



## SCIENCE IS NOT SCI-FI?

Pushing the boundaries of what's possible

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## INTRODUCTION BY TA CR CHAIRMAN



Dear readers,

I am pleased that you are looking at the 16th issue of our TA.Di magazine, which we have dedicated to the topic of pushing the boundaries between the possible and the impossible, not only in the field of applied research, development and innovation. In fact, we are also dedicating this year's TA CR Day to the same theme. At the Technology Agency of the Czech Republic, we have been trying to highlight the importance of applied research for society for almost 15 years.

Research and development constantly amaze us by pushing the boundaries of what is possible. What once seemed like a science fiction fantasy is a reality now. Modern technologies that seemed like the music of a distant future in the 1990 s are now a fixtures in our lives. People travel to space, work with artificial intelligence, and are able to print even an entire house on 3D printers. New knowledge in the field of genetics allows people to better understand diseases and genetic predispositions, leading to new possibilities for treatment and prevention.

Research and development are the pillars on which rests our hope for a better tomorrow. It is important that we recognise that without the support of the scientific community and academia, progress will not be made, and we will stagnate. Science, in general, has been and will be the engine of change that our world needs.

I wish you a pleasant reading.

Petr Konvalinka

T A  
Č R

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# SISTA is coming up

Author: **Veronika Dostálová**

**„The state administration is ossified, full of rigid processes and bureaucracy.“** It's a phrase that all of us have heard in some form at least once. Since the very beginning, we at TA CR have been striving to dispel this stereotype, trying to find new ways and innovate. For example, we have managed to design and implement the SIGMA Programme, we are mapping innovation capacities in the Czech Republic through the INKA survey, we have received a plug-in from the European Commission that will bring Czech companies closer to the EIC Accelerator, etc. And now we have a new challenge ahead of us - the new shared information system „SISTA“.

SISTA will serve as **a unified information system for the provision of funding for applied research within TA CR. Through SISTA, all processes of research project administration will be supported**, from proposal submission through evaluation to the implementation of calls and public tenders.

## Why are we doing this?

In the simplest terms, we do SISTA to automate as many tasks and activities as possible, freeing up capacity for more intensive, personal and human interaction with applicants and beneficiaries. At the same time, the new system should help reduce administration, both on the part of TA CR as administrators as well as on the part of external users of the system. Furthermore, we believe that

our approach also fulfils the government's aspiration that as many services provided by the public administration as possible should be digitised. This will make it easier for citizens to communicate with the authorities and to do their business remotely without having to travel. This saves time and money for citizens as well as the state. The vision of unifying the provision of public funding in the field of research can be supported by a simple, clearly arranged and user-friendly information system developed in line with the principles of eGovernment and administration reduction. That is why we at TA CR have started to develop our own information system that can be used by other public administration bodies to support research activities in the Czech Republic.

## SISTA will be unique

SISTA is unique in that it is not dependent on a single supplier, licensing model or operating environment. This is because multiple suppliers are involved in its development, developing or modifying individual functional parts according to set rules, and our IT colleagues are preparing to take over oversight of its operation.



## SISTA PROMISES A NUMBER OF NOVELTIES. THESE INCLUDE:

1. a more user-friendly and clearer environment
2. responsiveness on mobile devices
3. connectivity with other government systems
4. speeding up administrative processes without the need to prove/document material facts
5. use of identity within the eGovernment tools used
6. automatic import of prepared supporting documents (application, offer, need.)
7. better navigation and more practical information on projects
8. automation of common/repetitive processes (changes, approvals, acceptance.)
9. direct communication between users in real time with archiving capability
10. storage of important notes directly at the project
11. improved generator of forms and documents

## The development will take place gradually, by individual modules, until 2025. What will be the milestones?

### 2023

- » login of users via SISTA to existing systems (ISTA and IS BETA2)
- » entering of sectoral needs (BETA3 programme)
- » transfer of user accounts from ISTA and IS BETA2

### 2024

- » transition of proposals and completed projects
- » completion of the development of all support services for the core business of funding provision
- » launch of the Project Preparation service (BETA3 programme)
- » launch of the Public Tender and Project services (BETA3 programme)

### 2025

- » launch of the first call and tender in the new SISTA system



# Barbora Šmahlíková:

I like that when you prove something mathematically, your result is unquestionable

Author: Šárka Kovářiková

Photo: Jan Prokopius

Even though she feels like every other girl of her age, she is special in some ways. Does the name Barbora Šmahlíková mean nothing to you? Wrong! You should definitely let it stick in your mind, because we will surely hear a lot about this promising young student in the future. This June, she became the first ever recipient of the Government's Gifted Student Award, which is undoubtedly not her only academic achievement.



**Barbora, first I'd like to ask about your studies. You are currently studying Mathematical Methods specialisation at the Faculty of Information Technology of the Brno University of Technology. Why did you choose this specialisation?**

I have enjoyed mathematics since I was in primary school, and I also attended a grammar school with a focus on mathematics. During my bachelor's degree studies I then started research in a field that was very closely related to mathematics. Therefore, the choice of specialisation was very simple and natural for me - I just wanted to continue in what I already had experience in and what I enjoyed.

**What makes this discipline beautiful and unique to you?**

Mathematics is a beautiful discipline because it is all around us. I have always enjoyed thinking about problems, calculating examples or coming up with my own solutions. However, when studying mathematics itself, you often don't directly see what it is useful for. That's why I enjoy the connection between mathematics and computer science - you get to see exactly where different mathematical approaches can be applied. ▶



**In your opinion, does mathematics push the boundaries of what is possible? How does studying or working on research push your personal boundaries and in what ways?**

It is a discipline that, in my view, can and does push the boundaries, of what is possible. I like the fact that when you prove something mathematically, your result is unquestionable. It's not just about some experiments and tests that sometimes work out and sometimes they might not, but you know that what you've arrived at is really always valid. What I personally like about research is that I have the opportunity to come up with something new and in some way push the boundaries on a topic.

**As part of your master's studies, you are dealing with algorithms for Büchi automata and ELA automata. Could you briefly introduce this topic to our readers? What makes this topic interesting?**

A Büchi automaton is a model that we can use, for example, to describe the behaviour of a programme. It is a theoretical model, not a physical machine. One possible use of these automata is the so-called model checking, which is a technique that allows us to formally check whether a particular property holds in a programme, i.e. whether the programme „behaves as it should“. If not, this technique is able to find why the property does not hold and essentially show the programme developers where the error is. Based on this feedback, it can then be corrected. Having bug-free programmes is desirable in just about all cases, but it is especially critical in certain areas, such as healthcare, the aerospace industry, etc., where the slightest error can have fatal consequences.

Where do you want to go after graduation? Will you continue to do research? This is a question I don't know the answer to yet. I enjoy research, but at the same time, I would like to try other opportunities that life will offer

me. For now, I will definitely continue in research within the writing of my thesis, and I have another year to think about what comes next.

**You are the first ever recipient of the Government's Gifted Student Award, how does that feel?**

It's a very nice feeling. For me, the award is proof that I am doing something that is meaningful and that even people outside my field can appreciate. The award ceremony itself was



## Barbora Šmahlíková

is a student of Mathematical Methods at the Faculty of Information Technology, Brno University of Technology. She started her research at the beginning of her bachelor studies and since then she has gained a lot of experience in writing papers and presenting them not only at Czech but also at international conferences. She has won numerous awards for her research, including the Government's Gifted Student Award received this June. When not sitting at the computer, she likes to clear her head with long runs in nature.

definitely an experience of a lifetime for me, and all the interviews and articles about me make me feel special and also reassure me that even a very ordinary girl like me, who always rather wanted to blend in with the crowd, can do great things if she pursues her dreams.

**Together with the award, you also received a monetary gift of 50000 CZK. Do you already know how you will use it?**

I'm not going to do anything special with it now and spend the money right away. It's always good to have something saved up and when I need to buy something more expensive, it will come in handy.

**What advice would you give to aspiring researchers?**

Not to be afraid and to believe in themselves. I didn't believe in myself at all at the beginning and I couldn't imagine that I would be able to invent something new, let alone that I might even win some awards for my research one day. But at the beginning, nobody really expects you to come up with any ground-breaking ideas. It's just about being willing to learn new things and putting in the time.

**The last question is related to this year's theme of the magazine. Do you think science and research have any boundaries? How far can they be pushed? How do you want to push them in your discipline?**

They probably don't have any boundaries. And if there are any, we're a long way from them. But how far we can push them depends, of course, on the specific topic one is working on. I don't have an exact goal that I want to achieve, and I think that often it's impossible to say that in advance. But then you or someone else suddenly come up with something and a small idea can expand into huge dimensions. My goal is simply to contribute any small idea, which, however, can ultimately have a big impact.✖



# Vladimíra Petráková:

I would advise other women  
to prioritize their needs and go for  
what is important to them

Author: Šárka Kovářiková

Photo: Ústav fyzikální chemie J. Heyrovského

Although she never knew her grandfather, perhaps it was from him that she inherited her passion for science. Research work suited her well, also thanks to the flexibility offered by others in the field, and she was able to devote herself equally to science and to her young daughter. Today, she likens working in research to one big adventure comparable to raising children. Both activities are varied, but one is still learning new things and steps out of one's comfort zone almost every day.



**You used to believe that women and science do not go together, because of what happened to your mother, who, as a woman on maternity leave, was unable to continue working as a scientist. What finally changed your mind about becoming a researcher?**

From my family, I got a hard-to-define and describe feeling that doing science is hard, you have to fully commit to it and there is no time for anything else. My grandpa was a scientist, and although I never knew him, I listened to stories describing his gruelling work regime and the absolute support he had from my grandmother. My mother ended up not being a scientist for a combination of reasons, but I sensed that she regretted it and just didn't see it as an option. When a woman does science, she can't have a family.

For me, paradoxically, it was the need to have a flexible job where I could take care of my little daughter that brought me to my PhD studies. There I started to thrive, >



I discovered what science was all about and that I really enjoyed it. I decided I wanted to go on and become a scientist. I had a very supportive supervisor who gave me the opportunity to work on great projects, even though I didn't spend as much time in the lab and worked from home in the evenings. I found that combining family and science was possible and I think it even helped me in my work. I focused mostly on the important things.

**Together with your classmates from Czech Technical University in Prague (CTU), you founded the Czexpats\* in Science organization in 2018, which connects Czech researchers who live abroad or have returned from**

**abroad and want to further apply their experience in research. Do you see some progress in the five years that the organisation has been active among Czech researchers? Are they coming back to the Czech Republic in greater numbers and with new experience that they want to apply in Czech science and research?**

We see an interest in returning and we see an improvement in the opportunities they have to return. We try to contribute by offering them information and community support. At the same time, we try to identify and remove systemic barriers that exist in the Czech scientific environment for „newcomers“. We do not have precise data on the increasing number of returnees. However, our community of „repats“ - scientists who have returned to the Czech Republic - is growing significantly. One of the reasons for this is new calls for proposals, which make it possible to start research on new scientific topics and at the same time do not require significant previous contact with local institutions or knowledge of the environment and an established network of contacts.

At the same time, we see great and untapped potential in scientists who have made it abroad and want to stay there. In the vast majority of cases, they want to cooperate with scientists in the Czech Republic and support science here in some way, whether by cooperating in teaching, on joint projects or by hosting internships.

**You are currently leading an international team at the J. Heyrovský Institute of Physical Chemistry, but you also spent three years in Germany. What differences**

**do you perceive between working abroad and here, whether in working conditions, approach to women in research, or elsewhere?**

It is difficult for me to generalise, and my perception mainly reflects the experience from specific workplaces. In terms of research support and instrumentation, people recruitment and grant support, I think my experience here is similar to what I would have had in Berlin, perhaps better in some ways (for example, in the size of grants or instrumentation at our institute). I also very much appreciate how open my colleagues are to collaborating even across groups or institutes. In Berlin it was more compartmentalized and collaborations did not arise as easily and naturally.

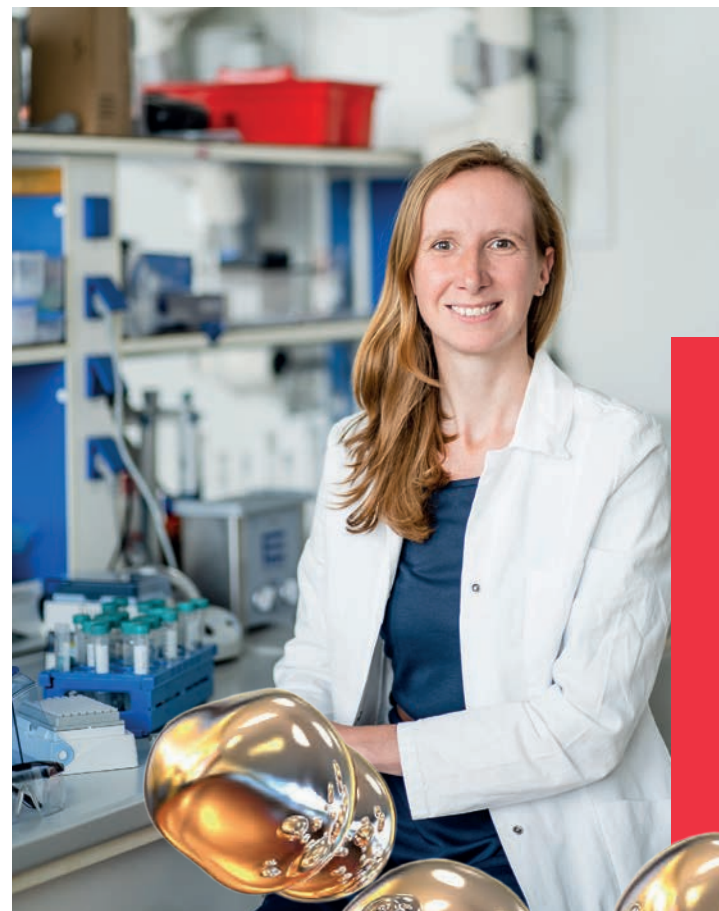
What is vastly different is salary transparency. In Berlin, everyone in a given position took the same salary, there were no extra rewards, personal bonuses or differences between disciplines. One of the consequences was that salaries were not a topic there at all and were simply not debated. Not even among colleagues or the administration

at the university or in management. It save a lot of time that we all could spent on something else.

I also see a significant difference in the position of women, in the way women are treated and supported in terms of combining childcare and work. It seems to me that in our country we have not yet even managed to accept that inequalities exist, that they are not fair and that society as a whole is suffering. When women point out inequalities, they are often labelled as whiny or weak. But even here, I see an effort to do something about it (at least locally) and I understand that it is a very difficult and sensitive topic for many. I was recently on a committee at a university and was struck by how common and accepted sexual innuendo was among colleagues. It brings unrelated topics into the work, and that brings women and students into uncomfortable situations. Moreover, one also thinks about the situation in retrospect and reflects whether one reacted well, should have reacted at all, or how to react next time. This brings additional unnecessary strain.

**Let's stay still on the topic of your career in the Czech Republic and Germany for a moment. What do you think we could learn from our German colleagues and what could they learn from us?**

Again, it's hard to generalize, but I'll try! We could learn from them goal focus and how to plan strategically based on data and how to define gradual steps to achieve a goal. They in turn could learn from us flexibility and a willingness to deal with situations that are not foreseen. And maybe also the ability to not take ourselves so seriously.



## doc. Ing. Vladimíra Petránková, Ph.D.

Vladimíra Petránková is the head of a research group at the Jaroslav Heyrovský Institute of Physical Chemistry of the Czech Academy of Sciences, where she is working on the use of plasmonic nanoparticles in super-resolution microscopy. Prior to that, she worked at the Freie Universität Berlin, where she received scholarship from the Humboldt Foundation and from the Christiane Nüsslein-Volhard-Foundation. She holds a PhD in biomedical engineering from the Czech Technical University in Prague and the Institute of Physics of the Czech Academy of Sciences, where she studied fluorescence from diamond nanoparticles. She is the recipient of several major national and international awards, such as the Lumina quaeruntur Prize awarded by the Czech Academy of Sciences. She is one of the founders of Czexpats in Science, where she has served as chair of the board since its inception.

**You are a Czech expert in nanotechnology. Can you tell us what is your work about?**

We study how light interacts with materials that are very small, smaller than the wavelength of light. With such a small dimension, some materials acquire new properties. We are trying to describe these properties, understand them and develop new tools based on them. In particular, we are studying how the position of the optical signal from molecules that are close to gold and silver nanoparticles changes. At the same time, we are developing and improving tools and methods that will allow us to observe and describe these processes with sufficient precision.

