TWAS 25TH ANNIVERSARY

3

YEAR 2008
VOL.20 NO.3

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TWAS newsletter

NEWSLETTER OF THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD

Published with the support of the Kuwait Foundation for the Advancement of Sciences

TWAS WILL BE 25 YEARS OLD THIS YEAR. A GALA CELEBRATION, SUPPORTED BY THE MEXICAN GOVERNMENT AND HOSTED BY THE MEXICAN ACADEMY OF SCIENCES, WILL TAKE PLACE IN MEXICO CITY FROM 10 TO 13 NOVEMBER. MORE THAN 300 SCIENTISTS WILL BE IN ATTENDANCE.

The four-day event will provide another opportunity for the Academy to examine its past and to explore its future – all within the context of TWAS's quarter century of experience in promoting science and science-based development in the South.

In the following article, TWAS president Jacob Palis reviews the challenges that the Academy has faced since its inception. Equally important, he analyses the issues that lie ahead for the Academy – an institution that now occupies a central place in the world of science.

A TWAS Jubilee

This year marks the 25th anniversary of TWAS. The Academy arrives at this historic date as a leading institution in international science and as a key voice for science in the South.

For this we are thankful, not just for the sense of accomplishment that this confers on the Academy but, more importantly, for the impact that our activities have had – and continue to have – on science and society, especially in the developing world.

A great deal of credit for the Academy's success goes to the dedication and commitment of its members. The Academy began with 42 members. Today TWAS's membership stands at 843. Nearly 85 percent of our members are from developing countries.

TWAS's twenty-fold increase in membership over the past quarter century is not only a reflection of the Academy's success, but also a clear sign of the growth in scientific capacity in the developing world.

Many factors have propelled this welcomed trend, including an increasing commitment on the part of governments in developing countries to invest in science and technology; the rise of new information and communication technologies that have made it easier and faster to acquire and share data and information; and better working and living conditions for scientists in South, which have encouraged a growing number of researchers to pursue their careers

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Published quarterly with the support of the Kuwait Foundation for the Advancement of Sciences (KFAS) by TWAS, the academy of sciences for the developing world
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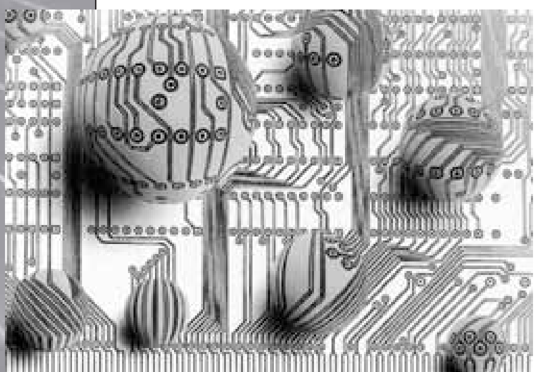
TWAS Newsletter, Vol. 20 No. 3, 2008



at home. In several developing countries, improving conditions have enticed scientists who have been part of the scientific diaspora to return home, sometimes decades after they left.

MUTUAL BENEFITS

The Academy is proud of the contributions it has made to these advances. Our ability to contribute to scientific capacity building in the South has been due, in no small measure, to the mutual benefits that the Academy and its members have long derived from each other.

On the one hand, election to TWAS bestows prestige and recognition to the scientists who are inducted into the Academy. Each year, the Academy receives about 200 nominations for membership. Only about 40 to 50 scientists are chosen. The process is highly competitive and membership is earned through noteworthy accomplishments. As a result, there is good reason for TWAS to claim that its members represent the best of science in the South.

On the other hand, the Academy's ability to include the developing world's most eminent scientists among its members enhances TWAS's profile and presence, not only in the scientific community but also in society at large, especially in the developing world.

Put another way, election to the Academy confirms a scientist's valuable contributions to his or her profession. Scientists elected to TWAS, in turn, help to enhance the Academy's visibility across the developing world through the impact that they have on both science and society.

FRIENDS AND BENEFACTORS

But it's not only the Academy's own work, and the contributions made by its members, that account for TWAS's achievements. Indeed the Academy's success is also due to the support of its friends and benefactors.

First and foremost, there is the Italian government whose generosity and vision of a better world have allowed TWAS to pursue its mandate in ways that would have been impossible without a secure funding base. Italy's support has enabled TWAS to become one of the world's foremost success stories of North-South cooperation. The ultimate goal has been to build scientific excellence in every country, including the least developed countries. The partnership between TWAS and the Italian government shows what can be done when reliable funding, good intentions and an unstinting commitment to tangible results come together to advance a worthy goal.

The Italian government took a leap of faith when it made its first annual contribution to the Academy in 1985. That leap has turned into a steady source of funding, which has

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enabled TWAS to move forward, step by step, to help advance the cause of science and science-based development in the South.

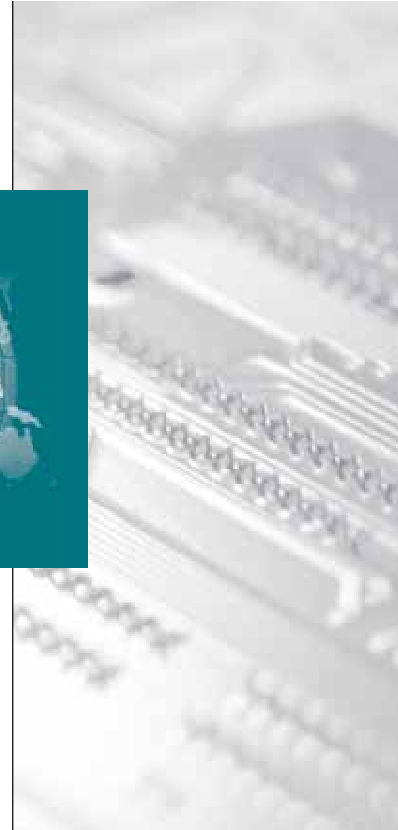
Words cannot convey our gratitude to Italy, which showed confidence in our cause when virtually no one else did, and then displayed a steady commitment to our purpose through these many years.

The Academy's success is Italy's success and any accolades we receive belong to Italy, too. We can only hope that our actions and impact have helped to place a positive spotlight on Italy and have given the developing world reason to praise the generosity and good will of a developed country that has meant so much to global efforts to promote science-based development.

I would also be remiss if I did not extend the Academy's thanks to the United Nations Educational, Scientific and Cultural Organization (UNESCO). TWAS is a proud member of the UNESCO family. This relationship has not only bestowed on the Academy the priceless imprimatur of a United Nations organization but also given us access to invaluable administrative assistance for budgeting and personnel matters.

TWAS has also reaped untold benefits from its close association with the Abdus Salam International Centre for Theoretical Physics (ICTP). As many of those associated with the Academy know, ICTP and TWAS share a common heritage. Abdus Salam (Nobel laureate in physics in 1979) was the founding director of ICTP and the founding president of TWAS. Indeed ICTP and TWAS represent two of the most enduring aspects of Salam's rich and enduring legacy. Through the years, ICTP has served as the home for the Academy's secretariat and subsequently for other organizations that operate under TWAS's administrative umbrella, including the Third World Organization for Women in Science (TWOWS), the InterAcademy Panel on International Issues (IAP) and the InterAcademy Medical Panel (IAMP).

Like TWAS, the Italian government has also generously supported ICTP. The Centre, in turn, has extended the same good will to TWAS as part of a virtuous circle of support that has truly made a difference for science throughout the developing world.



BASE BUILDING

Building on the financial base provided by the Italian government, TWAS has also received extensive programmatic support from a number of aid agencies and foundations.

The Swedish International Development Agency (Sida) has been providing major funding for the Academy's research grants programme, which has helped thousands of scientists across the South. More recently, it has expanded this research programme to include funding for teams of scientists in scientifically lagging countries. (TWAS has identified 80 developing countries that fall into this category.)

The goal is twofold. First, by supporting both individuals and *institutions, Sida is hopeful that TWAS's research grants can have an even greater impact on both science and society in the developing world. Second, by targeting a portion of its grant funds for scientific groups*

and institutions in the scientifically least proficient countries, it hopes to assist those most in need and thus help to narrow the disturbing – and growing – gap in scientific capacity that currently exists between countries, not just in the North and South, but also within the South itself. TWAS is eager to advance both goals and to put Sida's funding to work to meet the new challenges facing global science and particularly science in the developing world.

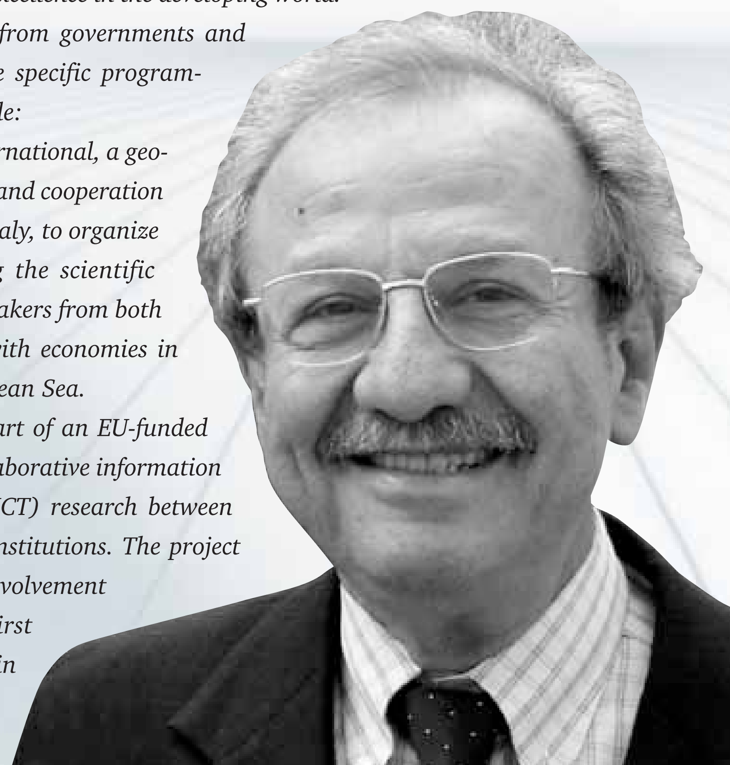
The Kuwait Foundation for the Advancement of Sciences (KFAS) has also provided annual funding for TWAS for the past two decades, supporting the Academy's desire – indeed need – to publish information about its activities. KFAS's funding, for example, is instrumental in the publication of the TWAS Newsletter.

Through the years, the Academy has also received valuable funding from the:

- *United Nations Development Programme's Special Unit for South-South Cooperation (UNDP-SSC) for a decade-long series of workshops and publications exploring innovative applications of science and technology to address such critical needs in the developing world as access to safe drinking water and the development of renewable energies.*
- *The Global Environment Facility (GEF) in Washington, DC, for a broad-ranging examination of best practices in the conservation and use of biodiversity in dryland regions. The initiative resulted in a series of workshops attended by more than 150 people and three major publications by the UNDP, Kluwer Publications and Harvard University Press.*
- *The Packard Foundation to profile successful scientific institutions in the developing world. These institutions include the Central Drug Research Institute in Lucknow, India; the Malagasy Institute for Applied Research in Antananarivo, Madagascar; the Centre of Biotechnology of Sfax, in Tunisia; the Institute of Medical Plant Development in Beijing, China; and the National Institute of Biodiversity (INBio), in Costa Rica. Together, the profiles offer a broad overview of the breadth of scientific excellence in the developing world.*

TWAS has also received funding from governments and multi-lateral organizations to pursue specific programmatic initiatives. These projects include:

- *In 2006, TWAS helped FORGEA International, a geomining and environmental training and cooperation centre based in Cagliari, Sardinia, Italy, to organize four workshops aimed at building the scientific capacity of scientists and decision-makers from both developing nations and countries with economies in transition bordering the Mediterranean Sea.*
- *In January 2008, TWAS became part of an EU-funded consortium aimed at promoting collaborative information and communication technologies (ICT) research between European, Caribbean and African institutions. The project will last two years. TWAS's main involvement will be the organization of the First EuroAfriCa-ICT Summit to be held in Brussels, Belgium, in early 2009.*



SOUTH FOR SOUTH

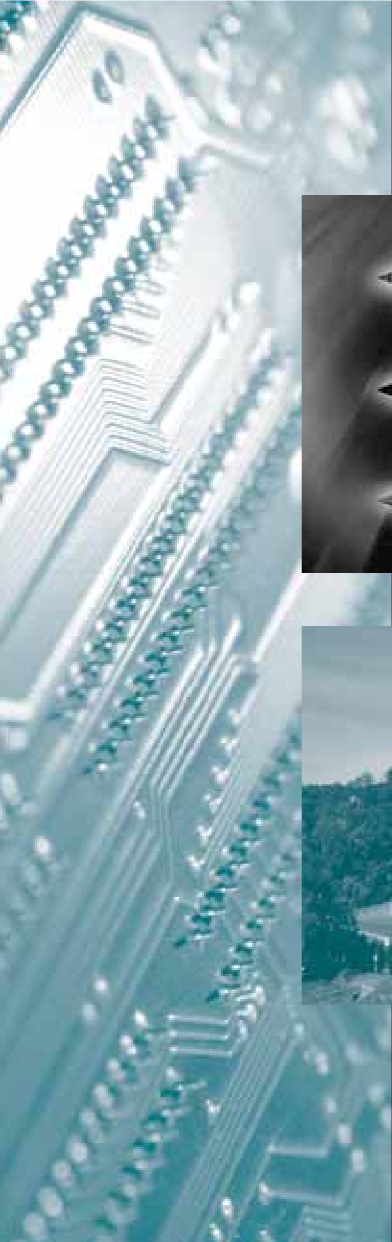
But perhaps most importantly, TWAS has been able to attract increasing funding from an increasing number of developing countries with growing economies. These developing countries have received TWAS funding in the past and are now able to provide funds to TWAS to help advance the Academy's cause.

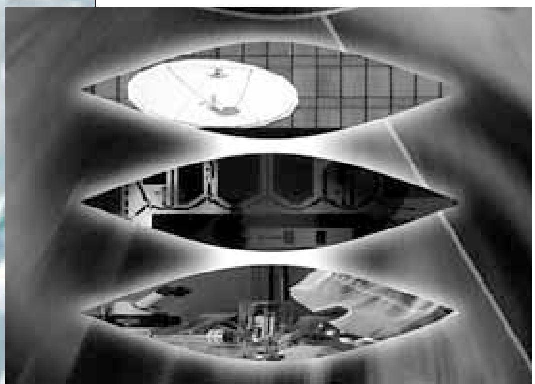
The two most important sources of funding from the South have been for the TWAS endowment fund and the TWAS South-South fellowship programme for postgraduate and postdoctoral students from the developing world.

The TWAS endowment fund, which now totals more than US$12 million, has been built up exclusively with donations from developing countries and from interest earned on the principal. As a reflection of the fund's success and as a part of the Academy's Jubilee anniversary, TWAS has set a new endowment target of US$25 million, which it hopes to reach by 2012.

To achieve this goal, the Academy has re-launched its endowment fund campaign designed to encourage national governments, foundations and individuals (most notably, TWAS members) to contribute to the fund. No money will be withdrawn from the endowment until the target is met. When that takes place, the annual interest earned on the endowment's principal (likely to vary between 3 and 6 percent) should be sufficient to cover most of TWAS's overhead costs. That would free the annual contribution from the Italian government for use solely for programmatic activities that would directly assist scientists and scientific institutions in the developing world.

The Academy now has sufficient funds to offer 250 fellowships a year to postgraduate and postdoctoral students in developing countries. This makes it the world's largest South-South fellowship programme. The initiative works like this: Participating countries, which now include Brazil, China, India, Malaysia, Mexico and Pakistan, waiver tuition fees and cover hospitality costs for students from other developing countries to attend universities and research institutes in their countries and obtain advanced degrees and training in a wide range of scientific





fields. TWAS, in turn, administers the programme and covers the cost of a round-trip airline ticket between the student's home country and the university or research institute where he or she is studying. The Academy estimates that annual expenditures for this programme total US$5 million.

This is potentially one of the most far-reaching initiatives for scientific capacity in the developing world. If we can sustain and even expand the number of fellowships in the years ahead, over the course of the next several decades the Academy could help train thousands of young scientists, significantly raising the level of scientific capacity in scientifically lagging countries across the developing world. Moreover, the sense of solidarity that the programme creates among developing countries could help forge a sense of common purpose that extends well beyond each nation's scientific community.

To provide even greater assistance to young scientists, TWAS has recently established a new category of membership – TWAS Young Affiliates – for scientists in the developing world who are less than 40 years old. Each Affiliate receives a five-year appointment and is invited to attend TWAS general meetings.

