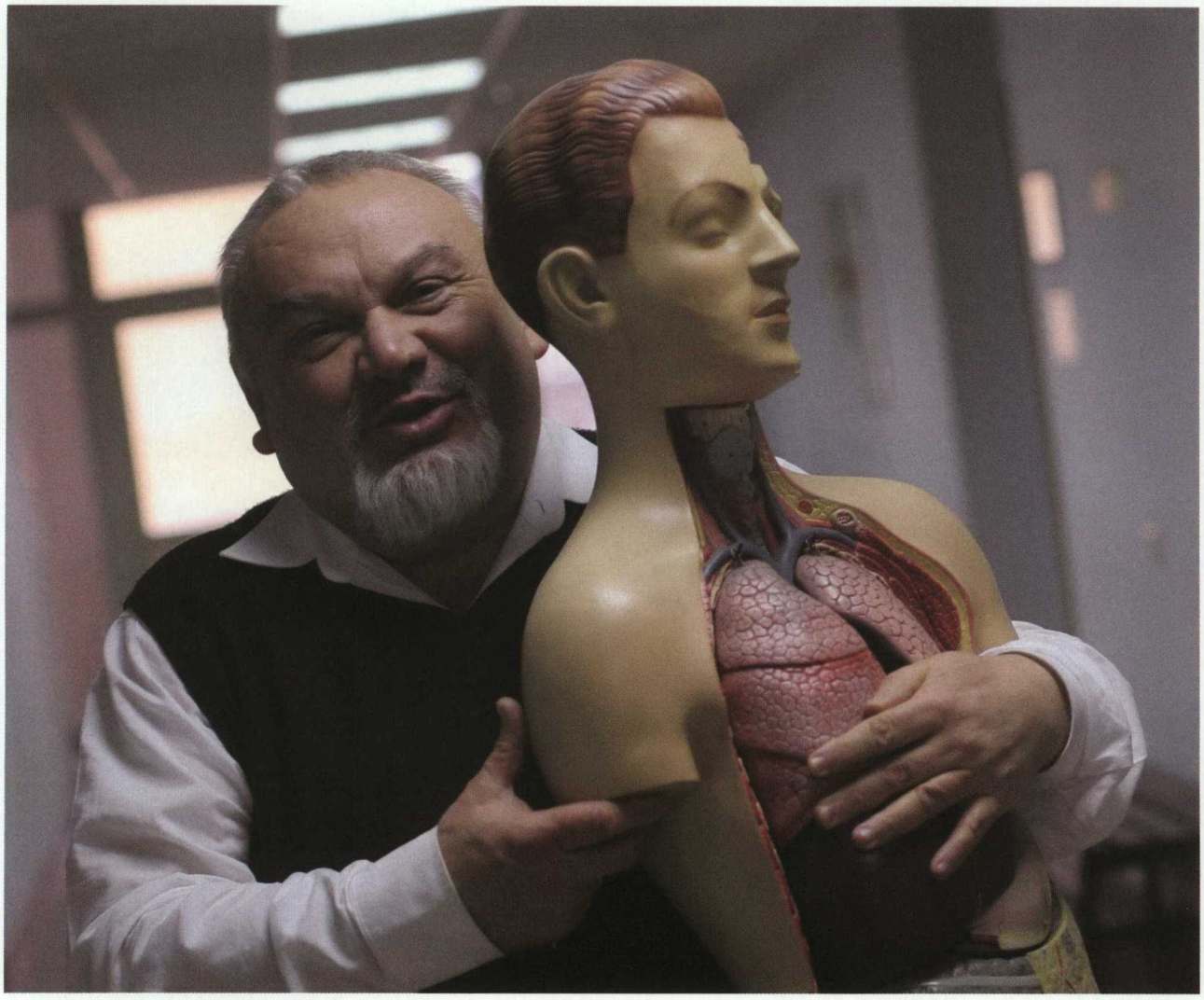
Interview with Prof. Ryszard Tadeusiewicz

I've Churned My Lump of Butter



Tomasz Żurek/Reporter

IT systems are faster than our brains, just as jet planes are faster than walkers. However, biological brains currently have an advantage over computers in being capable of creativity

Academia: Your excellent essays often encourage your readers to ask their own questions and engage in discussion. While preparing for this interview, I kept changing my mind as to where to start and how to keep you talking; I also have myriads of questions for you. Since the theme of this issue of *Academia* is "Information," I'll start by asking: how, in your view, have computers changed our approach to and understanding of information?

Ryszard Tadeusiewicz: *The invention of computers made people realize the importance and value of information. In the past we valued capital, land, raw materials, industrial production – the aspects of civilization based on materials and energy. The invention of computers and associated innovations (the Internet, cell phones, e-commerce, etc.) made it clear that information can also be a commodity, that there is money to be earned from creating and storing it, and that it affects all aspects of our lives. Hence the concept of the Information Society, Toffler's Third Wave, and the ubiquity of computers. It should be noted that*

the invention of computers (which was actually relatively recent, but has had such significance that it almost seems that these smart machines have always been with us) has brought with it many e-things: e-economy, e-working, e-entertainment, e-medicine, e-administration, and even e-politics. And this trend will continue!