**What makes this field beautiful and unique to you? Do you think nanotechnology is pushing the boundaries of what is possible? How? And how does working in research push your personal boundaries?**

I like how nanotechnology combines disciplines. In the group we need expertise in physics, chemistry, biochemistry or data processing. For me, nanotechnology presents interesting and fresh possibilities for creating new tools.

Working in research is very diverse and I always have to learn and improve myself in something. Be it terms of expertise or perhaps in terms of communication, how to manage people, motivate them, how to present or communicate. It's perennial stepping out of one's comfort zone in many aspects. It's such a big adventure, like having and raising children.

**You've proved to many people that work and family can be combined. Is there anything you wish you had known at the very beginning, before you combined the roles of mother and researcher?**

I've never thought of it that way! I guess I wish I'd known up front that the role of mother doesn't have to define me and that it's perfectly okay to have my own ambitions, desires and dreams, even if at the same time I'm looking after my children, whom I love very much.

**What advice would you give to other women who are or will be concerned by this merging of roles?**

I would advise other women to prioritise their needs and go for what is important to them. They should communicate their needs openly and seek out support networks or mentors. As far as choosing a workplace, look for one that allows flexibility and has an overall good and supportive atmosphere. I think it also helps to throw off perfectionism.✕



# A unique conference connecting the worlds of business and research

Author: **Petra Vrbová**

Photo: **Moravskoslezské inovační centrum, Depositphotos**



**For this autumn, the Moravian-Silesian Innovation Centre (MSIC) is preparing the third annual Business2Science conference in Ostrava, this time under the theme “Marketing Excellence or From the Laboratory to the Market and Back”. The conference aims to promote effective collaboration between research and business, which has long contributed to key cooperation and innovation ecosystem development.**



Supporting research is crucial for business development and the resulting effective collaboration between academia and business brings many opportunities for development and prosperity. The results of collaborative efforts enable the transfer of specialized knowledge, new technologies and important contacts, which contribute to the overall prosperity of the individual entities, the city, the region and society as a whole. Sharing research and market activities is also important for international cooperation.

This year's conference will build on the previous ones and will focus on marketing excellence in higher-order innovations. The main theme will be how best to acquire and use knowledge about the specific needs of people and companies in the marketplace, how to apply it appropriately in targeting research, and in the subsequent commercialisation of its results.

The conference, to be held on 19 October, will feature a varied programme. The first panel discussion will focus on what marketing excellence actually means and how it is approached in a corporation, SME, start-up and university. The second panel discussion will focus on market research and how it is done and how it is important for the successful commercialisation of research results. In addition, two case studies will be presented to show, through a specific example, what poor market research or the complete absence of it will cause. Attention will also be paid to what marketing looks like in start-ups with an intuitive approach vs. marketing within the MRL (Marketing Readiness Level). During the final pitch deck session, representatives from business, university and research organisations will then share the latest results of their work.

*“This conference is for everyone who wants to contribute to the development of the innovation ecosystem. It is also a great opportunity for collaboration and networking. We are happy to welcome any participant who is open to exploring new opportunities for cooperation in the fields of research and business,”* adds Pavel Csank, Chairman of the Board of MSIC, to the invitation. ✖

For more information about the conference and other related B2S activities, please visit





# World Road Congress 2023 address academics, companies and students from abroad

Author: **Pavel Šušák**  
Photo: **Archive WRC, Unsplash**

Prague will host the World Road Congress in autumn. This is an important event for the Czech Republic, where leaders in the field will present the latest trends and technologies in the road transport. "Since 2018, it has been our great ambition to integrate science, research and innovation into the technical programme. New technologies, innovations, unconventional solutions and applied research are moving the whole of society forward, and our sector has no other option than to get involved. Universities and regions, as founders of secondary schools, are very positive about the project and we believe that our cooperation will not end with the last day of the congress," said Václav Neuvirt, Director of the Organizing Committee and member of the PIARC Executive Committee. We asked him a few questions.



**The Czech Republic submitted the largest number of abstracts and full papers of all 125 member countries. This is a great achievement, how did you manage it?**

Our strategy, which our scientific secretary Luděk Bartoš came up with, was to analyse the individual technical topics of the congress, their relevance for the Czech Republic and then to identify potential experts who could cover the selected topics. The expert community itself took the project head-on and this is the result. I must say that this unquestionable success is highly appreciated and very often accentuated at the international plenary. We have been able to build on it with other activities and an increasing number of stakeholders are becoming involved in the project.

The Czech Republic has a great chance to become, through its dominant role in the WRC, a leader in the global road sector, which can only have positive consequences for all participating parties.

**The World Road Congress returns to Prague after 52 years. You also have a strong personal motivation to make the project a success, don't you?**

First of all, I would like to mention that for the Czech Republic it is a great honour and recognition of our activities that in the entire history of the World Road Association PIARC, our country is only the fourth one to host the World Road Congress for the second time. I am one of the few living participants of the 1971 WRC in Prague. Interestingly, my father, Jiří Neuvirt, helped organize the Congress at that time. Therefore, my strong motivation is to make sure that the Czech Republic leaves an indelible mark in the history of PIARC and becomes the leader of the world road industry next years.

**Who is leading the project in the Czech Republic and with whom are you cooperating?**

The congress is a "child" of a partnership between the Czech Road Society and the Ministry of Transport. However, we would never have been able to make this project happen without our partners, which are, among others, the Road and Motorway Directorate, the State Fund for Transport Infrastructure, the Confederation of Transport and Industry and CzechInvest. Special thanks go to our colleagues from the Road Construction Association who support us in motivating the Czech road industry to actively participate in the congress. Without the Czech firms we could not exist as a professional organisation.

This requires us to take the three mentioned steps:

- » active technical participation
- » large participation of Czech experts at the congress
- » broad and significant involvement of our industry in the Czech-Slovak pavilion and accompanying exhibition.

**We will see you at the Prague Congress Centre in October, is there anything you would like to say to potential delegates?**

Let's use this unique opportunity, which will not be repeated, to develop our beautiful industry.✖

[WWW.WRC2023PRAGUE.ORG](http://WWW.WRC2023PRAGUE.ORG)

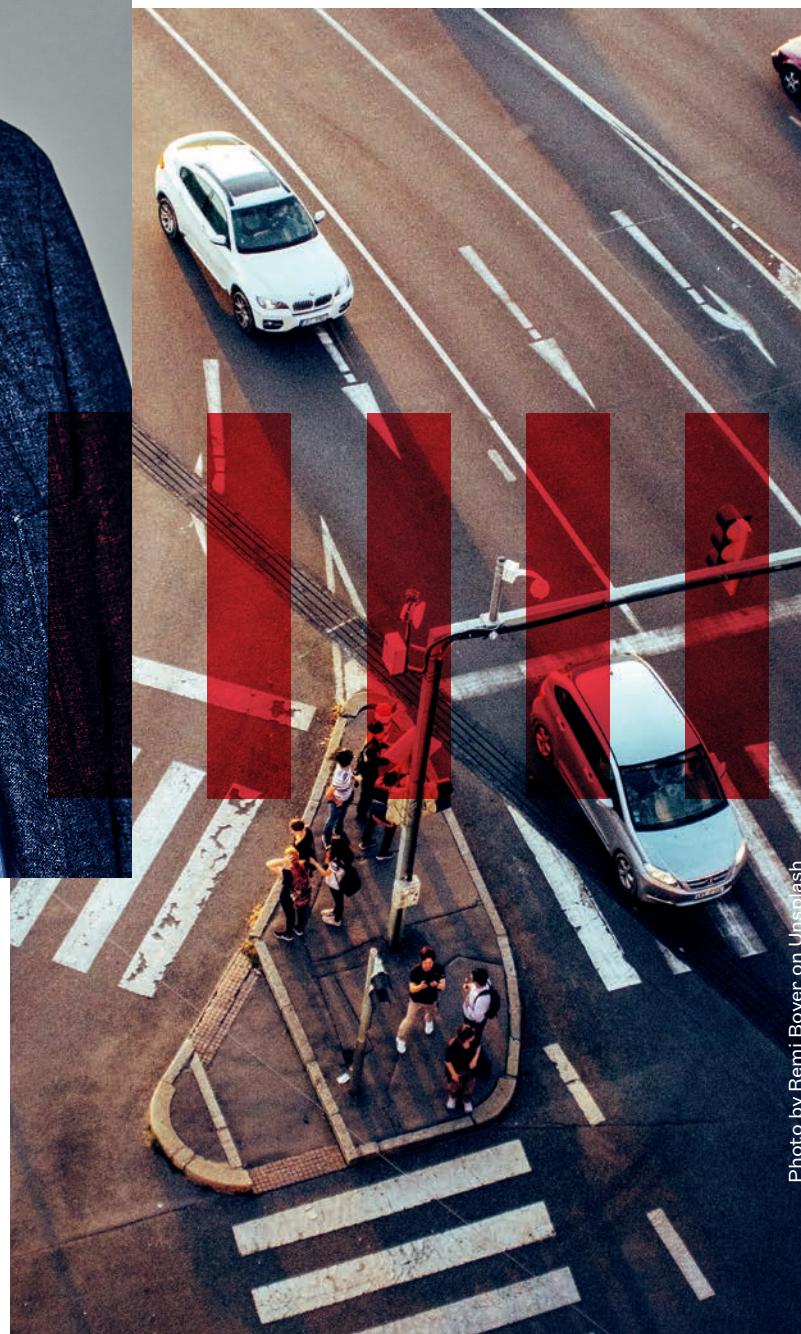


Photo by Remi Boyer on Unsplash



# How to move Czech education towards the trends of the 21st century?

Author: **Kateřina Bártová**

Photo: **Archiv Nadace ČS, Depositphotos**

## We asked Dana Brandenburg of the Česká spořitelna Foundation

The school develops the potential of all children, teaches them to build on their strengths, leads them to collaborate, and fosters a growth mindset, resilience and a lifelong learning attitude. This is the kind of education the Česká spořitelna Foundation wants for the young generation. Dana Brandenburg, the chairwoman of its Managing Board, told us how its philanthropy is helping to achieve this and what new plans it has in store.

### So what should a normal Czech school look like in 10 years?

We will never find a model suitable for everyone. Schools should be safe environments where children feel comfortable and understand what they are learning and why. If education is meaningful, it is easier to build a positive relationship with lifelong learning. Children should be actively involved, learning should develop their competences. The emphasis should be on practical application of the gained knowledge and skills and on linking the content of the curriculum to real life. It would be ideal if we could bet-

ter connect schools to the needs of employers and the changing labour market and get more experts from practice involved in teaching (this is, by the way, what our foundation's Day for School programme is trying to do). There should be no lack of space for personalisation of learning, because everyone learns differently and needs different support.

### And how exactly does the Foundation contribute to this ideal state?

The Foundation has a long history of supporting organisations that bring much-needed innovation to education



and have the potential and ambition to spread it. These include modern teaching methods (e.g. Starting Together for Kindergartens and Primary Schools), training programmes for teachers and principals supporting pedagogical work in schools (e.g. Teacher Live and Principal Live), regional cooperation projects (e.g. Educhange) or initiatives that change the education of future teachers (e.g. Open).

All the projects we support strive to make sure that schools provide the best possible conditions to develop competences. We see such ventures as an investment in education and the future prosperity of society as a whole. We function as an incubator for promising new projects, in which we invest in a pilot phase, or conversely as a multiplier for established programmes, which we help to spread to as many schools as possible. Since 2019, we have already invested nearly CZK 500 million in Czech education, and we are continuing to do so.

#### Do you rely on any relevant data when setting your goals?

We build our philanthropic operations on data. We support the creation of studies and analyses that we share with other actors in education. In 2020, this was the study "Inequalities in education as a source of inefficiency". It revealed a significantly higher educational failure rate for children from poorer backgrounds compared to other countries and started a debate on equal opportunities in education. Last year, we published a study 'Financial health in the course of lifetime and what influences it', which helped us to identify the main factors affecting financial health and to set out our approach to supporting financial education for young people. We are also increasingly focusing on measuring the impact of the activities we support. Still, this year we will publish a detailed map of our support in Czech schools.

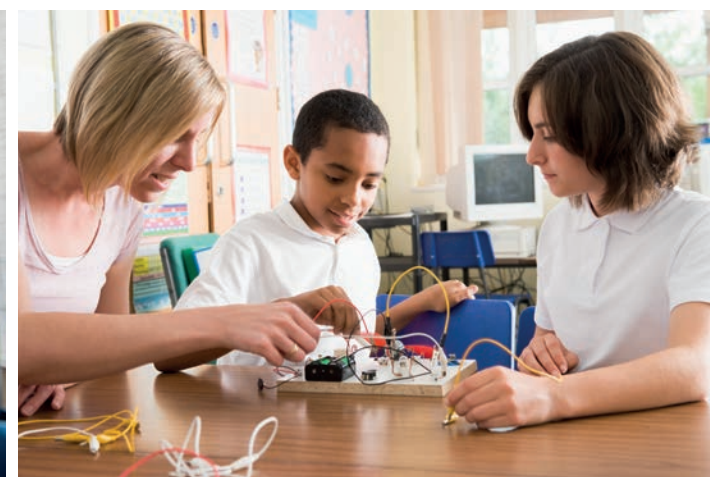
#### What does being financially healthy mean to you at the Foundation?

Financial health is similar to learning. We believe that it is necessary to start building good financial habits as early as possible. We are convinced that it is possible to develop competencies from childhood that will positively influence financial behaviour in adulthood. Financially healthy persons manage their finances properly, know what they can afford now and what expenses they can postpone. They do not act impulsively, but deliberately. They think about their future, build up a reserve for unexpected expenses, and have a long-term financial plan that allows them to pursue their dreams. We want to motivate the younger generation to take an interest in finance and not be afraid to talk about it, whether at home, at school or with friends.

#### You have made a commitment to make quality financial education available to all children in the Czech Republic by 2025. How far are you?

We are preparing our own financial education programme for children, their parents and teachers. We want to offer children an attractive programme that they can use also in their free time. We are preparing a comprehensive financial education methodology for teachers and preparing courses for them so they can feel stronger in finance themselves. We want to focus especially on schools with socially disadvantaged pupils.

The year of 2025 is the first milestone on the road to quality financial education. The topic is so urgent that it requires a rapid response. But getting quality financial education to all children so that it really permeates the curriculum in their schools will require long-term work, and that does not end in 2025, but rather begins.✖



#### Dana Brandenburg

She joined the Česká spořitelna Foundation in 2021 and soon became chairwoman of its Managing Board. Prior to that, she was Director of the Czech National Agency for International Education and Research for five years. In her previous engagement, she worked as Senior Project Manager in CHE Consult consultancy in Berlin. Since 2017, she has held the position of Vice President of the European Academic Cooperation Association and was a member of the Board of the Fulbright Commission in the Czech Republic. She graduated from the Faculty of International Relations at the Prague University of Economics and Business.

#### The Česká spořitelna Foundation

provides targeted support to projects and approaches that advance our education system and motivate students to develop the knowledge, skills and attitudes needed for an active personal and professional life in the 21st century. The main mission of the ČS Foundation is to develop children and young people and to motivate teachers and school leaders to develop competency-based learning. At the core of the Foundation's activities is the creation and dissemination of innovative educational methods and tools and the strengthening of the network of key actors in the field of education.





# Bizarre innovations and inventions of our time - we can't stop progress

Author: Šárka Kovářiková

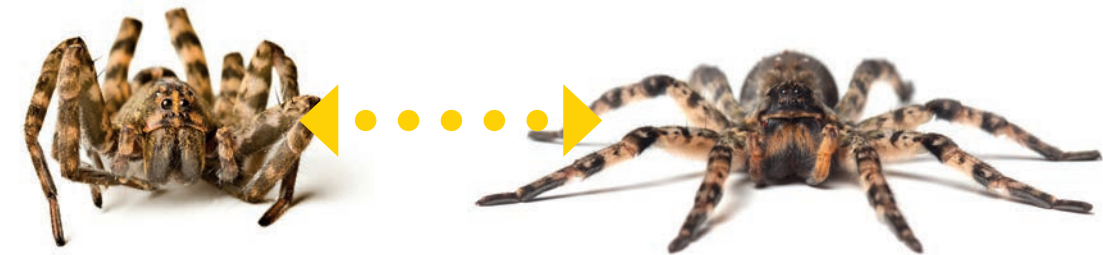
Photo: Unsplash, Depositphotos

Whether we want to or not, we cannot stop the progress of modern technology. Without even realising it, innovation intrudes into our lives every day, every hour and I would say every minute. Last night, I sat down in front of the TV and turned on Black Mirror series, where in the first episode of the latest season, the main character - an ordinary woman - became the heroine of a show that streamed her real life with only a few hours delay because she hadn't carefully read the terms and conditions when she bought a subscription to her favourite show. Now imagine if that happened to you. Scary, right? But before we can actually watch a series about us, our boss or the neighbour, let's take a look at what bizarre technologies and innovations are actually being created.