It is only fitting that TWAS's five regional offices will manage the Young Affiliate's programme. Over the past five years, the Academy has focused a great deal of attention on strengthening its five regional offices. This effort not only points to the growing scientific capacity of the developing world but also serves as a part of a larger strategy to help accelerate regional scientific capacity in the years ahead.

Finally, TWAS Prizes in the basic sciences, designed to promote the careers of scientists in the developing world, and the Trieste Science Prize (funded by illycaffè), designed to highlight and reward the developing world's most eminent scientists, have left an indelible mark on both scientists and scientific communities across the South.

WHERE TO NOW?

TWAS has had the good fortune to be aided by the Academy's dedicated members and a skilled and experienced staff; it has benefited from the generosity and active involvement of a long list of friends and supporters who have kindly given their time and money to advance TWAS's mandate; and it has had the foresight and discipline to pursue an agenda of critical importance to the developing world – and indeed the entire world.

In its efforts to help individual scientists and scientific institutions, the Academy's many small steps have ultimately added up to significant contributions to the world of science in the South.

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The Academy, I believe, deserves credit for helping to raise the profile of science in developing countries and, equally important, for helping to raise the profile of scientists in developing countries. It has assisted thousands of scientists at critical junctures in their careers. It has helped young scientists. It has served as a voice for the scientific community and helped to shape policy debates within developing countries by highlighting the importance of science and technology to development. And it has provided a bridge for South-South and North-South cooperation in science.

Yet, while much progress has been achieved over the past 25 years, and while we can be proud of the role that the Academy has played in these efforts, much more remains to be done.

TWAS must continue to work hard to help raise the profile of science in developing countries that have yet to fully embrace policies to promote scientific capacity building. Bridging the South-South divide in science is likely to be one of the critical issues for science in the developing world in the years ahead.

The Academy should continue to serve as a voice for critical science-related issues not just in the South but also throughout the world. Developing world scientists have a great deal to contribute to addressing such issues as climate change, energy security, biodiversity loss and emerging infectious diseases. The Academy should serve as a place where their ideas can be showcased and shared.

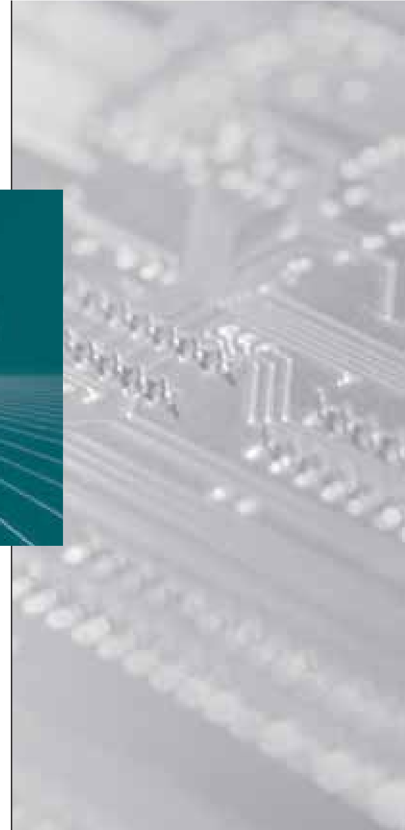
TWAS should continue to assist young and mid-career scientists at critical junctures of their careers. The future of science belongs to the next generation of scientists, and the Academy should focus on helping them achieve their full potential.

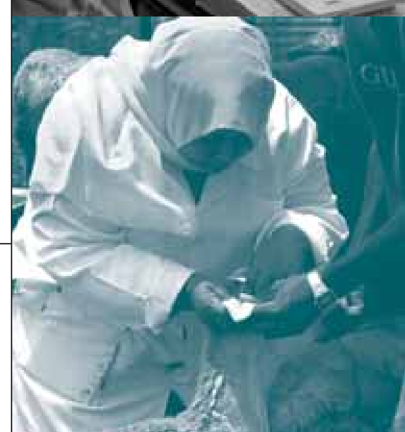
Finally, TWAS should expand its role as a conduit between the South and North to help advance scientific research and develop effective international policies for addressing some of the most critical issues of our day.

The Jubilee Anniversary of TWAS is, of course, a time of celebration – and the Academy certainly does have much to celebrate. But this is no time for complacency. Institutions resemble individuals in this respect: to rest on one's laurels and close one's eyes to change is to invite stagnation and decline.

Change, in fact, is inevitable and never more so than in the fast-paced global society of the 21st century. TWAS's success has proved that it has mastered the art – and science – of change. That is why I am confident that the Academy's next 25 years will be even more fruitful than the first 25 years, as TWAS applies lessons from its experience to meet the challenges of the future in ways that prove beneficial to the Academy, to science and, most importantly, to societies across the developing world. ■

Jacob Palis
TWAS President
Trieste, Italy





TWENTY PLUS FIVE

SINCE ITS 20TH ANNIVERSARY, TWAS HAS SOUGHT TO STRENGTHEN AND EXPAND ITS ROLE AS A KEY INTERNATIONAL PLAYER IN BUILDING SCIENTIFIC CAPACITY AND PROMOTING SCIENCE-BASED DEVELOPMENT IN THE DEVELOPING WORLD.

It has been five years since TWAS celebrated its 20th Anniversary in Beijing, China, at a memorable four-day event sponsored by the Chinese government. At that historic meeting, China's President Hu Jintao, speaking to more than 3,000 people at the opening ceremony held in the Great Hall of the People, suggested that TWAS would "play an even greater role in global science in the years ahead". C.N.R. Rao, then president of TWAS, observed that "The measure of our future success...will largely depend on the degree to which we help our fellow citizens improve their lives and achieve their 'place in the sun'."

The *TWAS Strategic Plan for 2004-2008* laid out a blueprint for advancing the Academy's goals. The plan called on TWAS not only to continue its efforts to build scientific capacity in the developing world, but also to help developing countries apply scientific knowledge and technological know-how to effectively address critical social and economic needs.

RAO TO PALIS

At TWAS's 17th General Meeting in Angra dos Reis, Brazil, Jacob Palis, professor emeritus at the *Instituto Nacional de Matemática Pura e Aplicada*, Rio de Janeiro, and president of the Brazilian Academy of Sciences, succeeded C.N.R. Rao to become the fourth president of TWAS.

In praising Rao's term as president, TWAS executive director, Mohamed H.A. Hassan, observed, "Rao helped to strengthen TWAS's two primary goals: excellence and inclusiveness."

Rao was instrumental in the creation of such new TWAS programmes as Grants for TWAS Research Units in Least Developed Countries (LDCs) and TWAS Research Professors in LDCs. He also led the expansion of TWAS's South-South fellowships scheme and established the CNR Rao Prize for Scientific Research to honour distinguished scientists from the developing world, especially from science-poor countries.

Reflecting on his time as TWAS president, Rao told meeting participants, "It has been an honour to have

served as president of TWAS. Indeed, it has been among the most rewarding experiences of my career."

Assuming the post of TWAS president, Palis pledged "to work tirelessly toward realizing the goals and ambitions of the Academy" to "benefit all the people of the South." Palis confirmed his commitment to expand TWAS's South-South collaborative programmes; provide greater support for scientists working under difficult conditions, including women scientists, scientists in sub-Saharan Africa and young scientists; enhance the role of the five TWAS regional offices; and promote North-South cooperation.

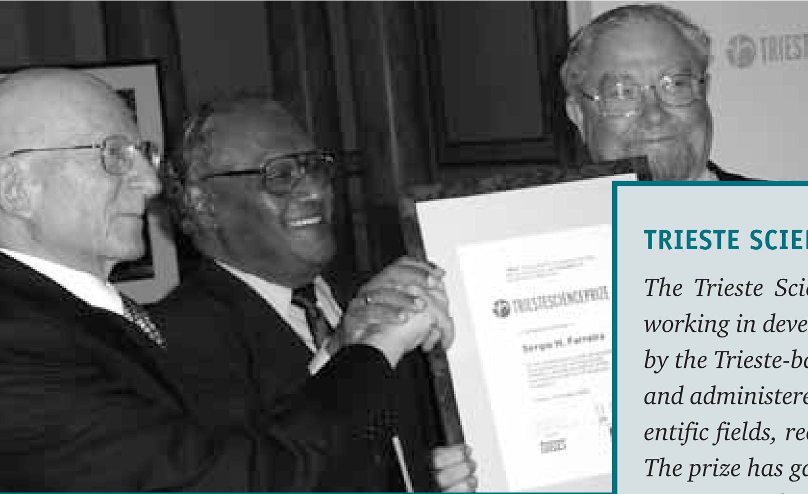
At the meeting in Brazil, TWAS members also chose a new Council. Reza Mansouri, professor of physics, Sharif University of Technology, Iran, and Keto Mshigeni, vice chancellor, Hubert Kairuki Memorial University, Tanzania, were elected to the Council for the first time. Two new vice presidents, who had formerly served on the TWAS Council, were also elected: Atta-ur-Rahman, Federal Minister for Higher Education in Pakistan (for central and south Asia) and Bai Chunli, executive vice president, Chinese Academy of Sciences (for east and southeast Asia).

Dorairajan Balasubramaniam, director of research, L.V. Prasad Eye Institute, India, replaced Palis as secretary general, and José L. Morán López, professor in the Department of Advanced Materials for Modern Technology at the Institute of Science and Technology in San Luis Potosí, Mexico, continued as TWAS treasurer. Other council members remaining at their posts were Jorgé E. Allende (vice president, Latin America and Caribbean region), professor at the Institute of Biomedical Sciences, University of Chile; Ismail Serageldin (vice president, Arab region), director of *Bibliotheca Alexandrina*; Ali Al-Shamlan, director general,

TWAS ENDOWMENT FUND

To mark its 25th Jubilee anniversary, TWAS has launched a new endowment fund campaign. The target is US$25 million. The Academy hopes to reach this goal by 2012. TWAS's first endowment fund campaign began in 1995 with a target of US$10 million. The endowment currently stands at US$12 million, thanks to generous contributions from governments, organizations and individuals in the developing world. The new campaign will extend its appeal to the North as well as the South.

With a US$25 million endowment, TWAS will be able to cover virtually all of its overhead expenses through interest earned on the endowment's principal. This will ensure that all funds received from the Italian government can be spent on programmatic activities that directly help scientists and scientific communities in the developing world. For additional information about the endowment fund campaign, including how you may contribute, please contact info@twas.org.



TRIESTE SCIENCE PRIZE

The Trieste Science Prize recognizes outstanding scientists living and working in developing countries. The prize, established in 2004, is funded by the Trieste-based illycaffè, one of the world's premier coffee producers, and administered by TWAS. Recipients, representing a broad range of scientific fields, receive a US$50,000 cash award.

The prize has gained international recognition, symbolizing the growing reputation of Trieste as a city of science. Andrea Illy, illycaffè's chief executive officer, has noted that the company is "delighted to be sponsoring the prize. The initiative is designed to promote the growing contributions of science in the developing world to the world of global science by bestowing deserved recognition and rewards on its most illustrious scientists."

For more information about the Trieste Prize, including a complete list of the prizewinners, please see www.twas.org.

Kuwait Foundation for the Advancement of Sciences (KFAS); Eugenia M. del Pino, professor of biological sciences, Pontifical Catholic University of Ecuador; Abdul H. Zakri, director of the Institute of Advanced Studies/United Nations University; and K.R. Sreenivasan, director of the Abdus Salam International Centre for Theoretical Physics (*ex-officio*).

In 2007, Romain Murenzi, Minister of Science, Technology, Scientific Research and Information Communication Technologies in Rwanda, was named TWAS vice president for Africa. He succeeded Lydia Makhubu, former vice chancellor of the University of Swaziland and founding president of the Third World Organization for Women in Science (TWOWS).

In December 2007, Academy members approved the revised Academy statutes and bylaws. Juan Roederer (TWAS Associate Fellow 1991), who headed the statutes and bylaws committee, noted that approval of these documents reflected "the Academy's transformation from a small institution, where decisions have often been made on an informal *ad hoc* basis, into a large and sophisticated organization requiring a more formal structural framework to operate more smoothly and effectively."

TWAS's five regional offices have expanded the Academy's regional presence and impact.

ADMINISTRATION

The TWAS Steering Committee met for the first time in January 2007, marking a new chapter in the management of TWAS. Palis noted that the meeting would enable "officials from the Italian government (TWAS's main funding agency), UNESCO (TWAS's main administrative agency) and the Academy to discuss the future direction of TWAS." He hoped this would lead to "a closer, more fruitful relationship that would advance the organizations' shared objectives in the years ahead."

The Steering Committee will meet once a year to assess the Academy's progress in advancing its goals and to provide advice on how TWAS might be able to fulfil its mandate more effectively.

Steering Committee members will review the Academy's strategic objectives and programmatic activities; assess the financial accounts of the previous year; and formally approve the budget for the current year of operation.

REGIONAL OFFICES

TWAS's five regional offices, all established within the past five years, have expanded the Academy's regional presence and impact. The first office – for East and Southeast Asia and the Pacific (TWAS-ROESEAP) – was created in 2003 and is hosted by the Chinese Academy of Sciences (CAS) in Beijing. In June 2004, the Brazilian Academy of Sciences launched the Regional Office for Latin America and the Caribbean (TWAS-ROLAC) in Rio de Janeiro at its annual meeting. In September 2004, the Kenya-based African Academy of Sciences

WITH ICGEB

In 2005, TWAS and the International Centre for Genetic Engineering and Biotechnology (ICGEB) launched a joint programme to promote research into abiotic stress in plants, especially in science- and technology-lagging countries (S&TLCs). Under the programme, small research networks (comprised of two to four institutions, one of which is a S&TLC) have been created to conduct research in this field. Five projects from a candidate pool of sixty were selected. Each was given US$20,000 per year for three years. For more information, see www.icgeb.org/twas-grants.html.

(AAS) created the TWAS Regional Office for Sub-Saharan Africa (TWAS-ROSSA). The same month, the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR) inaugurated the TWAS Regional Office for Central and South Asia (TWAS-ROCASA) in Bangalore, India. The fifth regional office, the TWAS Arab Regional Office (TWAS-ARO), was founded in 2005 at *Bibliotheca Alexandrina* in Alexandria, Egypt.

In addition to promoting TWAS's core activities, the regional offices support their own initiatives. For example, they have developed websites and organized scientific meetings on topics ranging from earth sciences to ocean data assimilation and prediction (TWAS-ROESEAP); memorial lectures such as the Thomas Risley Odhiambo Memorial Lecture in honour of one of TWAS's Founding Fellows (TWAS-ROSSA); and public lectures designed to increase citizen interest in science (TWAS-ARO). They have also taken the lead in the selection of TWAS Young Affiliates, a new category of Academy membership for scientists under 40, and in awarding prizes and recognition to young scientists from their region. The regional offices also administer TWAS prizes for science and the media, public understanding of science and science education.

The first coordinators' meeting of the five regional offices took place in 2007 at TWAS's 18th General Meeting in Trieste, Italy, where participants shared their experiences and ideas. The next coordinators' meeting will take place in Mexico City at the TWAS 19th General Meeting and 25th Anniversary celebration.

Since its launch in 1993, the Third World Organization for Women in Science (TWOWS) has played a pivotal role in recognizing and supporting the achievements of women scientists in the developing world. Over the past five years, the membership of TWOWS has increased from 2,800 to more than 3,300, as it continues to be the largest organization of women scientists in the world.

The membership of TWOWS has increased from 2,800 to more than 3,300.

TWOWS' flagship programme, 'Postgraduate Training Fellowships for Women Scientists in Sub-Saharan Africa and LDCs at Centres of Excellence in the South,' celebrates its tenth anniversary this year. Supported by the Swedish International Development Agency's Department for Research Cooperation (Sida-SAREC), the programme has assisted more than 300 young women scientists to date. Sida-SAREC has recently renewed the initiative, providing TWOWS with an additional US$3 million in funding for 2007–2010. Kaiser Jamil, TWOWS president and director of the School of Biotechnology, Mahatma Gandhi National Institute of Research and Social Action in Hyderabad, India, has noted that the programme has enabled TWOWS "to pursue and expand its efforts in recognizing and supporting women scientists in the developing world and has helped to increase the participation of these women in national and international decision-making processes."

