The Abdus Salam
International Centre for Theoretical Physics

United Nations Educational, Scientific and Cultural Organization

IAEA
International Atomic Energy Agency

NEWS from ICTP

G8-UNESCO World Forum

Education, Research and Innovation: New Partnership for Sustainable Development

United Nations
Educational, Scientific and
Cultural Organization

G8-UNESCO WORLD FORUM 2007 TRIESTE

Under the High Patronage of the President of the Republic of Italy

Trieste, Italy
10-12 May 2007

SPRING 2007

#120

Special Edition

Education. Innovation. Research.

At one time, not too long ago, these three critical factors, which play key roles in driving economic and social progress, largely operated as independent entities.

That is no longer the case. In today's world of global knowledge (and global competition), every prominent player in society—governments, international organizations, nongovernmental organizations, universities, research centres, and the private sector—views education, research and innovation not as isolated elements for economic progress but as integrated forces that must work together as seamlessly as possible if sustainable development is to be achieved.

This special issue of *News from ICTP* is designed to offer a sampling of the discussion that will take place during the G8-UNESCO World Forum on 'Education, Research and Innovation.' The event, which the Abdus Salam International Centre for Theoretical Physics (ICTP) is organizing, is taking place in Trieste, Italy, from 10 to 12 May 2007. It is only fitting to include voices not just from a variety of perspectives but also from diverse geographical settings.

Globalization, by definition, is a global process with global implications. But individuals (or individual nations) have not shared equally in its benefits; nor have they been equally burdened by its adverse consequences. Think about access to modern medical procedures and practices. Now think about the growing adverse impacts of global climate change. Poor people—and poor nations—have had too little of the former and are likely to experience too much of the latter.

It could well be that the most marginalized people of our increasingly globalized world will suffer the most from the globalized forces at work—unless we pursue collective measures to promote shared responsibilities and shared actions that not only help to create aggregate wealth but also greater equity.

That is why the second major theme of the forum—new partnerships for sustainable development—is of equal importance to the first. Just as the boundaries between critical societal pursuits—education, innovation and research—are disappearing, so too are the boundaries between disciplines, communities and nations. We are all in this globalized world together, and it is together, as partners, that we must meet the challenges we face. That is the message presented in the articles that follow, and that is the message that will be presented even more forcefully and broadly during the forum itself.

Daniel Schaffer
Public Information Officer
The Abdus Salam International Centre for Theoretical Physics
Trieste, Italy

Katepalli R. Sreenivasan

Director
The Abdus Salam International Centre for Theoretical Physics (ICTP)
Trieste, Italy

Katepalli R. Sreenivasan explains how the G8-UNESCO World Forum on 'Education, Research and Innovation: New Partnership for Sustainable Development' came to be and what he hopes will be accomplished as a result of this event.

Katepalli R. Sreenivasan

ON THE WAY TO THE FORUM

A little over a year ago, I wrote an article on the permanent migration of scientists from the poorer to the richer parts of the world. The article's main point was that such migration would decline if we could devise means to support the short-term mobility of scientists throughout the world and thus make it easier for them to exchange information and ideas. I sent the article to Antonio Bernardini, then working at the Italian Ministry of Foreign Affairs and entrusted with the coordination of international institutions in Trieste. He and his colleagues thought well enough of the article to express interest in organizing a meeting at ICTP focusing on the issue.

Some time later, preparations for the G8 annual meeting in St. Petersburg, Russia, scheduled for July 2006, were proceeding and a document for a joint declaration was being prepared. The meeting's focus was on the role of education and research in innovation societies.

Having been primed of my interest in such matters, Bernardini asked me to comment on the draft document. ICTP assistant director Claudio Tuniz and I reviewed the document and made two major suggestions. First, the outcome of the so-called knowledge triangle (involving education, research and innovation) should be connected to global sustainability. Second, although the document primarily dealt with G8 countries, reference should also be made to developing countries. Developing countries occupy more than two-thirds of the land and contain nearly 80 percent of the world’s population. Therefore, major problems that afflict developing countries—environmental pollution, land degradation, depletion of natural resources, the spread of diseases, poverty, starvation and illiteracy—affect the G8 countries in both direct and indirect ways. Thanks to Bernardini's efforts, several of our comments found their way into the final document.

As a consequence, the proposed meeting at ICTP, which was to concentrate on scientific mobility, was recast as a G8 forum designed to examine the relationship of the knowledge triangle to sustainability. While attention would remain primarily focused on G8 countries, connections to countries that do not belong to the G8 would also be explored. At this point, it was collectively thought that involving the United Nations Educational, Scientific and Cultural Organization (UNESCO) would be highly beneficial. UNESCO is one of ICTP's parent organizations and the Director-General had already launched the United Nations Decade of Education for Sustainable Development (2005-2014). It thus came to pass that the meeting would be called G8-UNESCO World Forum on 'Education, Research and Innovation: New Partnership for Sustainable Development.'

Trieste seemed to be the logical place to hold the event because of the city's unmatched efforts on behalf of science in developing countries—a role the city has played for more than four decades beginning with ICTP and, more recently, through other international institutions such as TWAS, the academy of sciences for the developing world, the International Centre for Science and High Technology (ICS) and the International Centre for Genetic Engineering and Biotechnology (ICGEB).

UNESCO's involvement expanded the character of the forum by making it more international in scope. This expansion was aided by the opportunism with respect to the availability of the right people willing and able to speak on the right subject, as well as a compromise among the wishes of the many parties involved, including suitable representation from the G8 countries. One common theme was embraced by all: To focus attention on Africa.

Ultimately, the forum provides a platform for expressing diverse viewpoints from representatives of governments, universities, research institutes, industries and the private sector on its main theme, 'Education, Research and Innovation: New Partnership for Sustainable Development.'

First and foremost, the forum is neither a purely political nor a purely scientific meeting. Second, it was decided early on that no formal resolutions would be passed at the conclusion of the event, not because good resolutions are to be avoided but because history shows that resolutions are rarely effective unless they are backed by financial and organizational commitments.

Instead, it was felt that, if the forum could bring out a few good ideas that resonate with attendees in such a way that they could work on them in their own way; if it could focus attention on important issues for which partial solutions have been achieved in different parts of the world; and if it could spark the imagination and commitment of the participants to address these issues in new and innovative ways—that would in themselves be significant contributions.

The forum also constitutes a platform for the presentation of initiatives that deserve further support, or for the development of new programmes aimed at the reduction of the technological gap in the world, primarily in sectors such as modern technologies of information and communication, nanotechnologies and bioengineering.

The key to the success of the forum resides in the quality of the speakers and the presentations, and the depth of the discussions. We strived to get the best people possible and indeed many luminaries from government, industry and academia have agreed to participate. There is little doubt that important things will be said. All presentations will be recorded and may subsequently be published as proceedings, if participants agree that this is a useful thing to do. We did not aim for long presentations or uniformity of views.