Photo by Shubham Dhage on Unsplash

## Necrobots or let's bring the dead to life

We don't have to go very far from the Black Mirror series. Necrobotics is an emerging scientific discipline that uses dead creatures to perform (for now) mechanical tasks. Researchers at Rice University in Houston have come up with the first step towards this area of research. Mechanical engineers inserted a needle into the body of a dead spider and, using compressed air, were able to create the coiling and unfolding motion of mechanically functioning



legs. This is because spiders, unlike humans and other mammals that move their limbs by synchronizing opposing muscles, use hydraulics. The experiment was carried out on wolf spiders. According to the experiments, the spider could lift up to 130% of its body weight and sometimes more. At the moment, the development process is still in its early stages. But researchers already know that smaller spiders can carry much heavier loads compared to their size. That's why they are likely to focus on testing with smaller spiders than wolf spiders in the future.



Photo by JC Gellidon on Unsplash

## Would you like a pig's heart?

Recently, the interest in xenotransplantation has increased significantly. What should we imagine under this complicated name? It is a so-called surgical revolution intended for people with non-functioning tissues or organs, which are replaced with a matching organ or tissue from an individual of another species. Paradoxically, pig is the closest to a human being, and so it is from pigs that organs are transplanted. Pig heart transplants have even been performed twice. But the fact that the operation ultimately ended in the death of one patient suggests that we are still in the early stages of development. Overcoming our body's immunity is very difficult, even with the latest biotechnologies.➤



## Let's print out what we feel like eating

Food created by 3D printing was first introduced by the Lipson lab back in 2005, but the technology was limited to a small number of uncooked foods. Which does not sound very appealing to us as consumers. So a team of experts from Columbia University in New York dove headfirst into preparation of meals. For dessert lovers, they have created a cheesecake made from edible ink that has been baked using a laser. The cake contained banana, jam, peanut butter and Nutella.

Researchers are optimistic about the future of laser cooking and 3D food printing. They could help chefs to enhance flavours, using minimal amounts of ingredients or flavourings. This could lead to new experiences in gastronomy. The technology could one day be at such a level that each person would have an individually assembled 3D meal package. A senior citizen would get a diet meal and a top athlete would get a meal fine-tuned for peak performance. The technology could also be useful for the rest of us who do not want to spend our free time in the kitchen but use it in other ways.

## Avatar

## not only on cinema screens

Imagine if we had an identical twin that could save our lives in the event of a serious illness. Experts from the American start-up Q Bio are working on this almost utopian idea and are able to create our "digital twin" through the Q Bio Gemini technology. The technology is unique in that it is the first in the world to be able to capture and monitor the comprehensive health status of patients in a scalable virtual model. The digital twin automatically reflects the most accurate physiological state of an individual and highlights the most significant changes in a person's physiology through a comprehensive summary that can be securely shared with doctors and specialists around the world.

And how is such a digital twin created? To create it, experts use a special scanner that examines a person's body in such depth that it can create a 3D model using a health-tracking computer. The scanner could also help identify structural changes inside the body and then link them to genetic risks, for example. According to their vision, we would walk into a place that would resemble something like a "body wash". The devices would quickly measure us, and the data would be used to update our digital twin stored in the cloud. So it's not a question of if, but when this technology becomes a reality.

## Last farewell in a mushroom suit

Science is also thinking of eco-friendly solutions for the final farewell to the deceased. This could be a mushroom burial gown instead of the traditional shroud. Because the fungal gown completely engulfs the human body, there will be no contamination of the surrounding plants that are planted in the soil. *"The Center for Disease Control in the U.S. confirms that we have 219 toxic pollutants in our bodies, and that includes preservatives, pesticides, and heavy metals like mercury and lead,"* artist Jae Rhim Lee informed a TEDx conference. Lee is the author of a project called Infinite Burial, which brings together science, culture and art. Mushrooms, she claims, are involved in the decomposition and disposal of poisons in the body of the deceased. Concluding her speech, Lee remarked, *"You are dust and to dust you shall return. Once we understand that we are connected to nature, we will see that the survival of our species depends on the survival of the planet. I believe this is the beginning of a real responsibility to nature."*

## Human sweat as battery power

Imagine if we went out for a workout and in the meantime the batteries in the smartwatch on our wrist were recharged. It may sound like science fiction, but it could soon be reality. Researchers at the University of Glasgow have developed a new type of flexible supercapacitor that replaces the electrolytes found in conventional batteries with sweat. What's more, it would only take 20 micro-litres of liquid to fully charge it. It is therefore only a matter of time before a new generation of wearable devices could be powered by human sweat instead of conventional, environmentally unfriendly batteries.

## We won't be needing Harry Potter anymore

A group of engineers at Iowa State University have invented a flexible, stretchable material that can hide objects even from radar detectors. The material could help the military make so-called stealth aircraft (*editor's note: combat aircraft designed to minimise detection by enemy assets*) more difficult to find. The researchers also report that the material will be able to absorb up to 75% of light in certain radar frequency bands. One day, the material could make objects completely invisible. It seems that researchers are slowly moving closer to making our dreams of an invisibility cloak from Hogwarts a reality. ✕



# Sustainable packaging

## Hand in hand towards a better green tomorrow

Author: **Šárka Kovářiková**

Photo: **RNDr. Mgr. Tomáš Vaněk, CSc z Ústavu experimentální botaniky AV ČR, v. v. i., Univerzita Tomáše Bati ve Zlíně, Unsplash**

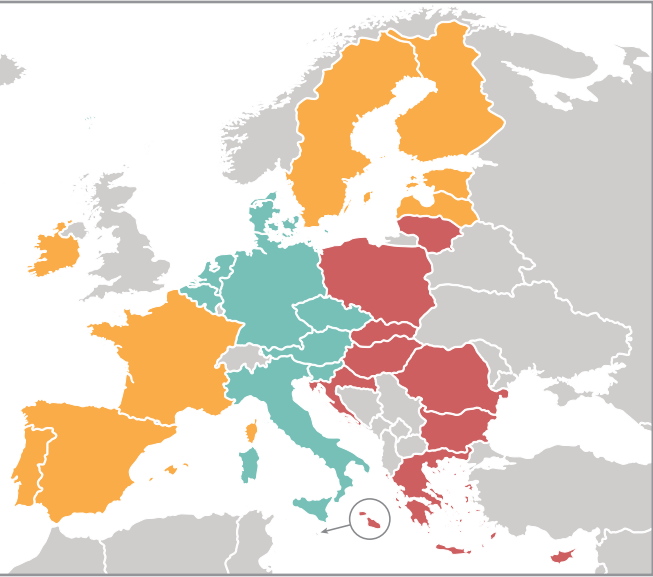
Would you say that it has been twenty-six years since the Czech Republic started to introduce waste sorting in a systematic way? In that time, recycling and environmental thinking in general have come a long way. To give you an idea - in the past, if people were willing to sort their waste, they had to walk twice the distance to the bin than they do today. It's probably clear that this did not make recycling more popular. Nevertheless, the Czechs have found their way to sorting. Nowadays, companies are trying to come up with ever more environmentally friendly packaging that does not burden the environment as much. In our country, applied research is being carried out, for example, by a biotechnology team from the South Moravia or Mendel University in Brno, but also by a number of other companies and institutions. So how is it with sustainable packaging?





Packaging waste and what does the EU say?

In June 2023, the European Commission issued a report informing about the possible failure of some EU Member States to meet their municipal waste targets. Based on evidence from a survey by the European Environment Agency, most are at risk of failing to meet the targets that have been set for 2025. This specifically concerns the area of preparing municipal waste for re-use and recycling of municipal waste. A total of nine countries are well on track to meet the targets, including not only the Czech Republic, but also Austria, Germany and Belgium. Europeans generated an average of 521 kg of municipal waste per person in 2020, of which 49% were prepared for reuse or recycling and 23% were landfilled. Eighteen Member States at risk of failing to meet the targets will have to adopt certain recommendations as soon as possible. These recommendations include a wide range of measures - reducing non-recyclable waste, increasing reuse, strengthening waste sorting, raising awareness of sorting and more. If the national authorities of the eighteen Member States react quickly to the European Commission's measures, they can greatly accelerate the improvement in recycling results.



- Member states not at risk for both targets
- Member states at risk for the municipal waste preparing for re-use and recycling target but at risk for the all packaging waste recycling target
- Member states at risk for both targets
- Outside coverage

Source: European Commission



Source: myco s.r.o.

Would you like a mushroom packaging from the South Moravia

How to replace disposable packaging with nature? The biotechnology team from the start-up Myco has found the answer. Their mushroom packaging idea scored big also in the Energy Globe World Award 2022, where they were among the fifteen best eco-friendly ideas out of one hundred and eighty. Their innovative packaging is made from mushroom mycelium and waste from the agricultural and wood processing industries. The choice of raw material, the way it is processed, and the diversity of the production process help to create materials with different properties. This material has one unifying parameter - biodegradability. This is a process that in nature (i.e. in moisture, with the help of bacteria) can break down the material very quickly (in about forty-five days). In an indoor environment, however, the material remains unchanged for years. Moreover, the mycelium serves as a good substitute for polystyrene foam - it has the same structure and can be moulded. Myco and its entire team are not resting on their laurels and are continuing to develop. They are now working with the Chemistry Faculty at Brno University of Technology, specifically on strength and appearance. In time, the company also sees the possibility of using the material to produce hard boards that could be used to replace particle board. The production of thermal and acoustic insulation is also being considered, given the porosity of the material, which is also more resistant to fire, does not melt at higher temperatures and does not produce toxic fumes when it burns.



Bon Appetit. Packaging ending up with food in the stomach

A research team from the Faculty of AgriSciences at Mendel University in Brno has been researching edible packaging that could be eaten with food. They are currently working on edible packaging made of protein that looks like kitchen foil. But this is not the only option. The packaging could also be liquid or in spray, and the researchers say the food would be dipped into it. The advantage of edible packaging is both the low-cost production from a small number of food items and the reduction in waste that would be produced from conventional packaging. "Edible packaging is one way to reduce the large amount of synthetic plastics that take up to decades to decompose in nature. Moreover, it can be used to reduce the overall waste produced. This is because we can also use waste materials from other technologies to produce edible packaging," said researcher Soňa Hermanová from the Institute of Food Technology at FA MENDEL. The next chapter in the research will be the incorporation of active ingredients that should increase the nutritional value as well as the functionality of the packaging.➤



### Willingness to pay extra for a recyclable beer can

Although awareness of environmental sustainability has been growing in recent years, Czechs are still not willing to pay extra for recyclable packaging. This information comes from an experiment conducted by the Ipsos agency online in March 2023 with a sample of seven hundred and three respondents. The experiment involved simulating a shop shelf where a few traditional beer brands were presented in a sustainable can. During the experiment, each respondent was exposed to several purchasing situations where they were offered different beer brands at different price levels. Some beer cans were labelled as new eco-friendly packaging. In another case, the retailer alerted the potential customer in the form of a banner on the e-shop with information about POS materials (editor's note: point of sale materials are typically examples of point-of-sale marketing, such as cardboard stands, shelf leaflets, stickers, etc.) due to the possibility that the label could be overlooked.

The research confirmed Ipsos agency's hypothesis that recyclable packaging increases brand appeal and purchase. A banner with an environmental message helps but does not necessarily need to be next to the product. The research also shows that it is important for customers that a product in new packaging is sold at the same price as in non-recyclable packaging. Thus, either the same cost must be incurred in the production of the packaging or the difference in price must be 'paid' by the manufacturer.



Recyclable packaging - a can made of used cans

## Examples of projects funded by TA CR that focus on sustainable packaging solutions

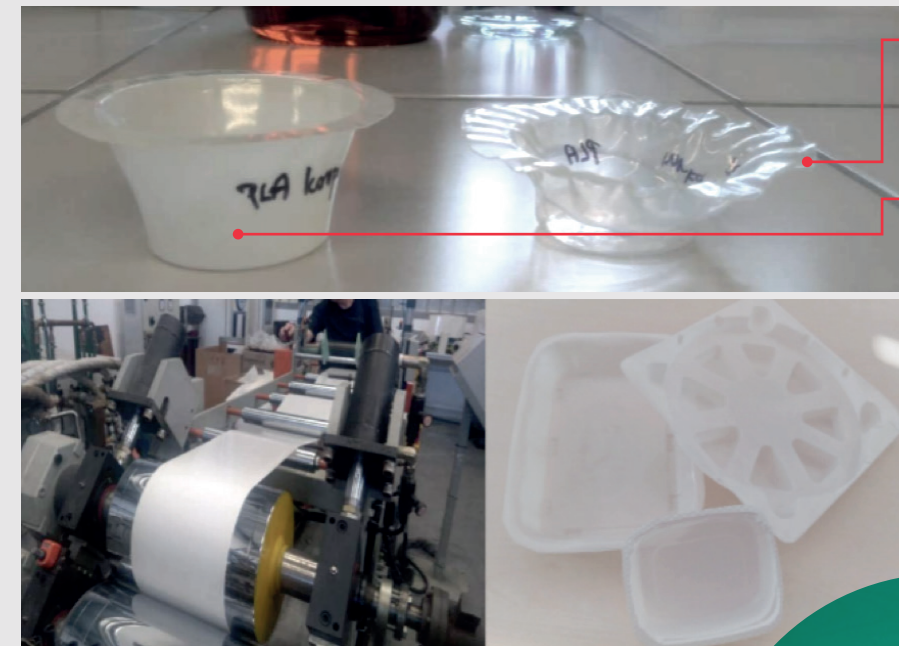
### Environmentally friendly packaging for food application

Researchers: **Tomas Bata University in Zlín / University Institute, BLATINIE, a. s.**  
Programme: **EPSILON**

Creating packaging from biodegradable plastics is a trend that makes it possible to reduce the environmental burden. The most common bioplastic in 2021 was thermoplastic polyester derived from lactic acid. The research project dealt specifically with the modification of this material with the aim of improving its useful material and mechanical properties while maintaining biodegradability, and at the same time creating conditions for the optimisation of processing parameters in real production leading to an increase in the efficiency and reliability of the production process. The benefits include not only the improvement of the economic parameters of this production, but above all the reduction of the amount of non-biodegradable municipal waste by 50 t/year with an increasing tendency depending on sales.



The findings are valid across the brands that were tested. It should be noted that for some beers price played a smaller role, while for others a greater one. Sustainability benefits may work differently for different alcohol brands and this is something to keep in mind. It is also important to consider the segments of people who buy a particular brand. Customers are aware of the topic of sustainability, but oftentimes their own convenience prevails over action. This may be also due to the family's difficult economic situation, which does not allow the purchase of recyclable packaging. ✖



PLA composite, tested sample (temperature 100 °C)

PLA bowl without modification, available on the market, tested sample (temperature 100 °C)

Preparation of tempered bio-bowls with enhanced shape stability at elevated temperature

Source: Tomas Bata University in Zlín

### Biodegradable polymers and their decomposition in composts

Researchers: **EKO-KOM, a. s., Institute of Experimental Botany of the Czech Academy of Sciences and the Crop Research Institute**  
Programme: **ALFA**

Interesting experimental research by Czech experts has proved that it is not true that all so-called biodegradable plastic packaging decomposes and disappears in a short time in nature. Consumers are misled by the many different labels on the packaging indicating biodegradability. If the market share of bioplastics is to grow, consumers need to be educated intensively about the meaning of the various 'bio-labels'. They also need to know how and where they can dispose of bioplastics within the municipal waste sorting system, taking into account the most appropriate treatment technologies in their locality. The results of the research in an experimental composting plant show that bioplastics do not decompose in conventional composts, or rather they decompose with difficulty and for a significantly longer period of time than declared by plastic producers. Bioplastics also degrade the quality of the compost. Only plastics based on polylactic acid (PLA), or starch, break down. Research has also shown that most types of commercially available bags for collecting compostable bio-waste made from bioplastics cannot be recommended for practical use. Some types of biodegradable plastics decompose easily in biogas plants, but these are rather sporadically used for the treatment of municipal bio-waste.

