

Gerardus 't Hooft

Nothing to fear from mistakes

Together with mentor Martinus J.G. Veltman, Gerardus 't Hooft's Nobel Prize in Physics 1999 was won for elucidating the quantum structure of electroweak interactions in atoms.

What is the one discovery that would herald a scientific revolution in the 21st century?

I think there will be many, but there is one field that is developing faster than many others: information and communication technology. I think that the discovery of genuine artificial intelligence (computer programs that have learned to think like a human) would have tremendous consequences. Today, many scientists think that it is impossible, but I don't. If such an intelligence can be constructed, it will quickly outsmart humans by a big margin. The consequences are difficult to predict, and even potentially dangerous — I don't fear that such a program will overthrow humanity or anything like that, but it might bring unparalleled power to those who are in possession of such a device.

How can the public be convinced of the importance of fundamental research with no applications in sight?

The only way to convince the public is by being convinced yourself that it is important. Not all scientists have this attitude. Some scientists draw a line between 'research that has immediate applications' and 'curiosity driven research', placing it around 2 or 3 years ahead. I put that line many centuries away from now, so my task is harder.

Even with this border many centuries away, you can still point to the haphazard and unpredictable path of history, and to the numerous occasions when healthy human curiosity was rewarded with fantastic opportunities and applications much sooner. There are so many examples that I find it easy to convince people of the importance of my research. The applications are only one of the motivations for doing my kind of research. The primary one is a pure desire for understanding the world in which we live. The public wants this too, and we scientists can deliver such understanding.

Why are we not even close to building a reliable quantum computer?

Here, I am much more pessimistic. I am not convinced that a genuine quantum computer can be

constructed that would outperform conventional computers by a big margin, because I have not seen convincing arguments that the numerous obstacles can be overcome. In contrast, conventional computers can, in principle, be improved so much that they will dwarf any of today's expectations of a quantum computer. It will all be in the software. Today's software industry is still very much of the 20th century type.

Many people consider the peer-review system broken. Do you share their view, and do you have a solution?

"The primary motivation is a pure desire for understanding the world."

Peer review is still very important, because all research and all researchers need to be checked and rated. But there is one thing more important — the free availability of research papers all over the world, to anyone, at all times. Unfortunately, the science publishing companies are so desperate to make money that they make scientists pay for the articles they see, and/or the articles they publish, and consequently, much of the peer-reviewed work is actually locked up. We scientists should do all

we can to change that situation. One problem is: who should pay? The scientist who wants to write a peer-reviewed article, or the one who wants to read it?

I would like to see some type of automated system, where a computer program checks a paper's citations and asks a few of the scientists who referenced it to provide some sort of rating; after all, if you cite a paper you often already have some sort of judgment of it. Of course this should not be done too often as this risks overloading scientists who give lots of citations.

What advice would you give all young researchers who are starting their research life so as to become a good scientist?

I once heard about a senior scientist, a Nobel laureate in fact, who gave this advice to a young scientist beginning his career: "Don't make any mistakes!" I came to realize that it is the worst possible advice he could have given. On the

contrary, if you are afraid of making mistakes, you may become a good textbook writer or a mediocre teacher, but you won't accomplish much as a scientist. Science advances by trial and error. Any mistakes made on the way are insignificant. The mistake will surface sooner or later and be corrected. It could be an insignificant mistake or a significant one, but even in the latter case the scientist responsible will not be punished for it; rather, he or she will be praised for being the first to ask the right question.

In short, my advice is: 'Don't be afraid of making mistakes, even in your published papers, but do make it a question of honour to be the first to discover your own mistakes; you don't want your referee or your colleagues to discover it. But then, even if they do, keep in mind that having asked the right question is of much more importance. You will be rewarded for that.'

PROFILE

- Theoretical physicist at Utrecht University, the Netherlands
- Born in 1946 in Dan Helder, the Netherlands
- Has a Nobel prize-winning grand-uncle, Frits Zernike
- 't Hooft was late learning to read, write or even speak
- Came second in the Dutch national maths olympiad, aged 16
- Was coxswain in the Triton rowing club, of the State University of Utrecht — helped by his ability to steer the boat in a straight line
- In 1972 't Hooft completed his PhD, married Albertha Schik (the couple has two daughters) and, together with former supervisor and long-time collaborator Martinus Veltman, joined CERN