Your main area of interest (if that can be said of someone with such diverse and well-documented scientific interests) is neural networks. What are they?

They are smart information systems which solve various practical problems by using analogies between computer processes and features of biological nervous systems. For example, by using a computer to imitate the learning processes inherent in neurons we can create information systems capable of solving problems which we cannot solve ourselves. Neural networks created by computers are capable of learning how to solve problems, thus freeing us from the laborious process of finding these methods ourselves and then coding them in a computer program.

Can neural networks teach us something about human brain function?

By their very nature and mode of operation neural networks are models of the brain, although they are very much simpler. They consist of cells that are modeled electronically or by simulation (using an ordinary computer, even a home laptop) with properties replicating those of human brain cells, using connections based on actual brain structures, able to receive and process various signals and independently learn the rules of their own operation. This makes them useful in technological applications, although they are also a fascinating experimental model allowing researchers to test and study various theories on how the human brain works.

Our brains are incredibly complex and contain inconceivable numbers - hundreds of billions - of neurons, which are biological processors handling information; they receive huge numbers of signals from receptors monitoring their surroundings (vision, hearing, smell), as well as from proprioceptors monitoring the condition and function of our internal organs. Understanding all the goings-on in such a complex system is incredibly difficult, whereas understanding the goings-on in a simple, artificial, fully-controlled neural network is relatively easy. We can then look for analogies between how neural networks work and the biological processes that occur in the brain as well as the mental processes that occur in the mind, which is based in the brain. Looking for those analogies and actually finding them is fascinating work!

"We now know too much about the brain" - those are your own words. You claim that computer modeling may turn out to be crucial in unraveling the secrets of the human mind...

Modeling is generally a powerful and useful technique. It is used by engineers before they build new cars or airplanes, since it's cheaper to create computer simulations of different design options and select the best ones than to build and test real prototypes. In the past, test pilots risked their lives every time they took the controls of a new plane, since it was difficult to predict how the machine would behave. Today, computer modeling allows us to test hundreds of variants in simulators prior to the maiden flight. Models are used by economists selecting their next investment; they help us predict weather and study demographics. Why shouldn't biologists or doctors use models as well? It's clearly safer to test therapies on computer simulations than to put patients at risk. It's better to try to steal nature's secrets using modeling than through expensive experiments on tissue samples (in vitro *experiments) or through morally-ambiguous animal testing* (in vivo), *where the advancement of knowledge is marred by the suffering and death of thousands of innocent creatures. Nowadays, alongside* in vitro *and* in vivo *research, there are biological and medical studies using computer models, known as* in silico. *This field could prove to be truly groundbreaking!*

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What could neural networks be better at than humans? Can artificial intelligence become comparable to human intelligence?

The main advantage of all electronic and IT systems is their speed. Computer microprocessors operate at gigahertz speeds, conducting billions of operations per second, while neurons in the human brain operate at frequencies of hundreds of hertz - over a million times slower! Signals in fiber optic or copper cables travel at the speed of light - 300 thousand kilometers per second, whereas the impulses in our nerves and the fibers connecting neurons in the brain travel at tens of centimeters per second. Whoever came up with the phrase "quick as a thought" was undoubtedly a great poet, but clearly knew nothing about neurophysiology. That's why IT systems will remain faster than our brains, just as jet planes are faster than walkers. However, biological brains have an advantage over computers: they are capable of operations which the artificial intelligence of "electronic brains" has yet to achieve. I'm talking about creativity; creating something (a scientific theory, music) from seemingly nothing. Although perhaps machines will manage that in the future, too?

Interview with Prof. Ryszard Tadeusiewicz

Private archives of Ryszard Tadeusiewicz

Scientific discoveries influence both business and politics. Businesses strive to influence the direction of scientific research. This is not a problem as long as businesses inspire and finance true research rather than seeking specific outcomes

Tell me how it was with GPS.

The story of GPS is almost like the story of overly ambitious, mutinous angels who fell from heaven into hell's abyss for committing the cardinal sin of pride. In the early 1970s, artificial intelligence celebrated numerous triumphs: computers won against people in chess, proved mathematical theorems, formulated military and financial strategies - they seemed omnipotent. And so some outstanding scholars of artificial intelligence - Herbert Simon, J.C. Shaw and Allen Newell - decided to build an electronic genius. They called it GPS, short for General Problem Solver. Today the same acronym is used to describe something quite different, but in those days it meant a computer that would answer any question and solve any doubt, just like the fictional Deep Thought. It also turned out to be an utter failure: it never solved a single problem. It literally couldn't do anything. It sank like the unsinkable Titanic on her maiden voyage. Still, Simon would later go on to win the Nobel Prize in economics...

Let's change the subject. You have an extraordinary academic profile: biocybernetics, medicine, arts, journalism. A great and versatile mind...