The researchers' experiments in modified bioreactors also established the boundary conditions at which bioplastics actually degrade. The applicability of biodegradable plastics is evident in some manufacturing sectors, possibly in agriculture in areas with significantly higher humidity and higher constant ambient temperature. Research on bioplastics and their properties is being carried out by a number of scientific teams in European countries. However, research in the Czech Republic has been unique in its scope and comprehensiveness of evaluation of bioplastics.



Setting up of a biocompost

Source: RNDr. Mgr. Tomáš Vaněk, CSc z Ústavu experimentální botaniky AV ČR, v. v. i.



# New technologies advance so much that sci-fi is no longer the sci-fi it used to be

Author: **Leoš Kopecký**

Photo: **Unsplash, Wikimedia, Depositphotos**

**The English writer Mary Wollstonecraft Shelley is considered the mother of the literary genre of science fiction. Her ground-breaking works include Frankenstein - a novel about a mad scientist and an artificial man (1818), and then The Last Man - the first apocalyptic novel (1826). Of course, we can only go on to list a number of authors of this genre, such as Edgar Allan Poe, Jules Verne, Isaac Asimov, Ray Bradbury, Arthur C. Clarke, Philip K. Dick, Robert A. Heinlein and others.**

Personally, I confess to feeling very lucky because I am “timed” in such a way that my life straddles that rare period when many science fiction ideas were realized and turned into workable progressive technologies. For example: I was born in 1958 and the first functional laser dates back to 1960. When I was a kid, I read a science fiction book by Alexei Tolstoy called The Rays of Engineer Garin, which talked about light rays passing through matter. Time has torn the curtain, and in 2018, I was already working for the world-famous HiLASE laser centre in Dolní Břežany. Or I remember a science fiction story in which there was a video phone, which is now a common thing, even wireless. It was great science fiction back then. So is anything possible today? Certainly not, but shouldn't I have rather said not YET? How far will new technologies go? That's getting harder and harder to predict. It might be instructive to look at a few innovations inspired or predicted

by science fiction authors in the past, and then think about what's next.

The science fiction genre has predicted credit cards, television, Moon landing, bionic limbs, military tanks, antidepressants and submarines. Even the concept of the internet has its origins in a book published almost 40 years ago, Neuromancer by William Gibson, who coined the term “cyberspace” and defined it as a “consensual hallucination”. The novel Neuromancer was first published in 1984. It has won several prestigious awards and is often referred to as the bible of cyberpunk. You will encounter there concepts such as virtual reality, artificial intelligence, genetic engineering, cloning and the aforementioned cyberspace. The first Czech translation was made by our sci-fi author Ondřej Neff in 1992.

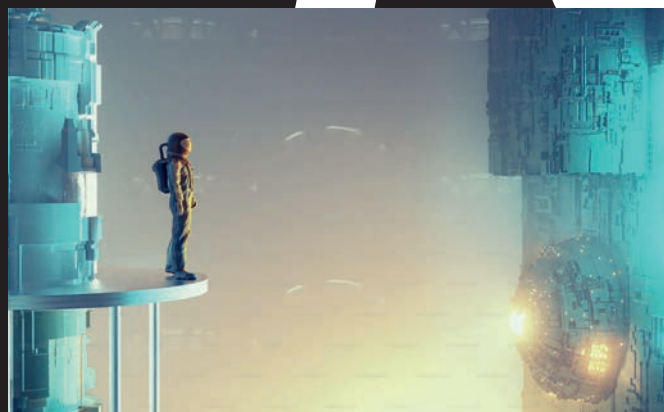
Some sci-fi predictions are chillingly accurate. See, for instance, the villainous computer HAL 9000 in Stanley Kubrick's 2001: A Space



Heinz Schulz-Neudamm. Distributed by UFA. Wikimedia Commons



Photo by Surface on Unsplash



# FUTURE

Odyssey, which still functions years later as a warning of the malign potential of artificial intelligence.

Many other predictions can be found pointing to the potential of technology to enrich and improve our lives. From the hologram table in George Lucas' Star Wars (1977) to video chat and flying cars in the 1960s TV series The Jetsons.

## Mobile phone from Star Trek

Next, let's not forget mobile phones. In the Star Trek TV series in 1966, a flip phone appeared as a communicator. Thirty years later, Motorola launched the first flip phone, which it called the StarTAC in keeping with the series. Interestingly, the makers of Star Trek also gave crew members a tricorder, a handheld device that collected and stored data from the planets Captain Kirk and his crew visited. If the creators had thought about combining the two, they might have foreshadowed a smartphone.

## Food printed on a 3D printer

3D printing of food is another example. The family in the animated series The Jetsons had a household food machine that produced complete meals. Star Trek had a replicator that could print food seemingly out of air in mere seconds. Now Columbia University has created a 3D printing technology that can produce whole cooked meals from prepared ingredients rather than molecules - although this technology is also in development, as is a perfect chocolate printer.

## Virtual reality

Perhaps the earliest credit for presenting VR including goggles goes to Stanley G. Weinbaum's 1935 story Pygmalion's Spectacles. Steven Lisberger's 1982 film Tron also represents an entry into the digital world, and Neal Stephenson's 1992 novel Snow Crash describes VR in the way it is implemented today: 'Using electronic mirrors inside a computer, this beam moves back and forth across the lenses of Hiro's glasses (the protagonist and hacker) in much the same way that an electron beam in a television rasterizes the inner surface of the screen. The resulting image is in the space in front of his view of reality, so Hiro isn't really there at all. He's in a computer-generated universe that draws on his glasses and pumps sound into his headphones.

Today's VR looks exactly as these authors envisioned it, offering an escape into alternate worlds through goggles that provide immersive 3D video and sound. Haptic gloves allow us to experience touch in our alternate universe, and researchers are working to bring tastes and smells into the experience as well.

## Video calls were predicted as early as 1911

Zoom, Google Meet, Facetime, WeChat. Today, callers spend 340 million minutes a day on WhatsApp alone. It

may have been technically impossible not so long ago, but it was predicted as early as 1911 by Luxembourg-American writer Hugo Gernsback in his novel Ralph 124C 41+: Romance of the Year 2660. And just for the record, microfilm, the vending machine, the jukebox, satellites, space flights, the tape recorder, artificial fabric, television, remote power transmission, and more can also be found there. Also, the 1927 German film Metropolis featured a wall-mounted videophone.

Ray Bradbury's 1953 novel, Fahrenheit 451, again features something strikingly similar to today's wireless headphones - shells and thimbles tucked into people's ears producing an electronic ocean of sound, music and conversation.

## The future of motoring

Flying and autonomous cars are also a very popular topic. In 1964, Isaac Asimov predicted in The New York Times that cars with "robotic brains" would be the centrepiece of the 2014 World's Fair. Asimov wrote at the time: "Much effort will be devoted to designing vehicles with robotic brains - vehicles that can be set up for specific destinations and that will then move there without being influenced by the slow reflexes of a human driver." Add to that the image of Agent 007 sitting in the back seat of his BMW, controlling the car with his phone in the 1997 film Tomorrow Never Dies, and it's clear that the future is here.

From the perspective of these actually recent science fiction stories, that particular future is already now. And what will be tomorrow? A super-future? No, it's going to be a normal future, we're just going to see faster changes. The next evolution will always be faster than the last, won't it? That's more of a philosophical question than a technological one. There will undoubtedly be modifications or extensions of the capabilities of human body, human-computer interactions, human-robot interactions, artificial intelligence, and so on, but that's not contemporary science fiction. That is more or less what we can expect to happen. That's evolution.

Does that mean that contemporary science fiction doesn't exist? For example, Spider-Man: Across the Spider-Verse, Guardians of the Galaxy Vol. 3, The Flash, Transformers: Rise of the Beasts, and Ant-Man and the Wasp: Quantumania are all being touted as top films in 2023. Is there really anything in those films that is as groundbreaking and revolutionary as the videophone was back when television wasn't widespread? So what is science fiction today? An invisibility cloak like Harry Potter wears, travel to another galaxy, or teleportation? I don't know. ✖

Sources: The article was compiled from several foreign sources, especially Micron company's content and without the use of artificial intelligence.



# Václav Moravec:

## The recent uproar over ChatGPT shows our unpreparedness for the advent of artificial intelligence

Author: **Leoš Kopecký**

Photo: **František Géla, FSV UK., Unsplash**

**Artificial intelligence and neural networks are mainly applied in routine processes. It is nevertheless good to look for answers to questions also in areas that require creativity, originality and ethics. The use of AI brings a lot of new things, and therefore we need to respond from an expert perspective to its development - what will be its role in journalism, how will copyright be dealt with, and should the development of these tools be more regulated or, on the contrary, should the public be educated to be able to use them properly?**

**You recently published sociological research called “In the shadow of ChatGPT: artificial intelligence in everyday life and in journalism through the eyes of the Czech population.” The study, which is part of an ongoing TA CR funded project, shows, among other things, that more than half of the Czech population thinks that technologies have both positive and negative impacts on our society. Men are more likely to have a positive view of technologies, as are young people under 34. On the other hand, the most sceptical group are people aged 35 to 54. Yet over 40% of the domestic population encounters AI in their normal lives at least once a day. How would you actually answer the study’s questions?**

The results of our research also show how large the techno-optimist and techno-pessimist groups are, as both are similar in percentage terms, between one tenth and one fifth of the adult population. For my part, I would opt for the Aristotelian middle way. And I admit that I sometimes tend to lean towards the pessimists when we don’t exploit the adaptive potential of AI input, and this applies to the interdisciplinary interlinking of the scientific sphere as well. Yet managing the challenge of artificial intelligence cannot be done without it. And in this respect, I am grateful for programmes supporting applied research such as ÉTA or SIGMA, which draw the social sciences into the technological world. As the discussion around ChatGPT, for example, demonstrates, the impact of AI on society

Photo by Resource Database on Unsplash



will be profound. Personally, I am struck by the degree of surprise in many disciplines, including journalism, at the profound transformation that the advent of generative AI will lead to. It demonstrates how little has been known about this issue, how we underestimate the broader education in the AI field. On the other hand, for experts who have been working on large-scale language models for several years, this was certainly not a surprise. If we can't manage not only the discussion, but, more importantly, society's adaptation to various forms of AI, then I'll count myself among the techno-pessimists. As a society, we have one of the last chances to not be reactive but proactive when it comes to AI.

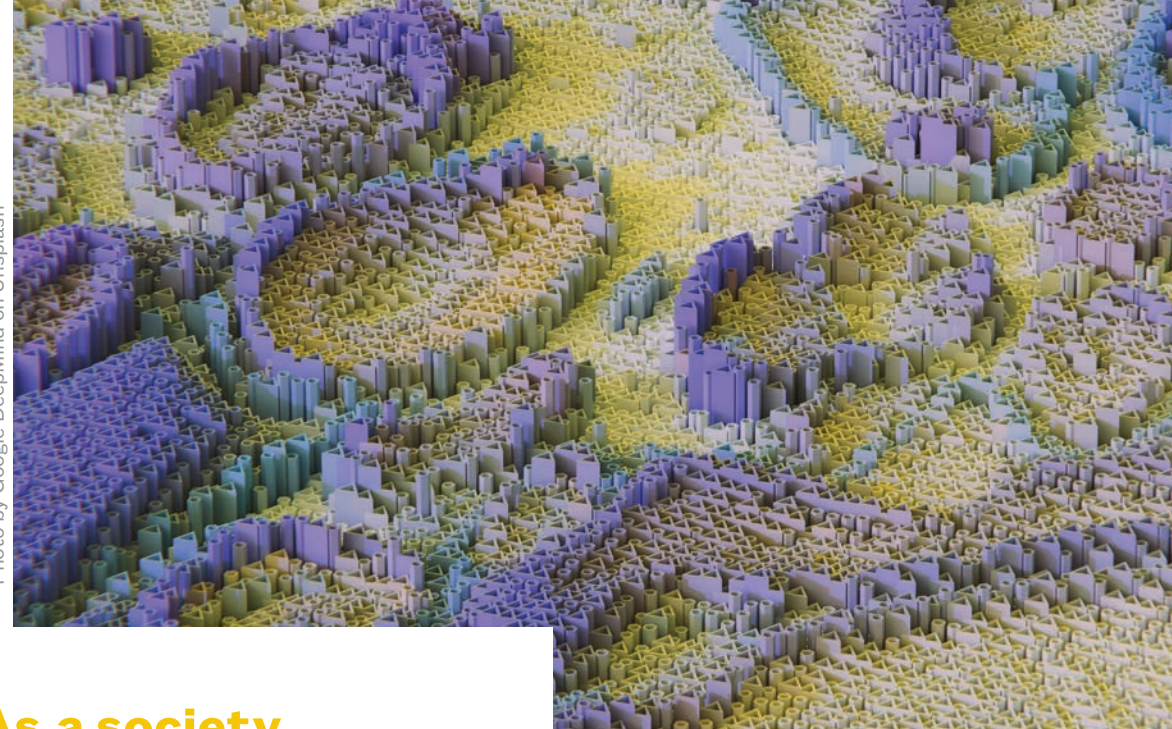
**This is quite a fundamental question, and it concerns the media and its influence in general. I remember that sometime in the middle of the last century the question was debated whether the media should be regulated so that they did not create and disseminate objectionable content, or whether society should be educated so that it could reveal objectionable content and not consume it. The decision was made to educate, and after some seventy years it is clear that the outcome is wrong. And what about when artificial intelligence enters the media stage?**

I think the application of AI in media is a multidimensional phenomenon, and so multidimensional solutions are needed.

Big language models are learned from the texts of journalists to which copyright is applied in the analogue world. Or take the example of photographs. Czech News Agency is grappling with what to do with its Profimedia database, which contains illustrative photos, when generative AI applications offer editorial offices and journalists illustrative images for free or at a fraction of the cost of the aforementioned database. For underfunded journalism, the learning of generative AI while not respecting copyright, or by ripping content from the web, is another blow. The superficiality of the society-wide discussion about the level of regulation before the advent of ChatGPT was incomprehensible, even though it was obvious what was to come. As early as sometime in 2016, it began to transpire in the US or the UK what AI would bring to journalism.

One of the aspects that the advanced use of AI brings is a new perspective on education, even in primary and secondary schools. In my view, it is clear that with the advent of AI, we cannot insist on a rigid dividing line between the humanities or social sciences and the technical disciplines. The emergence of hybrid interdisciplinary intersections is essential. We cannot say in primary school that someone is 'stupid at maths', but by popularising AI we can bring children to maths and statistics. The aforementioned popularisation allows us to understand, for example, the biases in the datasets from which neural networks learn.

Photo by Google DeepMind on Unsplash



**As a society, we have one of the last chances to not be reactive but proactive when it comes to AI.**



Photo by Ave Calvar on Unsplash



Photo by Rob Curran on Unsplash

Again, I will illustrate this with an example: if judges are to work with AI to write judgments, it will be essential for them to understand what the AI training data was like. The same applies to AI-generated texts in journalism.

Of course, alongside education, regulation must be another tool. In this context, the philosopher of informatics Luciano Floridi speaks of soft and hard ethics, where, for example, in the USA, they are closely watching what regulatory frameworks Europe will come up with, trying to find a balance between these two ethical entities. In other words, we cannot bet on one card on how to approach AI, and what could contribute to eliminating the negative impacts of AI on society, while at the same time contributing to the existence of socially responsible AI.

**What negative impacts are you referring to specifically?**

For example, just the biases encoded in the training sets that the AI learns from. AI can move towards neutrality if we eliminate the biases encoded in the datasets it learns from. If the datasets include, for example, deciding that the child is always assigned to the mother in divorce proceedings, or that African Americans get higher fines when fined by white police officers, that's a problem.

Another example, from journalism: the risks of personalizing news coverage. The artificial intelligence innovator that is Czech Radio is thinking along the lines of Swedish public radio, where is the limit of news personalization in public service media?

Are algorithms supposed to microtarget, personalize - target each individual, for example, iRozhlas (Czech Radio's webpage) readers? Yes, the technology allows us to give each iRozhlas reader their own homepage, but then we deprive them of information plurality. If we create a model tailored to the user, for example, only for economic news and weather reports, because they are only interested in these two topics, we are actually enclosing them in a thematic bubble. Is that correct? Where is the level of monetisation and datafication of journalism using AI elements?

**This is where we get to a point that personally bothers me, because we have learned to call artificial intelligence something that is not artificial intelligence because it is just a neural network. A real artificial intelligence would have decided that on its own.**

I'm currently finishing the writing of a book called Journalism 5.0 and its Ethics, which will be the conclusion of a project funded by TA CR, which started three years ago, and I see how the concept of artificial intelligence is fluctuating. And how the technical sciences themselves are changing the notion of artificial intelligence.