From the outset, we hoped that the situation in sub-Saharan Africa would receive particular attention. We also (dare I say, yet again?) hoped that there would be some discussion of Africa's needs that all of us will keep in mind and do our best to alleviate in our own ways. It is important to remember that good individuals working together will make the difference; indeed, it is our collective responsibility to make this difference. This will not happen by throwing money at the problem (although nothing can be done without money) but by building human capacity. This is a difficult and time-consuming task with no shortcuts, and it is a task that does not make headlines or excite the imagination of politicians, activists or the powerful. Yet there is no other way to use available resources wisely for the betterment of the world's populations. I hope that this will come through as one clear message of the forum, and that the institutions and people who are engaged in such efforts will receive support and recognition—not for their own sake but for redoubling their work. The fact is that unless the number of scientifically educated people exceeds a certain threshold in every country, it is not clear that scientists can have serious input into decisions that affect the fates of their societies.

Many sectors of the Italian government and UNESCO, Italian embassies throughout the world, and other organizations in Trieste and the region of Friuli Venezia Giulia have been involved in the organization of the forum. Whatever success has been achieved has been due to the unstinting interest from the very top; particularly the Prime Minister of Italy, Romano Prodi, and the Director-General of UNESCO, Koïchiro Matsuura. Too many others have contributed to this endeavour to name them all, but I should like to express my thanks to those who have worked with me in the trenches, so to speak, on a day-to-day basis. Within ICTP, numerous staff members have given their time and energy, in particular Claudio Tuniz, Federica Delconte and Stanka Tanaskovic; at the Ministry of Foreign Affairs, Teresa Savanella, Antonio Bernardini and Renzo Rosso; at UNESCO, the designates of the Director-General, Mary-Louise Kearney and Mohammed El-Tayeb; and at the Italian Permanent Mission to UNESCO, Ezio Bussoletti. □

Koïchiro Matsuura

Director-General, UNESCO
Paris, France

Koïchiro Matsuura explores how his organization's broad-ranging programmes seek to advance the goals of sustainable development through education, research and innovation.

Koïchiro Matsuura

INNOVATION FOR ALL

We will promote the global innovation society by developing and integrating all three elements of the knowledge triangle (education, research and innovation). We will do so by investing fully in people, skills and research, and by supporting the modernization of education systems to become more relevant to the needs of a global knowledge-based society.

That was the sentiment expressed by G8 leaders in a broad statement of intent which they endorsed at the G8 2006 Summit held in St. Petersburg, Russia, last July.

Ten months later, thanks to the generosity of the Italian government, the G8 and UNESCO have joined together to hold the G8-UNESCO World Forum on 'Education, Research and Innovation: New Partnership for Sustainable Development.'

The forum, which will take place from 10-12 May, will examine how to better utilize the synergies created by education, research and innovation as part of the larger global efforts now taking place to build a more prosperous, equitable and peaceful world. UNESCO, whose roots lie at the nexus between education, science and culture, is indeed honoured to be directly involved in the organization of this effort. We would like to thank the Abdus Salam International Centre for Theoretical Physics (ICTP) and the other members of the Trieste System for serving as hosts.

We live in a knowledge-based society where virtually every societal issue of consequence is directly linked to advances in science and technology.

Think of a world without the internet. That world did not exist two decades ago. Yet, today our global society could not function without electronic communications.

Now think of a world without nanotechnology. Easy to do, you say. But that won't be the case 10 years from now, when products and services in fields as diverse as facial cosmetics and water filtration systems are likely to be revolutionized by the ability of scientists and technicians to construct physical and biological structures one atom and one molecule at a time.

But it's not just broad advances in frontier areas of science and technology that will continue to define who we are and how well we live. Equally significant is how we choose to use the knowledge we create. The key is to generate knowledge, not just for its own sake, but also for the sake of spurring innovation—and then applying at least a portion of that innovation to addressing critical human needs.

After all, we not only live in a world of unprecedented change, driven largely by science and technology, but also in a world of vast inequality and crushing poverty. Science and technology will be able to fulfill their unlimited potential for social good when they not only broaden the horizons of the world of discovery but also confront the stark reality of everyday life for the one billion people who live on less than US$1 a day and who suffer disproportionately from malnutrition, disease and despair. Science and technology, therefore, must not only be used to satisfy human curiosity. They must also be used to help satisfy the basic needs of our most marginalized citizens.

Achieving this goal requires us to focus on promoting reforms in several fundamental aspects of society.

First, there is a need to achieve high-quality basic education, literacy and gender equality across the globe and especially among the world's poorest nations.

Second, there is a need to build and sustain human and institutional capacity for science, technology and innovation, especially among the world's most scientifically and technologically impoverished nations.

Third, there is a need to protect and promote indigenous knowledge, most notably as invaluable contributions to global efforts to advance public health, biodiversity and sustainable development.

Fourth, there is a need to embrace knowledge as a public asset and to make it accessible to all. Knowledge acts as a powerful lever in the fight against poverty, misunderstanding and suspicion. Therefore any barriers that stand in the way of sharing knowledge stand in the way of progress.

And, fifth, there is the need to nurture broad institutional networks where information is freely exchanged. Such networks, which have become easier to create and sustain thanks to the explosive growth of the internet, are designed to be horizontal, not hierarchical in nature and, as a result, tend to encourage cooperation among equals instead of 'benevolent' information flows from the 'haves' to 'have-nots.'

That, in turn, brings me to my final point. The forum's subtitle calls for a "New Partnership for Sustainable Development." The most critical word is "partnership," which refers not just to the relationship between education, research and innovation but also to the relationship between individuals and institutions in both the developed and developing world.

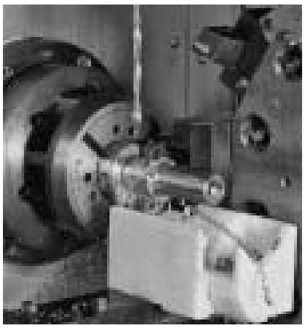
"Science," wrote Abdus Salam, the founding director of the International Centre for Theoretical Physics," is the common heritage of all humankind." I am sure that if Salam were alive today, he would be the first to agree that science—together with research and innovation—will also be among the most common elements of our future as well.

It is in the spirit of partnership that UNESCO looks forward to the discussions that will take place at the forum and to the follow-up activities that will enable our global society to reach out to the frontiers of science while simultaneously attending to the needs of our most vulnerable citizens.□

Janez Potočnik

European Commissioner for Science and Research
Brussels, Belgium

Janez Potočnik says that the EU's European Research Area (ERA) promotes scientific collaboration not only in Europe but also increasingly across the globe.



BETTER TOGETHER

We all know that the world is rapidly changing. In a sense, it is shrinking and becoming more interconnected. This new reality demands that we think differently about how we live and work. Most importantly, it demands closer cooperation among nations.

This philosophy lies at the heart of the European Union (EU): Together, we are stronger. This principle not only drives the relationship among our member states, but also drives our relationship with the global community.

ITER, the global fusion energy project, is an excellent example of international cooperation in science. The project's seven partners—the EU, China, South Korea, Japan, the United States, Russia and India—have pooled their knowledge and resources to work together on a critical scientific and technological problem of global interest. Each will contribute to the project and each will benefit. A simple yet compelling concept has led the partners to collaborate with one another: Together, the project partners can advance the frontiers of science and technology much more rapidly than they could ever do on their own. During a recent trip to India, I was able to visit fusion research facilities there and talk to fusion scientists. I learned first-hand how being an ITER partner benefits India and how having India as a partner benefits ITER.