My wife would tell you a completely different story about the greatness and versatility of my mind! She often criticizes me for forgetting domestic issues, and with good reason. Apparently even Professor Paganel from Verne's novel, famous for being absent-minded, wasn't as forgetful as me. Seriously though: you can only be a successful scientist through hard work. But to work hard and efficiently, you have to really enjoy what you do. I've been lucky in that I've always worked on things I find fascinating, so work's been a constant source of joy rather than weariness. And when you work long and hard, the result will come. It's like the old Polish fable about a frog that fell into a pot of cream: rather than accepting defeat and drowning, it kept thrashing its feet so hard that it churned the cream into a lump of butter, climbed onto it and hopped out. You could say I've also churned my lump of butter, although I don't want to hop out!

How does top-level administrative work affect your academic productivity?

At first I was worried that by giving in to requests that I apply for the position of rector of my alma mater I'd take on too many administrative duties and would have to really limit my research activities as a result. But it didn't turn out to be aş bad as I thought.

How do you, as a researcher, creator, long-term rector of the AGH University of Science and Technology and active educator, see the reforms of higher education in Poland? In your view, how will they alter science and research practice?

I largely see the current reforms in a negative light. They address secondary issues without solving the real problems facing Polish science. I'll use the Polish Academy of Sciences as an example, since we're talking in Academia*; analogous things can be said about the higher education reform. What has the recent new set of PAS statutes actually changed? Well, the Academy is now divided into five departments instead of the previous seven. The organization was experiencing plenty of problems, yet no one could explain to me why five departments is supposed to be better than seven. Other changes, in particular limiting the various privileges of older PAS members, are also a classic example of throwing out the baby with the bath water. I think the reforms of Polish science and higher education being pursued by Minister Barbara Kudrycka are a bit like trying to treat a patient without properly examining him first - without a proper diagnosis. This can't be good. A few days after Prof. Kudrycka was appointed as minister I had the opportunity to talk with her at length, since I had been nominated to become a deputy minister under her. My conclusions from the discussions were very pessimistic. I decided that I wouldn't join in efforts whose direction I didn't agree with, and turned down the post. Today I see that I made the right decision, since I would only have been embarrassed about the ministry's actions, or even would've re-*

signed during my term. I previously resigned as chairman of the Council for Information Society Technologies, after the council - originally set up in affiliation with the Ministry of Science and Information Society Technologies - was moved to the Ministry of the Interior and Administration, at that time headed by Minister Ludwik Dorn. I guess I still have my convictions from my days as rector of one of Poland's largest universities: I know that I don't get on well with everyone, and I don't think people should agree to have their name used to promote something they don't believe in, something that clashes with their views of what's right or wrong.

How heavily does scientific development in Poland and abroad rely on working with businesses?

Science is tied to business everywhere, because scientific discoveries have a direct or indirect impact on industry (and also on politics, which is noted less frequently). And so there's nothing surprising that businesses wish to influence the direction of scientific research, favoring subjects that are likely to generate big and fast profits. There's nothing wrong with that, as long as businesses inspire and finance research while intending to commercialize the results. This forms the basis for the development of modern IT, electronics, and telecommunications; it's how exploitation of energy sources (such as shale gas) is developed; it's also the basis of growth in the contemporary pharmaceutical industry and biomedical engineering.

Is that good or bad?

No society around the globe has the necessary budget (money directly from tax payers) to finance all valuable scientific research, so if businesses can step in as co-sponsors, there's no problem. The main outcomes of such collaboration are faster expansion of knowledge on one hand, and greater progress on the other. The latter is the result of the fact that in striving to commercialize research, businesses bring the results to ordinary people in the form new products and services - and that's what it's all about. Problems arise when businesses try to fund research meant to be directly beneficial for those businesses themselves, rather than research that strives to discover new truths per se. For example, certain forms of funding research into drug effectiveness, commissioned by pharmaceutical companies, smack of manipulation, and that must not be tolerated.

Private archives of Ryszard Tadeusiewicz

Prof. Ryszard Tadeusiewicz uses his articles to encourage his readers to ask questions and seek answers for themselves

What about politics?

We can get similarly ambiguous situations when pure science is tampered with by politicians. The current problems with science becoming politicized are widely known, but talking about them is riddled with difficulties (for example issues surrounding global climate change). Instead, I will just point out some infamous examples from the past, such as eugenics studies funded by the Nazis, or "Lysenkoism" practiced during Stalin's day in the USSR. Another contemporary field where politics interferes with academia is history - but let's not get into that here.

Interview by
Patrycja Dołowy,
Kraków, October 2011

Prof. Ryszard Tadeusiewicz - automation expert, one of the most active researchers in Poland, three-time rector of the AGH University of Science and Technology, member of numerous Polish and international organizations such as the Polish Academy of Sciences (PAN), the European Academy of Science, Art and Literature, the Russian Academy of Natural Sciences, and the Polish Academy of Arts and Sciences (PAU); honorary member of the Polish Information Processing Society and the scientific board of Collegium Invisibile, and member of the Social Committee for the Restoration of Kraków's Monuments. Holder of honorary degrees from 12 universities from Poland and abroad. Winner of numerous Polish and international prizes. Author of scores of scientific publications, books and popular articles.