In journalism theory, it's being treated as an umbrella for, say, machine learning and so on. For computer science, the only real artificial intelligence is Artificial General



Intelligence (AGI), which will be able to make decisions, will be autonomous, creative, and will be close to truly human. That is why they say, "...what you are talking about as artificial intelligence is 'weak artificial intelligence' and don't even call it artificial intelligence anymore". But at the same time, in the eyes of the public and in the eyes of many disciplines, we will still use the term AI as a buzzword until we get used to the fact that there are different degrees of AI, such as weak AI. Nevertheless, for the understanding of the general public I like the division between weak AI and general AI, whose development to fully replace humans is still a long way off.

### So how should we actually approach AI as a source of information?

In order to properly understand and use tools like ChatGPT, you need math, statistics, an understanding of what machine learning is based on, how the product is created, and an awareness of its limitations.

## PhDr. Václav Moravec, Ph.D. et., Ph.D.

He works at the Institute of Communication Studies and Journalism at the Faculty of Social Sciences of Charles University in Prague and at the Producing Department at Film and TV School of the Academy of Performing Arts in Prague (FAMU). He specializes in the transformation of audio-visual media, journalistic ethics and automated journalism. He is a member of the Executive Board of the artificial intelligence initiative PRG.AI (since 2019). He has been the principal investigator of several domestic and international research grants. COVID-19 infodemic project led by him became the absolute winner of the TA CR Awards in 2022. Since October 2021, he has been the principal investigator of the European grant 2020-EU-IA-0267, which deals with social science and technical research on information disorders in Central Europe. Within this grant, the Central European Digital Media Observatory (CEDMO) was established. He is the author of several monographs (e.g. COVID-19 infodemic /2022/, Transformations of Journalistic Ethics /2020/, Media in Fluid Times /2016/, etc.) and articles, especially in the field of journalistic ethics and automated journalism. He also works as a presenter and script editor. He has received several awards for his journalistic work (e.g. Novinářská křepelka Award, Elsa Award, TýTý, etc.).

I'm a typical case who used to flee high school before math, but one often meets his destiny on the road taken to avoid it. Now I need probability, a basic understanding of statistics, and an understanding of how algorithms, or neural networks, work. It is a mistake to think that knowledge is not needed, because we can nowadays „google“ all the information. We will need to discover how imperfect and flawed ChatGPT is. For a person's general knowledge, it is simply necessary to have a robust information base, which is certainly no useless junk.

**My Latin and History professor in high school once told me: "Colleague, from the way you ask I can see what you know about this problem." I think that without information, you can't formulate questions, hence, you can't give to AI an assignment to solve.**

This is partly what the advent of ChatGPT popularized in journalism and other fields. It's the understanding that one of the jobs of the future is "prompt engineering." The ability to design effective requests to artificial intelligence, thereby exposing its weaknesses, and it is PROMPT that can be copyrighted, which is being debated not only in journalism. So, prompt engineering is now a new field that is in vogue.

**Will our thinking not undergo a similar scenario as has happened with our ability to work and move? When machines and then robots came along, monotonous, strenuous and hard work decreased, and the result is that we are fatter, sicker and lazier. That applies, of course, only to the part of the population that passively accepts the results of evolution. But that will happen here, too, and part of the population may stop thinking.**

Undoubtedly, we must not accept that the latest technologies will lead to a more divided society and the spread of various pathologies. Certainly, if we are lazy and use technology only for our convenience, this is not the right way to go, and this is also true in relation to artificial intelligence. Concerning journalism, I say to our students: look at how the vocabulary of news journalism has narrowed since the 1990 s. Journalism has become such a routinised activity over the past decades, and if something is routine, automation will logically replace it. But at the same time, I would argue that if we use the tools of weak AI well to free ourselves from routine activities and push our creativity to invent new formats which ChatGPT and AI can't do, then there's an opportunity for us as a creative industry. I also stress to students that it's important that the moral authority in journalism doesn't shift to computer scientists, which is happening. And that we take it back and become aware of and embrace the new possibilities that technology brings. ✕

### SURVEY ON

## "How does the Czech public receive artificial intelligence for journalism?"

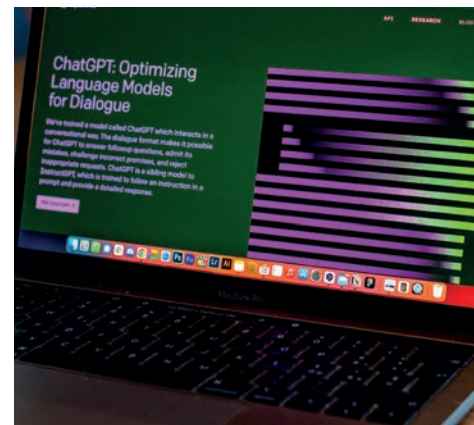
As part of the project "The Signal and the Noise in the Era of Journalism 5.0 - a Comparative Perspective of Journalistic Genres of Automated Content" funded by TA ČR, experts from the Faculty of Social Sciences of Charles University in Prague, Czech Radio and the Faculty of Electrical Engineering of the Czech Technical University in Prague carried out through the Ipsos company a questionnaire survey aimed at exploring the awareness of the Czech population about artificial intelligence. The experiment took place in April 2023, with a sample of one thousand forty-one respondents over the age of eighteen. We have selected some of the results to give a simplified picture of the Czechs' attitude towards artificial intelligence.

### 1 Experience and opinions on ChatGPT

The majority of respondents have never worked with ChatGPT. Young people are the most likely to have experience with the system. The survey also shows that four out of ten people think that the development of artificial intelligence like ChatGPT will create a hybrid relationship between the functioning of a "robot" and a human journalist.

### 2 How Czech society perceives technological progress

More than half of the respondents think that technologies have both positive and negative impacts on our society. Men have a more positive attitude towards technologies, as do people under the age of thirty-four. On the other hand, the most sceptical group are people aged thirty-five to fifty-four.



### 3 Experience with AI in everyday life

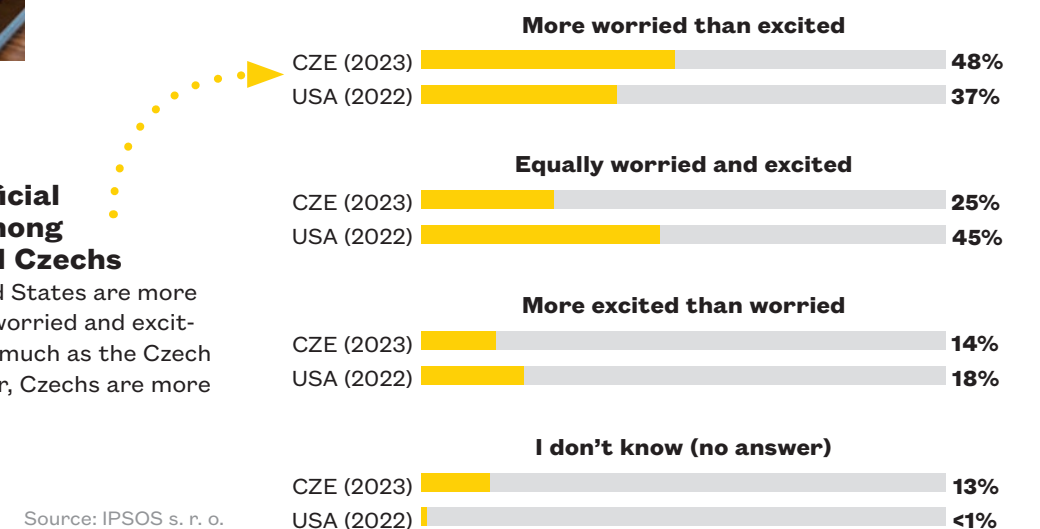
The research shows that 40% of respondents say they come into contact with AI at least once a day.

### 4 Czechs' concerns about the development of artificial intelligence

The survey results show that about half of the people are more worried than excited about the development of artificial intelligence. A quarter are equally concerned and enthusiastic about the development and only 15% of respondents have a positive attitude towards AI and its development.

### 5 Comparison of fear of artificial intelligence among Americans and Czechs

People in the United States are more likely to be equally worried and excited, almost twice as much as the Czech population. However, Czechs are more polarized.





# Light for the next century

Author: **Leoš Kopecký**

Photo: **Unsplash, Depositphotos**

Light has undoubtedly become a tool of the 21st century, and this is unlikely to change in the next century. At first glance, it is clear that the attention paid to light in our century is due to the current explosive development of lasers in both research and industry. It is also due to the development of fibre optics and, subsequently, the development of other information technologies exploiting the properties of photons. However, the potential of light is much greater and more diverse.

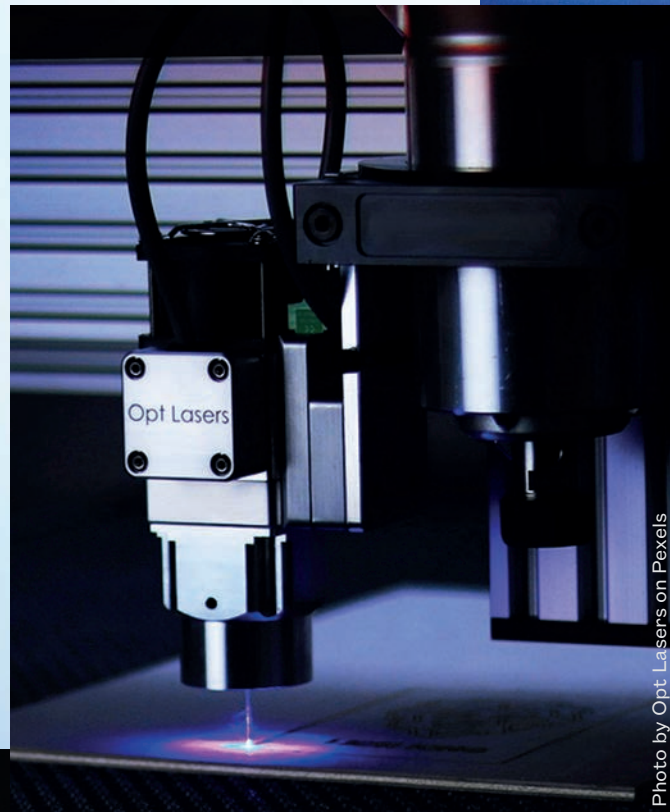


Photo by Opt Lasers on Pexels

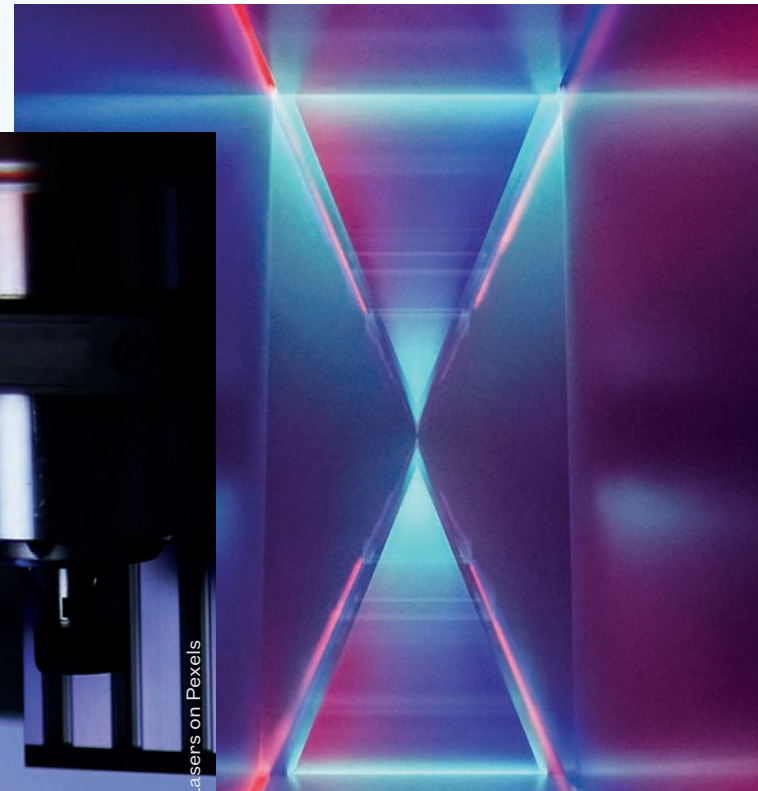


Photo by Rahul Pugazhendhi on Unsplash



Photo by Ricardo Aguilera on Unsplash



Photo by Museums of History New South Wales on Unsplash

Light is indeed an almost universal tool, even for our understanding of its own properties. For humans, light is, or should be, only that part of the electromagnetic waves that the human eye can detect - that is, what we see. But for some insects, for example, light is also ultraviolet radiation with high frequencies invisible to us, and for some reptiles, it is also the infrared part of the spectrum that we humans cannot see.

Okay, so light is not the same for every creature, which is quite understandable. Moreover, there's another inaccuracy. We have come to call light even the electromagnetic waves, where we perceive photons as particles that participate in a given event or phenomenon, even though their frequency is often such that we cannot see the images they create, we cannot perceive them with the eye. We simplify the problem a bit with the word "light". It is actually photons of different frequencies, or more often a stream of them, but it is still somehow acceptable and understandable for us lay persons thanks to this umbrella word. It allows us to get at least a little closer to the extremely attractive and promising field called photonics. It is a combination of parts of optics and electronics, a field that exploits interactions, mainly mechanisms of interaction between photons and electrons.

So far, three major milestones have been attained in the relatively young field of photonics. I have already mentioned two - the invention and application of the laser and the use of optical fibres for information transmission. The third milestone is the mastery of photonic chip manufacturing. That is, not electronic but optical semiconductor components.

Already in 2017, in the prestigious medium of Nature, researchers from MIT (Massachusetts Institute of Technology) published a paper on the development of a new system of optical circuits designed for the learning of >



deep neural networks. These are currently an extremely popular section of machine learning, or artificial intelligence, as they provide huge opportunities for the use of their properties and capabilities. Using light to process big data and logic is more economical and powerful than using the traditional systems we use today.

Instead of using electricity, which is the basis of all the chips in computers, mobile phones, servers, datacentres and the like, the researchers focused on a system that uses light. Optical computers, or optical (light) chips, are still in development, but the potential replacement of electronics is probably not far off.

Optical chips will be an extremely important part of future devices. Hence, it is interesting to check what is our government's actual support for the development of light technologies and, in particular, for research and development of their applications. Through the Technology Agency of the Czech Republic, 25 research projects related to the use of light in these contexts have been funded. The amount of funding exceeds CZK 0.5 billion. One of the most active players in this research and development is the Crytur company of Turnov.

For example, the global player Osram publishes the following text about the company on its website: „CRYTUR spol., s. r. o. is a first-class provider of integrated optoelectronic solutions for the science, medical and high-



-tech industries. With only 350 employees, it introduces and produces highly specialized solutions based on the high expertise and close customer cooperation with the global market. The product portfolio covers precise detectors for electron microscopy, laser rods, high-intensity lighting components and solutions, ionizing radiation detectors, high-resolution imaging systems and durable protection for temperature sensors.“

Nowadays, Crytur products facilitate the work of scientists and researchers around the world and are crucial to the proper functioning of many technologies in advanced industry. Single crystals, which serve as a source of laser radiation, are the basis of production. These single crystals are optical building blocks or components of scintillators or other detectors. Scintillators are at the heart of modern opto-electronic assemblies, resulting in high-end, small-series products that, for example, produce images in electron microscopy. The scintillation crystals themselves find applications primarily in scientific research. Some of the detectors are also used for particle research at scientific centres such as CERN.✖

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Sources: MM Průmyslové spektrum, VTM, Karel Javůrek, Nature

## Two examples of applied research projects funded by TA ČR and undertaken by Crytur experts

In 2021, a research project entitled **“Development of DUV seed laser for semiconductor lithography using solid-state laser amplifier at 1485 nm”** “ was completed. Experts from the Institute of Physics of the Czech Academy of Sciences - HiLASE Laser Centre, J. Rettenmaier & Söhne (JRS) from Germany and Nanjing Hurys Intelligent Technology from China collaborated with Crytur on this project. The developed module is used, for example, as a nanosecond amplifier for a commercial DUV (deep ultraviolet) excimer lithography station of the Japanese company Gigaphoton.