Efforts to promote science and technology through the EU's Research Framework Programmes provides another excellent example of the growing circle of cooperation that now delineates the expanding boundaries of science. The 2nd Research Framework Programme, which ran from 1987 to 1991, involved just 30 countries and territories from outside the EU. By the 6th Research Framework Programme, which ran from 2002 to 2006, 206 countries and territories were collaborating on science projects of common interest.

The EU's principal partners in scientific research have thus far largely come from developed countries—Australia, Canada, Japan and the United States. But that is rapidly changing. Indeed we are witnessing a dramatic increase in the involvement of such emerging economies as China and India and a noticeable increase in involvement of developing countries in general.

Cooperation takes many forms: from the development of clean coal technology in China, to improved methods for accessing safe drinking water supplies in Sri Lanka, to increasing the productivity of the groundnut harvest in Botswana, Namibia and Swaziland.

The EU has also sought to build bridges for international scientific collaboration beyond the activities associated with the research framework programmes. For example, later this year, the EU will put in place a European-wide system of 'scientific visas,' which should greatly simplify entry procedures for scientists who are coming from abroad to study, participate in conferences, and work on joint projects with their colleagues in Europe. Such visas are designed to help European scientists forge long-term partnerships with colleagues from around the globe.

The EU has made considerable progress in opening its borders to scientists from abroad over the past decade. But it must work even harder in the future to make science an integral part of its relationship with the rest of the world. The ultimate goal is for the EU to be seen as a truly global destination for science.

Greater openness is one of the main focal points of the EU's recently adopted vision designed to realize the continent's research potential. Knowledge is at the heart of this strategy and improving the research environment across a broad spectrum of issues is a major objective. Infrastructure, curricula, funding schemes and programmes for the exchange of personnel are all considered critical prerequisites for success.

Europe has many strengths in scientific research. Yet these strengths are too often dispersed and fragmented, which means we are not making the best use of them. To rectify this situation, the EU has called on not only researchers but also businesspeople, decision makers, educators and financiers to voice their opinions on how to tap the EU's wealth of scientific and technological expertise to advance economic development and social well-being. On the basis of the comments and suggestions received, the European Commission will come forward in 2008 with concrete proposals for measures that can improve the situation.

Knowledge and research are central to the national reform programmes that have been drawn up by the EU member states. All member states, for example, have agreed to increase their spending on research and development (R&D) to help advance the EU's overall goal of investing 3 percent of its gross domestic product (GDP) in R&D by 2010.

This target is important because it is a sign that the correct policies to support R&D are in place. At least two-thirds of R&D expenditure should come from the private sector by 2010 (the current figure is around 55 percent). Policy makers, of course, cannot force the private sector to invest in R&D. But they can create conditions that encourage such investment—for example, by improving national and cross-border frameworks for the protection of intellectual property rights, enhancing access to venture capital and increasing the role of private philanthropy to support research and development. Only by having the correct policies in place will we be able to boost private investment and so reach 3 percent.

In 2005, the EU adopted an innovation strategy designed to do just that—create the right conditions for more private investment in R&D. While the strategy has achieved some success, especially in facilitating cooperation between universities and the private sector, efforts to place science at the centre of sustainable economic development remain fragmented. National levels of investment in R&D, for example, vary widely across the EU, from just 0.4 percent of GDP in Cyprus to 3.86 percent in Sweden (among the highest levels in the world). Annual rates of growth in R&D investment also vary widely, from about 15 percent between 2001 and 2005 in Lithuania, Estonia and Latvia, to stagnation and even contraction in Belgium, the Netherlands and Portugal over the same period.

Member states administer some 95 percent of the public R&D funds available within the EU. National spending on R&D is generally directed towards national priorities and usually favours national research organizations. Nevertheless, much can be done with the 5 percent of public expenditure that the EU does administer. It does, after all, mean that the EU will have nearly €55 billion to spend over the next seven years under the 7th Research Framework Programme. Sixty percent of this funding will be dedicated to R&D activities centred on 10 thematic priorities closely linked to the major issues currently facing European society—for example, agriculture and food, public health and improved transportation schemes that pose less risk to the environment. The 7th

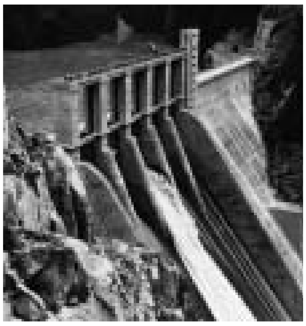
Research Framework Programme will also fund the newly created European Research Council (ERC). Through the ERC, the EU, for the first time, will support scientific research based solely on scientific excellence. The ERC will be an 'ideas factory,' pushing forward the frontiers of what we know about the world we live in.

It is not an exaggeration to say that Europe is entering a new era—an era of knowledge. Across the board, policies are designed with the recognition that greater emphasis on education, research and innovation—exactly those issues covered by the G8-UNESCO forum—will make them more efficient and effective. And we recognize that this knowledge-based approach will not succeed in isolation. In this area, as in others, the EU will seek to be a partner with others from around the globe. The message is clear: Together, we can do better.□

Isao Ike Yukawa

Adviser, Past-President
Kyocera Solar Group
Kyoto, Japan

Isao Ike Yukawa urges the world to turn to renewable energy to build a sustainable future.



SUSTAINABLE ENERGY

Industrialization has provided many benefits. However, the world's—and especially the developed world's—endless efforts to grow and expand its wealth have led to the burning of ever-greater amounts of fossil fuels. That, in turn, has caused ever-higher levels of greenhouse gas emissions that are now placing the health of our planet at risk.

Global warming is real. Science has confirmed it. Average citizens across the globe can see it and feel it, especially in a succession of unusual weather events that have become not so unusual at all.

According to the World Energy Council, global population increases by 100 million people each year. More people are creating a rising demand for energy, a trend compounded by increasing global wealth. Fossil fuels will likely be used to meet 85 percent of the world's electricity and transportation needs now and into the foreseeable future. According to the International Energy Agency (IEA), at least US$20 trillion will need to be invested in energy infrastructure over the next 25 years. In the developed world, carbon dioxide emissions are expected to increase 100 percent by 2050; in the developing world, emissions are expected to rise by 200 percent.

We cannot continue on this energy path without jeopardizing our planet. Yet we cannot stymie economic progress. Sustainable development, fueled by renewable energy, is the only answer. We have the tools necessary to succeed. The question is: Do we have the willpower and discipline to make wise and effective energy decisions?

Nature has provided us with the resources that we need to achieve sustainable economic development while curbing—and even reversing—global warming. Governments in developed and developing countries, international aid agencies, nongovernmental organizations and industry must work together to create a transition to sustainability through greater applications of energy-efficiency measures and increased use of renewable energy resources.

Kyoto's Impact

The Kyoto Protocol, which calls on developed countries to cut their emissions of greenhouse gas to 5 percent below 1990 levels by 2008-2010, has helped propel the development of renewable energy technologies worldwide. Wind, biomass, geothermal and hydropower have benefited as a result. Japan and Germany, for example, have created robust markets and built profitable industries for the generation of renewable electricity, mainly through the development and distribution of solar, thermal and photovoltaic (PV) technologies.

