

RWANDA'S SCIENTIFIC REVOLUTION

AN INTERVIEW WITH NEIL TUROK



Neil Turok

NEIL TUROK is a South African physicist and director of the Perimeter Institute for Theoretical Physics in Canada. In 2003, he founded the African Institute for Mathematical Sciences (AIMS) in Muizenberg, Cape Town. AIMS now has centres in six African countries, with the latest opening in Rwanda this year, where the AIMS Secretariat is also newly based. He was interviewed by New Agenda editor (and his father) BEN TUROK

Ben Turok: Rwanda has decided to put science at the heart of its development and to position itself as a hub of scientific development in Africa. Isn't that a bit surprising?

Neil Turok: We picture Rwanda as a very poor country in the middle of Africa, isolated, overwhelmed with colonialism, in the midst of turbulent conflict in the Congo and Burundi, with almost no natural resources to speak of. It should be the last place to find a technological hub for Africa.

Clearly, the country was galvanised by the horrors of the genocide 22 years ago and the new government had a remarkable vision – forced on them by necessity to some extent. They saw the information age coming with the internet. The only way the country would survive and succeed would be through promotion of knowledge and knowledge-based industries.

Lacking almost everything at the beginning, the new government was extremely successful at drawing back the diaspora: Rwandans who had left and gained positions like head of academic departments, head of ministries in western governments, top civil servants, people in industry. The government seems to have leaned on them to come back and contribute, and over the last twenty years, they have put together a remarkable collection of people, very committed, very dynamic. And they have made the most of

“

Universities don't see themselves as part of a global effort to educate and create opportunities. Or they don't enough.

the fact that there were almost no constraints. The good side of starting from nothing is that there is nothing to block you, and if you make the right choices, you can make progress very quickly.

In almost no time, they created universal primary and secondary education. They have tens of thousands of graduates now, each year, where before they had almost none. They have the best broadband internet in Africa, including South Africa or Nigeria or Egypt. They have done it by strategic partnerships. For example, going to Tanzania and negotiating for an optic fibre cable coming ashore at Dar es Salaam and going all the way across to Kigali. Through convincing Western donors to support aid projects and delivering results with superb efficiency, they have managed to make quite remarkable >>

progress. Today, Rwanda is on the verge of becoming the Switzerland or Hong Kong or Singapore of Africa, attracting business, attracting young entrepreneurs, creating a very simple, unbureaucratic environment within which people can launch knowledge-based industries.

AIMS: PAN-AFRICAN AND ANTICOLONIAL

BT: You founded the African Institute for Mathematical Sciences (AIMS) in Cape Town and from there you moved out into other African countries. How did that happen?

NT: After five years in Muizenberg, it became clear that we had to expand. Either we were going to create a centre for a thousand students here or we were going to go across Africa. Because we were already training students from all over Africa, there was a great demand from our advisors and alumni that we deliver high-quality education across the continent. In 2008, we decided to aim for 15 centres over the next decade and began to raise large amounts of money to enable this to happen. The second centre opened in Senegal in 2011, the third in Ghana in 2012, the fourth in Cameroon in 2013, and then Tanzania in 2014. We had a break for a year, and now Rwanda brings us to six centres, with a total student number between 250 and 300. The basic offering is a one-year masters programme in mathematical science.

BT: And what is mathematical science?

NT: Mathematical science comprises all the basic skills you need to become a researcher in any area of science, broadly defined, that is based on analytical or quantitative reasoning. Our particular strength is in mathematical modelling, data analysis, computer skills.



The scarcity of African astrophysicists means that this huge investment will be largely of benefit to Western and outside researchers.

We typically take students who have come through a traditional curriculum in mathematics or applied mathematics or computer science or even engineering. When they come to AIMS, they are exposed to a field like epidemiology for the first time and they realise that, with the skills they have, they can have a great impact – especially on advising governments which interventions will be most effective. We encourage students to get into these new, very relevant disciplines using the latest IT techniques.

