Interview with Prof. Jiří Homola,
Institute of Photonics and Electronics,
Czech Academy of Sciences

Science today is a team affair

Professor Homola can be introduced as a holder of many Czech and international awards, a leading scientist lecturing at two universities in the Czech Republic, in the USA and in Finland, one of the ten most-cited Czech scientists, or as a successful researcher whose optical biosensors are used by many research organisations around the world. For me personally, he is also a great guide to the world of photonics, someone who can tell the layperson about science in an enthusiastic and understandable manner and, last but not least, the perfect host and guide to his laboratories. I again arrived for the interview with my daughter, who appreciated his words on multidisciplinarity, the application of science, and teamwork. I left fascinated by his results and story, and with a beautiful flower no less.

Professor Homola, you are one of the world's leading scientists and you also enjoy success in what's termed applied research. Can you share your know-how?
I think what's important is that I can do work that I enjoy and that fulfils me, and that the area of research I focus on is fascinating and stimulating, so I can work on it with passion and dedication. I think the most important thing, however, is that I have managed to find loads of excellent colleagues and great people, both here at the Czech Academy of Sciences' Institute of Photonics and Electronics and at other sites, not just in the Czech Republic but also abroad. Science today is a team affair, and because our research is by nature multidisciplinary, teamwork is even more important for us than for research taking place within individual disciplines.

My passion is for diversity in the broadest sense. How diverse is your current team?
At the beginning, our team was mainly focused on physics research, but we soon realised that the fascinating problems we were interested in would require a multidisciplinary approach, and that we would not be able to progress without bridging research in physics with research in other fields, such as chemistry and biology. As such, we've established co-operation with institutions that excel in these fields, and we've also tried to bring these additional core competencies to our own workplace. The extent to which we have succeeded makes us unique today, even at a global level. I am proud to say that in our Institute on one floor, we have "traditional" physicists performing research on cutting-edge electromagnetic themes, studying the behaviour of photons within various optical structures and designing new optical measuring systems, who are co-operating with chemists studying molecular transport and devising ways to anchor biomolecules to the surfaces of our sensors, and biophysicists and biochemists working on the use of biosensors to deal with specific biological or bioanalytical problems. Biosensors developed at our laboratories allow for the study of interactions between biomolecules, deepening our knowledge of the world of biomolecules and perhaps helping us to uncover the molecular basis of diseases, allowing for the development of new drugs and therapies. These biosensors can also be used to detect dangerous foodborne pathogens to ensure food safety. At our Institute, we are currently able to cover all aspects of optical biosensor research, even if it may not always be to the same depth. As such, co-operation with other research institutions remains very important to us. Some of the Czech institutes with which we co-operate include the Czech Technical University, Charles University, the Institute of Hematology and Blood Transfusion, the Czech Academy of Sciences' Institute of Macromolecular Chemistry, and the National Institute of Mental Health. We also collaborate with a number of sites abroad, such as the University of Washington in Seattle.

How important is luck in science?
I have certainly been lucky in my choice of research focus – I chose an area of research which is not only fascinating, but also has potential across a wide range of applications. I felt that a huge space full of opportunities was opening up to us, which thrilled me. It was also important that, at that time, the institute's management were open-minded to my plans and supported my hunch that optical biosensors were an important research topic. I should note that when I began researching optical biosensors in the 1990s, the Institute of Photonics and Electronics was focused on traditional physics, and had practically no direct applicable experience of research in the fields of chemistry or biology. Although it is more common these days to create multidisciplinary teams, this was not back when I started, and it required an open mind from the institution's management. The example of our research team is good evidence that science cannot be entirely planned out precisely. An openness to new ideas is key to success in science.

You say that you had a hunch. Is a purely rational approach more important for making a decision as a scientist, or is there space for intuition and emotion too?
Rationality is the foundation of scientific work – without it scientific research is impossible. Intuition based on experience and knowledge is also important, because it can help you to anticipate what direction your research is going. Emotions are also a part of science. I know many scientists who at first glance may not stand out, but when it comes to their research they can hold arguments and discussions with enormous passion. One might say that you use both in research – reason in order to create new original ideas, and heart in order to be able to follow your ideas. Science today – in fact all activities performed at the highest level – requires a lot of time and energy, beyond what is normally standard. You can't do good science on a part-time basis. Without passion and enthusiasm, you won't achieve great results.

Let's turn from scientific plans and passionate ideas to specific applications. You began by mentioning the success of your biosensors in the world. How long and thorny was the path?
The biosensors developed by our team are truly

the product of many years of research – there have been over ten developmental generations between our first model and the form they take today, with a massive amount of further improvements. I'm proud that our biosensors are used not just in the Czech Republic, but also in other countries in Europe, Asia, and North America. In fact, that's where most of our biosensors are; the US Food and Drug Administration (FDA) also purchased one from us for its laboratory. The actual production of biosensing devices has never been our primary objective – our focus is on advancing science and technology. But I'm happy that we have been able to exploit some of the findings of our research to produce new devices which can help fellow scientists in their research. Our biosensors are also proof that we're not chasing pipe dreams, but that our science is applicable to real life problems.

Can one determine where the border is between research and its commercial exploitation? For the general public it isn't clear; is it to scientists? And what about intellectual property protection?

