automated and autonomous operation of trains, and holistic digital capacity management. This requires comprehensive system expertise coupled with innovative methods such as AI, and the realisation of halving of life cycle costs with massively shortened innovation cycles. The VIRTUAL VEHICLE's competences converge in the digital twin and simultaneously open up new possibilities.

Success Record

Over the past 20 years, VIRTUAL VEHICLE has set trends with the right topics and is regularly at the cutting edge of new technologies. It is exactly this pioneering spirit and the passion for new technological developments that will be the key to mastering the huge challenges presented by the mobility transition. ■

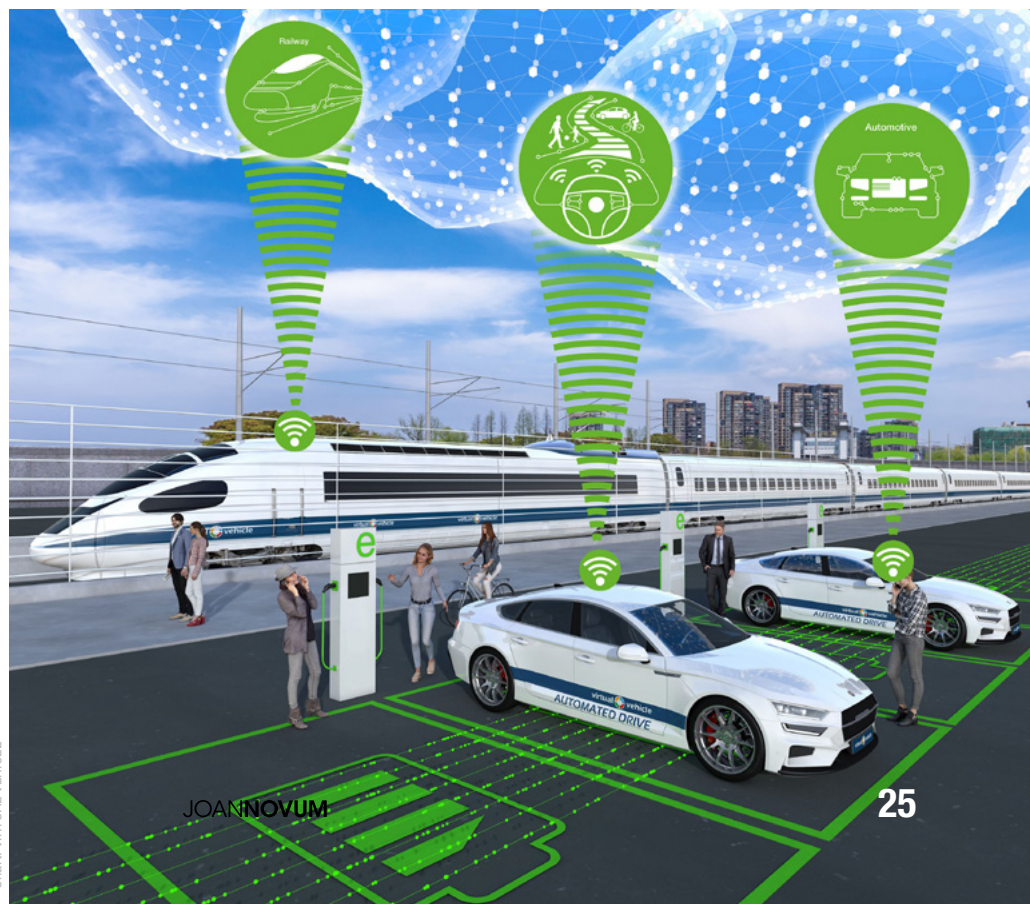
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Virtual Vehicle Research GmbH, with its more than 300 employees, is Europe's largest research centre for virtual vehicle development in the rail and automotive domains. The scientific focus lies on interdisciplinary cutting-edge research for climate-neutral mobility. The goal is the development of reliable, software-defined systems that secure sustainable competitive advantages and future jobs. VIRTUAL VEHICLE cooperates with almost 100 national and international industrial partners (OEMs, Tier-1 and Tier-2 suppliers, and software suppliers). Partnerships with around 50 scientific institutions around the world underline its reputation as an innovation catalyst for future vehicle technologies.

www.v2c2.at



The virtual development and commissioning of systems using digital twins play a key role in the development of "Green Vehicle Technologies". The coupling of "Credible Digital Twins" provides a virtual representation of the development, production, and operation of future vehicle systems and enables savings in the millions.



ARRIVALS

GREEN TRANSITION
IN AEROSPACE

TEXT: RENATE BUCHGRABER

To fly, to shame, or to shun? Who doesn't know this triad and, if possible, chooses a greener alternative? But there is hope for those who still have to fly and are concerned about their personal CO₂ balance: The green transformation of the aerospace sector has already started with considerable pioneering spirit. The four Rs of the circular economy play an important role: Redesign, Repair, Reuse and Recycle. MATERIALS is on board the Horizon 2020 project called SUSTAINair. The consortium consists of 11 partners and is led by AIT, the Austrian Institute of Technology, and MATERIALS is especially involved with Redesign and Repair.

SUSTAINAIR DEFINES NEW STANDARDS IN AEROSPACE PRODUCTION.

This ambitious research project creates the basis for cost-efficient operation with minimum CO₂ emissions. At the same time, resource consumption, waster, and emissions are to be reduced. This is all intended to make the life cycles of aeroplanes more ecological and to develop new technologies for repairable and variable

wing surfaces, for the connection of a range of different lightweight materials, for structure-monitoring sensors, and for maintenance and repair. Richard Görgl from the Niklasdorf site explains that "a new generation of aeroplanes is coming that will be smaller, lighter, and will use less fuel. Our contribution is to improve the technologies, manufacture the material connections in a new way, equip them with sensors, and make parts lighter by using additive manufacturing".

STRUCTURAL HEALTH MONITORING

The materials scientist Reinhard Kaindl is working closely with the MATERIALS team in Weiz on sensory technology for structural state monitoring: "We are developing new sensors that are intended to be used for the improved monitoring of the numerous components and their connections installed in planes and to make them safer. The overall goal is to make them 100 percent failsafe."



SHARK SKIN ON FOIL

We have all known for many years that Mother Nature is a good designer and constructor and has been a source of inspiration for many researchers to imitate efficient solutions that exist in nature in order to make certain effects useful for technical applications.

At MATERIALS, researchers are concentrating on large-scale applications of biomimetics, in other words they want to transfer bionic effects to large, and if required mechanically flexible surfaces, using a low-cost process. This is how ribbed structures similar to shark skin can be printed on foil using a roll-to-roll process.

This achieves the reduction of flow resistance of fast-moving objects that are equipped with this foil. This can be of interest for transportation vehicles that are based on land, water, and air and results in a reduction in fuel consumption.