Another field is financial mathematics, which is relatively new and sorely needed in Africa, where governments do not have local expertise to, for example, run the stock exchange or international trade. Those skills rely very heavily on mathematics and mathematical modelling. Another field is energy. Most African countries have energy shortages, power cuts, failures of long-term planning. Mathematical projections, modelling and analysis are very much needed. At some level, every single aspect of development relies upon mathematical thinking, projections, planning and so on. African has a terrible shortage of people with the necessary training.

BT: You are not a university or department.

NT: No. I would say that AIMS is a university of a new type: we are firmly focused on our objective, which is to create a highly skilled community of people working in Africa to transform the continent. We are far less interested in paper certification, in the reproduction of academic disciplines, in “ivory tower” academia, if you like. We want academics who are – even when doing very pure research – clearly focused on breakthrough discovery rather than the perpetuation of a profession.

BT: AIMS has also created a large research centre in South Africa.

NT: Yes, now with around five professors, about 25 PhD students, post-doctoral fellows and a number of special chairs. Its theme is mathematical modelling in interdisciplinary contexts, such as finance, biomathematics and epidemiology – and even cosmology and astrophysics.

South Africa will be the base for the largest telescope in the world, starting in 2020. The scarcity of African astrophysicists means that this huge investment will be largely of benefit to Western and outside researchers. We are trying to do our part to rapidly prepare a school of astrophysicists in Africa capable of exploiting this wonderful new device.

BT: Are there universities that sponsor AIMS?

NT: I wouldn't say “sponsor”. In every country we operate, we form partnerships with as many universities as we can. We try to complement what they do by bringing students from the whole of Africa together to learn mathematical science in a very non-standard 24/7 learning environment. They live in a purpose-designed

residential facility with the lecturers who visit for 3 weeks each. It is a sort of boot camp, where they can go about three times faster than they could in a typical university environment. Many of our students then go on to be lecturers or researchers at the local universities, spinning off into more specialised areas or helping with teaching methods. Our graduates have a very intensive preparation in the latest computer skills, which is very valuable in universities.

Through our name, reputation and educational model, we are able to attract some of the very highest quality lecturers in the world. They only have to teach for three weeks at AIMS and many of them are willing to do that, but they would not likely teach a regular course at an African university. So they come and teach – basically around the clock – and try to excite the top African students in cutting-edge disciplines. We encourage these outstanding lecturers to visit local universities and give seminars or raise awareness about leading-edge research globally.

BT: But you did have support from some European and South African universities when AIMS was founded.

NT: We had certain principles when we started, one of which was that we would be pan-African, that the student body would be representative of the continent. AIMS is an anti-colonial institution. It believes in the future of Africa, that Africa can be equal or better than the West in intellectual pursuits. We need Western scientists to share their skills and knowledge, and nevertheless we need the centre to be locally owned and run. Everything at AIMS is a delicate balance of international, African and national involvement. So our governing council involved three top universities in Europe – Oxford and Cambridge in

the UK and Orsay in France – and the three universities near Cape Town: Cape Town, Stellenbosch and Western Cape. They all wanted to contribute, and they allowed AIMS the freedom to govern itself and set its own strategy, in consultation with them, in the belief that there would be mutual benefits in the partnership.

CATALYST FOR THE FUTURE

BT: Now the Rwandan government wants you to act as a scientific catalyst for their whole education system.



We had certain principles when we started, one of which was that we would be pan-African, that the student body would be representative of the continent.

NT: Rwanda is pursuing in a very single-minded way something that I believe every African government increasingly aspires to, which is to make science, technology, engineering and mathematics the key part of their development.

In Rwanda, there is growing awareness that the fastest growing industries are knowledge intensive, and the extreme example is artificial intelligence. Industries may be entirely robotic in the future, and you will be very badly left behind and extremely disadvantaged unless you have smart people who understand these technologies and can invent with

them and exploit them. Rwanda is just unusually single-minded. They look at AIMS, they see an unusual approach to graduate training that is highly interdisciplinary and highly opportunistic – in that we are always looking for the latest, the most relevant, the most interesting fields – and they resonate very strongly with our pan-African mission, basically because they want to attract Africa’s top people, intellectuals, to come and get involved in Rwanda’s development. They are all about collecting the best talent they can and they see AIMS as a means to doing that.