This year marks the 15th anniversary of another TWAS affiliate, the InterAcademy Panel on International Issues (IAP), which now boasts a membership of 100 scientific academies worldwide. One of IAP's most important activities in the past five years has been to help build scientific capacity in the developing world through the creation and support of science academies. IAP assisted in the launch of the Network of African Science Academies (NASAC), the Network of Academies of Science in OIC Countries (NASIC) and the InterAmerican Network of Academies of Sciences (IANAS). Mohamed Hassan, representing TWAS, the lead academy for IAP's capacity building programme, remarked, "These regional networks have emerged as important networks in their own right. They have raised public awareness of specific regional concerns and disseminated information emphasizing the importance of science academies to national and regional leaders."

In addition, IAP, whose co-chairs are Chen Zhu, China's Minister of Health, and Howard Alper, chair of Canada's Science, Technology and Innovation Council and distinguished university professor at the University of Ottawa, supports programmes ranging from scientific communication for young scientists to promoting best practices in science education in sub-Saharan Africa. In the past five years, IAP has also issued eight public statements on such critical science-related topics as human reproductive cloning, health of mothers and children, scientific capacity building and biosecurity.

Anticipating its own future and the next generation of scientific leaders, IAP is beginning to reach out to young scientists through events such as the IAP Conference of Young Leaders in Science Technology and Innovation at the World Economic Forum's (the 'Summer Davos') Meeting of the New Champions in Tianjin, China, which took place in September 2008. With secure annual funding since 2004, when the Italian parliament passed a permanent law with such a provision, IAP has had the financial stability

CLIMATE CHANGE

Launched in 2001 and completed in 2007, the Assessments of Impacts and Adaptations to Climate Change (AIACC), was a global initiative designed to improve the capacity of scientists in the developing world to participate in climate change research projects. AIACC was funded by the Global Environmental Facility (GEF), with additional funding from the Canadian International Development Agency, the US Agency for International Development, the US Environmental Protection Agency and the Rockefeller Foundation. START (the global change SysTem for Analysis, Research and Training) and TWAS served as the executing agencies. Support was given to 24 regional study teams in 50 developing countries. The teams consisted of 235 scientists and more than 60 graduate and undergraduate students in 50 developing countries. For more information, see www.aiaccproject.org.

to expand its activities as well as establish a strong foundation for its future growth.

Five years ago, the InterAcademy Medical Panel (IAMP) moved from its headquarters in Washington, DC, to Trieste, Italy, to operate under the administrative umbrella of TWAS, thus becoming another important member of TWAS's 'family of affiliates'. When IAMP first arrived, it had 45 medical academy members. That number has grown to 65. IAMP's activity profile includes three important programmes: reducing maternal and perinatal mortality; improving the writing skills of scientists and clinicians; and examining emerging infectious diseases.

The main objectives of IAMP, whose executive co-chairs are Guy de Thé, member of the *Académie de Médicine*, Institut de France, and Anthony Mbewu, president of the Medical Research Council of South Africa, are to promote health through research and education, broaden capacity in health sciences and health professions, and provide independent, evidence-based advice on health-related science policy issues. Its strategic plan, covering the period 2008-2010, has established a programmatic roadmap that supports these general objectives, and also calls for devising strategies for such activities as controlling rheumatic fever and rheumatic heart disease in developing countries, assessing global healthcare quality, curbing the incidence of infectious disease and building an international mother-child research network. As Guy de Thé has observed, "IAMP's membership, focus and resources all suggest that it has a bright future – one that can make a difference not just for the organization itself but for our global society."

AAAS PLENARY LECTURE

In February 2007, TWAS executive director Mohamed H.A. Hassan gave one of four plenary lectures at the annual meeting of the American Association for the Advancement of Science (AAAS) in San Francisco, California. Other lecturers included John H. Holdren, then AAAS president; Larry Page, co-founder of Google; Nobel Laureate Steven Chu (Physics 1997); and Susan Solomon, co-chair, Working Group 1, Intergovernmental Panel on Climate Change (IPCC). In his presentation, Hassan examined the essential role that science, technology and innovation (STI) has played – and will continue to play – in economic and social development in developing countries. Broadly categorizing the world into three groups – strong, moderate and weak in STI capacity – Hassan contended that more must be done to narrow the gap between these groups. He focused special attention on the need to advance Millennium Development Goals (MDGs). For a more detailed account of his lecture, see TWAS Newsletter *vol. 1, number 19, "Sunlight and Shadows in the South," www.twas.org.*

LOOKING SOUTH

Over the past five years, TWAS's International Programme for Higher Education and Research (IPHER) has emerged as the largest programme of its kind in the world. It currently consists of 15 postgraduate and postdoctoral fellowship programmes, two fellowship programmes for advanced

UNDP SPECIAL UNIT FOR SOUTH-SOUTH COOPERATION

In the past five years, TWAS has continued its 'Sharing Innovative Experiences' workshop series together with the United Nations Development Programme Special Unit for South-South Cooperation (UNDP-SSC). The initiative is part of a multi-dimensional strategy to promote knowledge-sharing in the developing world. Seven workshops have been carried out during this period, exploring such themes as: Cities, Science and Sustainability, Capacity Building for Sustainable Development, Local Development: Applications of Knowledge Networks in the South, Successful Experiences in Providing Safe Drinking Water, Development of Pharmaceutical Products from Medicinal Plants, Successful Conservation and Sustainable Use of Biodiversity and Successful Uses of Renewable Energy Sources in the South. The series covers science-based issues of social concern but, even more importantly, issues that have inspired Southern solutions to Southern challenges through the use of Southern expertise. For more information and to browse the publications produced thus far, see tcdc.undp.org/widenew/sharingsearch.asp.

research and training, and three programmes for research collaboration. All told, IPHER assists nearly 200 scientists each year.

The fastest growing segment of IPHER – TWAS's South-South fellowship programme for postgraduate and postdoctorate students – operates in partnership with an increasing number of developing countries. Launched in 2004, with the governments of Brazil, China and India, the programme has grown from 70 fellowships to 250 fellowships in less than five years. Since its inception, agreements have also been signed with Mexico (2005), Pakistan (2007) and Malaysia (2008).

As TWAS President Jacob Palis has noted: "The fellowship programme, in many ways, represents the future of the Academy and, more importantly, the future of science in the developing world. We have taken – and will continue to take – steps to entice additional countries to join and expand our efforts."

TWAS's International Programme for Higher Education and Research has emerged as the largest programme of its kind in the world.

FIVE YEARS ON

Over the past five years, TWAS has made significant advances in building scientific capacity in the developing world, and has gained an even more powerful presence in science policy circles across the South. The Academy's current membership stands at 847 and its activities take place in some 100 developing countries.

TWAS has launched programmes to recognize and help young scientists and to provide assistance to scientists living and working in the world's most science-deprived countries and regions. It has worked closely with its partners to help improve conditions for women scientists in the South and to strengthen the capacity of science academies. It has actively participated in science-policy discussions and sought to lend its voice to science-related issues, especially in the developing world. Increasingly, it has played a key role as the 'voice of science' in debates over critical global issues.

The Academy is proud of the contributions it has made, both on its own and in partnership with other institutions, and it is pleased by the accelerated pace of positive change over the past five years.

But the Academy also recognizes that while it has much to celebrate, it still has much to do. Undaunted by the challenges ahead (in much the same way that it was undaunted by the challenges it faced in the past), TWAS intends to continue to work diligently towards its ultimate goal: to create strong scientific communities – and an enduring foundation for science-based development – in the developing world. There is no better way to celebrate our 25th anniversary than to continue to honour our pledge to help advance science in the South. ■

CHINA'S SCIENTIFIC OPENING

THE TWAS SECOND GENERAL CONFERENCE, HELD IN BEIJING FROM 14 TO 18 SEPTEMBER 1987, OPENED THE EYES OF THE INTERNATIONAL SCIENTIFIC COMMUNITY TO THE CHINA THAT WAS ABOUT TO BE. MOHAMED H.A. HASSAN, WHO WAS THEN EXECUTIVE SECRETARY AND IS NOW THE ACADEMY'S EXECUTIVE DIRECTOR, PLAYED A KEY ROLE IN ORGANIZING THE MEETING.

I thought my first impression would be the most enduring. When I landed at Beijing's international airport on 12 September 1987, I could hardly believe my eyes. The airport in Beijing, consisting of a few poorly maintained structures, was no larger than the airport in Trieste, a city in northern Italy with some 220,000 people that was home to the TWAS secretariat. That's where I had begun my 10-hour journey.

Abdus Salam, at the time the only scientist from the Islamic world to win the Nobel Prize (physics 1979) and the legendary founder of the International Centre for Theoretical Physics (ICTP), had lured me to Trieste from the University of Khartoum in Sudan, where I was a professor of mathematics. Salam had told me on more than one occasion that TWAS could make a real difference in the developing world. With his elegant English accent and penetrating deep brown eyes, he had an uncanny ability to make you believe what he believed.

Yet Beijing's international airport, marked by peeling paint and dim lighting, a lack of signs and service, and an endless and anxious wait for luggage and the few taxis that were available suggested that it was going to take a lot of work to realize Salam's dream – even (and perhaps especially) in the world's most populous nation. I could not help but think that the Academy might be just a tad too small to do the job.

The drive from the airport to the hotel, located on the outskirts of the city, was another eye-opener. The road we took was narrow and poorly paved. Street lighting was sporadic, adding a shadowy moonlit cast to the scene. A smattering of cars, mainly Japanese-made, jostled with numerous bicycles, wheel barrels and an occasional donkey cart. Beijing was certainly busy, even frenetic. It was well cared-for but poor. A metropolis, yes. A world-class city, no.

> ***The 'new' China was characterized by an embrace of science and technology.***

Yet it was not my initial reaction to Beijing that would be the most enduring. Instead, it was what was said at the conference – clearly and convincingly by Chinese scientists – that would leave the most lasting impression. That impression remains as compelling today as it was more than two decades ago.

At the conference, whose opening session took place in the Great Hall of the People, I learned of a China that virtually no one knew. That China – a 'new' China as the Chinese themselves described it – was characterized by an embrace of science and technology and by a heart-felt display of competence and confidence that impressed not just me but all who attended.

The experience would forever alter the participants' perception of what was possible in a world of unprecedented, but uneven, progress in science – a world that many feared would only widen the gap in science and technology (and thus in economic and social well-being) between developed and developing countries.

At TWAS's Second General Conference, China, in contrast, showed another scenario based on this compelling belief: that through national political will and commitment, developing countries could take advantage of global scientific and technological advances to close the science and technology gap – and thus to improve the lives of hundreds of million of people.

As Salam fervently hoped, developing countries could indeed change their circumstances and, in turn, change the world. Yet, as speaker after speaker from China indicated, it would largely be up to each developing country to do so. External aid was present in China, but it was the Chinese themselves who had instituted the reforms that were necessary to build a future of progress and promise based largely on science and technology.

The TWAS Second General Conference opened on 14 September, two days after I arrived, and continued for five days. More than 150 participants from 50 countries were in attendance, joined by some 150 participants from China. It marked the first time that so many scientists from both developing and developed countries

had met in a developing country to broadly discuss issues related to science and technology.

Preparations for the conference had begun two years earlier with conversations between Salam and Chinese leader Deng Xiaoping, the architect of the country's ideological and economic reforms. TWAS was eager to build on the success of its First General Conference, held in Trieste in July 1985. In Trieste, participants examined the state of science in the developing world and explored how to forge effective strategies for North-South and South-South cooperation. The same issues were on the agenda at the Beijing conference. But, in addition, nearly half of conference – 14 of the conference's 30 hours of discussion – focused on the state of science in China.

As explained at the conference, China's first forays into the world of modern science began soon after the Communists' victory over Chiang Kai-shek in 1949. Indeed the Chinese Academy of Sciences was established just two months after Mao Zedong assumed power.

Progress in China over the next two decades was slow but steady. Everything was then abruptly interrupted – and reversed – by the Cultural Revolution (1966-1976) and its tragic decade-long assault on intellectuals and scientists. Zhou Guangzhao, president of the Chinese Academy of Sciences, who addressed conference participants in the opening session, was one of several Chinese speakers to openly describe the Cultural Revolution as a "disaster".

The conference, noted Zhao Ziyang, general secretary of the Communist Party, would provide a "clear view" of the state of science and technology in his country. Conveying both a wish and a promise, Zhao went on to say, "China is a developing socialist country… The old China was backward and poor. Today's progress has been made after the founding of the new China. Therefore we are in the best position to understand Third World countries. Even if China is well developed in the future, she will never forget her Third World friends."

Even if China is well developed in the future, she will never forget her Third World friends.

HEARING IS BELIEVING

So, what did the participants at TWAS's Second General Conference in Beijing discover?

First, that China had developed wide-ranging expertise in a number of scientific fields, including agriculture, forestry, environmental monitoring and public health. In 1949, China, with a population of nearly 550 million, had just 50,000 people working in science and technology and only 500 scientists actively engaged in research. Throughout the country, there were a paltry 30 scientific institutes and fields of study were largely restricted to two – geology and taxonomy.

In contrast, by 1987, as reiterated by several of the Chinese scientists at the conference, the country had more than 10 million people working in virtually all fields of science and technology, including 300,000 active researchers. The Chinese Academy of Sciences alone had 80,000 scientists working in more than 120 research institutes. The nation's research enterprise was complemented by a rapidly growing system of higher education comprised of more than 1,000 universities with nearly 2 million students.

Second, we learned that China was now fully versed in such cutting-edge fields as biotechnology, computer technology and information science, electronics, high-energy physics, material science and structural chemistry. China, for example, was the first nation to carry out a total synthesis of crystalline natural bovine insulin. It had done world-class work on low-temperature high-conducting materials. It had launched 19 satellites. It had developed an extensive nationwide remote sensing system that provided invaluable information for the surveying of metals and minerals and the study of seismic zones. It had eliminated wheat rust and created hybrid rice varieties that had vastly increased crop yields, and had developed vaccines virtually eliminating diphtheria, scarlet fever and polio. It had drastically reduced incidences of malaria from 30 million to 1 million and of schistosomiasis from 11 million to 1 million.

China, in short, had built impressive capacity in the basic and applied sciences, and in conventional and frontier scientific fields as well. Equally important, as many of the speakers noted, it was determined to put that knowledge to work to improve the lives of its citizens. Perhaps most important of all, it had done this virtually on its own, learning from others along the way and adapting that knowledge to its circumstances.

Third, participants learned that while some of the scientific advances that China had achieved were somewhat known by the global scientific community, much of it was not. China was never bashful about tapping the knowledge and expertise of other countries. In fact, an estimated 100,000 Chinese students had studied abroad at the time the conference took place (since then, the number has mushroomed to more than one million). But China was determined to build its scientific and technological capacity largely on its own terms, following a series of carefully devised government-sponsored strategic plans.

Fourth, participants learned that this ideologically driven country was strictly adhering to a ‘dogma of pragmatism’ when it came to issues of scientific capacity building and science-based development. Instead of bemoaning its fate as a poor, impoverished country repressed by capitalist aggressors, the Chinese scientists who made presentations at the conference spoke about a comprehensive self-directed plan of action that demanded – and rewarded – results.

Finally, we learned that China, which had slowly opened the door of scientific exchange with both developed and developing countries, was now welcoming a host of partners in a broad range of fields. Indeed to facilitate the process, Chinese officials announced that they would launch a TWAS-China field office at the Chinese Academy of Sciences, designed, among other things, to promote cooperation in science and technology in the developing world.

AND OTHERS

While half of the conference was devoted to China, the other half was devoted to the state of science and technology in other developing countries. There were presentations from more than 20 developing countries, including Bolivia, Ghana, Jamaica and Kuwait. The presentations all pointed to slow, halting progress in a number of fields.

But overall what the presentations emphasized was the vast gap in science and technology that existed between developed and developing countries. Indeed several speakers commented that the North-South gap in science and technology was even greater than the gap in economic and social well-being.

For example, Salam, drawing information from his "little red science book", *The Regeneration of Science in the Third World,* which was published for the occasion, noted that developed countries spent on average from 2 to 2.5 percent of their annual gross domestic product on science and technology. Developing countries, in contrast, spent on average just 0.2 percent. He also noted that the gap in scientific knowledge between the North and South could be observed by "turning over the pages of *Nature*", where "not more than 2 percent of the papers originate from the South". As other participants noted, more than 90 percent of all scientific knowledge was produced by just 25 percent of the world's countries. The United States alone generated fully half of the world's scientific knowledge.