SUSTAINair

SUSTAINAIR.EU



Hand in Hand with CHIMERA

TEXT: CLAUDIA WELTIN



CHIMERA, a mobile robot developed at ROBOTICS, offers innovative solutions for a range of different tasks thanks to its robotic arm

The source of the name for this mobile robot is the Chimera, a hybrid creature in Greek mythology. However, the Chimera mobile robot is far removed from these mythological roots and operates at the ROBOTICS Institute in Klagenfurt and supports the local experts with their research. The main focus here is on value-creating work that occurs in the field of intralogistics in industrial companies.

Mobile robots are increasingly the standard solution in modern manufacturing companies for flexibly organised goods and material flows. They can quickly adapt themselves to changed production requirements by adapting the defined routes to match the task at hand and navigate safely and autonomously through the production halls. Currently, mobile robotic systems are especially used for intralogistics tasks and use dedicated charging stations. If the mobile robot has to work in an area designed for employees, then it makes sense to not only have a mobile robot, but one designed as a mobile manipulator, i.e., the mobile robot is equipped with its own articulated arm robot to deal with flexible loading and unloading of the robot. But even more important: A mobile manipulator is not only capable of carrying out transportation tasks as a variable position industrial robot, but also fulfil any manipulation tasks. However, the use of such a robot requires

the rethinking of classical production and intralogistics processes while also enabling new innovative solutions for digitalised production.

“We developed the mobile robotic platform CHIMERA in such a way that it can operate together with humans in a shared workspace”, Matthias Weyrer enthused about his robotic colleague. One crucial attribute of the robot is that it has become a holistically acting robot system through the connection of mobile and serial robots. The robot suitable for collaboration with humans can be configured for a certain task via a simple interaction. “You literally take the CHIMERA by the hand, by gripping the end of the robotic arm, and lead it to the next working point. Chimera remembers the action and carries it out automatically in the future”, Weyrer explains.

What does this mean for domestic companies?

In a similar fashion to an apprentice, the goal is to be able to teach a mobile manipulator to do things so that it can then carry out the task autonomously, reliably, and safely with regard to humans and the environment. Monotonous tasks can be assumed by robots in

A mobile manipulator is location-independent and is thus a power tool.

– Matthias Weyrer

the sense of digital production and humans can concentrate on value-creating tasks in industrial companies. ■



CHIMERA, pictured here during an inspection, remembers actions and can repeat them without human help.

Project management



Matthias Weyrer, a specialist for control theory and robotic kinematics, has worked at ROBOTICS since 2017. His current research focus is on the topic of collaborative robotics.



The construction phase of a Digital Twin Lab at the Klagenfurt site begins in 2023. First, 100 m² of laboratory space and 130 m² of office space will be occupied and research equipment with a value of 1.3 million Euros will be transferred from Graz to Klagenfurt. By 2027, there will be a team of 10 employees on site. The construction phase of the location is financially supported by the Carinthian state, which is a part owner of JOANNEUM RESEARCH.

Digital Twin Lab

The testing of automated driving does not immediately occur on roads or rails, but primarily in simulations. This enables millions of kilometres of testing to be done without starting the vehicle. In order to ensure that the test kilometres correspond exactly to reality, it is necessary to bring the real environment into a digital representation, i.e., to create a digital twin. A single system of sensors, located on the roof of a vehicle for example, can only acquire its environment from its specific perspective. This results in blind spots and blind angles. The experts at DIGITAL have closed this gap with a combination of mobile mapping methods that are vehicle-mounted, air-supported (drone), and personally carried (rucksack). Grants for the investment were provided by the FFG within the scope of "R&D Infrastructure Grant". ■





The Riegl VMX-2HA is the latest generation of vehicle-mounted mobile mapping systems from the Austrian company RIEGL Laser Measurement Systems GmbH. It is mounted on a measurement vehicle and used for the measurement of road space with millimetre accuracy. Two laser scanners record 3.6 million measurement points per second. 7 cameras and a panorama camera can take images with 114 megapixels.



If digital twins need to be created of areas that are unreachable or cannot be viewed by a vehicle or a drone, then terrestrial 3D laser scanners can be used. These can provide exact measurement of a stairwell, for example, whereby the laser scanner takes overlapping images at several locations that are subsequently merged into a single overall image in the Digital Twin Lab.



The survey drone very efficiently measures the environment from the air. Thanks to its own weight of 11 kg and load capability of 7 kg, it can carry a laser scanner, an optical camera, and a thermal camera. Each flight can cover an area of 2 km² and only needs to land to change the battery.



In order to derive the most seamless digital representation of the environment as possible, different measurement devices are combined so that measurements can be taken from the air, ground, roads, and even in impassable terrain. Only seamless digital twins can match the strict requirements of signal propagation simulation.

Project management



Patrick Luley, from the research group Remote Sensing and Geoinformation, conducts research into the creation of digital twins for autonomous driving.

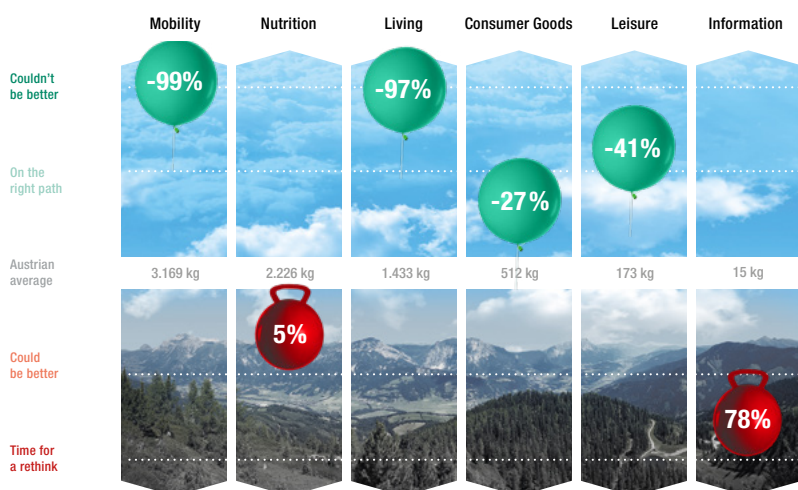


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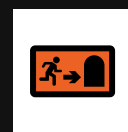
How it works

- Immediate activation of stop lights
- Prevent vehicles entering the tunnel
- Fewer people require evacuation
- Microphones detect sound incidents
- Crash, tyre burst, tyre sequal, horns, screams and cries
- Locate (and hear) people even with poor visibility

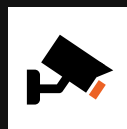
Benefits



Incident recognition in less than 1 second



Operator is able to direct tunnel occupants to safe areas even if the cameras are blind



Automatic activation of the relevant camera



Emergency services can be guided around dangerous areas to rescue people via safe escape routes



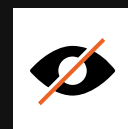
Tunnel stop lights can be immediately activated



Timely warning is preventing traffic congestion in the event of an incident



Fewer tunnel occupants require evacuation



Localisation of people in the tunnel even with poor visibility

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7.6 %

Forecasted growth
in population by
2075 in the core area

50

Minutes effective
travel time Graz-Klagenfurt

35 %

Increase in
commuting links

2.9 %

Growth in population
in a district due
presence of a station

1.1 %

Million people
in new conurbation

130,000

People in
manufacturing domain

32,000

Employers

THE HUGE OPPORTUNITY

TEXT: RENATE BUCHGRABER

The topic of the Semmering railway and the Koralm tunnel has been discussed since the 1990s. In 2026, the tunnel between Graz and Klagenfurt is due to open. This is the imminent culmination of a generational project, as this hole through the mountain will still be having an impact on our children's children. The regional economist Eric Kirschner from POLICIES, the Institute for Economic, Social and Innovation Research, is accompanying the project with regard to location effectiveness and the corresponding study was presented in the Autumn of 2022.

