Catching Up is Hard to Do

by Edmund Zingu

Science feeds development, and in Africa more countries are looking to beat the odds and gain benefits.

To excel in physics research in Africa is to conquer Mount Everest without the aid of additional oxygen. In a continent that generally lacks the infrastructure of research laboratories, technical support, and so forth, relatively few physicists have managed to perform at levels competitive with the best in the world.

Are the challenges of physicists in Africa any different from those facing physicists elsewhere? Physicists everywhere have to convince their governments, businesses, and the public that investment in physics is beneficial and will lead to economic development and an enhanced quality of life. But in countries where physics-based industries are absent and where people are shackled by poverty, physicists face enormous challenges accessing the resources they need.

The physics community is proud of its accomplishments. Physicists can easily identify instances of great intellectual achievement and impact, but unless they have an understanding of the practical value of their knowledge in the contemporary economy of their country, they will fail to persuade investors to support them.

Education and Innovation

The important role of education in wealth creation was emphasized by Osita Ogbu, Executive Director of the 17-member African Technology Policy Studies Network, when he stated: "With knowledge, you create your own wealth, with aid you create dependency." The participation rate in science education at secondary school level is a key indicator of a country's potential for producing a scientifically literate society, which in turn, is a prerequisite for the development of a physics tradition and technological and economic advancement. Some of the poorest countries have gross enrollment rates of between 5% and 10%. It is therefore not surprising that the development of a physics tradition, and the corresponding public investment in physics in those countries, is limited, or even nonexistent. With a poor base of indigenous talent to appreciate and use technology, the capacity of a country to innovate, adapt technology to local conditions, and use and maintain technologies is out of reach.

Secondary schools frequently lack suitably trained teachers who are enthusiastic and capable of stimulating scientific thinking. Most governments provide financial support to needy students at university. The poor prospects for job opportunities in the private sector have influenced students in Kenya to consider a guaranteed career in teaching because of the preferential financial support that the Kenyan government offers to students who include pedagogies in their study program. Consequently, in 2002, at least 95% of the students who graduated from one Kenyan university with a physics major had completed a second major in education and accepted a government requirement that they teach science at a secondary school after graduation.

The scholarship program is a step toward ensuring that science teachers will no longer be a scarce commodity in Kenya. The lack of adequate facilities for science teachers in Africa, though, continues to be a problem.

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Technological underdevelopment in Africa during the present period of accelerated technological change in the rest of the world makes it literally impossible for Africa to compete internationally, either in manufacturing or in advanced services. Each leap forward in global technology leaves Africa farther behind. Although wealth is not the sole indicator of technological development, it does determine a country's capacity to integrate technology into its economy. In 1960, the per capita income in the richest 5% of countries worldwide was 30 times that in the poorest 5%. By 1997, it was 74 times as high.

The period 1989-2000 saw 52,000 additional physics-based enterprises established in the UK. Consequently, 43% of manufacturing employment in the UK is in physics-based industries. Can such development be replicated in an Africa with no technology base?

African countries need to consider whether they should invest in basic sciences—whether they can enter the R&D (research & development) chain without a solid foundation in basic research. Physics and engineering departments in most African countries would not, on their own, be able to make meaningful contributions to technology development; their research output is just too limited.

Over the years, South Africa's national Council for Industrial and Scientific Research (CSIR), based in Pretoria, has become a vibrant hub for innovation and technology development. That facility, which undertakes R&D activities for local industries, could serve as a model for other African countries or regions. But bear in mind that the CSIR in South Africa is supported by an education system that enjoys substantial support from the government for teaching and research, and is located in a country that spends at least 0.81% of its GDP on R&D.

Although many governments worldwide recognize the need for investment in physics and other disciplines, no universal norm exists for any government to determine the appropriate amount of spending. The Organization for Economic Cooperation and Development (OECD) countries expend $200 per inhabitant on R&D; newly industrialized countries spend $66 per inhabitant; China, $17; India, $11; and Africa, $6 on average. Most countries in Africa—Mali, Uganda, and Zambia, to name a few—spend far less than the average, which means that very few African countries can meaningfully support R&D.

