Interview with John Ball

By Enrique Zuazua and Urkiri Salaberria*

interview to

John Ball

(Surrey, 1948)

"The development of a researcher's talent may be hindered by the failure to find the right problems"

John M. Ball, Sedleian Professor of Natural Philosophy at Oxford University (UK)

One of the first things that come to mind when one hears the name John Ball is certainly Mathematics. It is easy to find references to his achievements as a researcher. Along the following lines we shall have the opportunity to know his point of view on the current challenges of science.

(Interviewer Urkiri Salaberria) I'd like to start with your academic career... (Sir John M. Ball): Okay. I graduated in Mathematics from St John's College, Cambridge, where my father and brother went. At that time I was sure that what I really wanted to do was research. That's when I was offered the chance of doing a year's course in Oxford on Algebra. But this would have meant doing more exams, and so I said no. So I decided to go to Sussex, where a former school teacher of mine was a lecturer in the Applied Sciences department.Thus I did my thesis in Mechanical Engineering, though in fact in the end my thesis supervisor was David Edmunds in Mathematics, a change that was made possible through the help of a fellow student. Another key piece of help was that of one of my now great friends, Robin Knops, who in the end offered me my first job at Heriot-Watt University, who when hearing that I did not have a research project introduced me to Stuart Antman at a conference. Stu suggested I read an article by Wayne Dickey and that I should apply to it the methods in the book by Jacques-Louis Lions, which apart from being in French certainly wasn't easy. For me, at the age of 22, that moment was a real revelation, because I understood what it meant to be a researcher and where the difficulty of problems lay. Although I have to say I struggled over the footnotes in Lions book!

After my thesis I spent 6 months at Brown University. Then I returned to Great Britain and spent the next 23 years working at Heriot-Watt University.

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(Urkiri Salaberria) There is one thing that strikes me, and that is you are a professor in Natural Philosophy.

That's right. I've been a professor at Oxford since 1996. As for your surprise about the name of my university chair, it's because the old names of the chairs have been maintained and Natural Philosophy is equivalent to what today we understand as Applied Mathematics. At that time fields of knowledge were grouped together in a more general way; the chair Newton held at Cambridge was also known as Natural Philosophy, and that's the same one that Hawking holds today.

(Urkiri Salaberria) What do you find more attractive, posing problems or finding solutions?

That's an interesting question. In fact, as a student I remember writing an essay on the issue: What is more important in science, finding the right question or answering it? I've always thought that the most important thing is to find a good point of departure; in other words, the development of a researcher's talent may be hindered by the failure to find the right problems.

(Urkiri Salaberria) The method that mathematicians have of drawing up a list of problems to be solved and then getting together at congresses to try to find the solution is rather curious. Perhaps one of these problems, the Poincaré Conjecture, which came to public attention because of the controversy surrounding its solution in 2006, might serve as an example of how they work. What's the origin of a hypothesis? Is it something mathematicians have in their heads and then suddenly comes to light?

For me, problems come from the outside world. When we make models of reality it's because we're trying to understand something. We create a mathematical model that takes variables into account and then compares them. The difference between how mathematicians study mathematics and how other scientists do it is that mathematicians are guided more by the internal logic of the subject.

(Urkiri Salaberria) It seems that the only interlocutors who come close to mathematics are physicists: Have you ever been visited by a poet who wanted to find the structure of a poem?

As far as I know, writers don't usually come to mathematicians.

But going back to your previous question about the process of how ideas are generated; the way mathematicians work is that when we formulate something we often try to generalize it, developing it according to its natural internal structure. Then, it sometimes happens that this now more general mathematics can be used to address questions different from those for which it was first created.

(Dr. Zuazua) The application of models conceived for fluid mechanics in the study of human crowd behaviour, for example? Maybe mathematics will continue to evolve without limits in such a way that they might be applicable to all the disciplines of knowledge and all walks of life?

(Nodding) Love is a feeling particularly difficult to model, but I don't see why we shouldn't be able to create small models based on elements of this feeling. The same might be said for poetry. Who knows?

(Urkiri Salaberria) Are there any differences between infinite, and transfinite?