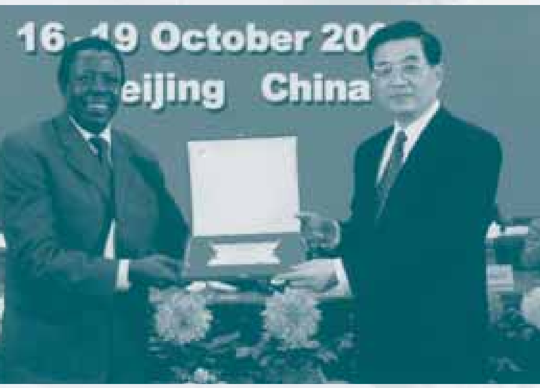
Representatives from the scientific community in the North were also present. In all, 11 presentations were made by officials from such organizations as the International Council of Scientific Unions (ICSU), the International Foundation for Science (IFS), the American Association for the Advancement of Science (AAAS) and the Science Council of Japan. Topics of discussion focused on burgeoning efforts to promote training programmes for scientists in developing countries and to devise joint scientific programmes in which scientists from the South could participate.

CHINA FIRST

But looming above all of the discussions was the presence of China and what it had accomplished on its own in such a brief time.

For China, TWAS's Second General Conference represented a 'scientific opening', a 'coming-out party' in which it was able to put on full display, for the first time, its growing capabilities in science, its ambitious plans for the future and its readiness to embark on major initiatives through South-South and North-South cooperation.

For TWAS, the conference represented an opportunity to showcase its unique role as a key player at the centre of science in the developing world – a player



that could tap its connections and growing credibility to serve as a catalyst for scientific cooperation and capacity building in the South.

For developing countries, the conference represented an unprecedented opportunity to exchange ideas and learn from one other – and to be exposed to examples of success that could serve as models for them to follow.

And for developed countries, the conference was a chance to gain first-hand access to the world of science in China and the developing world and to weigh where efforts for North-South cooperation would make the most difference.

At the conclusion of the conference, several other developing nations expressed their desire to host a similar conference that, like the conference in Beijing, would be designed to provide a broad overview of the state of science and technology in different regions of the developing world, as well as highlight the progress that had been made in the host country in their efforts to promote science-based development. In 1990, TWAS met in Venezuela, in 1992 in Kuwait, and in 1995 in Nigeria.

And so it has been ever since. TWAS's general conferences have become signature events for scientists and science policy-makers from the developing world, providing unique opportunities to gauge the progress that has been made to date and to assess what needs to be done to ensure continued progress in the future.

These conferences, begun in Beijing, have not only helped to change the world by making scientists and science policy-makers aware of the growing range of world-class science taking place in the South; they have also continually shown how much the world has changed – thanks to advances in science and technology in the developing world.

For China, TWAS's Second General Conference represented a 'coming-out party'.

THE FUTURE IS NOW

TWAS returned to China in October 2003 to celebrate the Academy's 20th anniversary. My journey to the conference, coinciding with the Academy's 9th General Conference, began in Trieste and ended at Beijing's international airport, just as it had 15 years earlier. The opening ceremony, just as before, was held in the Great Hall of the People.

I may have followed the same roads to the same places in Beijing, but everything had changed. The Beijing airport was a gleaming new state-of-the-art facility and one of the biggest and busiest airports in the world. The tree-lined avenues that led from the airport to the city centre were jammed with automobiles and taxis, and framed by sleek apartment houses, office buildings and commercial establishments. Enormous holes in the ground, accented by large construction cranes overhead, promised larger structures yet to come, including the venues for the 2008 Olympics. Beijing was not just a metropolis but a world-class city too.

Hu Jintao, president of China, addressed the opening ceremony before 3,000 people. The audience consisted not just of dignitaries and eminent scientists from around the world but many young Chinese students who filled the outer reaches of the Great Hall of the People. Hu had just spoken to China's first astronaut, Yang Liwei, who had returned home that morning after completing a 21-hour, 14-orbit journey around the Earth. The space flight, President Hu observed to the conference attendees, marked "another important step for the Chinese people scaling to the summit of world science and technology."

Sitting on the stage and looking beyond President Hu to the sea of people seated beyond, I could not help but think that one of those important steps in this long march toward the summit was the TWAS Second General Conference in Beijing in 1987. ■

Portions of this article appeared in Nature, *Vol. 455, 2 October 2008, as part of a series of articles examining 'Meetings That Changed The World'. To read the entire series, see www.nature.com/nature/focus/meetings*

SCIENCE IN MEXICO: PROGRESS AHEAD

THIS NOVEMBER, MEXICO WILL HOST THE 25TH ANNIVERSARY CELEBRATION OF TWAS. IN THE FOLLOWING ARTICLE, ROSAURA RUÍZ-GUTIÉRREZ AND JUAN PEDRO LACLETTE, THE CURRENT AND IMMEDIATE PAST PRESIDENTS OF THE MEXICAN ACADEMY OF SCIENCES, EXAMINE THE PROBLEMS AND PROMISE OF SCIENCE IN MEXICO – A NATION THAT BOASTS A WORLD-CLASS SCIENTIFIC COMMUNITY IN A VARIETY OF FIELDS. THE COMMUNITY HOWEVER REMAINS WOEFULLY UNDERFUNDED, HAS TOO FEW RESEARCHERS AND IS OVERLY CONCENTRATED IN MEXICO CITY.

Mexico's scientific community, like the nation itself, is growing in strength. Yet, both must contend with a number of chronic challenges that stand in the way of even greater progress – now and in the future.

While the *Real y Pontificia Universidad de México*, which was established in 1551, can rightfully lay claim to be the oldest continuously operating university in the Americas, modern science in Mexico is less than a century old.

To be sure, during the late 19th and early 20th centuries, individual scientists, in such fields as medicine, astronomy, chemistry and biology, did excellent research. But they did so largely on their own, simply because they had no other choice. More than 125 years after Mexico had gained its independence from Spain in 1821, the nation had virtually no institutional or financial frameworks in place to support individuals who desired to pursue careers in science.

These conditions began to change in the mid 20th century as the federal government began to recognize the important role that science and technology (S&T) could play in social and economic development. Investments in universities and research centres started to climb at a slow but steady pace.

Given the nation's lethargic start in building scientific capacity, it is in some ways remarkable that Mexico now has about 40,000 active scientists, including some 15,000 world-class scientists who enjoy substantial support from the government under the National System of Researchers.

Science in Mexico, as measured by the number of scientists actively publishing in their fields, has grown on average by about 8 percent a year over the past six decades. Mexico currently graduates about 2,200 PhDs annually; however, only 1,000 are added to its roster of researchers in the natural sciences each year.

In 2007, Mexico's scientific community received US$3.8 billion dollars in public funds. The private sector's contribution to S&T remains small but it is growing, largely driven forward by tax incentives designed to encourage research and development. The government's largess is distributed through three main channels: the Council for Science and Technology (CONACYT), which receives one-third of the government's funds allocated for science and technology for support of its 27 research centres, the National System of Researchers, the national scholarship system for graduate students and funding for major projects; the Ministry of Education, which receives another third of S&T funding, largely for the nation's public university system; and other federal ministries, including the ministries of health, agriculture, energy, and environment and natural resources, which receive the balance of funds.

SUPERBLY CONCENTRATED

Mexico's research is highly concentrated in the Federal District that encompasses Mexico City and the surrounding metropolitan area, where 20 million people, or 20 percent of the nation's population, lives.

Indeed nearly 50 percent of all researchers live and work in the metropolitan area. They are responsible for more than 50 percent of all the articles published in international peer-reviewed journals by Mexican scientists.

Scientific excellence can also be found in a number of Mexican states, including Jalisco, Nuevo León, Baja California, Guanajuato, Veracruz and the Yucatàn. (Mexico has 31 states in all.) But even in these states, the quality of science pales in comparison with the research that is taking place in the Federal District. In several other states, science hardly exists at all.

What may be even more striking is that research in Mexico is not just concentrated in a single region, but that it is largely concentrated within a single institution: the *Universidad Nacional Autónoma de México* (UNAM). With more than 45 research institutes, 300,000 students and 30,000 faculty members, and with field campuses in 18 states, UNAM alone accounts for nearly 40 percent of the nation's scientific publications. It is, by virtually all measures, Mexico's pre-eminent institution.

LEGAL LANDSCAPE

In 2002, Mexico's federal government passed a new Law for Science and Technology that was designed to address some of the nation's shortcomings in science.

Specifically, it called on Mexico to increase its annual spending on S&T to 1 percent of the nation's gross domestic product (GDP) by 2006. (For the past decade, the annual percentage has hovered around 0.4 percent). At the same time, the law required the government to take steps to reduce the concentration of funds among just a few institutions in a few places, and to devise a blueprint that would make S&T capacity building truly national in scope. It also put in place a general council for scientific research and technological development, presided over by the president of Mexico. The council was mandated to devise a coordinated framework upon which a national agenda for S&T could be built.

While progress has been made, the law's full intentions have yet to be fulfilled. One critical problem has been a shortage of funds. As stated above, the federal government's investment in S&T has barely inched above 0.40 percent of GDP. Compare that to more than 2.5 percent in many developed countries and more than 1 percent (and rising) in Brazil, China and India.

Moreover, efforts to coordinate the research agenda, at least at the ministerial level, have yet to take hold. Conventional bureaucratic turf issues remain deeply rooted and difficult to extract. In addition, too little attention has been paid to multidisciplinary research, where the future of frontier science lies. Even less attention has been paid to linking laboratory research to the private sector as part of a larger effort to instil a culture of innovation within the scientific community and the nation.

Over the past five years, Mexico's economy has grown at an average rate of 3 percent a year, riding a wave of globalization that has benefited other developing countries as well. (Recent spikes in food and energy prices, and turmoil in the capital markets, have placed this progress at risk.)

While encouraging and certainly welcomed, the rate of economic growth in Mexico has lagged far behind the red-hot emerging economies of China and India, where rates of annual growth have approached, and sometimes exceeded, 10 percent. Indeed it does not even match the growth rates of Latin America's most dynamic economies, of Brazil and Chile.

The relatively good economic news in Mexico has been primarily due to three factors: the opening up to global markets, improved governmental management of the economy and an abundance of cheap labour. Mexico's per capita GDP currently stands at US$12,800, which places it last among Organisation for Economic Co-operation and Development (OECD) member states, but first among the countries in Central and South America. In effect, Mexico is the world's poorest rich country. Or, if you prefer a more pessimistic take on the situation, the world's richest poor country.

STEPS AHEAD

The economic progress experienced by Mexico has recently shown signs that it may stall unless steps are taken to improve the nation's productivity and overall capacity to innovate. To create a stronger foundation for economic growth in the future will require investing more in S&T now. Better management of the economy remains an important factor in improving the nation's economic performance. Consequently, reforms designed to make the economy more competitive and transparent must continue to be put in place. But the broad social context in which the reforms are enacted must also change.

Cheap labour will only take Mexico so far in a global economy that places an increasing premium on knowledge, particularly scientific knowledge. That is why Mexico must pursue reforms which improve the nation's governance of S&T, and which place a greater emphasis on creating a culture of innovation.

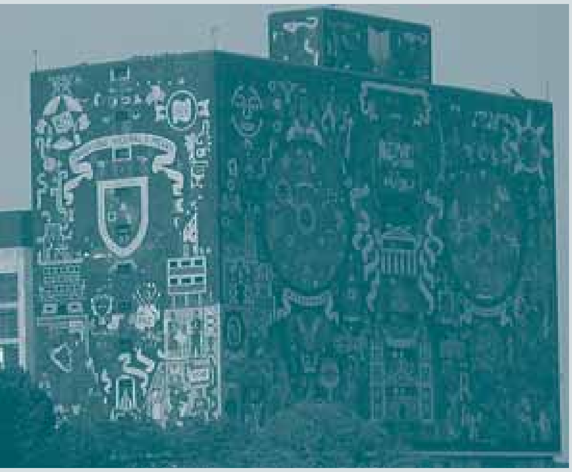
This will require even greater investments in education and training, a strengthening of the science and technology infrastructure in both the public and private sectors, easier access to capital for entrepreneurial high-tech companies, and the enactment of such specific measures as the building of technology incubators and technology transfer centres that help bring the academic community and private sector closer together.

Today, tax incentives are one of the primary means in Mexico by which the private sector is encouraged to invest in research and development. This strategy has benefited a number of large corporations. Steps must now be taken to reform the rules governing tax incentives to encourage entrepreneurs and scientists working together in small and medium-sized firms to garner economic rewards from their research and development efforts.

THE SCIENCE FRONT

Just as the nation must change, so too must Mexico's scientific community.

Scientists must be willing to devote at least a part of their research agenda to projects that are of direct interest and value to the nation. That doesn't mean basic, 'blue skies' research should be abandoned. But it does mean that a better balance between personal and demand-driven research must be struck. The nation's scientific community, especially the 15,000 scientists who enjoy an elite status within Mexico, must stand strongly behind the country's efforts to decentralize



the nation's scientific enterprise. A larger, more diverse scientific community is in everyone's interest. Indeed no other segment of society would benefit more from this development than the nation's scientists themselves.

And, finally, Mexico's scientific community must eagerly seek to partner with others outside of their circle of like-minded researchers. This outreach must take place with scientists in other fields, with economic development specialists who can help put their research findings into practice to improve peoples' lives, with the private sector that could serve as an increasing source of funding and direction for their research and help bring it closer to the market place, and, perhaps most importantly, with policymakers who are responsible for providing the primary source of funding for science in Mexico and who have a large say in determining the working conditions and standing of the scientific community within society.

NEED NOW

The changes that we have outlined above are not just desirable. They are necessary. The world is moving forward at too rapid a pace for Mexico to stand still and to expect to continue to make headway in the global economy.

In 2003, China surpassed Mexico as the second-largest trading partner of the United States. (Canada is the US's largest trading partner.) Will Mexico be able to respond to the growing competition from other developing countries not only in Asia but also increasingly among neighbouring countries in Central and South America?

Over the next decade, moreover, 15 million young Mexicans will be entering the workforce. Will Mexico be able to provide the next generation of workers with decent and secure jobs?

Mexico's nationalized oil industry has been one of the main sources of government revenues over the past several decades, accounting for more than 40 percent of government revenues in 2007. Yet national oil reserves have been declining and, as a result, so too have the revenues. Will Mexico find the financial means to explore for new oil and gas fields? More importantly, will it manage to devise an alternative strategy for economic development that will rely less on oil revenues as a mainstay of government revenues?

Each of these issues represents a formidable challenge. Collectively, they require Mexico to forthrightly face a future that will undoubtedly be dramatically different than the present – a future that will depend increasingly on a well-educated and well-trained labour force, a future that will require the entire nation to be engaged in the knowledge-based economy and not just select regions and groups, a future that will encourage and reward innovation and ensure that Mexico is not just content to be the lowest ranking member of the OECD, but will instead become a fully prosperous nation in which wealth and abundance is shared equitably among all of its people.

On behalf of the Mexican Academy of Sciences and Mexico's entire scientific community, let us conclude by saying how delighted we are to serve as the host of TWAS's Jubilee conference. We welcome the opportunity to showcase our nation's considerable scientific talents and strengths and to frankly examine how we can improve the state of Mexico's scientific community – and indeed all of Mexico – in a world where change is the only constant. ■

Rosaura Ruíz
President

Juan Pedro Laclette
Immediate Past President
Mexican Academy of Sciences
Mexico City, Mexico

IN LESS THAN TWO DECADES, RWANDA – ONE OF AFRICA'S SMALLEST, MOST DENSELY POPULATED AND RESOURCE-POOR COUNTRIES – HAS EMERGED FROM THE DEPTHS OF GENOCIDE TO BECOME A BEACON OF PROGRESS ON THE CONTINENT, THANKS IN LARGE MEASURE TO ITS INVESTMENT IN SCIENCE AND TECHNOLOGY (S&T).

Africa's troubles receive a great deal of media attention; Africa's successes not so much. One of the most important success stories in Africa over the past decade has taken place in Rwanda.The most important figure in this effort has been President Paul Kagame, who has put in place an ambitious programme designed to build a strong base in S&T in a matter of years – not decades.