The second research project is an example of even larger scale of international cooperation. Under the title **“Application and advanced optical materials for next-generation multipurpose lighting”**, research is conducted on luminescent components

for high-performance light sources and their application in sources with increased external quantum efficiency. There are five partners working on this project. In addition to Crytur, these are Korea Photonics Technology Institute - South Korea, SungKyunKwan University - South Korea, UJL - Philippines, and Charles University, Faculty of Mathematics and Physics. The research project will be completed at the end of this year, and its results will help further developments in LED and LD lighting and support the market with high-performance and high-quality lighting.

The upcoming research, development and application of the properties of light for industrial and other areas will be very fast and the development will be extremely dynamic. This is somehow natural for light as we don't know a higher speed yet.

Iceland  
Liechtenstein  
Norway grants  
Norway grants

## SOILCON conference took place on synergies of EEA & Norway Grants with the EU Soil Mission

The Technology Agency of the Czech Republic in cooperation with the Technology Centre Prague and the Research Council of Norway organised the **SOILCON conference** - **“Ground for future cooperation in Europe”** on EEA & Norway Grants synergies with the EU Mission “A Soil Deal for Europe”.

Have a look at the presentations and interviews with speakers at [www.tacr.cz/en/soilcon/](http://www.tacr.cz/en/soilcon/).



SOIL-  
CON.



# How has the international GO-SME project advanced the Brno-based company Enantis?

Author: **Alžběta Hauser**

Photo: **Unsplash, archiv Enantis**

Enantis is an innovative technology company focusing on protein engineering. The company was founded in 2006 as the first spin-off of Masaryk University. Our know-how is based on our state-of-the-art computer tools that can predict what changes of amino acid composition in a protein could improve its properties. Since 2014, we have been focusing on proteins from the family of fibroblast growth factors, which are known for their very low stability. On the other hand, their potential for applications in stem cell research, cultured meat, cosmetics and regenerative medicine is high.



Photo by Max Kleinen on Unsplash

Our first stabilized molecule was the FGF2 protein (*editor's note: Fibroblast growth factor 2 is a growth factor and a signalling protein*), which after our intervention achieved 19 °C improvement in temperature stability and its lifetime in cell culture media also extended up to 50 times. The native FGF2 molecule is only active for nine hours in culture media, whereas our FGF2-STAB® is active for more than twenty days under the same conditions. This stabilization allows scientists to use the protein for longer periods of time without media exchange, and at lower concentrations than the native FGF2 molecule, saving time and money. Also, in cosmetics or regenerative medicine, it is not necessary to apply the product so frequently. Following the successful stabilization of FGF2 and its patenting and global sales through a major distributor, we have focused on stabilizing other molecules in the same manner for various commercial applications.

A project funded by TA CR in the GAMA 2 Programme focused on the verification of the commercial potential of the FGF2-STAB® molecule in the cultured meat sector (meat grown from stem cells in a laboratory environment). The main objective of the project was to assess the accessibility of this market from the perspective

of the properties of our molecule, its price and the interest from customers. During the project, we sent out samples to the first customers to get their feedback. The outcome of the project was a market entry strategy that greatly helped us in deciding on further commercialization steps. The project has been successful and thanks to it we are now offering the molecule to interested customers and starting cooperation with large cultivation media manufacturers. Currently, the manufacturers are not yet selling the product to end customers but are in the process of increasing production capacity and specifying production processes where our protein already plays an integral role.

After the end of the project, we were also offered the opportunity to participate in the international GO-SME project, where we successfully presented our project and in the competition of 45 European companies we advanced to the finals. Based on this, we also had the opportunity to benefit from coaching by international business coaches. This experience was very valuable and, with the help of both coaches, helped us to set a clear path to commercialization in this market and avoid possible mistakes. Thanks to the guidance of the experts, we also decided to come to

market with a new product line, FGF2-STAB® MEAT, which is not based on human FGF2 but on bovine FGF2, which is more suitable for the market. As a result of the GO-SME project, we also decided not to bid for an offered European project, but started with direct sales - the product was already sufficiently developed and did not need to be incubated further. We are now in the phase of developing sales in this dynamic market and are closely monitoring the situation in Europe and the rest of the world regarding the approval of the first products based on cultured meat for human consumption.✗



## Combining the good with the useful: New composite material melts ice and snow

Author: **Leoš Kopecký**

Photo: **Ing. Jindřich Melichar, Ph.D. z FAST VUT v Brně, Unsplash**

**Materials engineering has been experiencing incredible development for several decades. Thanks to new technologies, the performance of materials can develop in quite surprising directions. One such example is a remotely controlled composite building material with autonomous heating that prevents the frost formation in winter. This will help improve the safety of road and highway bridges, airports, bus stops and other busy places.**

“The control will be provided by an autonomous system with remote access. Thanks to online monitoring of the temperature of the structure, taking into account the current weather forecast and temperature fluctuations, we can minimize the heating time and maximize the energy efficiency of the process,” explained Professor Rostislav Drochytka from the Faculty of Civil Engineering (Brno University of Technology).

A significant difference from the previously used methods of heating the material against ice formation - in particular the heating spiral placed in the structure - is the fact that the heating occurs evenly and faster throughout the entire volume of the material. The heating is also more reliable and less prone to failure. TA CR editor Leoš Kopecký talked to Pavel Dohnálek about some of the details of the research project.

**Doctor Dohnálek, the project text states: “By monitoring the temperature of the structure online, taking into account weather forecasts and temperature fluctuations, significant savings in heating energy will be achieved.” But at first glance, the project gives the impression that using your material will be energy intensive for the operation rather than delivering savings. Can you explain that?**

The main mechanism of energy savings is the predictive capability of the system. It is connected to the internet via a 5G network and thus can access the data it needs. For example, if there is a dry frost where ice does not form, the system will not switch on even though the temperature is below freezing. At the same time, thanks to the weather forecast, the system will know in advance that it is going to drizzle or snow and will be able to pre-heat the surface. Wireless connectivity and other new technologies allow remote control and make energy optimization easier. ➤





**The project report shows the basic composition of the composite, which is mainly cement, fly ash, silica sand, graphite, etc. Among other things, it includes steel wires. Why the wires?**

The original intention was that the wires would act as a dispersed reinforcement. This is based on the philosophy of composites - that is, by combining materials with different properties, we achieve new material properties. We tried them, but in the end we didn't use them, they weren't needed.

**One of the results of the research is the final recipe. How is such a composite recipe actually formed? What played the main role in your case? Intuition, chance, experience?**

We build on the team's experience. Our company BETOSAN has been in business for 30 years and we have developed all our products in our own laboratories. For the last 10-15 years, we have been carrying out this development in cooperation with Brno University of Technology, so the know-how is of course also on the side of the university, and this applies not only to recipes, but mainly to testing and instrumentation. Of course, we all study the technical literature. So at the beginning there is a proposal for a composition, which is then refined by testing. Classic research and development. Sometimes assumptions are confirmed, but sometimes they are not. Occasionally, we encounter a pleasant surprise and then we develop and test the path further. It's a gradual and long-term process. Of course, the use of waste raw materials in composite is extremely desirable and necessary because it not only makes production cheaper but also contributes to the principles of sustainability.

**What will the use of the composite look like in a real situation, for example on a construction site? In terms of power supply, electrodes, etc.?**

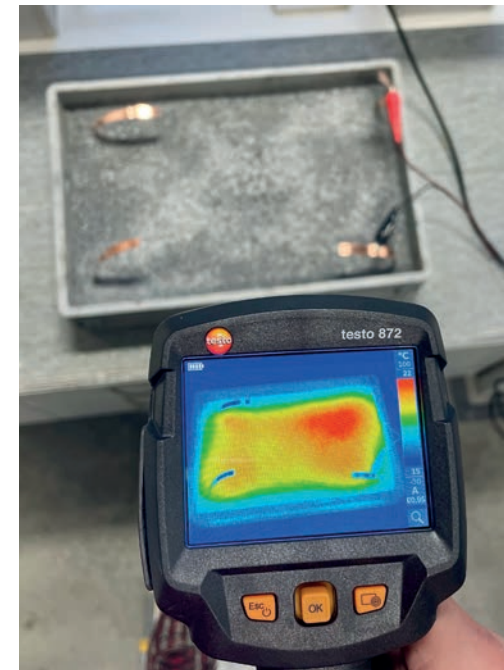
The mix is similar to a normal concrete mix, and this is how it will be handled. The electrodes to supply the current for heating are made of copper and will be spaced 50 cm apart. It is actually a commonly used earth strip with a cross section of 15 x 0.3 mm and will be connected to control units. The control system is being developed at the Faculty of Electrical Engineering and Communication Technology of Brno University of Technology. The computer, which is programmed to collect data from both the network and the material, evaluates and automatically controls the heating of the surface.

**The term "waste materials" came up several times in our conversation. What role do they play?**

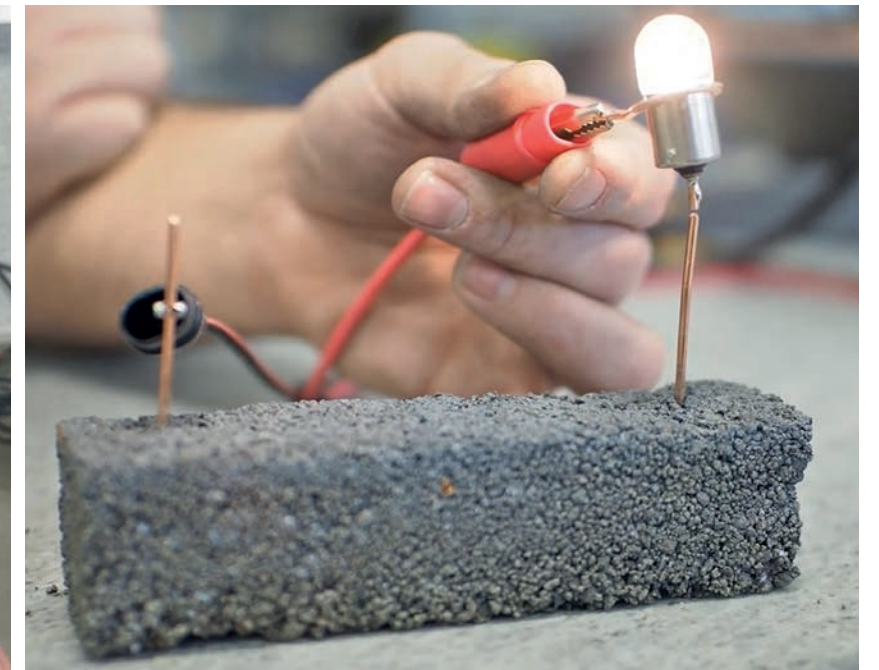
All companies are trying to achieve savings by using waste or secondary materials, and not only because Portland cement is expensive as a binder. There are also costs caused by emission allowances, general price increases and other influences. So, using fly ash, slag, and other waste materials is common. It is a topic that the Faculty of Civil Engineering at Brno University of Technology has been dealing with for a long time and with the help of the team around Professor Drochytka we are trying to apply new experience in the use of secondary raw materials more and more. This has economic as well as environmental impacts. ✖

## Ing. Pavel Dohnálek, Ph.D.

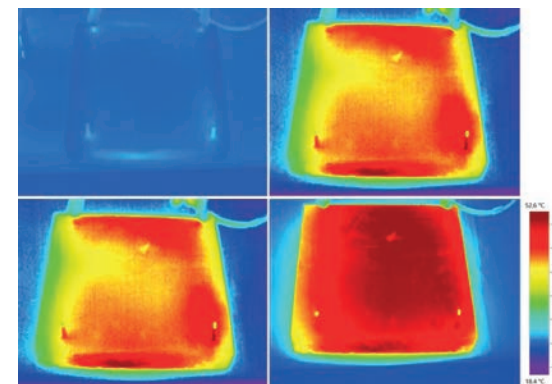
works in the BETOSAN, s. r. o. company as a technical director. He specializes, among other things, in research and development of new materials for production and sales by BETOSAN, s. r. o. In research and development he cooperates with leading Czech research organisations such as Centrum AdMas, Faculty of Civil Engineering, Brno University of Technology, Technical University of Liberec, J. Heyrovsky Institute of Physical Chemistry, Academy of Sciences of the Czech Republic and Institute of Inorganic Chemistry. During his tenure at BETOSAN, s. r. o. he was the principal investigator of several R & D projects in the Tandem and Tip programmes of the Ministry of Industry and Trade, and the TA CR ALFA programme. He also deals with the application of carbon fibre based composite materials for reinforcement of building structures.



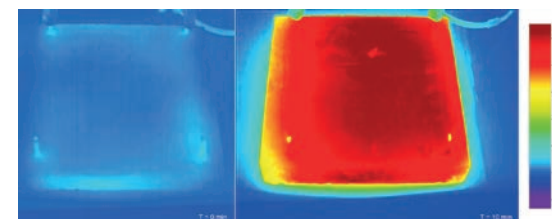
Verification of the course of temperatures within the volume of individual test bodies when the heating is on using a thermal camera.



Conductivity demonstration of mixtures using an electrical circuit connected through the volume of a test beam from one of the development versions of the conductive mixture.



A collage of images from the thermal camera showing the gradual increase in temperature of the test tile after the heating is turned on.



Comparison of test tile temperatures using thermal camera images, before and 10 minutes after heating was turned on.

## A smart composite building material

with a unique ability of autonomously controlled heating is being developed as part of new Czech research. The Technology Agency of the Czech Republic (TA CR) supported the innovation with almost CZK 15 million from the TREND Programme. The promising research is a collaboration between business and academia, namely BETOSAN, s. r. o. company, and the Faculty of Civil Engineering at Brno University of Technology (BUT).



## Electron microscopy – science for industry as well as medicine

Author: **Leoš Kopecký**  
Photo: **NenoVision, Depositphotos**

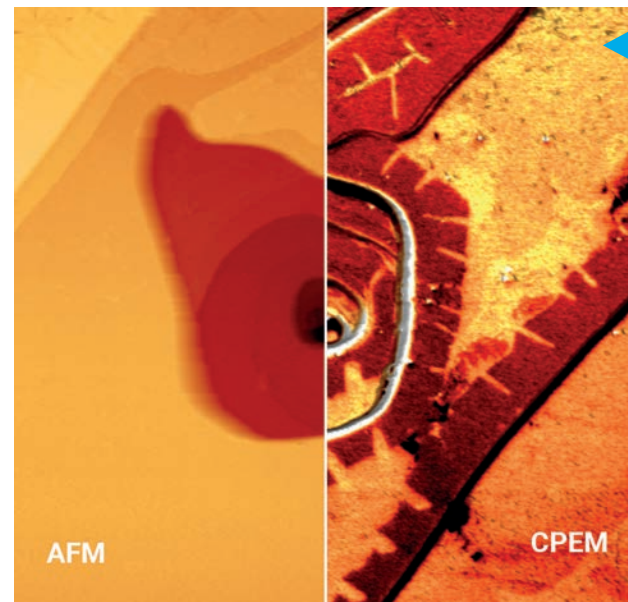
Hundreds of researchers and developers are involved in nanotechnology every day in the Czech Republic alone. One of the main tools for these technologies is the electron microscope, which is generally thought to be used mainly in the laboratories of research institutes. The fact that these tools are now commonly used in industry, engineering or metallurgy thus may come as a surprise to some.



In materials engineering today, we need to be able to navigate and be able to work in the nanoworld. It would seem that for engineering or metallurgical production, a larger scale for work and development would be sufficient, but this is not the case. The properties of materials are fundamentally influenced by their structure - the arrangement of atoms, molecules and ions, both on surfaces and in the volumes of materials.

*"The concept of materials engineering is based on the relationships between chemical composition, microstructure, processing conditions, utility properties and changes in the structure and properties of materials during operation. It is particularly necessary to emphasize the role of structure, because without knowing it and studying it in detail, it is not possible to develop new materials with the properties required by prospective engineering production,"* says prof. Ing. Josef Steidl, CSc., in an article in MM Průmyslové spektrum 2016.