Rwanda has succeeded in creating universal primary and secondary education of reasonable quality in a very short space of time. They are greatly expanding higher education. But they are well aware of all the problems of traditional approaches to primary, secondary and tertiary education: an over-reliance on rote learning; fixed, usually out-of-date curricula; compartmentalisation of knowledge.

I can give you a little example of a scientist or a technologist today. When they sit in their office or discuss with colleagues, what they actually do is not what they were examined on at university. They were taught to study textbooks, to answer questions of the same type that students have been answering for the last fifty years in those fields. What they *actually* do is use the internet to look at the latest idea. They make a mathematical model of some sort and they test it against the data. They need to be very *au fait* with data analysis, model building, projection, logical analysis and computing.

Now the irony is that none of these skills are ever taught at university. I experienced this thirty years ago when I went to postgraduate studies. It was quite a shock because I discovered that none of my undergraduate courses >>



None of my undergraduate courses were remotely relevant to what I was supposed to be doing.

were remotely relevant to what I was supposed to be doing. I had to learn whole new areas of mathematics. I wasn't taught mathematics, but leading-edge physics often requires new areas of maths that haven't previously been used in physics. You have to be able to jump in and learn quickly. So it is all about being agile intellectually, looking for connections that have been missed by previous scientists. It is not the mechanical application of systems that have already been developed, because largely the applications have already been worked out.

INSTITUTIONAL DRAG

BT: Are African universities producing good quality graduates in these areas?

NT: I would have to say that the quality is emerging *in spite of* the universities – and there is no blame attached to that at all. African universities have operated under very difficult conditions for the last three decades, as governments have increasingly been unable to provide the necessary support to sustain world-class learning. African academics have had to survive with very limited support, low salaries, unable to stay in touch with their international colleagues, overwhelmed by student numbers.

The quality is there. People have the ability to think everywhere in the

world. And there are large numbers of young people in Africa, many of them highly aspirant. They want the same things that everyone else in the world wants. They want to be successful, they want to understand the universe, they want to become quantum engineers, you name it. Access to the internet is only increasing these aspirations.

I think the students are very good at swimming against this ocean of difficulties, negotiating academic systems, getting what they can and battling their way through to find AIMS. When they do come to AIMS, they suddenly feel that, at last, somebody is there to support them and provide an environment in which they can study seriously. At each centre, there is a maximum of one-quarter local students from that country. So generally, they are leaving their homes, living in a 24/7 learning environment, with good internet, library, excellent lecturers flying in – and of course all their colleagues, from whom they learn the most of all. These are young people who will be the future leaders of Africa, so they learn a huge amount from each other. They learn to understand each other's cultures, they learn that many of their problems are common across Africa, and they start brainstorming



I think all the universities in the world are insufficiently outward looking. Often it is a question of survival. They focus on their own budget, their own success.

about what is needed to rescue the continent. So many of them reorient themselves when they come to AIMS. They start out as pure mathematicians and end up interested in bioscience or agriculture or energy or something much more applied.

BT: Is South Africa helping this development of science on the continent?

NT: The South African government provides more funding to AIMS than any other government – but it has been rather slow to appreciate the ocean of talent that lies untapped in Africa. South Africa tends to be rather nationalistic. For example, the Square Kilometre Array will be based in South Africa with telescopes all over southern Africa – it is a marvellous opportunity for a collective African scientific endeavour. I would say that the South African government hasn't a clear appreciation of how important it is to execute a systematic plan for the skilling of young people all over Africa. It can start in the very highest abstract disciplines like astrophysics, but it is even more urgent in applied fields.

BT: Are you saying that South African universities are not outward looking?

NT: I think all the universities in the world are insufficiently outward looking. Often it is a question of survival. They focus on their own budget, their own success. Their own place in the international league table. They don't see themselves as part of a global effort to educate and create opportunities. Or they don't enough. In many ways, they are assets to their countries, but they are often as much a drag on the pace of development. Like any large institution, universities move very slowly and they become focused on their own interests rather than those of the country or the continent.

NA