In Japan, the price of PV technologies has declined by 70 percent since 1994. That's the year Japan implemented a 10-year 'declining' rebate programme that has led to the installation of more than 1 gigawatt of PV capacity. Today, homeowners in Japan are installing solar systems without federal subsidies. By developing an effective, long-term renewable energy policy, Japan has created a self-sustaining PV market.

In Germany, a 'feed-in-tariffs' programme (which requires electrical utilities to purchase renewable energy from individual producers and, in effect, 'feed' this electricity into the grid) sparked a PV explosion that seems to be gaining force. More than two gigawatts of PV capacity have been installed in the past five years. Many countries in the European Union have launched similar programmes, spurring technological innovation and generating thousands of well-paying jobs across the continent.

PV technologies have thrived, in part, because Kyoto embedded market mechanisms such as the trading of renewable energy credits to reduce greenhouse gas emissions. To meet Kyoto's goals, many European countries have legislated programmes requiring that a percentage of their electricity come from renewable energy sources. But Europe is not alone. California is the world's third largest market for PVs and Texas has installed more than 2,000 megawatts of wind power. Governments have been responsible for launching these programmes but the private sector has played a key role in the manufacture and sale of renewable equipment.

While the Kyoto Protocol applies primarily to the developed world and excludes such fast-growing developing countries as China and India, it allows developing countries and non-signatory entities to participate through the sale of renewable energy credits. Although the United States has not ratified the Kyoto Protocol, some 280 US cities have. Moreover, 29 of the 50 states in the United States have instituted credit programmes for renewable energy sources.

Implementation of Kyoto protocol alone will not be sufficient to reverse global warming. We must employ additional policies that increase global demand for renewable energy and prod technological innovation. Countries in both the developed and developing world must be encouraged to turn to renewable energy to spur sustainable economic growth. The share of global energy powered by PV technologies remains less than 1 percent of global electricity production. Yet the potential for 'renewable' growth is there and the prospects for realizing this potential are within our reach.

Policies Forward

Global energy policies should focus on developing renewable energy and expanding energy storage capacities, especially among rural areas in developing countries that do not have access to a centralized energy grid. Building an electricity grid is expensive and when the grid relies on fossil fuels as its major energy source, it only adds to the global warming problem.

Many developing nations enjoy an abundance of solar energy that can be used to generate electricity. To help developing countries tap this resource, developed nations should lead by example and increase the use of renewable energy in their own countries. At the same time, developed nations should encourage and assist developing countries to make use of these technologies.

Renewable energy policies should be clearly articulated, and renewable energy laws and regulations should be easy to implement. Actions that generate clean energy should be rewarded. Actions that pollute and worsen global warming should be discouraged. Renewable energy policies should also be designed to nurture self-sustaining markets and spur employment.

Governments, particularly local governments, should institute financial incentives encouraging the construction industry to build 'zero-energy' buildings. Efficient lighting, solar water-heating and highly effective insulation should be the cornerstones of such efforts. Local governments should also streamline building permits and other regulatory and administrative procedures to encourage construction firms to build energy-efficient structures. Efforts to expand rural electrification should primarily rely on lower-cost PV technologies. International agencies like the United Nations Educational, Scientific and Cultural Organization (UNESCO), United Nations Development Programme

(UNDP), World Bank and International Monetary Fund (IMF) should partner with environmental groups, nongovernmental organizations and private foundations to help fund such projects in the developing world.

Governments, again especially local governments, should create incentives for training personnel skilled in renewable energy technologies. Combining economic subsidies and incentives for the construction of energy-efficient buildings, together with job-training programmes, could help developing nations create a durable foundation for building their own renewable and energy-efficiency industries. In short, governments, at all levels, should create programmes that stimulate competition, efficiency and self-sustaining markets.

To aid in this effort, developed countries should create mechanisms encouraging companies to build power plants in developing nations that rely on renewable energy and that promote energy efficiency among its clientele. Campaigns honouring such efforts should be launched. Overall, governments should reward companies that encourage the use of renewable energy and penalize companies that don't. As long as it is cheaper and easier to pollute, most businesses will choose to do so—whether the project is at home or elsewhere.

Governments can also implement policies that encourage imports of renewable technologies, especially when such imports generate jobs and curb pollution. Industries devoted to greater use of renewable energy should partner with governments, nongovernmental organizations and international aid agencies to identify appropriate projects and to participate in the training of workers. Government, industry and nongovernmental organizations, in short, can work together to design and institute markets that are efficient and effective.

Grand Challenge

Energy is essential to meeting such basic human and social needs as health, water, food and education, and to fuel the creation of wealth. Countries need not burn nonrenewable sources of energy to fulfill our global society's needs and wants. Renewable energy abounds but only if we actively seek to create it.

The challenge posed by the development of renewable energy should not be viewed as a burden but as an opportunity: to adequately attend to the needs of our global citizenry, especially our most marginalized citizenry; to satisfy the human desire to create ever-more useful technologies; and to sustain economic growth without harming the environment, especially by exacerbating the threat of global warming.

Implementation of the Kyoto Protocol has only begun to show that renewable energy development does not impede economic growth. Indeed it spurs it on.

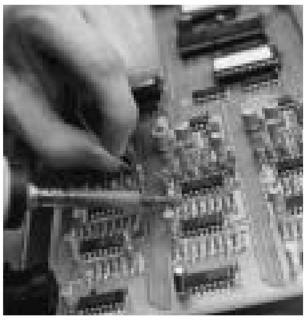
But the Kyoto Protocol is not enough. Additional programmes and actions for renewable energy production and use must be put in place. Cooperation among governments, international organizations, nongovernmental groups and the private sector is essential to advance such programmes. We are smart enough to continue to expand the global economy. We are smart enough to do this at an unprecedented rate and in places and for people that have yet to enjoy the benefits of economic globalization. And we are smart enough to do this without placing the health of our planet at risk.

This is the grand challenge of our time. We have the intelligence, resources and imagination to succeed. It's now time to marshal the willpower to transform our potential into reality. Future generations are depending on us. We cannot fail them.□

Atta-ur-Rahman

Federal Minister / Chairman
Higher Education Commission
Islamabad, Pakistan

Pakistan has dramatically increased its investment in higher education. Atta-ur-Rahman, the architect of this effort, examines its impact on his nation's well-being.



NURTURING KNOWLEDGE

In a world marked by contentious debates over a wide range of issues, a remarkable consensus has been reached on this critical point: Knowledge drives sustainable economic growth.

In today's intensely competitive global environment, only countries that support and promote knowledge, creativity and innovation will succeed. This makes the quest for quality higher education not just a moral imperative but also an economic and social necessity.

Stunning advances during the past few decades in the fields of information technology, biotechnology, material sciences, health sciences, renewable energy and a host of other fields are changing the world in which we live. Developing countries that have embraced such critical factors and innovation now find themselves on a path of social and economic development, while countries that have turned a cold shoulder to science and technology have been left farther behind.

Since its inception in 2002, Pakistan's Higher Education Commission (HEC) has systematically implemented a blueprint for educational reform based on the principles of 'information access, quality and relevance.' The strategy places a great deal of emphasis on improving classroom and laboratory facilities, attracting first-class faculty, creating a challenging learning environment for students and linking university education to national priorities for sustainable economic growth.