So how will Austria profit from the new transport link? The new conurbation that will emerge as a result of this in southern Austria will gain visibility in Europe: In actual fact, the 1.1 million people will it make one of the largest conurbations there are. Kirschner's assessment of the newly accessed region's strength is that "the urban merging between Graz and Klagenfurt will bring us up to the level of cities like Cologne". This link will also open up a bottleneck in terms of goods transportation as ports in Trieste and Poland are now directly accessible via the Baltic-Adriatic axis between the Baltic Sea and the Adriatic Sea.

A sustainable upgrade for the region

The opening of the Koralm railway can be described as the greatest socio-economic experiment in Austria since the Semmering line was opened in 1845. "The impact that will result from the

„An urban conurbation will emerge, a metropolitan region with international visibility and radiance“

Eric Kirschner

changed accessibility is in the same ballpark as that that occurred in the 19th century. They should not be underestimated: An urban agglomeration will occur, a metropolitan region with international visibility and radiance", Kirschner says.

How will this happen? The time to travel between Graz and Klagenfurt will lie around 50 minutes. This makes daily commuting attractive, something which will have a positive effect on the employment market. The areas of Wolfsberg and Deutschlandsberg, which are currently battling against emigration, will then find themselves in the middle of southern Austrian urban area. The prices for housing and plots of land are favourable compared to Graz and make the area attractive to young families. "This is important, because Deutschlands-

berg and Lower Carinthia are already suffering from an extreme shortage of manpower, even though the regions are highly industrialised. The mood in the population is positive and all are pulling in the same direction. The awareness is present that the railway will come. And that will make surviving in the region possible because a critical mass is achieved in the peripheral area of an urban agglomeration that is necessary for effective growth”, Kirschner explains.

Living in a new conurbation

Growth, however, also needs energy. A lot still needs to be done to ensure that the location is capable of handling the new possibilities and challenges. Key words here are digitalisation, energy transition, and demographic change. Kirschner is confident, “the necessary areas have already been secured. For example, there is an intercommunal park that is to be operated. An open issue is how the areas along the railway are to be used for business, technology parks, or new residence areas”. The planning of good

infrastructure is extremely important because the availability of a station and thus attractive transportation connections correlates directly with population growth. More people need more infrastructure. Kirschner’s response to this is, “the results of our studies show that a station within a range of 1.5 km has an impact of a 2.9 percent growth in population. If it is within 3 km, there is still a 2 percent increase. That is a significant impact on the overall demographic development”.

The study by POLICIES was conducted over the past two years. “Apart from the complexity of the study with its comprehensive modelling calculations and the dissecting of thousands of data sets, it was challenging to process the questions, also with regard to the communication with the stakeholders and affected parties. It is notable that companies, decision-makers, representatives of interested parties and politics all worked together”, Kirschner summarised the project’s success. And further, “the mu-

tual consensus could also be communicated across county and party-political borders”. ■

Project management



Eric Kirschner is an Environmental System Scientist and Economist. Apart from his activity as research group leader at JR, he also has numerous teaching assignments.

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Do E-Vehicles Meet Mobility's Needs?

MARKUS SCHMID

A rapid increase in the electrification of powertrains can be observed in almost all fields of mobility. The reasons for this are manifold. E-mobility definitely has a significant and immediate impact on the reduction of local emissions during the operation of vehicles in metropolitan areas and plays an important role in decarbonisation.

In recent years, industry has been able to offer an increasingly comprehensive portfolio of battery-electric vehicles. However, the goal that has been pursued so far is to match the range of e-vehicles with that of conventionally powered vehicles. The result of this has been a majority of electric vehicles with large battery storage leading to vehicles with considerably higher weight and cost. However, the success of e-mobility in the market depends on the affordability for customers and thus the achievable market volumes.

If the current mobility needs in urban and rural areas are considered, then it is apparent that 94 % of daily driven routes are below 50 km, 4 % between 50 and 100 km, and a small remaining share of over 100 km. From this perspective, the majority of e-vehicles do not fulfil the needs of many customers from the point of view of

cost per range. It therefore seems reasonable to run smaller vehicles with appropriate battery storage in order to cover the majority of individual mobility needs. This would achieve a better ecological overall energy balance and simultaneously enable significantly more attractive pricing.

In order to further improve the cost per range, vehicle developers are endeavouring to achieve high levels of efficiency in different operating phases of an e-vehicle. The interplay between automation, infotainment, and connectivity enables efficient operation and the highest possible range to be achieved and results in a comfortable e-vehicle independent of vehicle size.

Magna's development centre for complete vehicles in Graz is successfully pursuing the route of developing efficient e-vehicles. The results achieved are based on the comprehensive competence of its engineers from a range of different areas of expertise in cooperation with many cooperation partners. Over the next few years, we will be increasingly called upon to develop concepts/vehicles that correspond to the specific customer and market demands.



Markus Schmid is the General Manager of the Engineering Center Austria.



Ulrike Kleb (right.) is a specialist for statistics and data analysis.

IMPROFE: Quality Checks for E-Motors

Ulrike Kleb from the POLICIES institute is a specialist in the evaluation and interpretation of data. Her project team is developing methods for the project partner, Miba Automation Systems, who is working on the construction of a production line for electric motors. These methods are designed to detect faulty stators during production and to predict possible deviations.

TEXT: PETRA MRAVLAK

The stator is the heart of every electric motor. The project partner Miba Automation Systems is developing a process for the serial production of hairpin stators within the scope of the IMPROFE FFG project. Hairpin technology is still relatively new in the automotive industry and enables increased motor efficiency on the one hand and on the other flexible and relatively cost-effective production even in large volumes. This is where Ulrike Kleb from the POLICIES Institute and her team enter the scene. "To do this means that critical attributes of the stator need to be checked as completely as possible and inline, so directly in the manufacturing process," Kleb explains. "The machine positioning and wiring of the hairpins to an electrically conductive winding is done in three production steps: Widening, twisting, and contacting, meaning the connection of the ends via spot welding." The first two steps involve measuring the position of the pins using optical measurement methods thus ascertaining the quality. The quality check of the welding points is done by another project partner: The

Institute of Physics at the University of Graz. This check uses a laser-ultrasound method that enables the direct measurement of the welding seam. The measurement results are then used by the statistics experts to create forecasts for the further steps. "The ultimate goal is to detect a deviation and change the machine parameters in subsequent production steps so as to prevent the fault," Kleb explains. A digital representation of the manufacturing process is created for further optimisation. "In this way, the manufacturing process can be checked better and optimally controlled," Kleb continues. "The bottom line

is that the automotive industry is able to manufacture high quality hairpin stators in very high volumes with the efficient use of resources." IMPROFE will continue into 2024.