In order to compete internationally, African countries must acquire enterprise-specific knowledge, skills, and practices through an incremental process. They must also recognize that networking between competitors is essential in today's economy. The OECD, an international collaboration of developed countries, has played an important role in the economic, industrial, and technological development of its member countries.

Promising signs are on the horizon. The New Partnership for Africa's Development (NEPAD) which was established in 2001 has as its goals, to promote better government, end Africa's wars, and reduce poverty. The Heads of State of the G8 countries recently (July 2005) announced a multibillion dollar commitment to finance the G8 Africa Action Plan of 2002. Such aid through North- South partnerships between countries well-endowed with resources and those that have few will augment NEPAD's initiatives to achieve its objectives.

Opportunities are opening for African scientists through education and training at IAEA scientific laboratories and the International Centre for Theoretical Physics in Trieste, Italy, which the IAEA supports.

Within NEPAD, science and technology initiatives have been established to achieve some of the NEPAD objectives that would be necessary if Africa is to catch up with the rest of the world. The first NEPAD workshop on science and technology, held in February 2003, emphasized cooperation and the use of knowledge from institutions of excellence throughout Africa. A clear sign that NEPAD has the potential to positively impact science and technology in Africa is its strategy to network centers of excellence to promote and develop innovations that will address the continent's socio-economic challenges.

The IAEA funds important activities in the fields of radiation protection and safety, nuclear medicine, and maintenance of scientific instruments, all undertaken by a consortium of countries in Africa under the African Cooperative Agreement for Research, Development, and Training Related to Nuclear Science and Technology (AFRA). Through regional participation, intellectual and physical resources are coordinated, capabilities in the diversified areas of nuclear technology are enhanced, and the development of expertise is facilitated.

The Case of East Africa

The region of East Africa stretches from Sudan in the north to Swaziland in the south. With a population of 230 million, East Africa includes some of the oldest universities in Africa and some of the youngest democracies. In many ways, the region is representative of the entire continent.

Approximately 140 PhDs participate in active physics research there. That translates into approximately one PhD physicist for every 2 million people. By comparison, South Africa has one PhD physicist per 140,000 people and the US has one PhD physicist for every 8,000 people. Of the 80 or so research groups in East Africa, the majority do not have more than one member with a PhD in physics.

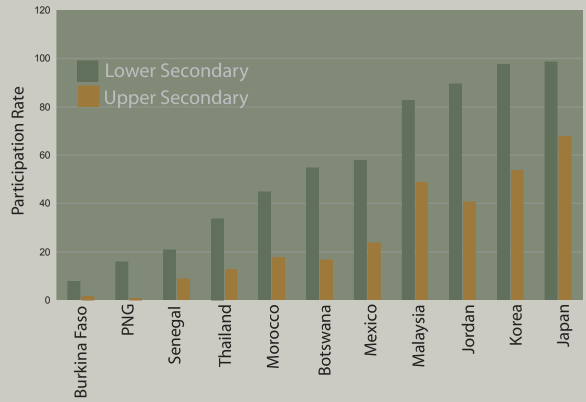
The Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy has played an important role in providing resources and opportunities for physicists from developing countries. The ICTP provides resources and opportunities so that physicists in Africa and other developing countries may attend classes, perform research, or work on publications at the center for short periods. The ICTP's affiliated centers and visiting scholars programs are well known in African universities; hardly a PhD physicist in East Africa has not had an association with the ICTP. (The Centre operates under a tripartite agreement between the government of Italy, the IAEA and the United Nations Educational, Scientific and Cultural Organization. See box on next page.)

In East Africa, two programs developing the research infrastructure have been especially noteworthy. During the 1980s and 1990s, the International Program for Physical Sciences (IPPS) in Uppsala, Sweden, invested extensively in the physics department at the University of Dar Es Salaam in Tanzania. The IPPS focused on one particular area of research—thin-film physics—and successfully developed a well-equipped laboratory. The program also provided travel funds so that physicists in neighboring countries could use the Dar Es Salaam facility. Although the facility is isolated in a single institution, it has provided opportunities and resources for a core of the current generation of physicists in the region. The foundation has been laid for the development of physics-based industries in Tanzania.