Attracting the Brightest

Boosting salaries. Pakistan has taken truly revolutionary steps to boost the salaries of university faculty members. Less than five years ago, salaries were often so low that professors had to seek additional part-time employment to make ends meet. Today, the annual salaries of faculty members, which average US$3,000, are three times higher than the salaries of federal ministers. As a result, we believe that a dramatic rise in compensation will encourage the nation's brightest students to pursue careers in higher education. Pakistan has some 100 million people younger than 25. With the prospects of a good and secure salary awaiting them, large numbers of people will likely make education and research a top career option. Individual choices, in turn, will enable the country to benefit from an ever-expanding pool of talented and well-educated citizens.

Stemming the brain drain. Pakistan has launched a comprehensive well-funded programme to encourage members of the nation's scientific and technological diaspora to come home. Over the past five years, some 300 émigrés—eminent researchers and practitioners in their fields of study who have lived most of their lives in developed countries—have returned. Former ICTP scientist Faheem Hussain, who now teaches at the National Centre for Physics (NCP) in Islamabad, is among them. Salaries are an important consideration in their decision, and returning professors are indeed well compensated. But they must also have access to excellent facilities. That is why the government has created centers of excellence in a wide range of fields, including the School of Mathematical Sciences in Lahore and Panjwani Centre for Molecular Medicine and Drug Research in Karachi. These centres operate both as unique entities within a university and in clusters across a number of universities.

Rewarding performance. Pakistan may be the only country in the world where a young productive researcher, who has published a large number of articles in international peer-reviewed journals, can receive much higher pay than a more senior, but less productive, colleague. We have rapidly moved towards a system that rewards performance, not age. We have done so by establishing a dual-layered pay system consisting of base pay and add-on 'research productivity allowances.' The latter, which utilize such yardsticks as the Science Citation Index, largely depend on the 'impact factors' of the articles that a faculty member has published—that is, the number of times that his or her articles has been cited in international peer-reviewed journals. A new tenure-track system, moreover, involves systematic international assessment of the performance of faculty members, providing a greater guarantee that those who receive permanent employment are truly worthy of the appointment.

Training the Brightest

The brightest students must have access to first-class training, both in Pakistan and abroad. That is why Pakistan has embarked on a broad-based training programme across the full spectrum of scientific and technical fields.

Training abroad. The Foreign Scholarship Programme is designed to strengthen research capabilities in fields of national relevance related to engineering and the basic and applied sciences. Since 2002, nearly 2,000 scholars have been sent abroad each year to universities in Australia, Europe, New Zealand and the United States. The number of scholarships is expected to double in the next five years. Each year, some 650 Pakistani students receive assistance as Fulbright Scholars, which enables them to travel to the United States to pursue advanced degrees. No other country in the world participates as extensively in this programme. Another 500 Pakistani students will be studying in Australia under the Australia-Pakistan Scholarship programme and only China has more students studying in Swedish universities.

Training at home. The nation's Higher Education Commission now provides scholarships that cover the cost of tuition and also provide a monthly stipend for qualified students seeking to earn doctorate degrees in science and other fields at universities within Pakistan. The programme, which was begun in 2002, has supported over 4,000 students.

Training for postdocs. Under the Postdoctoral Fellowship Programme, since 2002 more than 250 scholars have been placed at premier academic and research institutions abroad for periods of 9 to 12 months.

Leap-Frogging to Success

The recent development and application of new information and communication technologies has given developing nations such as Pakistan unprecedented opportunities to leap-frog into the global knowledge society. The government has sought to take advantage of these opportunities by rapidly expanding access to the internet, especially in universities and research centres.

Intranet. The Pakistan Educational and Research Network (PERN), a fibre-optic intranet system with broadband connections, is now available in more than 60 universities. As a full voting member of the Asia Pacific Advance Network Consortium (APAN), PERN also offers its member institutions such additional benefits as video conferencing and computer telephone access.

Virtual learning. In 2002, the government launched a 'virtual university,' the nation's first university to rely solely on new information and communication technologies. The goal is to provide affordable world-class education to hundreds of thousands of aspiring students. Using free-to-air satellite television broadcasts and the internet, the virtual university allows students to follow rigorous curricula without leaving their homes. This offers unprecedented educational opportunities for students residing in the most remote areas of Pakistan.

MIT open courseware. Through PERN, the Higher Education Commission has launched a mirror site of the Massachusetts Institute of Technology (MIT) open courseware programme, which is available free-of-charge on the internet. The programme provides course syllabi and lecture notes for more than 900 courses. CD sets, containing lectures delivered by MIT professors, have been distributed to universities across the country.

Video lectures. More than 700 lectures by Nobel Laureates and eminent professors are now available at library lecture theatres in universities throughout Pakistan. The government plans to expand the programme this autumn by offering real-time lectures delivered by scholars and scientists from eminent universities from around the world. The viewing rooms will be equipped with interactive systems allowing students to ask questions as if they were sitting in a lecture hall.

Digital library. The Higher Education Commission has created a digital library programme that provides universities and research centres free online access to more than 20,000 international journals from the world's leading publishers.

Innovation. The government has launched a major programme to promote innovation and entrepreneurship within Pakistan. The programme supports not just course work but also the creation of technology parks and incubators and access to venture capital and soft loans for start-up companies.

PAKSAT I. Pakistan launched its first education satellite into space in 2003. Today, the satellite beams two educational channels aired on television stations across the nation. Two additional satellite channels will soon be in operation.

In response to the increasing globalization of both work and workers, Pakistan plans to establish engineering and technology universities in collaboration with universities and research centres in a large number of countries, including Austria, China, France, Germany, Italy, Japan, the Netherlands, South Korea and Sweden. The partnering countries will appoint administrators and faculty, as well as oversee the curricula and examination procedures. Each university will receive an estimated US$400 million in startup funds. Over the next decade, more than 4,500 scholars and scientists are expected to receive doctoral degrees.

Education for Progress

Demographic changes unfolding in Europe and other countries offer unprecedented opportunities for developing countries such as Pakistan to serve as a source of labour for industrialized countries, not just for traditional low-paying manual and manufacturing jobs as in the past but also for posts in knowledge-based industries requiring well-educated and well-trained workers. In many developed countries, an aging population, combined with unwillingness on the part of university students to major in science and engineering, are conspiring to create potential shortages of educated workers. These trends suggest that Pakistan's efforts to provide quality higher education to hundreds of thousands of students will not only benefit Pakistan but also play a key role in sustaining economic growth in Europe and elsewhere.

A recent World Bank report has called the changes taking place in Pakistan's system of higher education a 'silent revolution.' As the impact of this revolution becomes more visible, it is my fervent hope that Pakistan will emerge as a leader in education, research and innovation, illustrating that the unprecedented scientific and technological advances now unfolding will truly be global in scope.□

Miguel Nussbaum

Catholic University of Chile
Santiago, Chile

HIGHER EDUCATION IN LATIN AMERICA

Science and technology did not assume a high level of importance in Latin America until the 1960s, when a substantial number of national councils for science and technology were established across much of the region. Paralleling this trend was the creation of faculties of science in many Latin American universities.