Ulrike Kleb studied technical mathematics at the TU Graz and has worked at JOANNEUM RESEARCH since 1992. She focusses on the application of data analysis, statistics, and artificial intelligence for quality and resource optimisation in production. ■

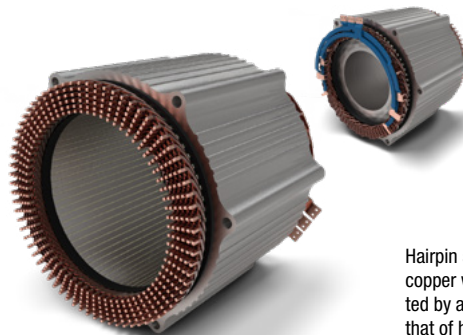


Chart: Miba

Hairpin stator: In contrast to wound coils, the copper wires in hairpin technology are connected by a welding seam. Their shape resembles that of hairpins, hence the name.

MOBILITY AND THE PO- WER OF THE INDIVIDUAL

TEXT: PETRA MRAVLAK

HOW CAN AUSTRIAN TRAFFIC BECOME CLIMATE-NEUTRAL? EXPERTS FROM A RANGE OF DIFFERENT SECTORS AND AREAS OF EXPERTISE EXPLORED THIS QUESTION IN DETAIL AT THE ALPBACH TECHNOLOGY DISCUSSIONS IN A SERIES OF TALKS ORGANISED BY JOANNEUM RESEARCH

There are currently 6.5 million motor vehicles driving on Austria's roads, which is 2 million more than 30 years ago. And these vehicles are responsible for a substantial amount of greenhouse gas that is powering global warming. JOANNEUM RESEARCH organised a working group at the European Forum in Alpbach to sketch the outline of a path to achieve the climate goals from the points of view of science, the automotive and recycling industry, government, as well as consumer protection and law. And all agreed upon one thing: There is no way past the comprehensive consideration of the impact of mobility on the environment and all factors must be included from energy consumption to the polluting emissions, from manufacturing to recycling. The methodical basis for this is provided by the research community in the form of lifecycle analysis.

The political framework

The political framework for the realisation of climate-neutral mobility in Austria is staked out in the form of the Mobility Master Plan 2030 from the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology. It provides the horizon for the transportation sector and is a part of the government's program that plans to achieve climate-neutrality by 2040 as well as of the goals of the EU's Green Deal and the Paris Climate Agreement. Reiner Reinbrech from the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology reported, "the starting point is a backcasting model that assumes a meaningful mix of transportation avoidance, shifting, and efficiency improvement for the individual transportation carriers and envisages a substantial increase in the energetic efficiency of the entire transportation system within the available CO₂ budget". The writing is on the wall for gasoline- and diesel-powered vehicles: The energy transition in road transportation by

2040 envisages the electrification of passenger car and two-wheeler stock and a stronger shift of goods transport towards rail, and the electrification or use of climate-neutral fuels for commercial vehicles and buses. The energy required is intended to be covered from domestically produced renewable sources.

The role of the automotive industry

Hanno Buchner, Head of Strategy and Innovation at the automotive supplier Magna Steyr Fahrzeugtechnik knows which requirements the automotive industry has to fulfil in the face of this massive technological shift: "The industry has to act along the entire value creation chain and look at the overall product lifecycle". Electrification is one of the megatrends in the industry that would have the greatest impacts in making it environmentally friendly. Buchner assumes that electrified vehicles will dominate production and sales by 2030 and the worldwide share will lie around 50 %. In some regions, the vehicle stock could be fully electric by 2035. If e-vehicles are powered by sustainably produced electricity, emissions can be largely reduced, the only emissions remaining are those released during manufacturing and even here a lot can be saved, just as the performance of batteries can be increased. Independently of future legislation, the large automotive manufacturers have also defined their own targets: The emission of greenhouse gases are to be reduced over the entire vehicle life-

cycle - between 30 and 50 percent by 2030 depending on the manufacturer. In addition, the use of secondary raw materials is to be increased, in particular those used in large amounts and associated with high energy intensity. "Among the first steps in measuring the CO₂ rucksack along the value creation chain are integrated supply chains and unified standard for the exchange of data and information", Buchner says. By 2025, all Magna sites in Europe will be "CO₂ neutral", and worldwide by 2030.

Peter Hartmann, R&D Funding Manager at the ZKW Group, a system supplier for the automotive industry, is investigating what the future looks like for automotive headlights. "Modern, smart car headlights are already characterised by a long lifetime and high complexity", Hartmann says. Depending on the model, they can contain up to 300 parts using five different plastics and metals, in particular aluminium. This also makes recycling difficult. "Currently, technical materials are often not reused", Hartmann explains. ZKW has developed a model of an eco-headlight that begins with a lifecycle analysis. Apart from an increase in functionality, this also boasts a lower environmental burden thanks to the metals used, a longer lifetime, the reprocessing, reuse, and implementation of new types of (bio) plastics and new design concepts to reduce weight and material used. As a system supplier, the scope for action is however very dependent on the automotive manufacturer's requirements. "Even



Since 1998, JOANNEUM RESEARCH has been a partner of the European Forum Alpbach and provides at least one program item every year.

if the lighting system has little influence on the CO₂ for the entire vehicle, it can still be considered as a complex subsystem and used as an example for other vehicle components” Hartmann says.

The recycling of raw materials

The more electric vehicles on Austria’s roads, the higher the number of batteries equipped with valuable and rare materials that will need to be correctly processed at the end of their lifecycle. The Saubermacher Dienstleistungs AG is well placed to do this with the construction of a recycling plant for lithium-ion batteries in Bremerhaven, which will be capable of mechanically processing up to 100,000 tons of car batteries per year. According to Astrid Arnberger, Head of R&D at Saubermacher, “the recycling efficiency of lithium-ion batteries is currently at 50 % and in the future reach up to 65 to 70 %. She continues, “ so far, only those materials were recycled that were the most economic, but in the future, there will be legislatively prescribed quotas for individual materials: The European battery directive plans a recycling rate of 90 percent for cobalt nickel and copper, and of 70 percent for lithium by 2025. In 2030, a further increase is planned. There will also be a mandatory quota for the use of secondary materials by manufacturers.

The evaluation of cars

The goal of the consumer protection program Green NCAP is the independent evaluation system of the environmental friendliness and sustainability of new vehicles, which is intended to provide both consumers and legislators in various countries a basis for their decisions. “The prerequisite is intensive testing in the laboratory and on the road that goes far beyond conventional certification”, reports Aleksandar Damyanov, Technical Manager in the company. “The insights gained are then transferred into a rating system that is built upon three indices: the Clean Air Index, which represents the polluting emissions, the Energy Efficiency Index, and the Greenhouse Gas Index, which represents the climate-damaging fuels.” The entire lifetime

of a product must be considered and included if the environmental behaviour is to be meaningfully analysed. This is why the Green NCAP has developed an online platform that includes all of these criteria in the evaluation and encompasses a large number of vehicles. Green NCAP is backed by a consortium of stakeholders representing a range of different interest from automobile clubs to the ministries of different EU countries.

