A Multidimensional Man

Richard Ernst, pioneer of one and two-dimensional NMR, talks about why multidimensionality is important in life as well as science.

Bio
Richard Ernst is a Swiss physical chemist who won the 1991 Nobel Prize in Chemistry for his work towards the development of nuclear magnetic resonance spectroscopy as a high-resolution technique. Stephanie Harris is a graduate student at the University of Bristol, UK, whose research focuses on time-resolved ultrafast transient absorption spectroscopy.

After finishing your PhD you took a job in industry rather than staying in academia, was this a conscious decision?

Yes, first I wanted to get rid of the university and second I wanted to get rid of Switzerland. I needed to get out and California was the right place to look for another job. It had to be industrial; I wanted to become a useful member of society and not just an academic. An academic is a bad notion. But afterwards I went back to ETH Zurich where I had studied for my doctorate. That was probably a mistake. I'd always sworn that I would never go back to that university but I didn't follow my intuition. After about a year I had a nervous breakdown. I couldn't stand Switzerland anymore and I thought that's my end or at least that's the end of my scientific career. I wanted to go and work in a post office and stamp envelopes. Very slowly, and after a long struggle, I became a scientist again who developed the necessary skills to teach, but it was hard to start again.

What helped you to regain your interest in science during that time?

You have to be motivated, you have to ask questions, and you have to try and understand what is going on around you. This motivates you to learn. You never understand enough or have solved all the problems so you try to improve your knowledge and that is what I did. Finally, of course, teaching helped. The students tell you what they expect from you and you have to try to become a good teacher. You need more knowledge to do that. Even if you go to a Kindergarten and give a lecture, they ask you crazy questions that you can't answer. You then know that you are missing knowledge and this helps you to go away and grow in the proper direction.

You have previously spoken about the importance of maintaining a passion outside of science. Could you explain why you think this is so important?

You have to be inspired by something. Inspiration normally comes from an external source, from somewhere unexpected making access to different fields important. This allows you to transfer knowledge from one field to another, opening up novel routes of exploration. Without this kind of inspiration you can become very narrow-minded. If you have a passion outside of science you

should be proud of it, it makes life more enjoyable. Too many scientists lose their humanity in the sense that they only have one focus; their research, but science is not the only aspect to life, there are other aspects too and you have to give them a chance.

Your talk at this year's meeting suggested we must do all we can to ensure scientific research does not turn into a rat race. Do you think this is possible whilst there is such strong competition for funding?

I think so, you should try not to care about the environment in which you're working and you should not think about research as a race or competition. Instead just try to follow your ideas and do what you want and what you think will be the most interesting.

Is the best way to learn by doing rather than from a textbook?

There are good teachers and there are bad teachers. The bad teachers think that you should strictly follow what they say, their rules and obey. The good teachers allow you to develop your own personality and ways of learning. Personally, I had different teachers, teachers who had set expectations, which I was made to follow and others who just set me off on a subject and then said "go look for yourself." Those ones were the better teachers; they had more success with me. It's more inspiring and more motivating when you have freedom and are responsible for what you are doing, not just obeying orders like a slave.

Do you think universities should alter the way they teach Chemistry?

Yes, in teaching the most important thing is that you throw the students into the cold water and let them swim for themselves. You shouldn't first teach them the motions on dry land, just throw them in and see what happens. You learn by doing, it is not a logical process where you start with Adam and Eve and go from there. You should start from a subject that interests you and then develop the skills you need to solve a particular problem. It's is also important not to first learn a skill and then ask yourself "what can I use this skill for?" It's about learning on the spot, on the job.

How would you explain NMR to someone without a scientific background?

First of all I would explain that NMR is something useful. You can image human bodies, you can analyse chemicals so it's relevant. Once you've convinced the audience of that you can go on to explain how to do it, how do you get inside of the human body, how can you analyse molecules? All that sets the scene for going into more detail. I tell them about the atomic nuclei which act like spies, spies inside a human body like yours, and that they give you messages which you can record with electronic equipment. Once you've recorded these messages, you can try to analyse and understand them. That's already quite a lot, you have a goal, you have a tool for getting the information and you need some mathematical and experimental techniques to make it possible. You can then go on and say "yes, but how does it really work?" Well, the atomic nuclei, they have

a magnetic moment. When you apply a magnetic field they start to process about it with a frequency that is proportional to the magnetic field strength. Therefore if you measure that frequency you are measuring the local magnetic field. Then you have to ask "what are these local magnetic fields telling me about the chemical environment?" You can measure spin-spin couplings, the coupling between different nuclei and the distance between them. In this way you can get information about the inside and what nature is doing internally. You could then go further into technology and speak about the low sensitivity of NMR, the fact that you hardly see any signal unless you apply the right technology, Fourier transforms for instance.

Should science communication be taught to scientists or do they need to develop this skill by themselves?

You need to have good role models telling and showing you how to do it. After that you just need experience. Again you just have to be thrown into the cold water. Go into that kindergarten and teach those little children NMR and you'll learn something. So no, you don't need to have a lecture about science communication but just go out and try to communicate.

In your personal opinion what is the most beautiful experiment to have utilised NMR or 2D-NMR?

I would say magnetic resonance imaging, MRI. It allows you to really look inside the human body, telling you its secrets. MRI has been very important for me. For example there was one time that I was confused, my wife said something's wrong with you, you have to go to the hospital so we went. They used MRI to image my brain and found a stenosis where the blood wasn't passing through properly anymore. I also had an MRI scan when I had issues with my leg so it's really a very useful technique.

It seems that many of your beliefs are centred on the need for balance. How do you try and achieve balance in your own life?

You just have to listen to yourself and take your feelings seriously. When you feel that you've done too much science, you have to get out into life and do something different. In the early part of my life it was music that kept me alive. Initially I was playing and composing music, nowadays I'm just listening. It is important to get out of the science lab and do something more for my mind and enjoyment.

Social responsibility in science is also important to you. During your time as president of the research council at ETH Zurich were there any practical measures you took to encourage social responsibility within the research staff?

Yes, teaching to the public is important to me. We held a public teaching event to mark the 150th anniversary of ETH Zurich. For that event we sent 150 professors onto the streets of Zurich to teach to the public. We constructed tents in the city centre and had professors in there, we gave on order of 300 open lectures in

three weeks. This event taught the public about science and scientific views but had the added advantage of motivating the professors to think about the public, the public's response to them and the importance of being exposed to the public. Initially they were sceptical but by the end they liked it and we want to do it again. The public responded well, it was really a positive event from both sides.