Jan Neuman, a graduate of the Faculty of Mechanical Engineering at Brno University of Technology (BUT), is behind the development of one of the world's most advanced innovations in electron microscopy called LiteScope. LiteScope is a device that enables the combination of two techniques - AFM (atomic force microscopy) and SEM (scanning electron microscopy). Jan Neuman needed in his measurements to characterise samples in both devices, and it was impractical to move them from one to the other. So the need to integrate two functions into one device initiated the creation of NenoVision - the first ever spin-off of CEITEC BUT. In an interview with Kristýna Fialová in December, he described the development as follows: *"Atomic force microscopy is a well-established technique and so is electron microscopy. And what we have done is that we have combined the advantages of both. The hardest thing was and is to show the world how the combination is good and indispensable. When you*



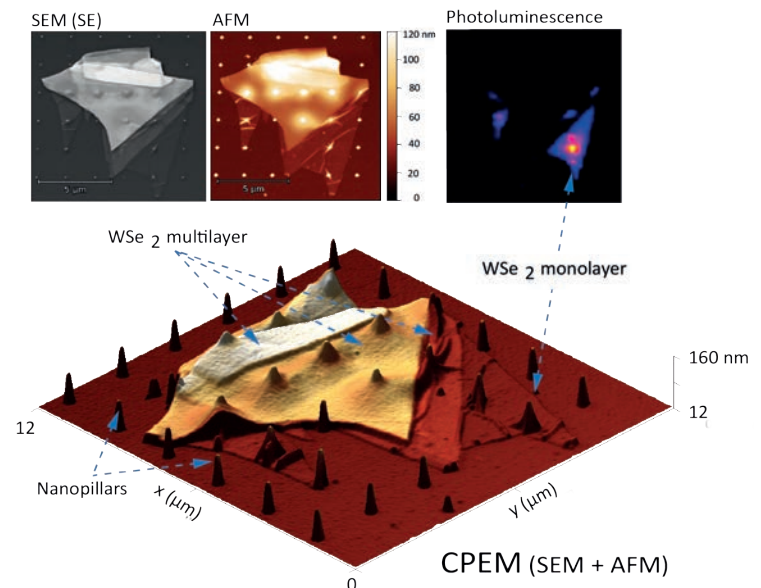
#### Do you see the difference between the images?

The darker areas are very thin layers of graphene formed on silicon carbide (SiC). The structures shown have their size only in units or tens of nanometres. The first image on the left is from a top-class atomic force microscope (AFM), and although it is a great imaging technique, the image is blurry compared to the second, which uses the capabilities of two microscopes, an AFM and an SEM (scanning electron microscope) together. This is the world's revolutionary CPEM (Correlative Probe and Electron Microscopy) technology.

A specific example of use can be the characterization of materials for hybrid coatings of orthopaedic implants. This involves the preparation of novel hybrid coatings for the surface treatment of Ti-6Al-4 V alloys for potential orthopaedic and dental applications. LiteScope was used for surface analysis of the coating materials, to investigate their topography and roughness.

Similarly, the LiteScope has been used to characterize the microstructure evolution during flow forming of AISI 304L austenitic stainless steel. An article published in Practical Metallography by Julian Rozo Vasquez and his research colleagues from the Technical University of Dortmund presents the potential of AFM-in-SEM measurements in steel and alloy analysis.

The unique device initially made it possible to measure the topography of a sample at a nanometre level - to show its relief, which an electron microscope cannot do. Gradually, other techniques common to AFM were added and today LiteScope can measure electrical, mechanical, chemical and magnetic properties of materials. In addition, for advanced interpretation of measurement results, the use of artificial intelligence comes into play to improve accuracy and reduce the time demands on the human operator.



What you see is not part of a computer game. It is the result of a nanotechnological process, it is the real structure of another nanomaterial. And that chosen one is WSe<sub>2</sub> - tungsten diselenide. The picture shows the analysis when studying its properties after depositing a layer on the nanopillar structure. CPEM technology can combine the analyses by several techniques into a single three-dimensional image, greatly facilitating scientists in studying the properties of these special materials.

WSe<sub>2</sub> is a very stable semiconductor, and its monolayer is, for example, interesting and important for future applications in nanoelectronic, spintronic, as well as quantum devices. Mechanically exfoliated WSe<sub>2</sub> monolayers are transparent photovoltaic materials with LED properties, thus with potential applications in solar cells and photonics.

The further development of LiteScope will allow to push the capabilities of microscopes beyond the known limits of technological possibilities.

The development of this device, which is currently unparalleled in the world, is far from over, and experts estimate that the number of applications will grow many times over in the coming period. Similarly, they expect the microscopy market to grow and reach USD 11.71 billion by 2030. ✖



## Several important research projects in this field are funded by TA CR. In those projects, Nenovision is either the principal investigator or a cooperating partner.

### Innovation of methods and equipment in correlative microscopy

Researchers: **NenoVision, s. r. o., Czech Technical University in Prague / Faculty of Electrical Engineering**  
Programme: **DELTA**

The project aims to innovate and commercialize new methods and state-of-art instrumentation in correlative probe-electron (AFM-SEM) microscopy, to develop (HW, and SW) methods, demonstrate, and promote the use of the correlative AFM-SEM microscopy for key applications in photovoltaics, photocatalysis, nanolithography, nanodevices, biosensors and in life sciences, and to develop the worldwide first Tabletop AirSEM microscope integrated with AFM and demonstrate its use for state-of-art correlative AFM-SEM microscopy under ambient conditions.



### New users for the LiteScope™ microscope

Researchers: **NenoVision, s. r. o., Institute of Physics of Materials of the Czech Academy of Sciences, Institute of Scientific Instruments of the Czech Academy of Sciences, and Brno University of Technology / Faculty of Mechanical Engineering**  
Programme: **TREND**

The aim of the project is to develop new technologies for the LiteScope device™ expanding its imaging capabilities with functionalities that will attract new users-customers and help Nenovision to establish itself in developed foreign markets. Three areas have been identified that will allow the necessary technological and commercial advantage to be obtained. Hence, the project will develop: a) unique multifunctional probes for scanning probe microscopy with the possibility of applying to the sample surface electrical voltage, intense laser light and a working gas through a probe cavity, b) highly compact device for in-situ mechanical loading, c) own very precise probes and automated etching equipment for their electrochemical preparation and their characterization.



Furthermore, for example:

### Next Generation of Integrated Atomic Force and Scanning Electron Microscopy

Researchers: **NenoVision, s. r. o., Palacký University Olomouc / Faculty of Science, Institute of Physics of Materials of the Czech Academy of Sciences, and Brno University of Technology / Faculty of Information Technology**  
Programme: **TREND**

The aim is to strengthen competitiveness and commercial potential of NenoVision's LiteScope product on the international market with the help of next generation equipment and accessories. The innovations will focus on four areas representing the project's sub-goals: a) Upgrade of hardware devices - development of new modules that allow sample rotation, cooling, heating and probe loading through Load-Lock of electron microscopes. b) Software development of image analysis procedures obtained by multilevel correlation techniques. c) Development of applications and examples of correlative techniques combining AFM/SEM with the use of newly developed hardware and software modules. d) Strengthening the cooperation between NenoVision and academic partners with the aim of an effective transfer of experience, know-how and high-tech technology.



### Process monitoring and failure analysis solutions for energy-efficient devices and products in microelectronics

Researchers: **CRYTUR, spol. s r. o., NenoVision, s. r. o., TESCAN Brno, s. r. o., and Brno University of Technology / Central European Institute of Technology**  
Programme: **EPSILON**

The project focused on the development of an X-ray tomograph that would enable the monitoring and evaluation of the quality of microelectronic components at a spatial resolution of less than 100 nm.



### Development of SPM applications suitable for correlative microscopy

Researchers: **Brno University of Technology, NenoVision, s. r. o. and Brno University of Technology / Rector's Office**  
Programme: **ZÉTA**

Scanning probe microscopy (SPM) is used to analyse material surfaces at the atomic level. The aim of the project was experimental verification of the technology's applications on a wide range of samples and creation of key applications for measuring electrical, magnetic and mechanical properties of materials.



### Centre of electron and photonic optics

Researchers: **Institute of Physics of Materials of the Czech Academy of Sciences, Biology Centre of the Czech Academy of Sciences, Czech Technical University in Prague / Faculty of Mechanical Engineering, CRYTUR, spol. s r. o., Institute of Physics of the Czech Academy of Sciences, Masaryk University / Central European Institute of Technology, Meopta - optika, s. r. o., MESING, spol. s r. o., Thermo Fisher Scientific Brno, s. r. o., Palacký University Olomouc / Faculty of Science, Institute of Photonics and Electronics of the Czech Academy of Sciences, Institute of Plasma Physics of the Czech Academy of Sciences, Institute of Macromolecular Chemistry of the Czech Academy of Sciences, Brno University of Technology / Faculty of Mechanical Engineering, and Brno University of Technology / Central European Institute of Technology**  
Programme: **NCK**

The Centre brought together all the key academic and industrial players in the Czech Republic involved in research in electron and photon optics. The Centre's activities focused on applied research and technology transfer in the areas of electron microscopy and lithography, optical microscopy and spectroscopy, laser technologies, optical and quantum metrology, fibre optics, high-precision optical manufacturing and sophisticated optical systems. The total number of collaborating entities in this project - companies and research institutes - was 14, of which 10 were research organisations. The work of the researchers and developers within the project has produced 225 partial results, including 108 function samples, 20 verified technologies and many others.



The text is a compilation of content from MM Průmyslové spektrum, Deník, L. Kopecký, CEP.





**Are you sure that this is THE THING?  
And are you sure that THE THING  
is exactly here right now?**

Author: **Leoš Kopecký**  
Photo: **Veracity Protocol**



**The rapid development of information technology brings new opportunities for the development and improvement of processes in many areas of production. They help to meet the high demands placed on quality, greatly assist the development of automation and robotics, increase efficiency and productivity or promote sustainability. This includes unique Czech technology for identification and authentication of objects.**

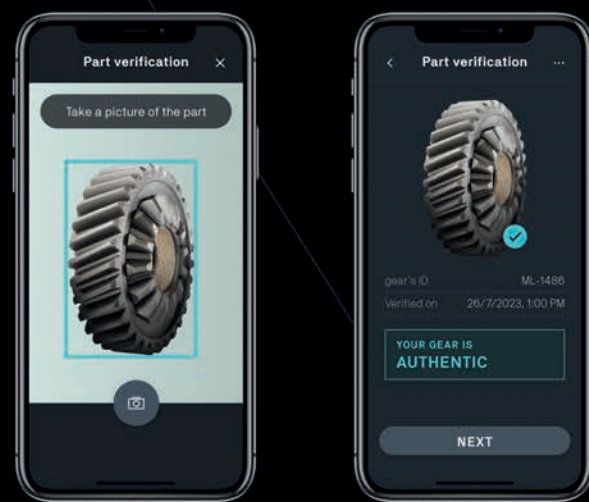


**P**ractical authentication advanced, reliable and non-invasive identification are not only a necessity in the fight against counterfeiting today but are also essential for advanced manufacturing and Industry 4.0. As the capabilities of progressive technologies grow, so do the demands for identification of individual parts or components of processes, production parts and final products. We need to know with certainty that what is actually in a given place is what is supposed to be there and not just something very similar.

Productivity is an important indicator of the degree of advancement or development of production, which is mainly monitored by economists.

Compared to industrially developed countries, we in the Czech Republic certainly have a lot of catching up to do, and one of the reasons for this is the lack of support for production management by information technologies, whether it is wireless technology, the Internet of Things (IoT), the Industrial Internet of Things (IIoT) or the use of the potential of 5G networks. These information technologies, when implemented correctly, undoubtedly bring efficiency gains, loss elimination and quality growth to the process. A Czech progressive technology for object identification may be one of them. The company Veracity Protocol has created a system for identification and authentication of objects by scan- ➔





Illustrative sample from the Veracity Protocol mobile application, in which the entire process takes place.

ning their surface and subsequent evaluation by artificial intelligence.

The principle is that each physical item has its own unique microstructure, something like a fingerprint. The Veracity Protocol's application automatically takes a picture of the physical object, identifies thousands of unique features of its microstructure, translates them into one unique number (physical code) and stores them in a blockchain or standard database. When a similar object is re-verified, the application can then compare with high accuracy the original code with the newly created code. If the codes match, then the microstructures of the objects also match, and the item can be declared original or identical. This method can be used for single pieces of object as well as for a range of products and is easily integrated into manufacturing processes. One

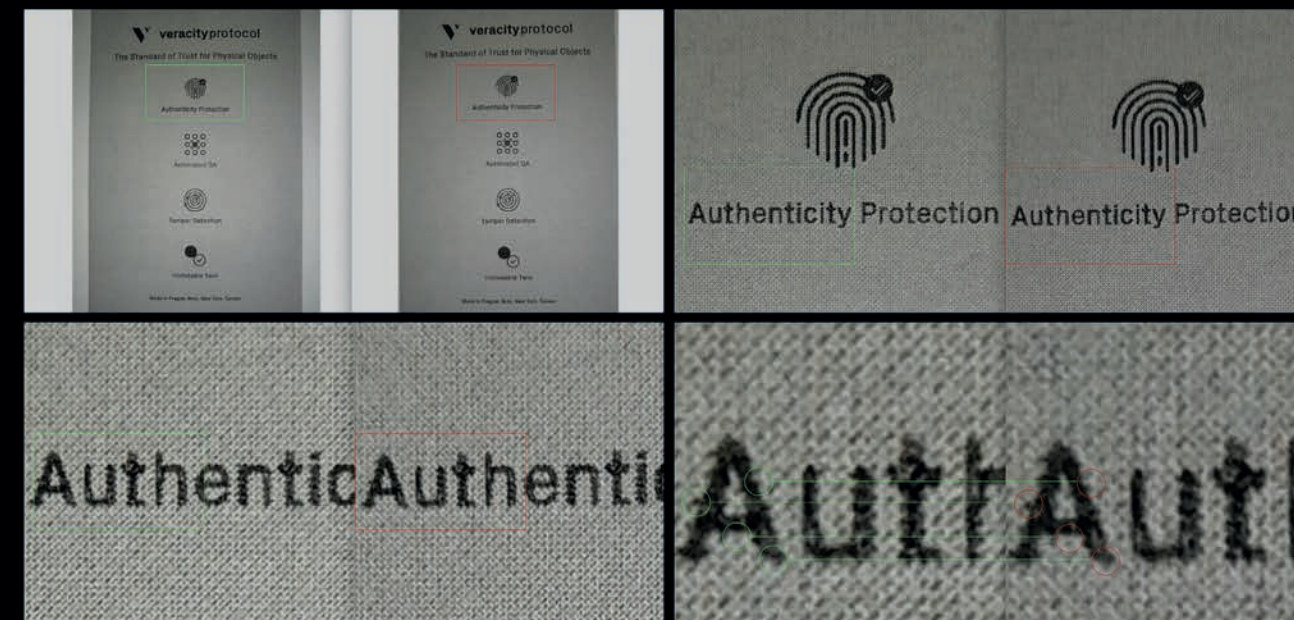
of the key points of Industry 4.0 is made-to-order production and piece-by-piece specialisation. It is this type of production that brings an increased risk of part substitution, which, especially when used in just-in-time processes (*Editor's note: A method used to reduce costs and increase efficiency, where materials arrive exactly when they are needed*), can cause unnecessary losses.

Unique computer vision models (Vision AI Models) have been created and optimized through the Veracity Protocol for more than five years. This is actually a very short time, given the complexity of the solution. A part of the specialized datasets is being created with TA CR funding (CZK 7.8 million) under the TREND Programme in cooperation with experts from the Faculty of Information Technology at Brno University of Technology. The re-

sulting solution will be used for further optimization of the current "Vision AI models" from Veracity Protocol.

*"One of the important industry segments demanding the developed technology is the automotive segment. Authenticity of parts and prevention of substitution are key factors affecting reliability, warranties, predictability of production and trust and confidence in customer-supplier relationships,"* says in relation to the project Ing. Kamil Behůň from the Department of Computer Graphics and Multimedia at Brno University of Technology.

Every automotive manufacturer requires a comprehensive system to monitor and track a large number of components within their distribution channels without marking or modifying the components in any way that may affect the component's perfor-



Recognition of microscopic differences is fully automated.

mance. Veracity Protocol's Vision AI models generate a virtual non-invasive code as an identifier for each component, allowing any participant in the process to identify, verify and track items throughout the distribution chain without the need for any special hardware.

Another specific industrial application of the technology is the possibility of its use in metal weld inspection using a smartphone and cloud infrastructure. The result is an increase in inspection speed and accuracy, a reduction in human error and an overall improvement in quality control.

Further use of the system is possible in authentication of luxury or branded products. The system will enable the provision of basic information to consumers and enable trustworthy 'second-hand' transactions through product verification by smartphone.✗

## Veracity Protocol Inc.

is an American security company with offices in New York, Prague and Taipei. Their team consists of computer vision PhDs and machine learning engineers. They have been recognized as one of the top innovative global start-ups by Intel, Techstars and Starburst Aerospace. The company's goal is to build trust that protects not only brands, products and customers, but also overall national security. Veracity Protocol is involved in critical electronics, aerospace, automotive, fashion, art and other industries.