Okay. The transfinite is a question that doesn't enter Dr. Zuazua's field or mine; there are other fields of mathematics that work with many kinds of infinities. For us there are only two types of infinite; one is the size of the set of all the real numbers, which we know to be much greater than the number of integers 1,2,3,4,5... to infinity. But we often work in infinite dimensions - by this we mean not that space is infinite-dimensional, but that in mathematical models we often need to use infinitely many variables, such as the velocity of a fluid at each point of a container. Unfortunately, we have little or no intuition of higher dimensions - three or four at most. So when we work with infinite dimensions, we make a drawing on two-dimensional paper, and hope that our pictures and ideas also apply to higher dimensions. Sometimes this works and sometimes it doesn't.

(Urkiri Salaberria) Is mathematics universal?

The universe is very large, and we only concern ourselves with a very small part of it. In this sense…

I don't know… let's imagine that there are 140 billion galaxies, and in each galaxy there may be 200 billion stars, so making fantastic extrapolations from our small part of the universe could be very misleading. What works down here might not work out there. It's wonderful what we can see in the starry sky at night, and I believe it's a humbling experience.

(Dr. Zuazua) That's true, and even the concept of what constitutes life itself is not very clear.

(Both smile) That's right.

John Ball

(Dr. Zuazua) Going back to the subject of universality - it is indeed possible to speak of a discipline which, while different in form, depending on the culture, is structurally speaking the same…

It's certainly true that there is an underlying structure to mathematics. We try little by little to get a better understanding of this structure. Most mathematicians behave as if they are Platonists; in other words they think of the structure as if it exists independently of the material world, and yearn to get closer to it. And when I say '"mathematicians"' I don't just mean those whom today we call mathematicians, but those who use mathematics, such as physicists, chemists… In fact the borders between these subjects are blurred.

(Dr. Zuazua) Perhaps what makes we mathematicians different from those in other disciplines is the speed with which they understand things; mathematicians are quite a lot slower. I remember how long it took me to understand the theory of elasticity, and why each material has its own Lamé coefficient. I'm fascinated how with only a little information physicists and chemists are able to formulate hypotheses and theories. Is it because we are stricter?

(They smile) Maybe it's because it's hard for us to interpret an observation without having a theory. Perhaps intuition plays a more fundamental role in other scientific disciplines. It is extraordinary how ideas about the world develop. One of things that strikes me as remarkable is how scientists became convinced of the existence of atoms without ever having observed them.

(Urkiri Salaberria) What about models. Aren't they the fruit of intuition?

We work with models, which are simplified idealizations of real situations. Take the Boltzmann equation, for example, a model for moderately rarified gases. We could criticize how it is derived, but it is often used by physicists as offering a basis of an understanding of thermodynamics, despite its very special character. (Looking at Dr. Zuazua) For a mathematician to say that he understands something, he must have arrived at a depth of understanding greater than those in other disciplines when they say they've understood something…

"Love is a feeling particularly difficult to model, but I don't see why we shouldn't be able to create small models based on elements of this feeling"

(Dr. Zuazua) That's what I meant when I said we were slower.

Yes, it could be that someone working in materials science says that they understand something when they understand the physical processes at work, but for a mathematician working on such problems understanding means something different - we need to be able to predict what happens on the basis of the underlying equations.

(Dr. Zuazua) Yes; for example, in the talk you gave on Poincaré conjecture, there must have been people who went away with the feeling that they understood it, while it took us mathematicians almost 150 years.

Do you think that doctors will accept mathematical tools in the future?

What happens when we go to see the doctor? We describe our symptoms, which are making our life unpleasant, and then the doctor prescribes some drugs to treat those symptoms and to restore us to a state where we feel well again. This is a typical case of a control problem, though mathematical control theory is little used in medicine. The problem is that we don't know what the equations are, but maybe that will change in the future. Instead, doctors rely on personal experience and act as they have acted before in similar situations.

There is always a problem of introducing new ways of thinking into a subject. I think it was Max Planck who said that new discoveries do not become accepted by convincing their opponents, but only when their opponents die. The key lies in the younger generations who are more willing to learn new things and are not wedded to old ways of thinking.

"Young researchers are under a lot of pressure and perhaps this has a negative effect on their results"

(Urkiri Salaberria) You've mentioned the younger generations - how do you see youth today?

Childhood is disappearing due to a lot of factors: television, internet. Innocence is almost a thing of the past. As far as research is concerned, in our time we were able to do research without the need to justify anything in order to get paid. Now I see that young researchers cannot be really happy in their work because they are constantly having to justify what they are doing. Young researchers are under a lot of pressure, and perhaps this has a negative effect on their results.