An absence of societal pressures on scientists, however, meant that they had little reason to develop the knowledge and know-how they needed to address the scientific and technological needs of their countries. Education had become increasingly diverse but its quality seemed to suffer as a result. During this period, the emphasis was on expanding higher education and not on improving instruction. Quantity trumped quality.

Studies of the relationship between university enrolment and per capita gross domestic product (GDP) in Latin America reveal that the rising number of university-educated professionals did not have the impact on national wealth that one might expect. Between 1970 and 2000, for example, university student enrolment in Latin America grew by a factor of seven while GDP rose by only 40 percent.

While the number of university students increased substantially, the meagre impact on the national economy indicates that there was not equivalent concern for the quality of teaching and research.

If a sustainable economic development is to take place in Latin America, it is of vital importance that the quality of education be improved to nurture a workforce capable of generating new knowledge, which can be put to work on the critical problems Latin America faces.

Economic and technological development must be rooted in a nation's identity and culture. That is why countries in Latin America must provide a learning environment for quality education that is relevant to national realities and that builds technological skills for combating problems of critical national importance.

Romain Murenzi

Minister of Science, Technology and Scientific Research
Kigali, Rwanda

Rwanda is seeking to leave its past behind to embark on an ambitious strategy for sustainable economic growth. Science, technology and innovation are at the centre of these efforts.

BRIGHTER RWANDA

Rwanda, a landlocked country in sub-Saharan Africa, is home to some nine million people. It has few natural resources and suffers from a chronic shortage of skilled labour. It is also a country that has struggled desperately with the nightmare of genocide. An estimated one million people were killed over a three-month period in 1994, leaving a legacy of death and despair.

Slow but steady progress—driven by a new way of thinking—is healing the nation and instilling a growing sense among the people that the future will indeed be better than the past.

This hope is due in part to an emerging consensus within Rwanda that science, technology and innovation must be at the centre of the nation's economic development policies.

Rwanda, which not so long ago served as one the prime examples of sub-Saharan Africa's profound malaise, is emerging as a model for sustainable economic growth. Its efforts are based not on an abstract paradigm for progress devised by others, but on the stark realities that it faces. A keen appreciation for the way things are has enabled Rwanda not only to fully assess its weaknesses but also to develop a sharp eye for opportunities to alleviate poverty and spur growth.

Under the leadership of President Paul Kagame, Rwanda has embraced what others have known for some time: that science, technology and innovation are not luxuries but essential prerequisites both for the promotion of national well-being and wealth.

Rwanda is virtually devoid of all resources except one: human resources. Therefore a cornerstone of its national strategy for sustainable development is to improve the nation's educational system by reforming the curriculum, upgrading teaching standards, and making the classroom environment more welcoming and challenging. Another key strategy is to increase funding for science and technology as part of a larger effort to accelerate science-based sustainable growth.

Fifty years ago, the internationally renowned economist Robert Solow (Nobel Prize in economics 1987) published a landmark study showing that nearly 90 percent of the growth in economic output in the United States between 1909 and 1949, a period of unprecedented prosperity unmatched in the annals of world history (unmatched, that is, until the recent pace of growth in China), was due to a well-funded, comprehensive effort to develop and then apply science and technology to economic development.

As part of this successful strategy, Solow and other developmental economists who have followed in his footsteps, have emphasized the importance of both developing an educational system capable of nurturing a knowledgeable and skilled labour force (particularly in science and technology), and of creating a work environment that provides ample opportunities for this well-educated and highly skilled labour force to put their knowledge and expertise to work for society. More recently, like-minded policies adopted by China, India and several other developing countries have confirmed the wisdom of this analysis.

Strategic Success

For countries with similar standards of living, small differences in the rate of growth, fueled by sustained commitments to science, technology and innovation, can lead to very different economic outcomes over the long term. Some 150 years ago, for example, Argentina and the United States enjoyed about the same level of wealth. In the late 19th century, the United States embarked on a science- and technology-driven path for economic development. Argentina, meanwhile, continued to rely mainly on its natural base as its primary source of wealth. While Argentina continued to do well (indeed in the early 20th century, economists ranked Argentina the world's 9th richest nation), it could not keep pace with its neighbour to the North. Today, the United States has an annual gross domestic product (GDP) of nearly US$12.5 trillion. Argentina, meanwhile, has a GDP of less than US$0.2 trillion.

The lesson for countries like Rwanda is this: Economic growth is driven by sustained investments in human capital (labour), physical capital (plant and equipment) and intellectual capital (technology). And, now more than ever, it is intellectual capital that determines how prosperous a country will be. It's not by chance that analysts increasingly point to our global 'knowledge' society as the primary force driving unprecedented rates of economic development in the developing world. Excluding fast-growing China and India, the World Bank estimates that the economies of developing countries have grown 5 to 6 percent a year over the past two years. Economists, however, also acknowledge a growing gap in wealth between developing countries that have embraced science, technology and innovation and those that have not.

Recognizing these trends, Rwanda's President Kagame has asserted that his nation's development will ultimately depend on its "human resource base" and that it will "continue to invest in its people and...strive to open up the frontiers of science, technology and research." The most visible sign of this commitment is the government's pledge to nearly double its investment in science and technology from 1.6 percent to 3 percent of the nation's GDP over the next five years.

Increased funding is, of course, important. But it is the specific actions taken by government, nongovernmental organizations, the private sector and external aid agencies that will ultimately determine whether Rwanda overcomes its past misfortunes to become a full member of the global knowledge society.

To meet this challenge, the government has developed a National Policy on Science, Technology, Research and Innovation, coupled with a new ministry in the Office of the President in charge of science, technology and scientific research, to transform the national science, technology, and research strategic plans for economic growth and poverty reduction into concrete actions that attain concrete results. The strategy calls for greater investments in training scientists, engineers and medical doctors at home and abroad; upgrading the nation's scientific infrastructure, particularly its laboratories and innovation centres; and expanding opportunities for international scientific exchange.

A key aspect of the strategy is to forge greater links between universities and the private sector through the creation of science and technology incubators and parks; low-cost technology consultation centres; and the development of field demonstration units for technology transfer and innovation.

To help ensure that the plan does not shortchange the nation's poorest citizens, Rwanda's Ministry of Science, Technology and Scientific Research has organized a working group comprised of a broad spectrum of stakeholders from government, universities, research institutes, grassroots organizations and private corporations. The ultimate challenge, the government has concluded, is to create a strategy that simultaneously addresses issues related to social well-being and wealth creation.

Such a strategy can only be sustained through the creation of laws and regulations that encourage citizens to create products and services that society wants——both at home and abroad. That is why Rwanda's government has introduced a series of legislative reforms designed to uplift the nation's social welfare while enhancing the business environment for investors. It is a delicate balancing act but one that must be pursued, especially in an impoverished nation like Rwanda.

Funding Success

One of the most important steps that the government can take for the nation's scientific and technological communities is to ensure sufficient and reliable sources of funding for research and development. To meet this challenge, the government is establishing a National Commission for Science, Technology and Innovation coupled with a national research fund. The fund will come from two sources: a specific percentage of the government's budget will be dedicated to these efforts and bilateral and multilateral agencies will be encouraged to contribute to it. The purpose of the fund, which will be allocated to both scientists and scientific institutions on a competitive basis, is to provide seed money for innovative research designed to contribute to the social and economic development of Rwanda.