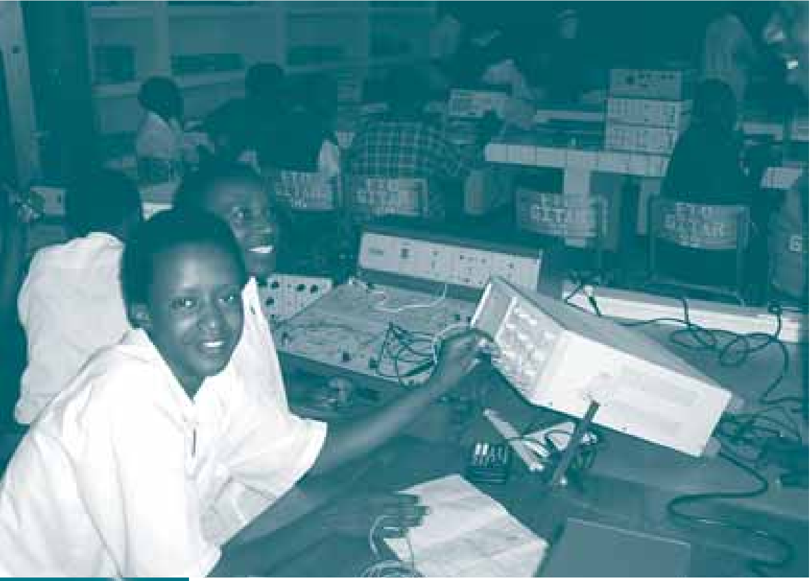
A key player in executing Rwanda's ambitious plans for science-based development is ***Romain Murenzi*** *(TWAS Fellow 2005 and vice president for Africa), who serves as the nation's Minister of Science and Technology. In addition to his ministerial responsibilities, Murenzi is on the Board of*

RWANDA ON THE MOVE

Directors of the Development Gateway Foundation, an international non-profit organization dedicated to reducing poverty and fostering change in developing countries by expanding the use of information technologies. He is also a board member of the Dian Fossey Gorilla Fund International, an organization committed to mountain gorilla conservation.

Murenzi obtained his undergraduate degree in mathematics from the University of Burundi in the early 1980s. He taught for several years, first in a secondary school and then at the University of Burundi, before receiving a fellowship from the University of Louvain in Belgium, where he earned both a master's degree and a doctorate in physics. Murenzi, who worked at universities in Europe and the United States during the 1990s, was professor and chair of the department of physics at Clark Atlanta University, a historically black school in the state of Georgia, USA. His research interests have focused on such leading-edge technologies as continuous wavelength applications to multidimensional signal processing. He is the co-author of Two-Dimensional Wavelets and their Relatives, *published by Cambridge University Press.*

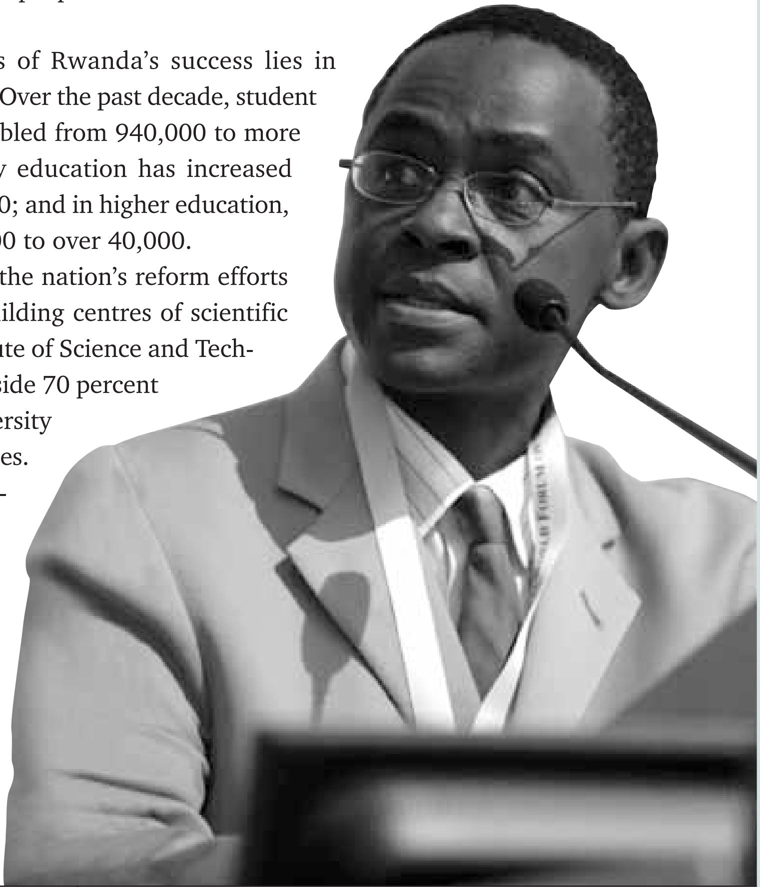
Murenzi returned to Rwanda in 2001 to serve as Minister of Education, Science, Technology and Scientific Research. Since then, he has helped to expand and modernize Rwanda's educational system and devise strategies for building the nation's S&T capacity based on Rwanda's long-term goal to create a knowledge-based and technology-directed economy by 2020. In December 2007, his ministry's responsibilities were expanded to include information and communication technologies. This July, the editor of the TWAS Newsletter *conducted an email interview with Minister Murenzi. Excerpts follow.*



What are the most important steps that Rwanda has taken in recent years to build a strong foundation for science-based sustainable development?

We live in a knowledge-based global economy and it is difficult to see how any nation can address its critical social needs and create secure, well-paying jobs for its citizens without helping them acquire the skills that they need to prosper in a highly competitive world. In the 21st century, this means two things above all others: one, providing all citizens with an excellent education and, two, building indigenous capacity in S&T. This is a critical challenge for a country like Rwanda, a small landlocked nation with just 10 million people and few natural resources. Nearly 90 percent of our population are subsistence farmers.

Rwanda's government now spends 1.6 percent of its gross domestic product (GDP) on S&T. By 2012, it hopes to increase this level to 3 percent, which would be comparable to the level in developed countries. Rwanda is admittedly working from a small economic base. The per capita GDP in 2007 was just US$365. But it's important to bear in mind that our economy is growing rapidly. In 2002, for example, per capita GDP was just US$202. These encouraging trends are unfolding against the background of Rwanda's recent history, which culminated in the genocide of 1994. The tragic loss of up to one million people left our human resource base in a desperate situation.



One of the most significant aspects of Rwanda's success lies in improvements to our educational system. Over the past decade, student enrolment in primary education has doubled from 940,000 to more than 2 million; enrolment in secondary education has increased seven-fold from 50,000 to around 350,000; and in higher education, it has risen more than 10-fold, from 3,000 to over 40,000.

In Rwanda, S&T are at the centre of the nation's reform efforts in higher education. Not only are we building centres of scientific excellence (for example, the Kigali Institute of Science and Technology [KIST]), but we are also setting aside 70 percent of all government student loans for university students majoring in S&T-related disciplines.

In addition, the government is investing in projects to improve the nation's technological capabilities. For example, with financial assistance from the World Bank, we have built a state-of-the-art technical secondary school, *Ecole Technique Officielle* (ETO) in Gitarama. The goal is to provide students with the world-class technical skills that are coveted by both industry and acade-

mia. Since its inception in 2002, several hundred students have earned technical certificates from ETO. Now, in partnership with the Rwanda Workforce Development Authority, a number of graduates are participating in one-year industrial work-study placement schemes to further develop their skills in a business environment.

At the same time, the government has focused on promoting demand-driven research designed to address such critical societal challenges as the need to increase agricultural production (focusing on science-tested ways to boost the yields of wheat, rice, maize and other diet staples), to improve public health (through, for example, research into vaccines to combat malaria) and to protect the environment (by strengthening the research base to enhance forest and soil conservation).

We are also very keen to build up our nascent system of innovation. This will require not only enhancing our educational and research systems but also nurturing entrepreneurial skills by encouraging the commercialization of knowledge-based products and services and protecting intellectual property rights (IPRs). The creation of effective laws and regulations to cultivate an environment of innovation and to secure IPRs are critical aspects of our overall strategy. So, too, is the creation of technology incubators and parks, as well as innovation centres, which can serve as a bridge between universities and the private sector.

Public officials in Rwanda have spoken about the nation's dream of becoming the Singapore of Africa. Is the dream realistic? Are expectations now being set too high for Rwanda's future?

Rwanda does have aspirations to become one of Africa's major knowledge and high-technology hubs and, equally important, a middle-income country by 2020. But we also believe that the process by which we seek to achieve these goals is just as important as attaining the goal itself. Top-level government commitment for building S&T capacity is essential for realizing Rwanda's dreams. As President Kagame, the architect of our nation's wide-ranging efforts to promote science-based development, has stated: "Africa must either begin to build its scientific and training capabilities or remain an impoverished appendage to the global economy." The president has challenged Africa's leaders to place S&T at the centre of their national economic development agendas and not to relegate S&T to the sidelines, as they have so often done in the past. He has asserted time and again that S&T capacity building is a prerequisite for poverty alleviation and sustainable economic growth. He has also maintained that both science and technology are necessary tools for economic transformation and has called for applying "science and technology holistically – to promote education and training; to commercialize ideas, develop businesses and quicken the pace of wealth-creation and employment-generation; to enable government to make available better services; and to provide the basic tools to society for both self- and collective-betterment." Rwanda may not be able to replicate the success of Singapore, but we certainly think that Singapore has a great deal to teach us when it comes to developing effective policies for science-based development. Moreover, I think it is fair to say that we believe setting expectations too low poses a far greater risk than setting expectations too high.

Could you provide some examples of how Rwanda promotes science-based sustainable development?

The *Rwanda Vision 2020* report, which calls for Rwanda to become a middle-income country by 2020, focuses first on accelerating the rate of poverty reduction. The report suggests we should seek to do so by promoting the pro-poor aspects of our national growth agenda. This, of course, requires policies designed to raise the incomes of Rwanda's poorest citizens through jobs creation and family planning. But the report also emphasizes the importance of education, improved health care and the provision of such basic services as access to safe drinking water and adequate sanitation. Such measures cannot succeed without advances in, and applications of, S&T that are in line with achieving the Millennium Development Goals (MDGs). In addition, the *Rwanda Vision 2020* report emphasizes the importance of building the necessary infrastructure for improved transportation and communication. Here again S&T must play a pivotal role. Finally, it stresses the significance of combatting corruption and fostering an environment that rewards competence and accomplishment rather than tolerating connections and deception. The scientific community, which values transparency, can serve as a model for this effort. It will certainly be a beneficiary.

Rwanda's first *Poverty Reduction Strategy Paper* (PRSP), which covered the period from 2002 to 2005 and was endorsed by the World Bank and the International Monetary Fund (IMF), laid the analytical framework for transforming the lofty ideals presented in the *Vision 2020* report into an action-oriented plan. The paper emphasized the need to focus on initiatives to recover from the effects of war and genocide in the mid-1990s. Specifically, it called for increasing food supplies to meet the nutritional needs of the population and for rebuilding – and expanding – the nation's transportation and institutional infrastructures, including education, health care

and housing. Progress has been achieved in some areas, most notably in education, largely through the measures I mentioned earlier. Health care and housing have also improved. Yet obstacles, particularly in administration and management, have stood in the way of attaining even greater progress.

Rwanda's first *Economic Development and Poverty Reduction Strategy* (EDPRS), approved in 2007 by the government, provides a medium-term strategy for wealth creation and poverty reduction for the years 2008-2012. Several broad initiatives underpin the strategy, including a programme designed to foster jobs growth in export industries through large public investments for training in such areas as finance, business and innovation. The goal is to build on the growing strength of the nation's educational system and to provide the additional skills that are needed to compete in the global market place. Such efforts require that learning be encouraged and rewarded not just in school but also in the workplace – and indeed throughout a person's entire life. EDPRS also seeks to address the nation's institutional shortcomings by promoting such factors as greater accountability, rigorous project monitoring, a larger role for the private sector and closer alignment between the priorities of the nation and the priorities of donors.

Rwanda has launched a programme to provide high-speed internet connections to every school within the next two years. How does the programme work?

With the support of the US Trade and Development Agency (USTDA) and the World Bank, Rwanda plans to build a national fibre optic network linked, on one end, to the ocean-floor high-speed cables currently being built from South Africa to Sudan along the east coast of Africa and, on the other end, to satellite electronic communications systems in each of Rwanda's 30 districts. The goal is to provide internet access throughout Rwanda. We hope to complete the project by the end of 2009. In particular, the project is designed to serve schools, hospitals and health clinics, governmental offices and other vital community-based institutions with a broad and enduring network of information and communication technologies (ICTs). We hope to then put the network to work on critical social and economic needs. For example, we plan to transform King

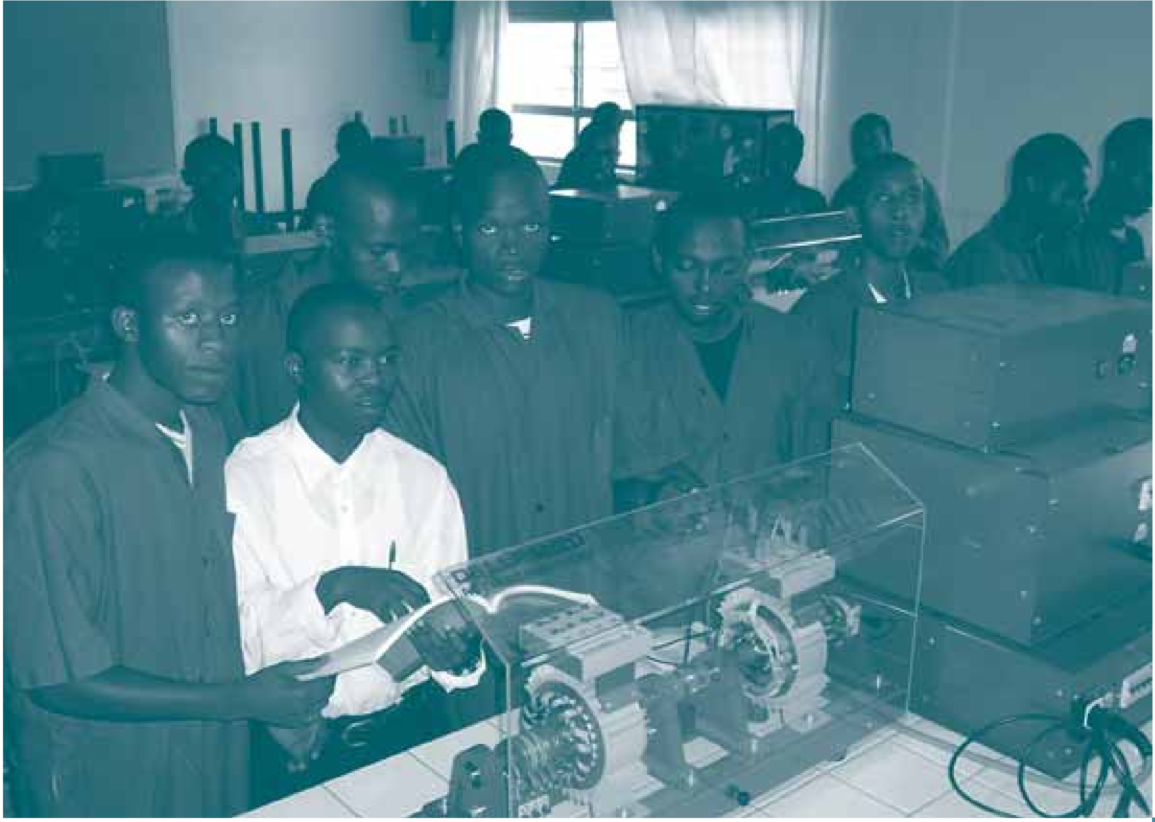
Faisal Hospital into a centre of excellence for medical research and care. Telemedicine will be an important part of this initiative.

To take advantage of its emerging ICTs capabilities, the government of Rwanda is working in partnership with the One Laptop Per Child programme, based at the Massachusetts Institute of Technology's (MIT) Media Lab in the United States. A pilot programme, launched in October 2007, led to the distribution of several hundred laptops among children in a semi-rural school in eastern Rwanda. The programme's immediate success – the children quickly and proudly learned to use their computers – led the government to begin a nationwide One Laptop Per Child programme this year. Plans call for 50 percent of Rwanda's primary-school-age students to have access to a laptop computer by 2012.

Is your strategy for science-based development based on the experience of other nations or have you mapped your own unique way for attaining success?

Rwanda's troubled experience in the 1990s left the nation's economy devastated and much of the infrastructure destroyed. Most significantly, it devastated our population. Death and destruction often meant that all hope in the future was lost. With so few skilled workers (particularly in the sciences, technology and management) and scant natural resources to rely on (Rwanda has neither the oil of Nigeria, the diamonds of the Congo nor the gold of South Africa), we faced a desperate situation. Successfully rehabilitating the nation's infrastructure, restoring public services and re-establishing a credible government in the eyes of both the people and the international community required Rwanda's government to devise and implement multi-faceted reforms that would achieve near-term results for improving the well-being of the people, yet continue to remain focused on a long-term vision for sustainable development.