The borderline between basic research focused on acquiring knowledge and research focused on practical application is frequently a blurry one. These types of research don't just influence each other, but they also frequently overlap. As such, it isn't always easy to make the right decision on how to share and protect the results of scientific research. In basic research, scientific work often follows a line: idea/hypothesis - verification - publication. Sometimes, however, we arrive at a crossroads where we have to consider whether the research performed is so unique, with such potential for application in practice that we should delay the process of publication to undertake further investigations and market research on future commercialisation. Although many scientists are happy when they can showcase their new results to the scientific world as soon as possible, the decision on publication timing is important in order to avoid premature disclosure through publication or conference talks, which might prevent patent protection and put the research's commercial potential under threat. A certain experience of life is often important, as this can help scientists to decide how to approach these kinds of situations. Although we pay attention to securing the protection of scientific results with commercial potential, one should note that most scientific ideas, even brilliant ones, don't end up making it to the commercial phase. This might be because it isn't the right time, partners or funding for commercialisation cannot be found, or new ideas are unable to prevail when competing with tried-and-tested or other new solutions. This is the reality, but that doesn't mean that we shouldn't try hard to bring our original scientific ideas to practice. We should continue to undertake our research and strive to find the best possible solutions.

It is right that, in recent years, greater focus has been put on development and protection of intellectual property in the Czech Republic, and the situation here is improving. Protecting an institution's intellectual property is very important. Furthermore, the intellectual wealth of an institution is not just the ideas and results contained in publications and patents. Institutions usually have extensive know-how collected over many years of systematic work in their fields, and this too needs to be flourished and protected.

How do you see the quality of Czech science compared to that in other countries?

The quality of Czech science is undoubtedly improving, one reason being that it is increasingly becoming a part of global science. In terms of the size of our scientific base and the volume of funds spent, we cannot compare ourselves with the scientific superpowers. But if we look at the costs spent on science and the outcomes produced by Czech science, then I think we have something to be proud of. In multiple fields, results of Czech science are on the same level as those in countries which are dominant in these fields.

You have taught in the USA and Finland, and in the Czech Republic you lecture at Charles University and the Czech Technical University. How do the students compare?

Comparing the American and Czech university education systems was very interesting for me. I think that American students are perceived much more as the focus of the university, and it is much more about them than we are used to, and that American students have high expectations of their university. Here, we are sometimes overly bureaucratic (something which unfortunately doesn't just apply to education and science) and thus I feel it is much harder for us to respond to new challenges and opportunities. Apart from that, it should be said that our top universities have a great history and provide high-quality education. In terms of knowledge of physics and mathematics, for example, best Czech students are at the same level as American students at the top universities. American students perhaps focus a little more on the application of knowledge and links with practice. American students can also work well with sources, with information from various fields, and they can quickly come up to speed on areas they did not know much about. Basically, they can build on their foundations and move forwards, often with a minimum of further guidance. I am glad that the Czech university education (and Czech students), has undergone positive changes since the 1990s, and Czech students today are much closer to their American counterparts in terms of the quality and breadth of their preparation than they were when I was a student. I have noticed that compared to my generation, today's Czech students are more courageous, they can describe and discuss their ideas better, while also talking about problems more openly.

We have discussed basic and applied research. How do you perceive the issue of the quality of science and how to assess this?

I have already said that in many cases basic and applied research overlap, and a strict division of science is not helpful. What one can distinguish is that the demands on both types of research are different. For basic research, which helps add to the knowledge base we share amongst the human race, the most frequent outcome is scientific publication. This can be assessed according to frequency of citation or journal quality. Although applied research often also leads to quality scientific publications, it is also possible to assess value of its results with respect to how they advance technology or solve a particular problem. Even so, we should still differentiate good applied research based on original scientific solutions from simple "non-inventive innovations". The quality and innovativeness of ideas is much more important than the quantity – you can't replace one unique idea with ten average ones. And therefore, in assessing applied research one should place great importance on originality and innovativeness.

How do you as a scientist perceive the expectations that are placed on you?

It is my conviction that scientists have great social responsibility, going beyond just the development of science and education within their own fields. I think that scientists should focus on the challenges facing society, and also endeavour to describe and present their research and its benefits realistically and honestly. In today's hectic world filled with information and media spin, scientific findings and discoveries are often presented in a rather simplified manner. Although I understand the attempt to make it simple, this is sometimes to the detriment of the scientific work being presented, as over-simplification does not allow you to capture the nature of the findings, often leading to a misrepresentation of their importance and potential impact. But I think that scientists across different disciplines can contribute to discussions of society-wide problems by using actual facts, knowledge, and arguments, helping to replace ad-hoc decision-making with sophisticated solutions based on an analysis of the problem and an assessment of previous measures. We know that we are working for Czech taxpayers, and I believe that the more useful the outcome of our work is to society, the more everyone will be satisfied. The commercialisation of scientific findings is just one way that science can be used; we should try to use the others too.

Introducing the Institute

The Institute of Photonics and Electronics of the Czech Academy of Sciences (IPE) performs basic and applied research in the fields of photonics, optoelectronics and electronics. Scientists at the IPE undertake research and development in optical biosensors, fibre lasers, special optical fibres, optical imaging methods and the study of the electrodynamic properties of biological systems, as well as electronic and optical phenomena on nanomaterial surfaces. The Institute also runs the Laboratory of the National Time and Frequency Standard.

By Linda Štucbartová

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