Kenya took a different approach. The Kenyan government entered into a loan agreement with the World Bank and purchased research equipment for each of its five physics departments. The Kenyan government has made a commendable and serious attempt to cultivate the research base that would eventually support technological development. If Kenya handles its opportunities well, over the next few years its research initiative, combined with its strategy to train large numbers of science teachers, should lead to a flourishing of science in general and of physics in particular.

Participation Rate in Science

Lower & Upper Secondary



Enrollment rates in science at secondary schools vary dramatically by country. Some poor countries have rates of between 5% and 10%, compared to far higher levels in richer countries.

Source: World Bank, K.M. Lewin, "Mapping Science Education in Developing Countries" (2000).

Investing in People

Scientific advancement cannot occur without quality education; to achieve that quality, Africa will require significant investment at all educational levels.

Worldwide, competitors have become collaborators and have enhanced their economic, technological, or academic statures by forming alliances and partnerships. For African countries to significantly advance, they must collaborate regionally or internationally. The success of those partnerships will depend on having a well-endowed leading member. Examples of partnerships include the African Materials Research Society, African Institute for Mathematical Sciences, Working Group on Space Sciences in Africa, and African Laser Centre. Those initiatives, in which South Africa plays a leading role, carry the hope that expertise will be developed to create a science and technology infrastructure in Africa.

Can the world afford to let Africa remain far behind? Programs and approaches have demonstrated the potential to develop physics for the benefit of the African society. Having African countries participate with others in a global village of technology is in the interest of every nation.

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ICTP

a home away from home

For the four decades of its existence, the Abdus Salam International Centre for Theoretical Physics (ICTP) has served as a scientific home away from home for some 100,000 scientists from around the world. ICTP has nurtured young scientists from almost all developing countries, exposed them to new frontiers, and provided them a springboard for testing their own ideas and launching their scientific careers.

In today's world, when it comes to economic and social well-being, developing nations face the dual challenge of trying to catch up with developed countries while simultaneously keeping abreast of the latest technologies.

It was on 22 September 1960 at the plenary session of the IAEA's Fourth General Conference that Abdus Salam, then a 34-year-old physicist, first called for the creation of an international institute for theoretical physics. Four years later, with the backing of IAEA's Director General Sigvard Eklund and a pledge of generous support from the Italian government, the International Centre for Theoretical Physics was officially launched in Trieste, Italy.

Broadly cast, ICTP's mandate seeks to foster, through research and training, progress in all branches of theoretical physics and mathematics, with special attention to the needs of developing countries.

Over the past 40 years, scientists from more than 170 countries have participated in ICTP's schools, workshops and conferences or have come to the Centre as visiting scientists with the opportunity to pursue their own research and forge new collaborations.

Each year the Centre sponsors over 50 research and training activities that attract on average a total of 4,000 scientists. Another 2,000 scientists come to the ICTP each year to participate in activities that the Centre hosts for other organizations that include local institutions and other organizations in Italy and the world.

Meanwhile, the ties between ICTP and IAEA, which remained strong over the past four decades, have grown even stronger ever since IAEA Director General Mohamed ElBaradei visited the Centre in September 1999. The IAEA now co-sponsors 10 to 15 training and research courses at ICTP each year in fields ranging from plasma physics to nuclear data collection. IAEA staff members serve as directors of many of these activities, working closely with ICTP staff and scientists.

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IAEA's efforts to advance peaceful applications of nuclear research in areas of public health and the environment complement ICTP's efforts. Together they help to build the scientific capacity of countries in the developing world in ways that provide invaluable assistance to scientists there.

The two organizations not only share common values, but also a common history. Both organizations look forward to the future with confidence and commitment.

Sandwich Programme

The ICTP and IAEA have recently strengthened their collaboration through the creation of the Sandwich Training Educational Programme (STEP), launched in 2002. STEP offers IAEA fellowships to PhD students from developing countries in fields covered by the IAEA Technical Cooperation Programmes and within the scientific and technical competence of the ICTP. The fields include atomic, laser, nuclear and plasma physics, mathematical modeling, medical radiation physics, and nuclear, isotopic and synchrotron radiation techniques. To date, more than 40 scientists from 15 countries have participated in the programme. For additional information, see www.ictp.it (Training and Education).