AN INTERVIEW WITH

André Neves

by **Carlos Florentino***

André Neves is an outstanding portuguese mathematician working in the U.S.A. He has held research and professorship positions at Princeton University, at the Imperial College of London and at the University of Chicago, where he is based now. He obtained his undergraduate degree in 1999, at Instituto Superior Técnico, in Lisbon, and the Ph.D. in 2005 at Stanford University, under the supervision of Richard Schoen.

He works on Differential Geometry and Analysis of Partial Differential Equations. Among several distinctions and awards, he was invited speaker at the International Congress of Mathematicians in Seoul (2014) and was awarded a New Horizons in Mathematics Prize in 2015 for "outstanding contributions to several areas of differential geometry, including work on scalar curvature, geometric flows, and his solution (with Codá· Marques) of the 50-year-old Willmore Conjecture." He also received the Oswald Veblen Prize in Geometry in 2016 (conferred by the American Mathematical Society), and was recently elected to the American Academy of Arts and Sciences.

André Neves was the lecturer of this year's Pedro Nunes Lectures, with a seminar entitled: *Counting minimal surfaces in negatively curved 3-manifolds*, the first of this series which took place online. As in previous editions, we took this opportunity for a short interview.

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Let us start by talking about your early years. In School/High School, was Mathematics your favorite subject? What other subjects captured your interest?

I always loved Mathematics. My fondest memories from High School are of being alone in my room studying Mathematics, while listening to music.

Can you tell us about your decision to study at Instituto Superior Técnico (IST)? What made you choose the undergraduate degree in Mathematics and Computation?

It was non-linear, I am afraid. I first chose to pursue an Engineering degree because I could not imagine that one could be a mathematician. I literally thought that all Mathematics had been done by Cauchy, Bolzano, and Weierstrass. Only when I took an ODE's class with Professor José Sousa Ramos I realized that there was a whole world out there to be explored. I then changed my major from Engineering to Mathematics.

Can you describe the study environment at IST during your time there, in particular the role of your professors and colleagues in your Mathematics background, and in your path to become a researcher?

I loved it! It was a very small group and I had the good fortune of being taught by several young mathematicians that had just finished their Ph.D.'s and returned from abroad (mostly from the United States). They would teach Mathematics that seemed very original, sophisticated, and it was truly inspiring.

It is clear that your Ph.D. at Stanford University was a fundamental step in your career. Can you also describe the academic environment there, in particular how you came to work on the interface between Geometry and Analysis, and the role of Prof. Richard Schoen, your advisor?

On my first year, I took a course in Riemannian Geometry that was taught by Rick Schoen. I loved the class and the subject and decided to pursue my Ph.D. in that area. Rick was the first outstanding mathematician I met, and he has served as a role model since.

He was not afraid of pursuing hard questions and if he felt he had a good idea, he would fiercely pursue it. Most importantly, I understood that there is always a good reason for an idea to work, and that trying things just for the sake of it rarely works. He shaped my mathematical career.

Other key moments in your career were the Postdoc at Princeton, the position at Imperial College and the award of an ERC (European Research Council) grant. Can you tell us about those periods?

The time at Princeton was a bit stressful because one of the hardest periods in a mathematics career is the transition from Postdoc to mathematician. There is a tension that comes from the fact that, on one hand, we have to come up with our own problems and carve our own way of doing Mathematics, but on the other hand we also have the pressure to have papers published, because we will be applying for tenure-track jobs soon.

At Imperial College, I had a tenured job and so the pressure of publishing decreased. I was freer to pursue other directions in Mathematics and to tackle problems in which I had to start from scratch.

The ERC grant helped me because it reduced my administrative duties and allowed me to hire postdocs, some of which became good collaborators of mine.

You have established many research collaborations, but the one with Fernando Codá Marques is noteworthy. Can you summarize the story of how you became collaborators and friends?

We met at Princeton and became friends as we were one of the few Portuguese speaking people at the Mathematics Department. We were working on the same field and so we kept discussing mathematics problems on a regular basis. For the first years not much happened, but after a while we were able to look at some old problems with a new point of view and then our mathematics collaborations started.

Some mathematicians follow mostly one problem or guiding principle in their research, others keep changing fields and exploring different topics. Do you have a main philosophical guiding principle?

It is hard for me to answer because I literally pursue the questions that interest me at any given time. As I have become more confident, I have learned that if there is some phenomenon I don't understand, then it is probably worthwhile to pursue that.

You are probably the portuguese mathematician that received more international prizes and awards. What do you think are the most important qualities a researcher must have to achieve such success at the international level?

Being courageous and bold in the sense of not being afraid of addressing problems that are perceived as being hard is a good quality to have, in my opinion.

You have worked both in Europe and in the United States. Do you think there are key differences in the ways Mathematics is viewed by academic departments, and their approaches to research training and funding?

In the U.S. the grants tend to be smaller, but more mathematicians are funded. In Europe, the grants are higher but less mathematicians are funded. I think that is partly because the University Departments in the U.S. fund the postdocs and the students, and so less funding is needed at the individual level. That being said, I am not sure that has

any effect in the quality of research. Both continents have stellar mathematicians.

Even though the World today is facing many crisis, and the areas of research and development are constantly evolving, many European countries have recently invested in Pure Mathematics, by creating Research Institutes in which Fundamental Mathematics form a central part, such as the ICMAT (Instituto de Ciencias Matemáticas, Madrid, Spain) or the IST Austria (Institute of Science and Technology Austria). Do you feel that the establishment of such a Research Institute in Portugal is crucial to promote research in Fundamental Science?

Of course! It would be wonderful if Portugal had a Research Institute in Mathematics like it has in other fields, for instance the *Champalimaud Centre for the Unknown* or the *Gulbenkian Institute of Science*.

Research today in Mathematics is being influenced and shifted by the rise of neighbouring disciplines, such as Data Science, Machine Learning, Quantum Computing, Mathematical Biology, etc, and there is a big pressure to give most of the funds to *Applicable Mathematics*. Do you think Pure Mathematics can continue it's path as before or, in order to strive and be funded, has to stay in close daily contact with Applied Sciences?

I think it is important for Mathematics to be in contact with Applied Sciences for two reasons. One, of course, is the funding issue. The other is more philosophical and is related with the fact that if we work with physical quantities that are governed by fundamental principles, then the mathematical research arising from that tends to reach several fields of Mathematics and Applied Sciences.

For instance, the fact that minimal surfaces are physical objects (i.e., they can be observed) is one of the reasons that minimal surfaces are found across several fields of Mathematics (Geometry, Relativity, Algebraic Geometry, Dynamical Systems, etc).

For instance, I ask questions and talk to colleagues of mine working in Materials Science to have a better idea of how minimal surfaces should distribute themselves in space (they call them gyroids).

What excites you most in mathematics research, and what makes you pursue problem after problem, even after solving already many famous ones? Do you want to tell us about your future projects?

I have always been attracted by simple questions that an undergraduate can understand, but that in order to be solved one needs sophisticated mathematics.

As for the problems that I pursue, it is a mix. Some of them I am motivated because the problems are spin-offs from a larger question that I cannot answer. Other times, I hear about some theorem or conjecture which I find fascinating and so I try to see if I can explain that to myself using the tools that I know. Most of the times I don't, and that means I now have a new direction of research.

You often mention your interest in following portuguese mathematics. Do you see yourself returning to Portugal and establishing a new research group here?

Of course. I would love to have the opportunity to establish a research group in Portugal and help the young undergraduates pursue a career in Mathematics, in the same way that people helped me when I was an undergraduate.