Climate change lawsuits and private enforcement

Martin Wiedenbauer, lawyer at WMWP Lawyers, says that “we are currently at the beginning of the era of climate change lawsuits. An increasing number of citizens, environmental agencies and NGOs are using lawsuits to force companies to reduce their greenhouse gas emissions. “A precedence case is the judgement passed by a district court in Den Haag in 2021 against the Dutch company Shell which subsequently immediately reacted with measures. And in Germany, provincial court cases are currently being held against Volkswagen.” The peculiarity here: In the past, environmental court cases mainly dealt with compensation of damage that had already occurred, nowadays the environmental lawsuits are focussed on the future regarding damage that has not yet occurred. Wiedenbauer sees them as a powerful instrument and a sign that private enforcement of claims in the domain of environmental protection will take hold. It is also of interest to note that

the German climate protection law of 2021 had to be amended regarding intertemporal freedom protection: The German state is obliged to ensure intergenerational justice, also regarding climate protection.

The power of individuals

Humans still have the means at hand to steer the climate in the right direction. The required processes for this are currently being introduced across

**A SUSTAINABLE
DEVELOPMENT OF
THE TRANSPORTATION
SECTOR IS ONLY POSSIBLE
WITH CLIMATE-NEUTRAL
PRODUCTS AND SERVICES
THAT FULFIL THE CIRCULAR
ECONOMY CRITERIA.**

Gerfried Jungmeier
SUSTAINABILITY EXPERT

all walks of life and economic sectors. But just as politics and business are under pressure all over the world the create the required framework conditions, each person is required to rethink their mobility habits. Many small steps are needed to create one giant step. Whatever: The data regarding the continuing acceleration of global warming and its dramatic consequences clearly show that the efforts made

to reduce the emission of climate-damaging gases are not yet sufficient.

The European Forum Alpbach took place between 21st August and 2nd September 2022. In a discussion initiated by JOANNEUM RESEARCH and moderated by CEO Heinz Mayer, experts discussed a practical topic “The Circular Economy and Climate-Neutral Mobility – The passenger car as a case study”. The technology discussions in Alpbach are organised by AIT Austrian Institute of Technology and ORF Radio Ö1 in cooperation with the European Forum Alpbach. ■

FOCUSSING ON THE LIFECYCLE

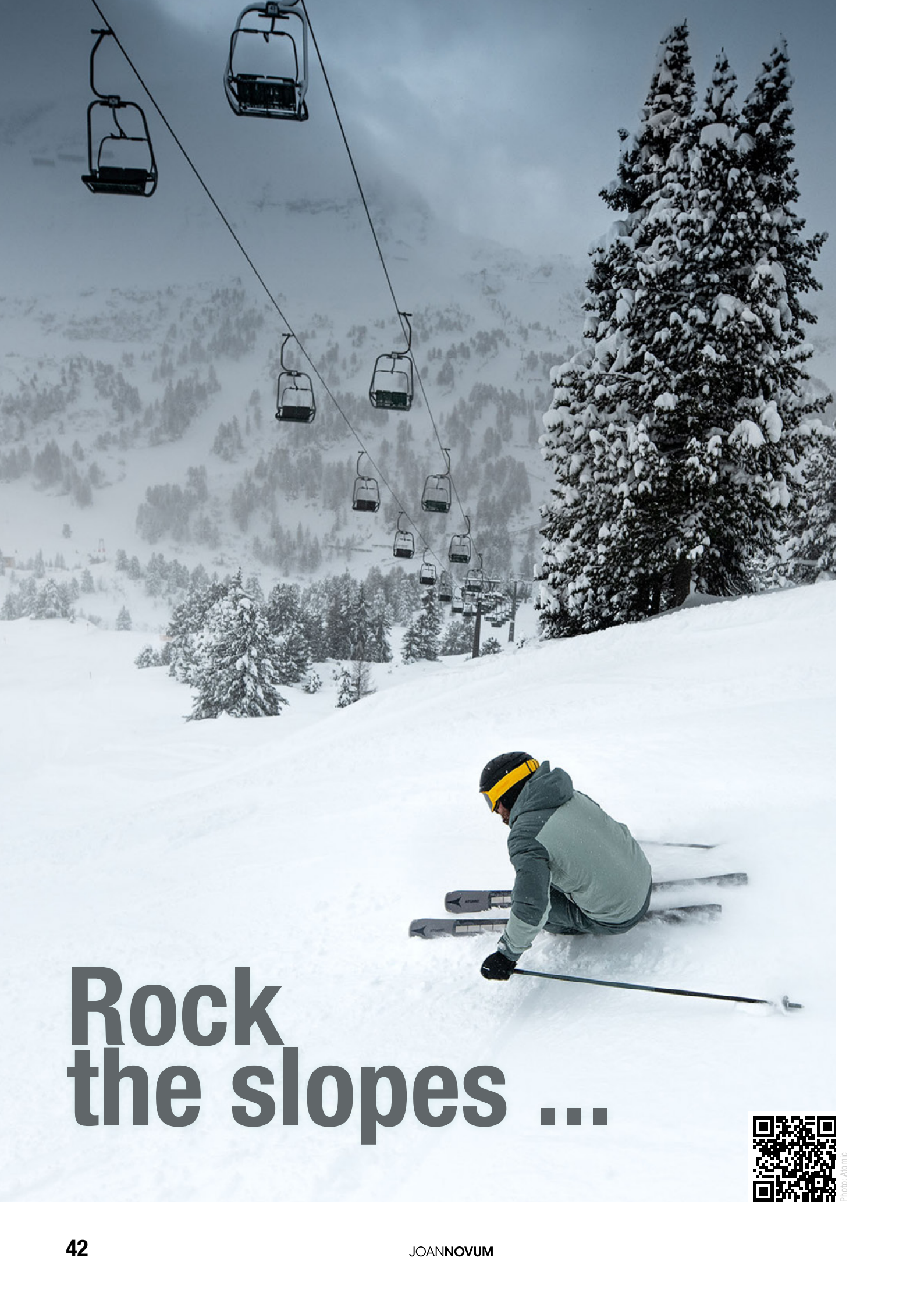
Gerfried Jungmeier, expert in sustainability at JOANNEUM RESEARCH, sketched out possible paths towards climate-neutral mobility in his talk about the results from the current cooperation with the Technical University of Graz and the IEA (International Energy Agency). The cooperation worked out **scenarios for the transportation sector for the entire fleet of vehicles in Austria**. “We are the first ones in the whole world to investigate greenhouse emissions and the primary energy requirements between 1990 up to 2050 in combination with the development of the vehicle fleet within the framework of dynamic lifecycle analyses”, Jungmeier says. Looking into the past and into the future allowed us to determine how much energy has been consumed and how much greenhouse gas (the total of CO₂, CH₄ und N₂O) has been emitted at which point in time in a vehicle’s lifecycle. This allows us to check what role future forms of powertrain such as electric, e-fuel, biofuel, or hydrogen can play in achieving the climate goals.