Besides funding broad initiatives for individual and institutional capacity building, the fund will seek to finance a national information centre equipped with state-of-the-art electronic communications focusing on data collection for the earth sciences; regional centres of excellence for biodiversity and alternative energy; and well-equipped laboratories in human, animal, and plant health.

Despite its best intentions, Rwanda cannot succeed in its effort to build a knowledge-based society on its own. It will need help from its international friends.

That's why the government of Rwanda has been aggressively pursuing programmes for international cooperation in science and technology across the globe. Part of the effort involves securing funds from international aid agencies like the World Bank; part of the effort involves forging bilateral agreements with such institutions as the United Kingdom's Department for International Development (DFID), the Swedish International Development Agency (Sida) and the United States Agency for International Development (USAID); and part of the effort involves speaking out on behalf of Rwanda's commitment to science-based sustainable development. Over the past year, President Kagame has delivered lectures on science, technology and innovation to attract interest and ultimately funding from abroad at The Royal Society in the UK in September 2006, the African Union Summit in January 2007, and the Sub-Saharan Africa Information and Communications Technology Conference organized by the US Agency for Trade and Development in March 2007. He has also spoken at the corporate headquarters of Cisco, Microsoft and Qualcomm.

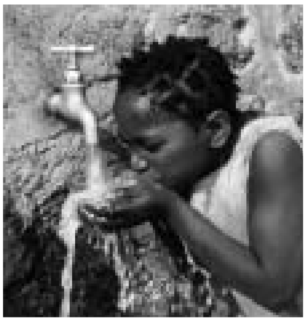
The president's message is simple, direct and compelling. "The application of science and technology," he says, "is fundamental and indeed indispensable to our social and economic transformation." Rwanda's strategy, he adds, focuses on "applying science and technology holistically—in all levels of education and training, in commercializing ideas, in developing business and quickening the pace of wealth-creation and employment-generation, in enabling government to provide better services, and indeed in providing basic tools to society at large for self- and collective betterment."

Rwanda, in short, is determined to create an environment that nurtures economic security and prosperity for all, and to do so by building a strong foundation for science, technology and innovation.□

Mohamed H.A. Hassan

Executive Director
TWAS, the academy of sciences for the developing world
Trieste, Italy

Mohamed H.A. Hassan examines the positive steps that have recently been taken in Africa to build capacity in science, technology and innovation.



FORUM FOR PROGRESS

At the African Union (AU) Summit, held in January 2007 in Addis Ababa, Ethiopia, 53 African leaders discussed regional strategies for the promotion of science and technology. They announced that 2007 would be the year of "African scientific innovation." And they also agreed to focus on issues related to science and technology at the next AU Summit to take place in Accra, Ghana, this July.

Africa's leaders have expressed support for science and technology in the past. But the meetings were followed by meagre results and ultimately disappointment and despair. This time the level of commitment—and enthusiasm—is different. And this time the results could well be different too.

Leaders at the AU Summit recommended that each African country should spend at least 1 percent of its GDP on science and technology. Such a recommendation had been made several times before. This time, however, it may actually be fulfilled.

In fact, several African nations, most notably those that have also embraced democracy and good governance, have substantially increased their investments in science and technology. These include the following 10 countries: Ghana, Kenya, Mozambique, Nigeria, Rwanda, Senegal, South Africa, Tanzania, Uganda and Zambia.

The government of Nigeria, for example, has provided US$5 million to launch an endowment fund for the African Academy of Sciences. Nigeria has also announced plans to launch its own national science foundation, modeled after the US National Science Foundation, and has pledged US$5 billion to the foundation's endowment fund (money that is to be derived largely from revenues generated by the nation's oil and gas industries). Only one nation in sub-Saharan Africa—South Africa—currently has a national science foundation.

At the AU Summit, Paul Kagame, President of Rwanda, announced that his country has dramatically boosted expenditures on science and technology from less than 0.5 percent of GDP a few years ago to 1.6 percent today. He also committed his nation to increase investments in science and technology to 3 percent of GDP within the next five years. That would make Rwanda's investment in science and technology, percentage-wise, comparable to that of South Korea and higher than that of most developed countries. A nation teetering on collapse less than a decade ago and still living in the shadow of genocide has embarked on a path leading to science-based sustainable development. Rwanda remains poor, but it is no longer hopelessly poor (see "Brighter Rwanda," p. 20).

Last year, Uganda received a US$30 million loan from the World Bank to support its science and technology initiatives, including the creation of centres of scientific excellence that will serve not only Uganda but the entire region. The grant was given, in part, because of Uganda's successful efforts to build its own scientific and technological capacities, particularly in the fields of public health and agricultural science.

This year, Zambia will receive a US$30 million loan from the African Development Bank to fund teaching and research at the University of Zambia and provide postgraduate fellowships to some 300 students majoring in science and engineering. At the AU Summit, Levy Patrick Mwanawasa, President of Zambia, proclaimed that building capacity in "science and technology is the only means to develop my country."

Bingu wa Mutharika, President of Malawi, acknowledged at the AU Summit that building scientific and technological capacity provides the only sure way to break the long-standing cycle of extreme poverty that has gripped the African continent for decades. "We have depended on donor countries for scientific development for so long," he noted. "It is time to commit more resources in our national budget to advance science and technology." He urged his minister of finance to make science and technology a budget priority and to provide additional funds for this effort on a sustained basis. He also pledged to create international centres of excellence in the fields of hydrology and biotechnology.

Fulfilling Promises

What makes the prospects for international cooperation on science and technology for sustainable well-being so promising, even (or perhaps especially) when it comes to Africa, is that the global scientific community will not be acting alone in this effort.

In fact, over the past several years, there have been increasing commitments by governments in the developed world, and particularly among G8 countries, to support science, technology and innovation in low-income countries and especially in Africa.

In 2005, the Commission for Africa Report, *Our Common Interest*, solicited by the United Kingdom's Prime Minister Tony Blair and published on the occasion the G8 Summit at Gleneagles, Scotland, called on G8 countries to provide US$5 billion to help rebuild Africa's universities. The report also called for investing an additional US$3 billion to help establish centres of scientific excellence in Africa. The G8 member countries unanimously pledged to support these recommendations.

That decision was greeted with enthusiasm in Africa and throughout much of the world. Yet, to date, G8 member countries have officially authorized only US$160 million of support, targeted for the creation of networks of centres of excellence proposed by the AU's New Partnership for Africa's Development (NEPAD). Equally distressing, little of this money has actually been transferred to Africa. The international scientific community has an important stake in the success of this initiative and it must continue to urge G8 countries to fulfill the pledges that they made at Gleneagles some 18 months ago.

Other Sources

Rising levels of scientific excellence in developing countries—most notably, Brazil, China, India and South Africa—have opened new opportunities for South-South collaboration in education and research, particularly for the science-poor countries of Africa. Let me give some examples.