It is, of course, important to consider development strategies adopted by other countries, especially those examples of 'best practices' in the development and use of S&T that offer a blue-



print for 'leapfrogging' old technologies for new ones. Perhaps more importantly, we can learn a great deal from the S&T-friendly policies adopted by developing countries that have made great strides in promoting science-based development. There is, after all, no point in re-inventing the wheel. But there might be value in retracing the tracks of others. Ultimately, however, strategies and developmental models initiated and implemented elsewhere must conform to each country's social and cultural values and must be reconfigured in response to each country's economic and resource conditions. This is true not just in Rwanda but everywhere.

Do you see Rwanda as a role model for other African nations? What lessons do you think other African nations can learn from Rwanda's experience?

Rwanda's successful efforts to promote science-based development show that a clear vision, committed leadership and a strategic plan of action are all essential for success. What is most encouraging is not just the progress that has been made, but that the rate of progress has been accelerating. Rwanda does not presume to have all the answers. We do, however, believe the level of success that we have achieved makes it possible for us to serve as a model for other countries, just as other countries have served as a model for us. We think that our experience could prove especially helpful to other nations in Africa.

What we have done, of course, we could not have done alone. We are grateful for the support that we have received from national and international aid agencies. The United Kingdom, for example, has provided financial aid to help build our educational system. It has also funded an invaluable initiative that enabled us to devise a national strategy for S&T development. Sweden has invested substantial sums of money in the construction of our ICT infrastructure. Germany has supported our vocational education initiatives, and the United States has financed public health programmes, especially for combatting malaria and HIV/AIDS.

But we have also benefitted from what some might consider unusual forms of cooperation, especially for a poor developing country. Rwanda is part of the East Africa Community, which encourages the free movement of labour across national boundaries. As word of our progress has spread across the region, we have welcomed an increasing number of professors and researchers from neighbouring countries, including Burundi, the Congo, Kenya, Tanzania and Uganda. We are also welcoming a small but increasing number of skilled and educated workers from the developed world – individuals who are encouraged by our success and who want to join efforts to build a better future for our country. The rector of Kigali University of Science and Technology, for example, is from the United Kingdom. The head of the University of Kigali's School of Finance and Banking is from South Africa, and the newly appointed director general of King Faisal Hospital is from the United States. This kind of cooperation bodes well for Rwanda's future. It is cooperation based not on the heartfelt need to aid a poor and helpless country. Instead, it is based on the allure of a country building a bright future for its people that others – both at home and abroad – would like to be a part of. That, in a sense, is what globalization, at its best, is all about.

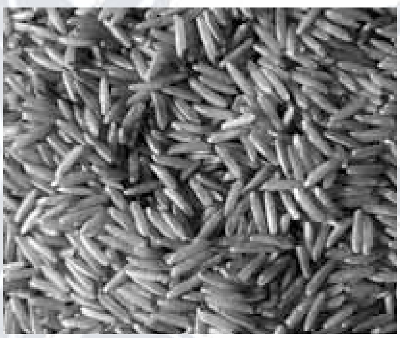
Where do you see Rwanda five years from now in terms of scientific capacity and economic and social well-being? And 10 years from now?

Rwanda's success in enacting effective policies for sustainable development will ultimately depend on our ability to nurture an environment that values and supports S&T. This means providing universal access to education and nurturing scientific centres of excellence, developing a strong and transparent legal and regulatory structure, building an adequate infrastructure and creating credible financial institutions and a transparent and accountable governmental decision-making process. S&T do not take root in a vacuum. Indeed only when the appropriate 'nurturing' factors are in place can S&T begin to flourish and make their mark on society.

We are in the nurturing stage. Ten years from now we expect S&T to be fully rooted in society, providing continual nourishment to a strong and vibrant economy that offers a multitude of material benefits to our people. If we succeed, it would mean that in less than a generation we would have moved from a society largely dependent upon subsistence agriculture to one that embraces knowledge as a fundamental tool for growth. ■

RESEARCH GRANTS PROGRAMME

A LACK OF BASIC EQUIPMENT, LABORATORY SUPPLIES AND SCIENTIFIC LITERATURE OFTEN HAMPERS THE WORK OF MANY CREATIVE AND TALENTED YOUNG SCIENTISTS IN DEVELOPING COUNTRIES. INDEED IT IS A LACK OF SUPPORT THAT OFTEN DISCOURAGES MANY YOUNG SCIENTISTS FROM REMAINING IN THEIR NATIVE COUNTRIES.



In response to this challenge, in 1986, TWAS launched a Research Grants Programme to provide promising young researchers with a modest level of support to help them pursue their careers at home. The initiative, which has been generously supported by the Swedish International Development Agency (Sida) and the Italian government, is today one of the most prestigious grants programmes for young scientists from the developing world. To date, TWAS has awarded nearly 2,000 grants to scientists in 24 developing countries.

The following article profiles three recipients of the TWAS Research Grant: Balakrishna Pisupati, from India, who received grants in agricultural biotechnology in 1993 and 1995; Yalemtsehay Mekonnen, from Ethiopia, who received a grant in 1993 in physiology; and Fernando Torres, from Peru, who received a grant in 2006 in materials science.

SALT-TOLERANT RICE

Balakrishna Pisupati was a young researcher working at the newly established M.S. Swaminathan Research Foundation, in Chennai, India, when, in 1993, he first heard of an unexpected source of funding.

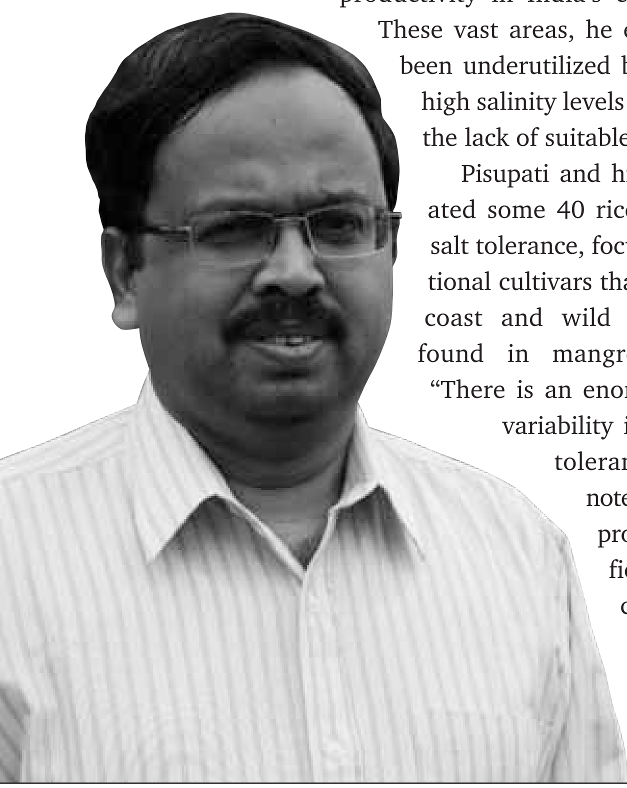
"I had just started researching the molecular mechanisms of salt tolerance in rice when I learned about the TWAS research grants," Pisupati says. At the time, the Foundation, launched by the famed agricultural scientist and TWAS Founding Fellow M.S. Swaminathan, "was a fledgling organization that had just begun to establish its laboratory facilities."

Pisupati applied for a TWAS grant for a project using molecular techniques to study the genetic conservation and enhancement of salt tolerance in rice. "Over 60 percent of the Indian population lives within six kilo-

meters of the coast," he explains. "Yet rice cultivation on the coast has always been difficult because of the susceptibility of rice to salt stress. So, I felt it was necessary to focus my research on identifying and developing salt tolerant rice cultivars."

To understand the basis of the salinity tolerance of several traditional and wild salt-tolerant rice cultivars, Pisupati wanted to assess the physiological and genetic components of this tolerance, applying molecular marking techniques (in which fragments of DNA are used to 'flag' a gene with a particular characteristic).

"As a salt-sensitive crop, rice has acquired most of its genes for salt tolerance from traditional cultivars," Pisupati says. "There was a need to identify and evaluate new genetic sources of salt-tolerant genes to improve productivity in India's coastal areas." These vast areas, he explains, have been underutilized because of the high salinity levels in the soil and the lack of suitable germplasm.



Pisupati and his team evaluated some 40 rice varieties for salt tolerance, focusing on traditional cultivars that grow on the coast and wild rice varieties found in mangrove swamps. "There is an enormous genetic variability in rice for salt tolerance," Pisupati notes. "Genetic improvement is difficult due to the complex mechanisms that confer tolerance."

Rice is the staple food for more than half of the world's population.

New technology

Pisupati used what was at the time a new technology – Random Amplified Polymorphic DNA (RAPD) markers – to detect genetic diversity among traditional coastal rice cultivars having different levels of tolerance to salinity. "The aim was to identify new sources of genetic material to breed salt tolerance. The first step was to tag salt-tolerance loci in rice using molecular markers," he explains. One outcome of the study, he says, was to reinforce the the usefulness of the RAPD markers in identifying genetic diversity.

"This research proved relevant to coastal production systems both in India and other parts of the world," he says. Rice is a major staple food in three of the world's four most populous nations – China, India and Indonesia. In fact, it is the staple food for more than half of the world's population. According to the UN Food and Agricultural Organization (FAO), in developing countries, rice provides more than 25 percent of people's energy intake and 20 percent of their dietary protein.

Good timing

"The grant" says Pisupati, "came at a critical time. It enabled us to purchase the equipment and supplies needed to screen a large amount of wild rice germplasm." The equipment also helped the young Swaminathan Foundation as a whole by allowing its researchers to pursue similar work.

Pisupati's research, he says, "resulted in the development of a genetic library for salt tolerance and, more

importantly, for the creation of more salt-tolerant rice that is now being tested and that we hope will soon be available to farmers. In addition, it led to the publication of a monograph on a variety of wild rice, and to several follow-up projects to study the molecular basis of tolerance."

A salt-tolerant rice variety, based on research that Pisupati and his team did with funding from the TWAS grant, is currently being field-tested. "If the transformed variety of rice proves to perform better in saline soils, it could be of particular significance because of the projected rise in sea levels due to global warming along the Indian coast," he notes.

The situation for scientists and researchers in Ethiopia has improved, but much more needs to be done.

Follow up

"In 1995, I was fortunate to receive a second grant from TWAS," says Pisupati. "By then, India's Department of Biotechnology was also supporting my research," which used yet another novel technique – DDRT-PCR (differential display reverse transcription based polymerase chain reaction) – to visualize the mRNA (messenger RNA) in rice that is expressed under salt stress. This technique has proven invaluable in identifying unknown genes.

"Over the course of the two grants," Pisupati adds, "I published four research articles in international peer reviewed journals based on the research."

Today

While at the M.S. Swaminathan Research Foundation, Pisupati also focused on "the interface between science and policy." He strongly believes that in many crucial areas, "good policy-making depends on a scientific understanding of the issues."

An interest in decision-making led Pisupati, in 1999, to move from laboratory research to policy analysis with the IUCN (the World Conservation Union). Today he is with the United Nations Environment Programme (UNEP), based in Nairobi, Kenya, where he focuses on environmental governance issues in the Division of Environmental Law and Conventions.

"I remember fondly my experience with TWAS," Pisupati says. "The grants came at a critical time in my career, and provided necessary support for research that I hope will benefit many people, both in my home country and elsewhere."

AFRICA'S MORINGA TREE

Yalemtsehay Mekonnen received a TWAS Research Grant in 1993 for a project to document various uses of the African moringa tree (*Moringa stenopetala*) in southern Ethiopia, both as a source of food and a medicinal plant. She also tested the effects of extracts of its leaves, seeds and roots on laboratory animals. Mekonnen, who is based at the Addis Ababa University's Department of Biology, learned about the TWAS grants from colleagues who had previously received Academy funding.

The African moringa tree is native to southern Ethiopia and northern Kenya. It grows widely there, especially in the Gemugofa and Sidamo regions, where locals use it for food and medicinal purposes. Except for its wood and bark, every part of this deciduous tree is edible. Its leaves, which have a strong, spinach-like flavour, are rich in calcium, iron and other minerals, and vitamins A, B and C. They are eaten as a supplement to the major staple foods.

The tree is one of 13 species of the *Moringaceae* family, which has only one genus. The best known of these is *Moringa oleifera*, native to the Indian sub-continent, where its use in *Ayurveda* (according to which it can treat 300 ailments, including rheumatism, asthma and dyspepsia) dates back several centuries.

This related tree – *M. oleifera* – is so rich in nutrients that it has generated much interest in the past decade on the part of non-governmental organizations promoting it as a cheap food source in the fight against global hunger. Both of these moringa varities – *M. oleifera* (which grows in many tropical and subtropical countries) and the African moringa – are drought resistant, so they provide nutritious food even during dry seasons.

Given this international interest in *M. oleifera,* Mekonnen realized that the unassuming *M. stenopetala* also had potential as a source of nutritious food and lead compounds (*i.e.,* biologically active chemical compounds) for the development of pharmaceutical products. "The traditional use of plants as medicine is commonplace in Ethiopia," Mekonnen explains, "but many people are unaware of the uses of moringa" because the tree does not grow in their area.

The TWAS grant allowed Mekonnen to purchase valuable equipment, including a Grass polygraph, which is used to study the effects of plant extracts on laboratory prepared tissues.

"Thanks to the TWAS grant," Mekonnen says, "I have been able to advance my research on the moringa tree and to network with other researchers who are interested in this tree. It also provided the basis for me to obtain additional grants, including one from Addis Ababa University's Research and Publications Office and another from the International Foundation for Science (IFS)." The moringa project, on which she collaborated with researchers from Addis Ababa University and universities in England and Germany, "resulted in five publications in national and international peer-reviewed journals, including *Phytotherapy Research* and *Planta Medica*."

Food and medicine

Mekonnen's study confirmed that the African moringa tree (also known locally as aleko or shiferaw) is used for a variety of purposes in southern Ethiopia. In most households, the fresh leaves are cooked and eaten. The tree is particularly valued in the Konso region, where both its leaves and roots are used as a medicine. Konso villagers "eat the fresh leaves on a daily basis," Mekonnen says, "mixing the leaves with maize and then cooking them in earthen pots."

Villagers claim that the leaves (boiled in water) relieve hypertension and stomach pain, and that the roots and leaves, chopped and mixed with water, are an effective treatment for malaria. In areas where leishmaniasis is prevalent, the roots are used to treat this parasitic disease, which is spread by sand flies.

In addition, Mekonnen's team discovered that, in Sudan, moringa seeds are used to clarify and purify muddy water. In areas where boiling river or pond water is impractical, local women rely on the crushed seeds to clarify it. The seed powder attracts dirt particles and some microorganisms, causing them to coagulate and sink to the bottom. The clean water can then be poured off.

Combatting parasitic diseases

Mekonnen and her team conducted a series of laboratory experiments to evaluate claims that *M. stenopetala* could be used to treat malaria and other parasitic dis-



eases. Crude ethanol extracts of the leaves and roots were tested on promastigotes of *Leishmania donovani* (the infective stage of the disease inoculated into the blood by the bite of the sandfly vector). Within 48 hours, the parasite underwent morphological changes, indicating an adverse reaction to the *M. stenopetala* extract.

Leaf and root extracts of *M. stenopetala* were also tested against the infective stages of *Trypanosoma brucei* (a parasite that causes a sleeping-sickness-like disease in horses, cattle and sheep in tropical Africa), and *Trypanosoma cruzi* (the causal agent of Chagas disease in South America). Of particular note, both an ethanol extract of fresh root wood and an acetone extract of dried leaves showed activity against *T. brucei*. Additional experiments on the seeds indicated that their antitrypanosomal and, in particular, antimicrobial properties could potentially be used to produce antibacterial phytopharmaceuticals. While promising, "the evidence for moringa's activity against parasitic diseases remains inconclusive," Mekonnen says. "Preclinical studies on human subjects must still be done."

"The TWAS grant helped launch my research career."

Planting trees

Mekonnen's research team also helped establish an *ad hoc* national committee to promote the dissemination and use of *M. stenopetala* in Ethiopia. As part of this effort, trees were introduced into new areas, and people were encouraged to eat the leaves with their staple foods. Public information campaigns were initiated to make more people aware of the trees' medicinal uses.

Progress in these efforts has been slow, Mekonnen says, due to a lack of funds. Team members, she adds, are busy with many other commitments. "Changing peoples' attitudes and convincing them to adopt new food items in their diets takes time," she says, "and will require additional publicity campaigns."

The same is true of efforts to influence policy. For example, lobbying efforts designed to convince Ethiopia's Science and Technology Commission to introduce improved planting techniques for *M. stenopetala* have borne little fruit.

Despite these setbacks, Meknonnen hopes that the project will prove relevant not only for Ethiopia but also for other African countries, and that it "will serve as a model for similar studies on uses of plants."