The result: **“Climate neutrality in the transportation sector by 2040 is, although visionary, technically perfectly possible”**, Jungmeier reports. “And with battery-powered electric vehicles, bio-fuels, hydrogen, and e-fuels”. It is worth noting that when regarded over the entire lifecycle e-fuels, just as other renewable fuels, emit similarly low levels of emissions as electric vehicles, but they are significantly worse in primary energy requirements. For example, the production of hydrogen or the provision of CO₂ requires considerably more (renewable) electricity than battery-electric vehicles. Although electric vehicles create more emission during production, they are climate-neutral when driven, assuming the electricity comes from renewable sources-

To reach the climate goals, it is now necessary to force the registration of e-vehicles in particular and to rapidly increase the production of additional renewable electricity, expand the charging infrastructure, and build plant for the production of e-fuels and hydrogen. Important influencing factors are the future development of demand for transportation services for people and goods, the rate of vehicle use, the country-wide vehicle fleet, and the total of driven kilometres per year.



Gerfried Jungmeier is an expert for sustainability and lifecycle analysis at the LIFE Institute.



Rock the slopes ...



Photo: Atomic

TEXT: ELKE ZENZ

... with smart skis. The PyzoFlex® developed in Weiz helps material developers and (hobby) sportspeople to obtain data-based feedback about the skiing and material behaviour of alpine skis. This provides important benefits for the skiing experience, the safety of skiers, and the longevity of the material.

A team from MATERIALS, the Institute for Sensors, Photonics and Manufacturing Technologies, modified the patented PyzoFlex® technology for use in alpine skis within the scope of the H2020 project “Smart2Go”. PyzoFlex® is based on sensors made of special polymers adapted in geometry and size to each application and printed over a large area on film using a low-cost screen-printing process.

The name PyzoFlex® is derived from the core attributes of this innovative sensor as it acquires dynamic changes in temperature (pyroelectric), pressure (piezoelectric), and vibrations. When using film as a carrier, the sensors then also possess high flexibility and can therefore be printed on a range of curved surfaces. “In addition, the polymers used permit the design of a highly energy-efficient system that can even be used for energy generation, i.e., energy harvesting,” Gregor Scheipl, the product manager for PyzoFlex®, explains.

These skis were developed and tested in cooperation with national and international partners including ATOMIC, Varta Microinnovation, and VTT. The tests were conducted with Salzburg Research directly on Austria’s slopes: “The goal of the project was to generate data regarding the performance of the skier and the material. We achieved this goal in the test runs and acquired very valuable

data.” The smart skis are equipped with an energy-autonomous sensor system that records the ski’s vibrations and transmits this data wirelessly. This generates excellent feedback about the ski’s performance.

How does it work? The printed piezoelectric sensors measure flexing and vibration such as the turn line, the turn switch points (TSPs), and ski deflection on the slope. The sensor system was mounted directly on the ski and acquired, processed and stored the signals, or transmitted them wirelessly as a live stream. Even the power was supplied directly by the ski: A microbattery (50mAh, Varta) and printed, organic solar cells (OPV, Armor) to capture solar energy. The built-in energy management chip enables the system

to use additional energy harvesting sourcing such as thermal, magnetic, or vibrational.

“We and our project partners are hoping for new insights into skiing and material behaviour of the skis. This will bring additional benefits regarding safety and less wear,” Tschopp explains. ■



Andreas Tschopp is an electrical engineer at MATERIALS specialised in the development of complex sensor systems with a focus on pyro-, piezo-, and optical sensors.

Smart2Go
Ski Demonstrator consisting of:

- (1) Screen printed electro-active polymer sensors (PyzoFlex®) by Joanneum Research (AUT)
- (2) Analog frontend plus analogue to digital converter on polyimide flex PCB by Joanneum Research (AUT)
- (3) Roll2Roll fabricated energy supply platform including microcontroller and energy management IC by VTT (FIN)
- (4) Ultrathin (390µm) flexible microbattery from Varta Microinnovation (AUT)
- (5) Ultrathin supercapacitor from Tampere University of Applied Sciences (FIN)
- (6) Flexible organic photovoltaic films (OPV) by Armor (FRA)
- (7) Redster G7 ski (length: 1.75m; radius: 19.6m) by Atomic (AUT)

In Pursuit of Excellence!

The very capable researchers at JOANNEUM RESEARCH publish almost 200 papers per year in scientific journals, books, or proceedings, hold around 250 scientific talks, and supervise 60 theses papers.

Following is a small selection:

Photo: PEXELS



People, not just places: Expanding Physical and Social Vulnerability Indices by Psychological Indicators

Philipp Babczyk, Sebastian Seebauer | Journal of Flood Risk Management (2021)

This publication investigates the extension of physical and social vulnerability indices by psychological indicators. When analysing the social vulnerability of residents in areas in danger of flooding, socio-demographic indicators are normally employed. It has been shown to be useful to also include psychological factors such as people's attitude to risk along with their convictions and ability to act in a more holistic observation. The article introduces a series of indicators from research into psychological risks. Physical and psychological indicators are compared regarding their influence on vulnerability results such as damage to buildings or emotional suffering. The survey data, based on results from 456 endangered households in Austria confirmed the added value of considering psychological indicators in the measurement of vulnerability. Psychological factors play an important role in the explanation of health-related consequences and psychological stress. General intentions towards flooding preparedness, fear of flooding, and self-effectiveness are the most important.

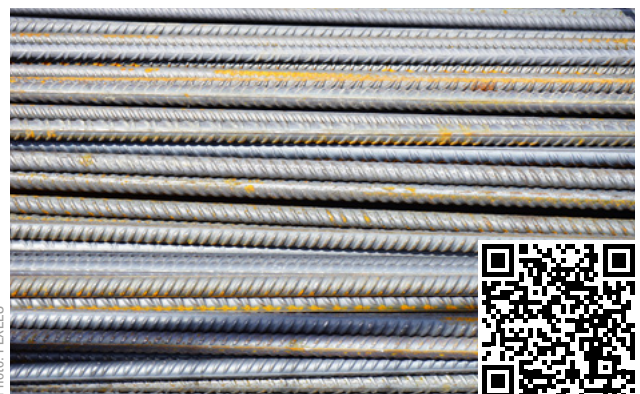
Recycling of Steel – Opportunities and Challenges of Innovative and Sustainable Recycling

Sabine Dworak, Johann Fellner, Martin Beermann, Monika Häuselmann, Johannes Schenk, Susanne Michelic, Julian Cejka, Amin Sakic, Jakob Mayer, Karl Steininger | Österr. Wasser- und Abfallwirtschaft (2022)

Compared to producing steel from iron ore (primary route), the smelting of scrap steel requires fewer resources and has environmental and economic advantages.