- China's Development Fund for Africa, approved in 2006, will provide US$5 billion over the next five years to assist African countries to achieve the Millennium Development Goals (MDGs) through cooperation with China. This represents a new long-term vision for China's relationship with Africa. If this vision is realized, it could accelerate efforts for sustainable development in Africa and spur other donors to fulfill their commitments.
- Brazil's pro-Africa programme supports scientific and technological capacity building in the Portuguese-speaking countries of Angola and Mozambique. The programme includes research collaboration activities with Brazilian institutions.
- The joint Brazil, India and Senegal biofuels project in Senegal will seek to transfer Brazilian and Indian expertise in the development of biofuels to one of Africa's most scientifically proficient nations.

- The India, Brazil and South Africa (IBSA) tripartite initiative, signed by the ministers of science and technology last year, will provide funds to engage in joint problem-solving projects that focus on developing products with commercial value.

Moving Forward

What does all of this activity mean? Is it just another episode of fleeting interest in countries and in people that have been left behind? Or, are we entering a new era marked by sustained investments in science, technology and innovation, not just in the developed world but, increasingly, in the developing world as well?

I believe that we have more reason for optimism than cynicism. We may indeed be witnessing the beginning of a transformational moment in global science and science-based sustainable development.

But for us to seize this moment, we need to develop and implement an action agenda designed to sustain—and expand—international cooperation in science, technology and innovation.

So let me outline the concepts and actions that I think should guide us as we move forward together.

- First, investments in science, technology and innovation are not luxuries. As Bernando Houssay, Argentina's first Nobel Laureate and one only of three Nobel Prize winners to be honoured for research conducted in the developing world, observed decades ago: "Argentina is too poor to have the luxury of NOT investing in science."
- Second, both rich and poor countries are more committed than ever to building global capacity in science, technology and innovation. The G8 and AU have both expressed strong support for such efforts within just the past year. The scientific community should play a visible and forceful role in helping to transform this hopeful rhetoric into action.
- Third, every country must educate and support a new generation of home-grown, problem-solving, world-class scientists. This means expanding and reforming educational systems to help train students for the challenges that they are likely to face in the work place.
- Fourth, world-class universities and centres of excellence play a fundamental role in advancing international cooperation in science, technology and innovation for sustainable well-being. Both domestic and external funds should be invested in such institutions.
- Fifth, we must create broad channels of communication that help both scientists and economic development specialists learn from the experiences of others. Therefore we should work together to develop a large portfolio of successful experiences in the application of science, technology and innovation for sustainable well-being and seek to develop networks that broaden the impact of these successful experiences.
- Sixth, the success of Brazil, China, India and other developing nations should not blind us to the fact that as many as half of all nations in the South, which represent more than a third of all the countries in the world and are home to more than 50 percent of humanity, have very limited capacity in science, technology and innovation.

The key challenge facing the international science community—and the global community more generally—is how to take advantage of the rapidly growing capacity in science, technology and innovation now being experienced by some developing countries to forge North-South partnerships that help build the capacity of developing nations that have been left behind. The call for international partnerships for sustainable development, the overarching theme of the G8-UNESCO World Forum, could make a huge difference in this worthy campaign.

The chances for success have rarely been brighter. The consequences of neglect and indifference have rarely been more troubling. The international science community should seize this moment. If we don't, it could well fade into history as a lost opportunity that we can ill-afford to lose.□

Mohamed H.A. Hassan

ACROSS THE SOUTH

The challenges for international cooperation in science, technology and innovation for sustainable well-being are many. And so, too, are the opportunities. New fields of science and new cutting-edge technologies, for example, promise to have extraordinary impacts on global well-being.

Information and communication technologies are not just highly specialized fields in their own right but also 'enabling' forces that help to advance all fields of science and technology. ICTs, in fact, have led to a melding of fundamental and experimental research through the facilitation of mathematical modelling.

Biotechnology is having a strong impact on agriculture, public health, medicine and environmental science, transforming each in new and unexpected ways.

Nanotechnology promises to revolutionize material science; to bring physics, biology and chemistry closer together; and ultimately to have broad-ranging implications in a variety of critical areas, including water, energy, human health and the environment.

Space science and technology help to monitor environmental change and devise effective responses to a host of ecological problems, including assessing rates of deforestation and desertification.

Several developing countries, especially those with growing scientific and technological capabilities, have been eager to embrace and to pursue these new technologies.

China and Brazil, for example, have partnered in a joint initiative leading to the launch of two satellites designed to chart land and ocean resources. Two more satellites are planned for 2008. Nigeria has launched two remote-sensing satellites, and its first communications satellite, built in collaboration with China, will lift off this year.

China is investing substantial sums of money in nanoscience and nanotechnology. That investment is paying off handsomely in terms of publications. In fact, a recent survey found that, in 2004, Chinese scientists published the largest number of papers on nanotechnology in international peer-reviewed journals, exceeding the number of papers published by scientists in the United States. Brazil, India and South Africa are also making substantial investments in nanotechnology.

India's investment in information and communication technologies is well known. The nation now enjoys world-class status in this field and is home to a number of corporations that rank among the largest and most influential in the world, including Infosys, Wipro and Tata Consultancy Services.

Brazil, Malaysia, Pakistan and South Africa, and many other developing countries have all invested enormous resources in the development and expansion of information and communications technologies. And let us not forget that South Korea, a nation that in 1962 had a gross national product of just US$2.3 billion (comparable to that of Uganda), embraced information technologies as one of the key sectors in its plans for long-term sustainable growth—first in terms of telephony technologies and more recently in terms of the internet. Today South Korea's GDP, which exceeds US$765 billion, ranks 11th in the world.

Then, there is the field of biotechnology. Again developing countries have taken significant steps in joining the global scientific community. Malaysia, for example, has embarked on a broad-based biotechnology programme to increase national wealth and improve the well-being of its citizens. China has made biotechnology a top priority, launching five large biotechnology research centres. In Africa, Nigeria has developed a national biotechnology policy and Ghana has drafted a biosafety law that is now awaiting legislative approval. Governments across Africa have acknowledged the need to develop capacity in biotechnology and are now trying to match their rhetoric with action.

NEWS
from
ICTP

The Abdus Salam International Centre for Theoretical Physics (ICTP) is administered by two United Nations Agencies—the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the International Atomic Energy Agency (IAEA)—under an agreement with the Government of Italy. Katepalli R. Sreenivasan serves as the Centre's director.

News from ICTP is a quarterly publication designed to keep scientists and staff informed on past and future activities at ICTP and initiatives in their home countries. The text may be reproduced freely with due credit to the source.

Editor-in-Chief
Daniel Schaffer

Managing Editor
Anna Triolo

Photos
UNESCO Photobank
ICTP Photo Archives
Massimo Silvano

Layout
Associazione Progettisti Grafici

Direttore Responsabile
Fabio Pagan

Printed by
Graphart S.r.l.

G8-UNESCO WORLD FORUM
2007 TRIESTE

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

Public Information Office

The Abdus Salam
International Centre for Theoretical Physics

Strada Costiera, 11
34014 Grignano - Trieste
Italy
fax: (+39) 04022407564
sci_info@ictp.it
www.ictp.it

Poste Italiane S.p.A. - Spedizione in Abbonamento Postale - D.L. 353/2003 (conv. in L. 27/02/2004 n° 46) art. 1, comma 2, DCB Trieste

Special Edition