Today

Mekonnen continues to research the African moringa tree, and other plants of potential medicinal and nutritional value, performing *in vivo* and *in vitro* physiological tests of extracts. Her other work includes assessing hazards to human and animal health and the environment (from chemical and other contaminants), and promoting the safe and sustainable use of natural resources.

"The situation for scientists and researchers in Ethiopia has improved," Mekonnen says. For instance, "more funds are now available for research at public universities and government organizations. In addition, more Ethiopian scientists now compete in the international arena for research funds." But much more needs to be done, she says. "We are just at the beginning and must continue to build our scientific capacity if we are to become full and active partners in international research projects."

"The TWAS grant helped launch my research career," Mekonnen says. "Several of my colleagues are also grateful for the TWAS grant, which enabled them to initiate research in their respective fields.

NATURE AND THE VERY SMALL

"We use nature as a source of inspiration to develop advanced biodegradable materials for various applications," Fernando Torres says. His home country of Peru, he notes, "has a high level of biodiversity." He and his team "are trying to develop bio-inspired materials, focusing on the structure–property relationships at the nano level." That is, how the structure of materials – observed at the scale of one-millionth of a millimeter – partly determines the properties (such as strength or elasticity) that they possess.

Torres does his research at Peru's Pontificia Universidad Católica, a private university in the capital city of Lima, where he is an associate professor of mechanical engineering and group leader of the polymers and composites group.

Natural plastics and artificial muscles

His current project, for which he was awarded a TWAS Research Grant in 2006, "aims to characterize the electroactive and piezoelectrical properties of different bio-based materials, or biopolymers, and to understand how their molecular organization determines such behavior."

Torres explains that "certain biopolymers (*i.e.,* natural polymers or plastics) possess electroactive properties." This means that when voltage is applied to them they contract or expand, then return to their original shape. Some electroactive biopolymers (EAPs) also act as electrical conductors. "Biopolymers with an electroactive nature can be used for such applications as controlled release devices for drugs and sensitive membranes for biomedical implants," he says. Because of their ability to expand and contract, EAPs also have potential robotic applications as 'artificial muscles'.

Other biopolymers possess piezoelectrical properties – that is, when subjected to a mechanical pressure, they become electrically polarized, with a positive electric charge on one end and a negative on the other. The French chemist Pierre Curie and his brother Jacques discovered piezoelectricity in quartz crystals more than a century ago. Its first practical use was in the sonar devices that allowed war ships to detect enemy submarines during World War II. Later applications included ceramic phonograph cartridges, igniters for gas stoves, and ultrasonic transducers in remote controls.

In contrast to synthetic polymers, biopolymers can be obtained from renewable resources and are biodegradable. "Starch is a low-cost agricultural product that can be readily extracted from potatoes, for example," Torres notes. Moreover, while synthetic plastics are difficult to mold or dissolve, natural polymers – because of their regular structure – are more easily manipulated.

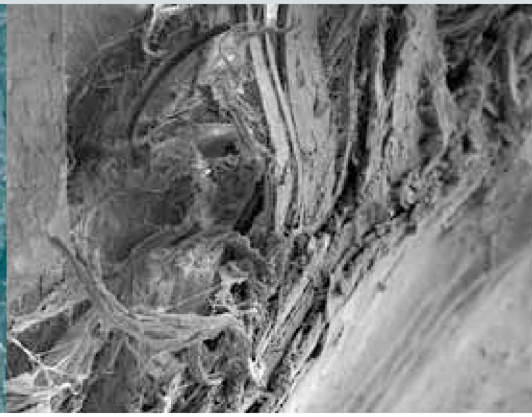
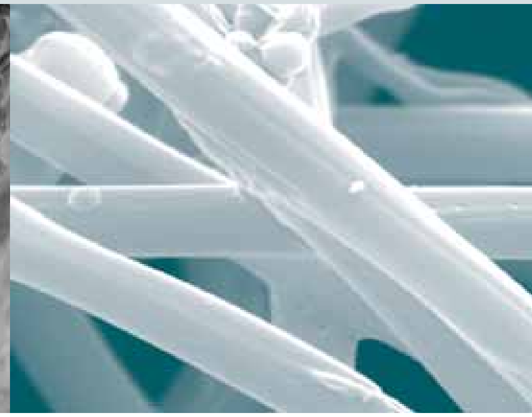
"We are studying different ways of processing starch as a thermoplastic," which melts when heated and turns into a glassy state when cooled, Torres says. "Starch can be used in the gel state as well," for so-called 'smart gels' – for example, drug-delivery systems allowing the controlled release of pain relievers and other medications, he adds.

In this project, Torres and his team are studying the electroactive and piezoelectrical properties of several natural systems, including the gel network formed by starch granules when gelatinized; the nanofibres network of cellulose produced by bacterial strains belonging to the genera *Acetobacter*; the spider silk of *Argiope argentata*; and the thread byssus of sea mussels.

"Based on the understanding of these biological structures," explains Torres, "we also intend to develop synthetic bionanomaterials that may be used as microelectromechanical systems (MEMS) and smart nanocomposite materials." MEMS, which range in size from micrometers to millimeters and are made using integrated circuit (IC) techniques, can be integrated micro devices that combine electrical and mechanical components.

Plywood structure of fish scales

Torres's other lines of research focus on the molecular physics of

elastic proteins, such as those found in fish scales, spider silk and other common resources in Peru. In hopes of discovering highly valuable applications for these mundane objects, Torres assesses their structure and composition using several highly sophisticated tests, including: X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM), and nuclear magnetic resonance (NMR) spectroscopy.

For example, Torres has investigated the "nanocomposite laminate structure" of scales from the Amazonian fish *Arapaima gigas*, one of the largest scaled freshwater fishes in the world. The large bony scales, he observes, reveal "a fibrous layer of collagen and a plywood-like structure." The scales' structure, he says, "resembles that of a modern laminate composite, such as the panels on a Formula One race car, only on the nanoscale."

"The TWAS grant has allowed us to study the properties of biological materials."

To study the mineral phase, the fish scales were burned at 600°C until all the organic components were degraded. The remaining ashes were then observed under the microscope and weighed to determine the ratio of organic and inorganic components.

Mussel byssus and spider silk are two other promising biomaterials that have attracted attention because of their exceptional mechanical properties – namely, their strength and extensibility. "Thread byssus," explains Torres, "are the natural collagen fibre-reinforced composite materials used by sea mussels to attach themselves to rocks." In addition to their great tensile strength, they can extend to twice their original size and have a water-resistant adhesive surface. "Spider silk," says Torres, "is stronger than steel. According to some experts, a pencil thick strand of spider silk could stop a Boeing 747 in flight."

Spider silk for cables

"The TWAS grant," Torres says, "has allowed us to begin a different approach to the study of the properties of biological materials. In the past, we were mainly studying the mechanical, rheological (ability to elastically deform) and morphological (form and structure) properties of these materials."

Torres and his team used the grant funds to purchase equipment to study the piezoelectric properties of materials. This included a load cell and oscilloscope to measure stress and voltage and to evaluate the piezoelectric properties of natural polymers, and an anti-vibration platform and micromanipulator to assess natural polymer properties at the micro-level. This new equipment, Torres says, will encourage others at the institution to carry out similar research.

"Based on our current research," Torres adds, "we would like to produce both smart biomaterials and synthetic materials with properties that cannot be attained with synthetic polymers." Examples of the latter, he says, would include "synthetic spider silk, super-strong fibres for ropes and cables, bulletproof vests and other military protective equipment." ■

SERVING YOUTH

TWAS IS INCREASINGLY COMMITTED TO RECOGNIZING AND ASSISTING YOUNG SCIENTISTS IN THE DEVELOPING WORLD. IT IS ALL PART OF THE ACADEMY'S LARGER EFFORTS TO HELP BUILD A STRONG AND ENDURING FOUNDATION FOR SCIENCE-BASED DEVELOPMENT ACROSS THE SOUTH.

In 1986, TWAS, in cooperation with science academies, research councils and ministries of science across the developing world, launched an awards programme that was one of the global scientific community's earliest initiatives to honour and reward young scientists in the South. Currently, some 45 national organizations participate in the TWAS Prizes for Young Scientists programme. Last year, 43 scientists in 25 countries were awarded the prize.

More recently, TWAS has expanded its initiatives focusing on young scientists in two significant ways.

First, the Academy, in cooperation with its regional offices, has sponsored a series of Regional Conferences for Young Scientists. The first conference was held to coincide with the TWAS 10th General Conference, in Rio de Janeiro, Brazil, in September 2006. It was organized by the TWAS Regional Office for Latin America and the Caribbean (TWAS-ROLAC), at the Brazilian Academy of Sciences, in Rio de Janeiro.

This successful event was quickly followed by a second conference, organized by the TWAS Regional Office for Sub-Saharan Africa (TWAS-ROSSA), at the African Academy of Sciences, in Nairobi, Kenya. TWAS-ROLAC held its second Young Scientist's Conference in December 2007, and TWAS-ROSSA will be holding its third conference in December 2008.

On a second front, the Academy has also established a new category of membership: TWAS Young Affiliates, consisting of scientists younger than 40 years of age. The first group of Young Affiliates, 25 in all (each of the Academy's five regional office selected five Affiliates), were welcomed into the Academy at the TWAS 18th General Meeting, in Trieste, in November 2007. Affiliate members, who hold the appointment for five years, will not only be able to cite this honour on their resumes but will also be invited to attend TWAS general conferences cost free. Over time, the Academy hopes to establish an alumni network of Affiliates that will open vital channels of communication for the developing world's most promising young scientists.

In what follows, we profile three individuals who have participated in and benefited from TWAS's programmatic efforts to assist young scientists. These brief profiles are intended to provide a sampling of the increasing pool of scientific talent that is emerging in the South – talent that TWAS is committed to help in the years ahead as part of the Academy's larger mandate to build scientific capacity in the developing world.

TWAS-ROSSA YOUNG SCIENTISTS CONFERENCE

Malik Maaza, a 44-year-old native of Algeria, heads the nanosciences laboratories at iThemba Labs–National Research Foundation of South Africa. His research focuses largely on applications of nanotechnology.

Maaza holds undergraduate degrees in solid state physics and photonics, from the University of Oran in Algeria and the University of Paris VI (France), and a doctorate degree in neutron optics, also from the University of Paris VI. His work experience centres on the field of nanoscience and, more specifically, on fibre optics and the science of solar energy.

He has been involved in the creation of a number of laser and nano laboratories and networks in Africa, including the South African National Laser Centre, the African Laser Centre (a project of NEPAD, the New Partnership for Africa's Development), the South African Nanotechnology Initiative (SANi) and the Nanosciences African Network (NANOAFNET).

Maaza participated in the first TWAS-ROSSA Young Scientists Conference, hosted by the African Academy of Sciences, in Nairobi, in December 2006. His presentation addressed the role nanotechnology can play in helping the developing world, and more specifically sub-Saharan Africa, meet the Millennium Development Goals (MDGs) for poverty reduction, improved public health, and the sustainable use of natural resources.

The conference drew more than two dozen young scientists from 11 African nations and 10 eminent senior scientists from around the world. The theme of the event was 'Mentoring Young Scientists for the Effective Application of Science and Technology in Africa' and it focused mainly on biological sciences.

Tremendous opportunity

"Being invited to the TWAS-ROSSA conference," Maaza says, "was a tremendous opportunity for me to spread the message about the necessity of Africa getting on board the ongoing revolution of nanotechnology, to both policy-makers and young scientists in Africa."

In his presentation, 'Applications of Nanotechnology in the Life Sciences', Maaza stressed the "importance of Africa engaging in a pragmatic way in the emerging nano-era." He noted that "global investment in nanotechnology has increased steadily, from approximately US$4 billion in 1999 to US$15 billion in 2007."

Maaza cited a 2005 report of the UN Task Force on Science, Technology and Innovation, which concluded that advances in nanotechnology could provide greater access to safe drinking water, help enhance agricultural production and improve nutrition, aid in the fight against infectious diseases, and make information and communication technologies less expensive and more readily available.

The Nairobi conference, says Maaza, was "a unique event, bringing together so many young scientists from different parts of Africa." The gathering, he adds, "allowed me to exchange constructive views about the multi-disciplinarity of nanosciences and technologies with scientists from many countries on the continent."

Conference participants, he adds, were eager to hear about "the potential of nanosciences and nanotechnologies to tackle crucial continental issues, such as water purification and health (in terms of one-cell-based local drug delivery), as well as applications for providing energy to rural areas."

NANOAFNET's 318 members and representatives use nanosciences to address African needs.

Nanosciences African Network

Maaza used the second half of his talk to introduce conference participants to the Nanosciences African Network (NANOAFNET), which has received "major financial and moral support" from TWAS and the Abdus Salam International Centre for Theoretical Physics (ICTP), also in Trieste.

NANOAFNET is a continental initiative aiming to use nanosciences and technologies to address African needs by developing cost-effective and easily implemented solutions to the continent's health, energy, water supply and environmental challenges. It also aims to enhance the capacity and international visibility of the African scientific community through the development and improved coordination of world-class multidisciplinary research in nanosciences and technologies.

In his presentation, Maaza explained how the network, in which he has been actively involved since its inception in 2005, has devised a wide-ranging capacity-building strategy designed to:

- increase the number of nanoscience and technology programmes in universities across the continent, both at the undergraduate and graduate levels;
- build world-class nanoscience and technology research centres in Africa;
- encourage interdisciplinary research and development in nanoscience and technology; and
- partner with other African initiatives to help build a strong foundation in nanoscience and technology across the continent.

Following his talk, Maaza says, "a number of conference participants expressed a keen interest both in nanoscience and technology and in joining NANOAFNET."

"Many of these young scientists," he continues, "have since joined the network and attended conferences and workshops on nanosciences organized by NANOAFNET and sponsored by TWAS." These events have included the sixth International EBASI (Edward Bouchet Abdus Salam Institute) Conference, the US-Africa Workshop on Nanosciences and the first ICTP Africa College on 'Science at the Nanoscale', all hosted by iThemba Labs (the official headquarters of NANOAFNET), in Cape Town, South Africa, in 2007.

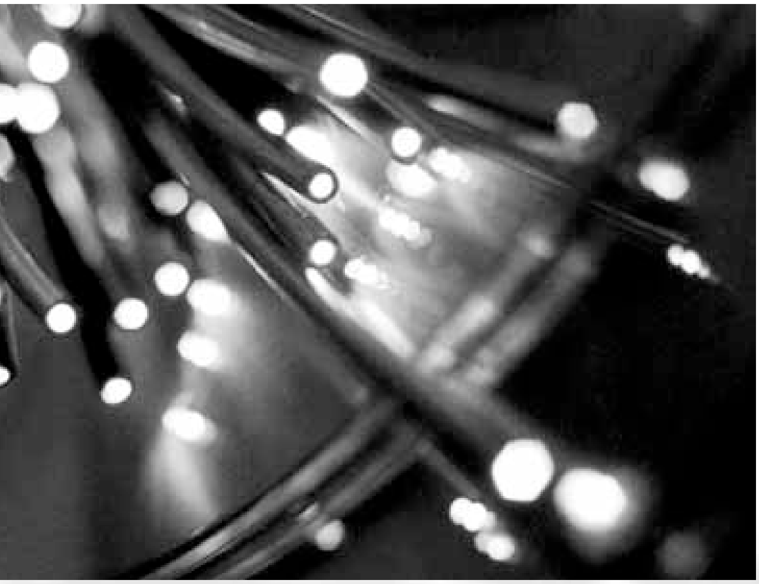
By helping spread the word about the network, the TWAS-ROSSA conference, Maaza says, "significantly increased the presence of NANOAFNET on the continent."

Looking to the future

Inspired by the success of the Nairobi event, NANOAFNET has since launched a postgraduate training programme, created, says Maaza, "in the spirit of TWAS-ROSSA and with the aim of capacity building" on the continent. The initiative is currently providing training to 16 MSc and PhD candidates from seven African nations. Students complete study stays of 3 months up to one year.

"In terms of senior human capital mobility," he adds, "the network has implemented a second programme aimed at improving the synergy of senior scientists." Using a matching funds strategy, with support from TWAS, ICTP and ROSSA, it has so far provided study grants for nine senior scientists from eight countries for stays from one month up to a year.

The training programmes, he says, have "helped both senior and junior grantees to publish in peer-reviewed journals with a significant impact factor," including *Optical Materials*, *Physics Letters A*, and the *International Journal of Nanotechnology*.