This interdisciplinary work uses quantitative and qualitative analyses to investigate the potential for the optimisation of sustainable recycling of steel in Austria. The impact of materials on processes and products were also analysed and summarised. The work showed that the share of end-of-life scrap in the total scrap volume will increase to 75 %, however currently, due to the current manner of scrap handling and the associated impurities, only a fraction of the end-of-life scrap can actually be used within Europe and in Austria for the production of high-performance steels. The improved pre-selection, removal of unwanted accompanying elements via secondary metallurgical processes, and better understanding of the interaction of different accompanying elements can release the available potential and contribute to a reduction of the ecological footprint.

Photo: PEXELS





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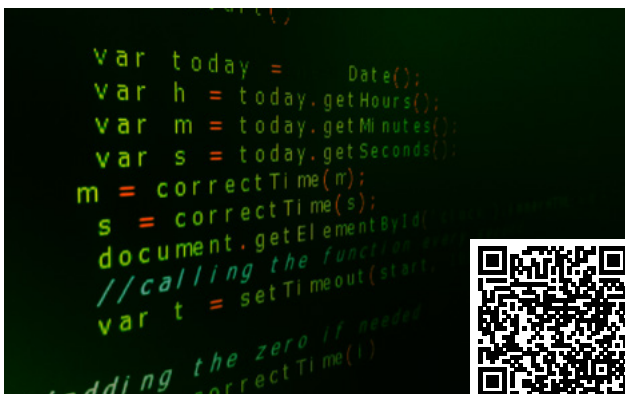


Photo: PEXELS

Double Success for the DIGITAL Institute at the Space4Energy Hackathon

Janik Deutscher, Karlheinz Gutjahr, Martin Puhm and Andreas Wimmer, all scientists in the Remote Sensing and Geoinformation Research Group at the DIGITAL Institute were able to convince the jury of experts at the Space4Energy Hackathon and secured wins in two of the four categories.

The team around Janik Deutscher – Martin Puhm and Andreas Wimmer from the DIGITAL Institute and Sebastian Vogler, founder of the BeetleForTech startup won in the “Space4Biomass” category. The researchers are working on the space-supported survey of storm-felled biomass potential.

The recently founded team consisting of Karlheinz Gutjahr from the DIGITAL Institute together with Sahir Khan and Lukas Prenner won in the “Space4Wind” category with their entry for site optimisation of wind turbines.

The Space4Energy Hackaton is hosted by the ESA BIC, Green Energy Lab, and the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology. The competition asks the question how our increasingly integrated and sustainable energy systems can profit from the flood of satellite data and services. All in all, 17 project ideas were entered in four different categories.

ROBOTICS: Award for a Master thesis

Alexander Weissmann spent months on intensive research and on his Master thesis at the ROBOTICS Institute. His diligence paid off: His work, entitled “Classification and Tracking of Humans with mm-Radar-Waves and LiDAR on a Mobile Robot in Cluttered Environments” at the FH Carinthia in Mechatronics was awarded in the category “Best Mechatronic Master Thesis in Austrian Applied Universities”. The award was presented at the conference of the Austrian Mechatronic Platform at the FH’s campus. OÖ in Wels.



Photo: PEXELS

Learn more ...

Gender Equality Survey 2022 in Non-university, Scientific-Technical Research

The current gender equality survey 2022 was conducted by the POLICIES INSTITUTE and contracted by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology. Participation by female scientists increased between 2019 and 2021: Around 29 % of the scientists were female in 2021 and just 27 % in 2019. The COVID-19 pandemic does not seem to have had a negative effect on women’s participation in non-university, scientific-technical research.



Photo: iStock

Learn more about the results

News Shots

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Space as a Motor for Business

On the 4th of October 2022, JOANNEUM RESEARCH hosted a forum together with VRVis on the topic of everyday space technology. The high-profile speakers presented how Austrian space technologies are driving attractive areas of application forwards. The scientific event was opened by Barbara Eibinger-Miedl, the State Councillor for Economic Affairs and Research. The speakers were ÖAW director Christiane Helling, Mars expert Gerhard Paar, 3D specialist Christoph Traxler, satellite researcher Michael Schmidt, geodata expert Roland Perko, general manager at MAGNA STEYR Aerospace Armin Scheinost, and FFG section head Andreas Geisler.



Photo: JOANNEUM RESEARCH



Photo: JOANNEUM RESEARCH

System Integrator Symposium 2022

After a two-year break, the ROBOTICS Institute were able to host a symposium on the 12th of October 2022 at the Lakeside Science & Technology Park in Klagenfurt with a special focus on system integrators. This year's scientific focus lay on the digital twin. The SIT2022 was dedicated to the opportunities that the application of digital twins can bring to production in the future and how companies can profit from this technology.

INSPIRE: Gender Equality and Inclusion in European Research

In recent years, considerable effort has been made to remove gender-specific inequalities in research and innovation particularly via equality plans. These envisage concrete measures for the introduction of organisational changes in research institutions and organisation across Europe. The project INSPIRE, with the participation of POLICIES, was designed to promote and distribute this knowledge.



Photo: JOANNEUM RESEARCH

Photo: JOANNEUM RESEARCH



(Cyber)-Security: Strategies, Research, and Products

The Internet never forgets! Around 70 interested people visited the opening event of the new four-part event series dedicated to (cyber)-security on the 24th of November 2022 in Graz. The speakers from left to right alongside JR CEO Heinz Mayer (left): Christian Derler (JR-DIGITAL), Ingo Pill (SAL), Klaus Mits (Austrian Federal Bureau of Investigation), and Markus Seme (Bearing Point).

Career: Anton Scheibelmasser is the new ROBOTICS Director

As of 1st October 2022, Anton Scheibelmasser assumed the role of Director at the ROBOTICS Institute in Klagenfurt. He will lead the institute into the future, up to June 30th, 2023, alongside Michael Hofbauer: The institute's field of activity will be extended, and the number of employees doubled by 2027. Scheibelmasser commented, "I am convinced that robotics will herald in the next industrial revolution and be able to compensate for the omnipresent labour shortage."



Photo: JOANNEUM RESEARCH

Photos: JOANNEUM RESEARCH



UN/A Symposium

In September 2022, the United Nations' office for outer space affairs (UNOOSA) hosted the UN/Austria Symposium as an online event in Graz together with Austrian organisations such as JOANNEUM RESEARCH. This year saw the participation of over 800 experts and space enthusiasts from 104 nations. The symposium's focus lay on the introduction of the latest initiatives to mitigate and adapt to climate change and support sustainability on Earth.

News from the Moon

The launch of NASA's Artemis 1 rocket on the 16th of November 2022 is the first step to put man back on the moon. A receiver developed by DIGITAL ensured the correctly functioning communication to and from the moon rocket. This is sold by the company CPI/VERTEX ANTENNENTECHNIK GmbH, who provided the signal receiver to the British Goonhilly ground station. The antenna is responsible for the communication to and from the moon rocket when it is in the line of sight of the antenna.