# Forgive us, Mother Earth, you are already too small for us...

Author: Jan Kellner, Leoš Kopecký

Photo: Unsplash,  
Výzkumný a zkušební letecký ústav, a. s.,  
AXA/ESA

Photo by Joshua Fuller on Unsplash

The VZLUSAT-1 satellite started a new era of Czech space research. The satellite was launched on 23 June 2017, and the last message it sent to Earth was from 6 June 2023. The same day the satellite burned up in the atmosphere. So it worked for almost six years, which is an incredible achievement. It was a 2U CubeSat (i.e. a small satellite based on a cube, which can be made up of a larger number of cubes), which means that it was made up of two blocks of a classic CubeSat, measuring 10×10×20 centimetres and weighing about two kilograms. Besides the communications apparatus, computer and power equipment, the small space of the satellite could accommodate several other scientific instruments. In addition to own financial resources from cooperating partners, the development and launch of the satellite received funding from the Technology Agency of the Czech Republic under the ALFA Programme (projects TA03011329 and TA04011295) and from the Ministry of Industry and Trade through the institutional funding provided to the Czech Aerospace Research Centre.

## Czechia in space

Even without a spaceport, the Czech Republic is a world leader in space research and development. You may know that in 1978 Vladimír Remek became the first European (i.e. not American or Soviet) cosmonaut, but it may come as a surprise that we have launched a total of twelve satellites into space since that year. Since signing an entry agreement with the European Space Agency in 1996 and full membership in 2008 and with Prague as headquarters for the European Global Navigation Satellite System Agency (GSA), we have become a major player in European space development. Since 2012, Prague has hosted the headquarters of the GSA, which expanded its operations in 2021, along with a name change, to the European Union Agency for the Space Programme (EUSPA). The Agency is now in charge of five large-scale projects: Copernicus, EGNOS, Galileo, GOVSATCOM and SST.

## From Magion to Planetum-1

Magion, MIMOSA, VZLUSat, Lucky 7, BDSAT and Planetum-1. These are the names of Czechoslovak and Czech satellites that have orbited our planet. A total of three were launched in 2022. The most important of these is VZLUSat 2 with a particle detector for measuring the flux of photons, electrons and protons of cosmic rays, which ➤





Nanodružice VZLUSat 1

Výzkumný a zkušební letecký ústav, a. s.



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can determine the direction of flight and the energy of individual particles. This data is intended to help develop technologies to protect instruments and astronauts from ionising radiation and to test the functionality of existing technologies in space. It entered orbit on 13 January 2022 as the second of a series. Its sibling, VZLUSat 1, launched in 2017, recorded the oxygen concentration in the atmosphere and operated successfully for almost six years, the longest of any Czech satellite launched to date.

#### Areas of space development (not only) in our country

Space research is very well developed in the Czech Republic, mainly thanks to the combination of academic base, know-how of private companies and their practical applications in research. The strengths of Czech space research and development can be found, among others, in observation and imaging technologies, navigation, space debris monitoring, satellite operations and telecommunications. Last but not least, in simulation and testing of new technologies. A practical example of current capabilities is the supply of mechanisms to unfold solar panels on the new generation of Iridium satellites, which provide a global telecommunications network. Other areas currently under development

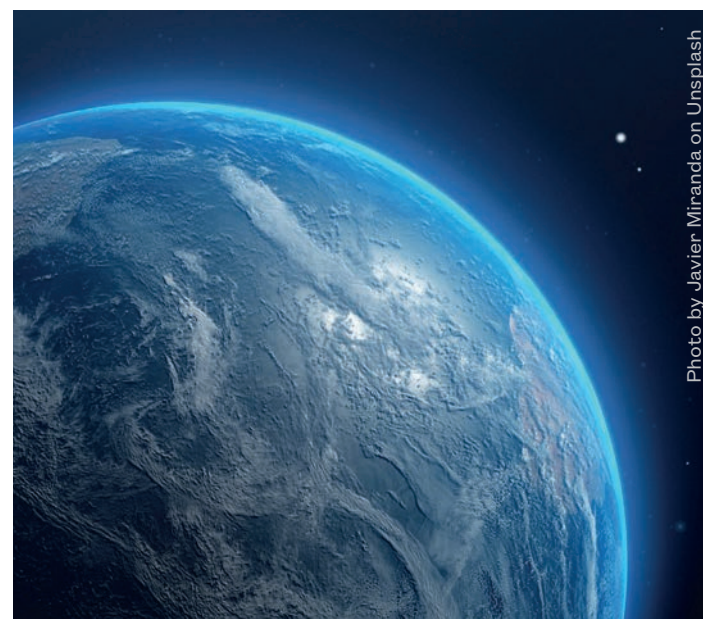


Photo by Javier Miranda on Unsplash



Photo by Manuel Meurisse on Unsplash

are positioning mechanisms for antennas, nozzles and various structural components.

#### Too many satellites

Due to the increasing complexity of the orbital environment, spacecraft are increasingly vulnerable to collisions with other satellites or their debris. Today, a growing amount of 'space debris', i.e. spontaneously moving debris and components of spacecraft, can be observed in orbit. A rough estimate is that only 5% of objects orbiting the Earth are functional. In addition to collisions in orbit, some larger objects are also threatening to hit the Earth's surface. The Space Surveillance and Tracking (SST) programme seeks to avoid these risks.

The Czech industry together with academia are active in research, space debris monitoring and related data processing. They also collaborate on the control software for the space telescope, which is part of a specialised observatory on the west coast of Australia. Czech experts are also expected to participate in a second planned telescope of this type, to be built in Chile.

#### Simulation and testing

While the fruit of a research programme may be a satellite in orbit, many crucial development steps precede a successful mission. Computer simulation of the environment, material properties, multiphysics, mechanics, acoustics or aerodynamics and aeroelasticity of objects is an integral part of space research. One of the most innovative tools that can simulate such calculations in real time is the Comsol Multiphysics software. For the aforementioned satellite collision problem, Comsol offers several approaches to calculate trajectories of orbiting bodies, including differential equations in a rotating system or simulation of Keplerian two-body mechanics. Other possibilities for the application of software simulation in space research can be found in the fields of mechanical and physical resistance of materials, thermal calculations or flow analysis.

#### What's on the horizon?

It is clear that the complex nature, significant investment risk and high cost of space research require a major effort on the part of management of the whole apparatus. In spite of that, the door is still open for innovations in the field of space research in the Czech Republic, as can be read in the National Space Plan 2020-2025 issued by the Ministry of Transport. Another good sign is the calls from the EUSPA agency or the European Space Agency (ESA). Responding to these calls is the upcoming Czech satellite mission SOVA, led by the Brno-based OHB Czechspace, which will focus on exploring poorly documented layers of the atmosphere and their influence on extreme climate phenomena on Earth.✗



# TA CR Awards for 2023

Author: **Veronika Dostálová**

Photo: **Unsplash, Depositphotos**

Since 2013, we have had a very pleasant and, at the same time, difficult duty at the turn of spring and summer - to nominate the best applied research projects for the past year, which will receive a glass statue from Lukáš Jabůrek at the TA CR Awards ceremony in autumn. Although we have been doing this activity for almost ten years, it is getting harder and harder to choose the best projects. Not because there are not enough applied research projects or because they are not of high quality. On the contrary. Each year, countless top-class projects appear that not only make a high contribution to society and our economy, but at the same time have much more in common - unique partnerships, interdisciplinarity, perseverance, courage and belief in themselves and the team.

The purpose of the TA CR Awards is not only to pay tribute to outstanding researchers, but also to motivate exceptional talents, to highlight their tireless work and, last but not least, to strengthen the positive relationship of the wider public to research. The TA CR Day, within the framework of which the TA CR Awards are presented, can already be described as one of the highly significant traditional events in the field of research. The winning projects are nominated by our colleagues who, throughout the year, monitor projects with excellent results, unique cooperation and high contribution to our country. The winners are then selected by an independent committee of internal and external experts in science and research.

This year's theme of the TA CR Day is "Science is not sci-fi: pushing the boundaries of what's possible". Our colleagues were therefore tasked with selecting progressive projects that break the boundaries of the impossible but are not well known in society. We targeted projects that, on closer inspection, might seem like the music of the future, but the opposite is true. Some may be surprised by the final selection. However, I believe that the following description of the projects will change this surprise and you will feel a drop of pride that such great ideas are coming to existence in our country.



## Category BUSINESS

### Autonomous Robotic Building System

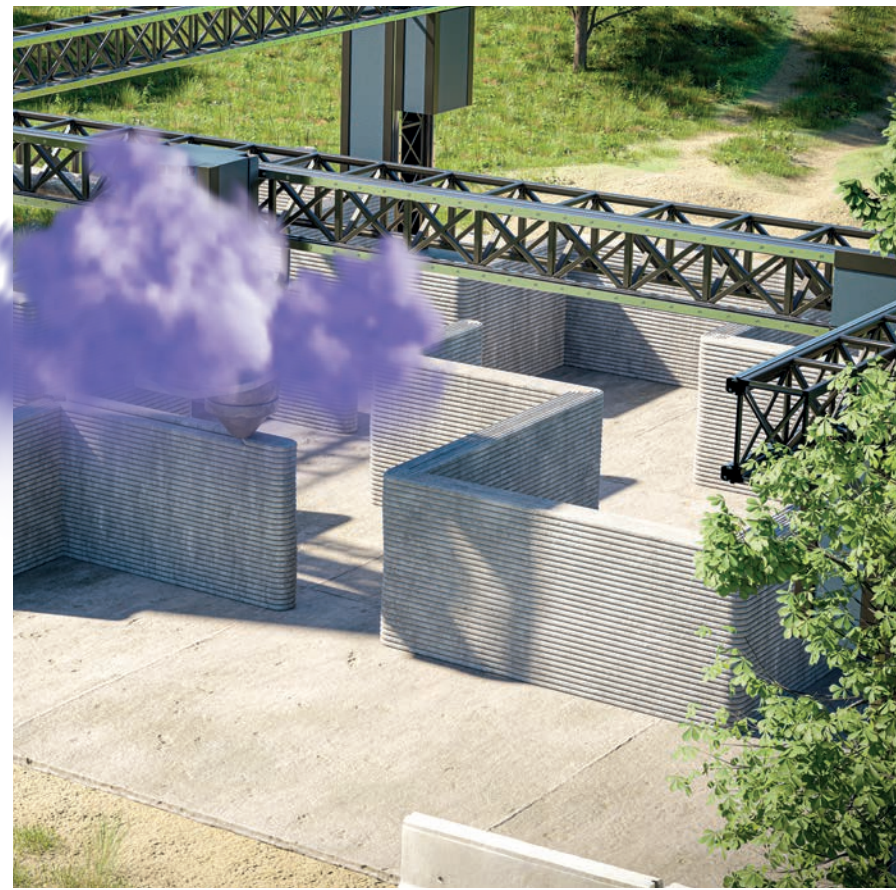
#### Researchers:

- DEK, a. s.
- Czech Technical University in Prague / Faculty of Civil Engineering

**Imagine that a robot builds your house. Does this idea sound like a scene from a sci-fi movie to you? Wrong! Experts from DEK, a. s. together with colleagues from the Faculty of Civil Engineering of the Czech Technical University have turned this futuristic vision into reality. They have developed an autonomous robot for 3D printing or robotic masonry directly on the construction site. This technology represents an extraordinary contribution to the construction industry - it can replace some of the construction work performed by humans, eliminating the current labour shortage and making construction production more efficient. It will also help to reduce the risks that arise for humans during work, while improving the quality of the work carried out. The system is intended for use by small and medium-sized construction companies.**

The result of the project is a working prototype of a robotic system with verified performance and quality of the completed work for three construction processes:

- » **Wall construction by 3D printing technology** - a print head as well as special building materials have been developed for robotic 3D printing of walls.
- » **Robotic masonry** - the device is a working instrument for masonry work, which provides the following technological processes of masonry: depalletizing - removal of the piece component including the masonry component from the place of delivery, checking the quality of the masonry component, application of mortar/adhesive on the masonry component, capture, repositioning of the masonry component in space, placement of the piece component including the masonry component in the exact position in the structure according to specified coordinates.



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## Category SOCIETY

### Psychodiagnostic application to identify gifted children

#### Researchers:

- Masaryk University / Faculty of Social Studies
- Janáček Academy of Performing Arts

Primary school pupils with exceptional intellectual talent account for approximately 3% of the population, which represents some 27000 children in the Czech Republic. However, only 1120 pupils are identified, and the true giftedness of most pupils is not revealed at all during their schooling. This unfavourable state of affairs is also highlighted in a report by the Czech School Inspectorate, which recommends that schools focus their attention on the identification of giftedness. Experts from Masaryk University and the Janáček Academy of Performing Arts have therefore focused on identifying exceptionally gifted children. The aim of their project was to deliver novel, psychometrically sound standardized on-line assessment system to assist teachers in identification of gifted students. The developed application does not focus solely on cognitive abilities but also targets the non-intellectual ones. This is due to the fact that difficulties in these areas can effectively disguise the

intellectual potential of some talented youths. The application will thoroughly map the ability profile and the strengths and weaknesses of the examinees, so that the findings can be immediately followed by personalized intervention and development programs.

The system consists of four sub-tests:

- » logical reasoning,
- » spatial reasoning,
- » processing speed
- » socioemotional difficulties

Each schoolteacher with a purchased license can selectively, universally or even repeatedly test his/her students, either with individual tests or with their entire psychodiagnostic system. This way, not only the ability profile of individual pupils can be obtained, but also the performance of the whole class. Currently, there is no solution in the Czech Republic comparable to the described product in terms of focus, comprehensiveness or quality.





## Category GOVERNANCE

**The influence of technical snow on biological components of the natural environment on the territory of the Krkonoše National Park and its protection zone**

### Researchers:

- Masaryk University / Faculty of Science
- Biology Centre of the Czech Academy of Sciences

The aim of the project, in which researchers from the Faculty of Science of Masaryk University and the Biological Centre of the Czech Academy of Sciences collaborated, was to evaluate the impact of the production and application of technical snow on biological components of the natural environment in the territory of the Krkonoše National Park and its protection zone. The project evaluated the impact of snow-making on both aquatic and terrestrial ecosystems, i.e. on soil organisms as well as on the aboveground component - vegetation and invertebrates on the soil surface. One of the project's objectives was to use the results of the research as a basis for the preparation of a strategic document "Principles of care for the Krkonoše National Park in accordance with the provisions of the amendment to Act No. 114/1992 Coll. and other internal framework documents of the Park's Administration". Thanks to the results of the project, the document "Principles of Care" itself has undergone a number of partial modifications. Among the project outputs is the "Methodological Guideline for assessing the impact of technical snow production and application on biological components of the environment in special protection areas", which can serve as a supporting material for water authorities when deciding on permits for surface water management under the Water Act.

Photo by Ondra Mach on Unsplash

## Category PARTNERSHIP

### Biorefining as circular technology

### Researchers:

- Institute of Chemical Process Fundamentals of the Czech Academy of Sciences
- Algamo, s. r. o.
- Institute of Biophysics of the Czech Academy of Sciences
- Institute of Botany of the Czech Academy of Sciences
- BRIKLIS, spol. s r. o.
- EcoFuel Laboratories, s. r. o.
- Mgr. David Novotný
- Institute of Microbiology of the Czech Academy of Sciences
- ORLEN UniCRE, a. s.
- RABBIT Trhový Štěpánov, a. s.
- REMA Systém, a. s.
- Global Change Research Institute of the Czech Academy of Sciences
- Silva Tarouca Research Institute for Landscape and Ornamental Gardening
- Czech University of Life Sciences Prague / Faculty of Environmental Sciences
- Czech Technical University in Prague / Faculty of Electrical Engineering
- University of Chemistry and Technology Prague / Faculty of Food and Biochemical Technology

The National Competence Centre BIOCIRTECH covers the whole area of processing of microbial, plant, animal and waste biomass, including that of municipal origin and sewage sludge using chemical, biochemical as well as physical processes in order to obtain valuable products with high added value and use in agriculture, food, manufacturing and energy industries. The aim was to develop new products from renewable sources processed with environmentally friendly technologies in accordance with the circular economy, addressing current social issues such as food sustainability, use of natural resources, and sustainable energy. The research potential of participating partners contributed to increasing the competitiveness of Czech companies (not only project participants) in the world and enriched their commercial product range. The project resulted in a total of over 90 individual outputs of the following types: Utility Model, Function Sample, Verified Technology, Pilot Plant.

We would like to thank our partners



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The event is held under the auspices of the Minister for Science, Research and Innovation, Helena Langšádlová.