Photo: JOANNEUM RESEARCH

Use it or Lose it

In a recent study conducted by COREMED, the centre for regenerative medicine and precision medicine, and the Med University Graz, researchers have proved the rejuvenating effect of physical exercise on a cellular level.

TEXT: ELKE ZENZ

Regular physical exercise can positively affect ageing processes and verifiably slow them. The difference in biological age between sporty and non-sporty people can be up to 10 years. A glance at demographic forecasts shows that the number of over-60s will triple by 2050; at the same time, the age group of 85+ is the fastest growing. The trend is that we spend the last 10 to 15 years in a reduced or poor state of health. Thus the “health-span”, the time we spend in a healthy state, lags the “life-span” or life expectancy by a long way. This not only results in losses in terms of quality of life for individuals, but also a massive medical and nursing care problem. To help counteract this, researchers and medical personnel worldwide are searching for effective strategies to support healthy ageing. So

far, no miracle cure for eternal youth has been found, however the solution may be closer than we think: Studies raise hope that regular exercise contributes to the protection and maintenance of our cells and results in slower ageing. This effect can be explained using the Telomere length, a cellular marker of biological age. Telomeres can be considered as protective caps on the ends of our chromosomes: Each cell division shortens these Telomeres, which in time result in cell death. According to studies, regular exercise intervenes in this process and activates cellular processes that protect the Telomeres and even act to extend them. Although well maintained or longer Telomeres cannot turn back the flow of time, they are still sometimes involved in helping to age healthier and maintain agility. In fact, Telomeres are not only associated with cell ageing, but also with chronic illnesses such as diabetes mellitus, tumours, and cardiovascular diseases. This underlines once again the benefits to health of regular exercise. The good news is that you don't have to exhaust yourself doing sport every day. Moderate exercise at least three times a week should be enough to protect the Telomeres and thus influence the ageing process. ■



The difference in biological age between sporty and non-sporty people can be up to 10 years. That should be enough to motivate us to exercise more.

Research from A to Z

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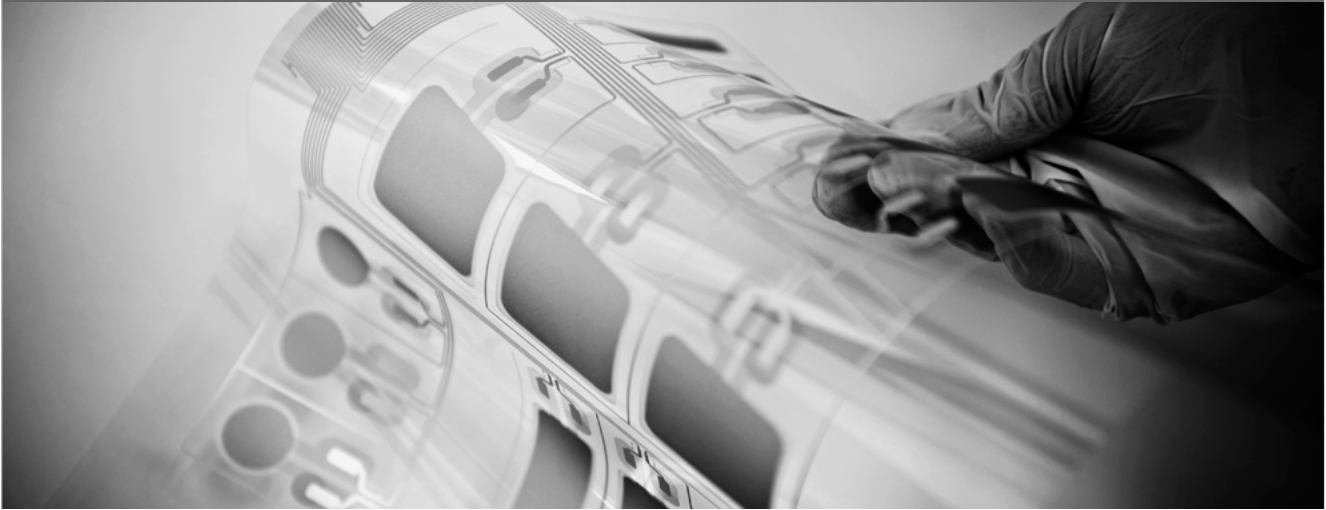
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JOANNEUM RESEARCH Mobility

info

With its headquarters located in Graz, JOANNEUM RESEARCH is a provider of innovation and technology in the field of applied research. As a research company belonging to the Austrian states and regions, we use our research competence to shape the development of our modern society and economy both sustainably and human-centric. We live by the highest social and scientific ideals as a multi-disciplinary team working in flexible and innovation-friendly structures.

As a research institution equipped with a public mandate, JOANNEUM RESEARCH assumes a role for the identification and generation of solutions for socially relevant challenges such as climate change, energy supply, digital transformation, mobility, civil and military security, as well as social change.

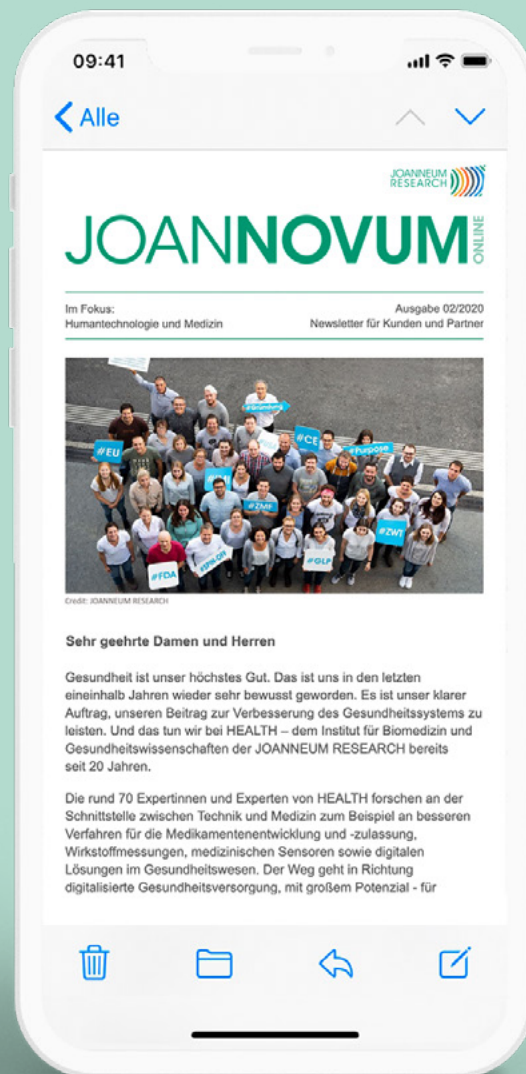
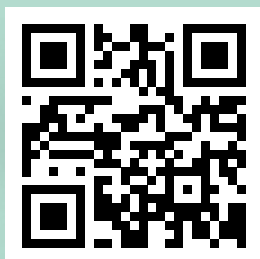
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