NANOAFNET currently has 318 members and representatives from 29 African nations. In addition to the initial four regional coordination hubs (in North Africa, East Africa, West Africa and Southern Africa), Maaza says, the network has established four coordination hubs in the Middle East/Persian Gulf region (in Oman, Algeria), Europe (the UK) and North America (USA).

"The first TWAS-ROSSA Young Scientists Conference in Nairobi," says Maaza, "was crucial because it provided NANOAFNET with its first continental platform. One important outcome was that key policy-makers, both from Africa and with international agencies, have since strongly backed the network."

This support, he says, will make possible the launching, later this year, of the African Nanotechnology Centre, which will "aim to find solutions to Africa's urgent socio-economic challenges, especially concerning energy, water and health." The centre plans to coordinate activities with the Trieste-based International Centre for Science and High Technology (ICS), and the International Council for Science (ICSU), as well as the business sector within and outside Africa.

Maaza is confident that, thanks to TWAS-ROSSA, NANOAFNET has gotten a strong start on achieving its mission and vision: to recruit the African science and technology community to the promising future that is the emergent multidisciplinary field of nanoscience and nanotechnology.

TWAS YOUNG SCIENTIST AWARD

The TWAS Prizes for Young Scientists in Developing Countries are awarded to scientists under 40 years of age. The prizes are given in collaboration with national science academies, scientific research councils and ministries of science and technology in a number of developing countries. The Academy provides the prize money (up to US$2,000), while the national organizations select the winners.

Recipients are chosen from among each of the major fields of natural science (biology, chemistry, physics and mathematics) on a rotating basis. The awards are presented by a high-ranking official, such as a government minister, at a special ceremony.

Cancer immunotherapy

Tania Crombet Ramos is Director of Clinical Research at the Center of Molecular Immunology (CIM), in Havana, Cuba. Born in Havana in 1970, Crombet Ramos received her MD from the Higher Institute of Medical Sciences, Havana, in 1993, and her PhD in Medical Sciences from the same institute, in 2004.

> ***The West Havana Scientific Pole is at the heart of Cuba's advanced biotechnology sector.***

Crombet Ramos' research focuses on passive and active cancer immunotherapy and the treatment of tumours. Cancer immunotherapy, which uses a patient's immune system to attack the malignant cells, can be either active or passive. The former aims at stimulating the patient's own immune response, whereas in the latter the patient is injected with antibodies produced in the lab.

"Our main goal at CIM," says Crombet Ramos, "is to obtain and produce new bio-pharmaceutical products for the treatment of cancer and other chronic non-communicable diseases, and to then introduce these into the nation's public health-care system."

As Clinical Research Director, Crombet Ramos oversees the Trial Design and Data Management department, devoted to the design and execution of clinical trials; the Good Clinical Practice department; and the research laboratory, in which patients' humoral (or, antibody) and cellular immune responses are evaluated.

"The centre's vaccines and antibodies," she says, "are also being evaluated in clinical trials outside Cuba, including in Canada, China, Germany, Indonesia, India, Japan, Malaysia and the United States."

Crombet Ramos and her team are currently conducting a "clinical trial involving 40 children suffering from brain-stem glioma." Brain-stem tumours, which affect the part of the brain connected to the spinal cord, account for over 10 percent of childhood brain tumours, and mostly occur in children between the ages of six and nine. Because of the poor prognosis, this is a particularly dreaded form of cancer. Most children die within a year of diagnosis.

"The clinical trial," Crombet Ramos says, "will evaluate the effectiveness of a combination therapy: the addition of humanized anti-EGFR (epidermal growth factor receptor) monoclonal antibody therapy to the standard external beam radiotherapy."

The epidermal growth factor receptor is a type of hormone that stimulates the proliferation of cells. Its 'over-expression' (or overactivity), she explains, has been linked to the growth of tumours, through a process known as angiogenesis, in which a network of blood vessels forms around the tumour, supplying it with nutrients and oxygen.

Monoclonal antibodies (MAbs), so called because they are produced from a single immune cell, are the most widely used form of passive cancer immunotherapy today. Because MAbs were originally made from mouse cells, the body often rejected them as foreign antigens. To overcome this problem, researchers developed so-called 'humanized' (or 'chimeric') antibodies, replacing some parts of the mouse antibody with human proteins.

West Havana Scientific Pole

The Center of Molecular Immunology, inaugurated in 1994, is part of the West Havana Scientific Pole, an integrated cluster of more than 50 institutions, including research institutes, university branches and hospitals, as well as manufacturing centres.

Designed to speed up research and development through cooperation in the fields of medicine, agriculture and animal health, the pole was created in the early 1990s. With some 12,000 employees, including 7,000 scientists and engineers, it is considered the heart of Cuba's advanced biotechnology sector.

CIM "currently markets several biopharmaceutical products," says Crombet Ramos. These include "a monoclonal antibody for the treatment of patients with organ transplant rejection, human recombinant erythropoietin (a hormone produced by the kidneys that stimulates production of red blood cells) for the treatment of anaemia, and a humanized monoclonal antibody that recognizes the epidermal growth factor receptor for cancer treatment."

The institution employs about 650 people, she says, "most of them specialists in cancer immunotherapy or mammalian cell culture." CIM organizes its research into five departments: research and development, clinical research, bioinformatics, production and quality assurance. The institute aims to make its activities financially self-sufficient, while continuing to serve the health needs of the nation.

Future trends

"Future trends in cancer immunotherapy research," predicts Crombet Ramos, "will include the optimization of combination of chemotherapy with active and passive immunotherapy, enhancing our understanding of the mechanisms involved in certain patients' resistance to immunotherapy, the use of stimulators to overcome host immune suppression induced by tumour, and the development of cancer vaccines."

For her research in the field of passive and active cancer immunotherapy, resulting in a patent for a combined immunotherapy for treatment of tumours, Crombet Ramos was awarded a TWAS Prize for Young Scientists by the Cuban Academy of Sciences in 2007.

The prize was shared with Luis Javier González Lopez, head of the Division of Physical Chemistry at the Genetic Engineering and Biotechnology Center in Havana (CIGB). González Lopez was honoured for his work on the development of strategies to combine selective peptide isolation, isotopic marking and mass spectrometry.

Crombet Ramos has published over 30 papers in leading scientific journals and has been invited to speak at over 15 international congresses on oncology and immunology. In 2002, she was awarded the Prize of the Cuban Minister of Science for publishing articles with the year's highest scientific impact among Cuban researchers. In 2004, she received a patent for a type of combination immunotherapy for treatment of tumours.

Crombet Ramos is donating the funds from the TWAS prize to support the clinical trial that she and her team are conducting on children suffering from brainstem cancer.

TWAS YOUNG AFFILIATES

TWAS initiated its affiliate membership category for young scientists in 2007. Each year, each of the five TWAS Regional Offices will select up to five scientists under the age of 40 to be TWAS Young Affiliates for a period of five years, during which time they will be invited to participate in TWAS general meetings and conferences. Young Affiliates must be living and working in a developing country and have an excellent track record of at least 10 international publications.

Nidal Chamoun, a 39-year-old native of Damascus, Syria, obtained his *diplôme d'ingénieur* from the Ecole Centrale Paris, and, in parallel, his *diplôme d'études approfondies* in electronics from the *Université Pierre et Marie Curie*, Paris, France, in 1991. After completing one year of military service in his native Syria, he continued his graduate studies, obtaining a certificate of advanced study in mathematics from Cambridge University (UK), in 1993, and his PhD in particle physics and field theory from Oxford University (UK) in 1996.

He currently divides his time between the Higher Institute for Applied Sciences and Technology (HIAST), in Damascus, and the University of Damascus, where he teaches several mathematics and physics courses.

Chamoun was chosen as one of the 25 TWAS Young Affiliates of 2007. His research in theoretical and mathematical physics focuses on both particle physics and cosmology, "two fields," as he says, "which, to the layman, may appear to be worlds apart, but that in reality overlap."

"Particle physics," he explains, "is concerned with the microscopic world, describing the fundamental constituents of matter, while cosmology deals with the universe as a whole." Despite being at opposite ends of a spectrum, "there are many research problems that lie at the intersection of these two fields." This is because one can "apply particle physics theories to understand the universe at its birth, and use cosmological and astrophysical data to test competing particle physics theories."

Invisible world

Chamoun's current research concerns what he calls "one of the great unsolved scientific enigmas" – the existence of so-called 'dark matter'. Astronomical observations in the 1930s of the motions of clusters of galaxies indicated that their gravity was greater than that which could be explained by the matter observable in them. To explain this discrepancy, scientists in the 1970s posited the existence of a matter that emits no light (and is thus unobservable).

"Recent astrophysical data," Chamoun says, "indicate that, whereas ordinary (baryonic) matter constitutes only 4 to 5 percent of the total cosmic energy density of the universe, about 20 percent is non-luminous (dark) matter. The remaining part is dark energy." ('Dark energy' is the mysterious force believed to be responsible for the accelerating expansion of the universe.)

"Although evidence of the existence of dark matter was found seven decades ago," he explains, "we still do not know its composition. None of the particles in the 'Standard Model' (SM) of particle physics are viable candidates to make up a major part of the dark matter." To be successful, he adds, any extension of the SM "must address this problem."

Chamoun's research concerns one of the great unsolved scientific enigmas.

The so-called Standard Model of particle physics refers to a currently accepted field theory that is able to account for the electromagnetic, weak and strong forces (whereas general relativity deals with the gravitational forces). One extension of this field theory is supersymmetry, according to which for every type of elementary particle there is a corresponding particle. Supersymmetry is "an essential ingredient in string theory," Chamoun explains, "which aims to unify gravity with the other three forces."

"In the supersymmetric extension of the Standard Model," he says, "the lightest superpartner particle (LSP) appears as a natural candidate for the dark matter, since it cannot decay into SM particles, and remains in the universe as a relic of the Big Bang."

"In collaboration with scientists from China and Egypt," he says, "I am now studying such particle physics models, some supersymmetric and others not, that predict dark matter candidates with appropriate properties, in particular having the right relic abundance."

The beginning of time

Thanks to a 1998 TWAS grant, Chamoun has also collaborated with scientists in Argentina on problems involved in 'inflation theory'. This extension of Big Bang theory, first proposed in 1980, has since become accepted as the standard model for cosmology. Inflation theory posits that, in the fraction of a second (around 10-35 second) following the Big Bang, the universe underwent an extremely rapid (exponential) expansion.

The theory has been accepted partly because it explains features of the current universe that the Big Bang theory by itself cannot, including its apparent flatness. The flatness of the observable universe is explainable by the analogy of a hugely inflated balloon: if expanded sufficiently, the area surrounding each point on its surface will appear flat (just as, when we look out to the horizon, the Earth appears flat). The known universe is smaller than the universe as a whole, and we are not able to see far enough out to observe any curvature that might exist. In addition, the extremely rapid expansion of spacetime would have smoothed out any spatial undulations.

Another problem solved by the theory is that of 'structure formation'. Astronomical observations show that, on a large-enough scale, the observable universe is both homogenous and isotropic (*i.e.,* uniform when measured along axes in all directions). If expanding spacetime was smooth and uniform, then what allowed the eventual formation of 'structures' – *i.e.,* the 'clumping together' of matter to become stars, planets and galaxies? On the other hand, if it tended towards chaos, what explains its current homogeneity? Inflation theory posits the existence of quantum fluctuations, which produced tiny 'ripples' in spacetime, sufficient, over time, to allow structure formation, but not so great as to result in chaos.

Chamoun says that, while "many enigmas" – including the 'flatness' and 'structure formation' problems – can be explained by inflation theory, "the nature of the 'inflaton', the field responsible for generating the inflation, is still unknown."

"Some theoretical models," he explains, "change the matter content of the universe, while others give the inflaton geometrical interpretations as the distance separating branes in superstring theory." A 'brane' (short for 'membrane') is a type of higher-dimensional surface (*i.e.,* one having more than the four dimensions – three of space and one of time – of our everyday world). "We argued that a variation of constants in the very early universe could generate inflation."

Chamoun and his colleagues "considered a scenario in which the strong coupling constant (*i.e.,* the charge corresponding to the strong forces) was changing in time." This scenario, he says "could solve the cosmological problems usually addressed by inflation."

Scientists, no matter where they come from, all aspire towards a common goal.

Not the end

The Standard Model of particle physics, and many inflationary paradigms, involve a theoretical type of matter known as scalar field matter. One example of a scalar elementary particle is the Higgs boson, sometimes referred to as the 'God particle' (ubiquitous, yet never seen), which most scientists believe is responsible for giving matter its mass.

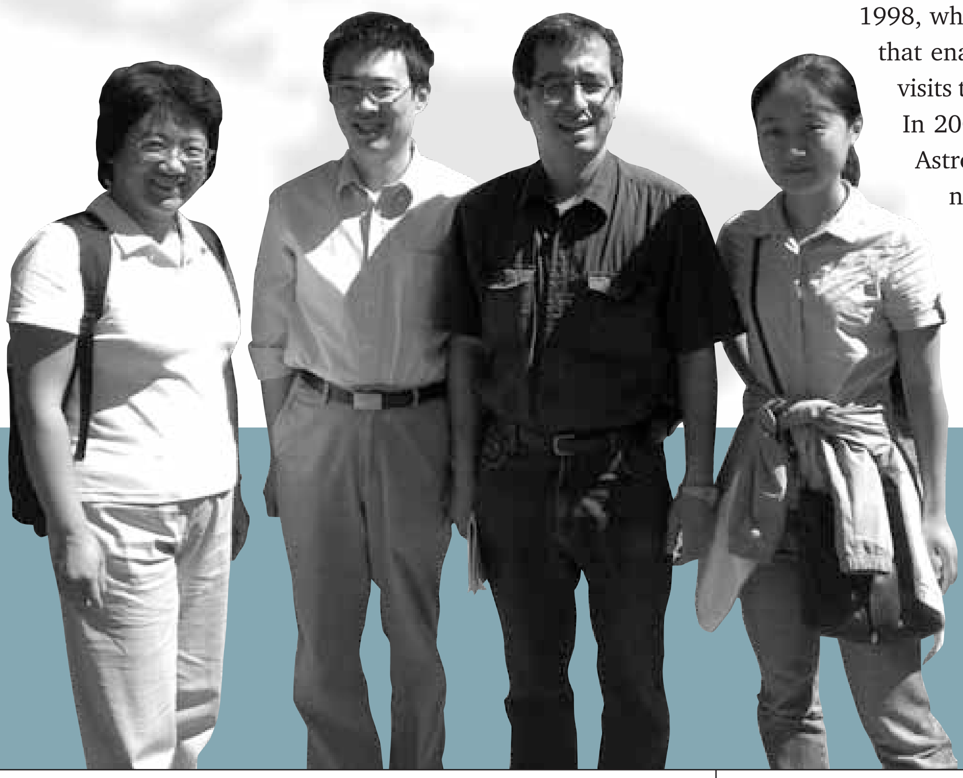
On 10 September, the European Organization for Nuclear Research (CERN), near Geneva, Switzerland, successfully fired up its Large Hadron Collider (LHC), after some 15 years of construction and preparations. The world's most powerful particle accelerator will shoot beams of protons, at nearly the speed of light, around a 27-kilometre underground track, in order to smash them together.

The idea is to recreate conditions in the first fraction of a second after the Big Bang, allowing scientists insights into the beginning of the universe. Among other things, CERN's researchers hope to finally detect the Higgs boson, to shed some light on dark matter and perhaps confirm the supersymmetry theory.

Chamoun was recruited by the Arabic-language service of BBC Radio to reassure its listeners that the start up of the giant particle collider, even if it should create 'micro black holes', would not result in the end of the world.

International collaboration

Chamoun often works in collaboration with scientists in other countries. Indeed, his ties with TWAS date back to 1998, when he was awarded a TWAS grant that enabled him to make three scientific visits to La Plata University, in Argentina. In 2006, Chamoun visited the National Astronomical Observatories of the Chinese Academy of Sciences (CAS) on a TWAS-CAS fellowship. In addition, he has made several scientific visits to the ICTP in Trieste, Italy.



"These visits have been very fruitful," he says. "They have allowed me to build up ties with the scientific communities in these countries." One result of the Chinese collaboration was the publication of the paper "The Van Der Waals Interactions and the Photoelectric Effect in Non-Commutative Quantum Mechanics", in the journal *Chinese Physics Letters*, one of 15 papers Chamoun has published in national and international journals.

Because of the isolation of researchers in his field in his home country, such international collaboration has been especially important to Chamoun. "In Syria," he says, "there are very few people working in theoretical particle physics and cosmology."

"In my country," he continues, "undergraduate physics programmes do not include advanced topics such as general relativity and quantum field theory. And there are neither research groups nor postgraduate programmes in my field in the Syrian universities."

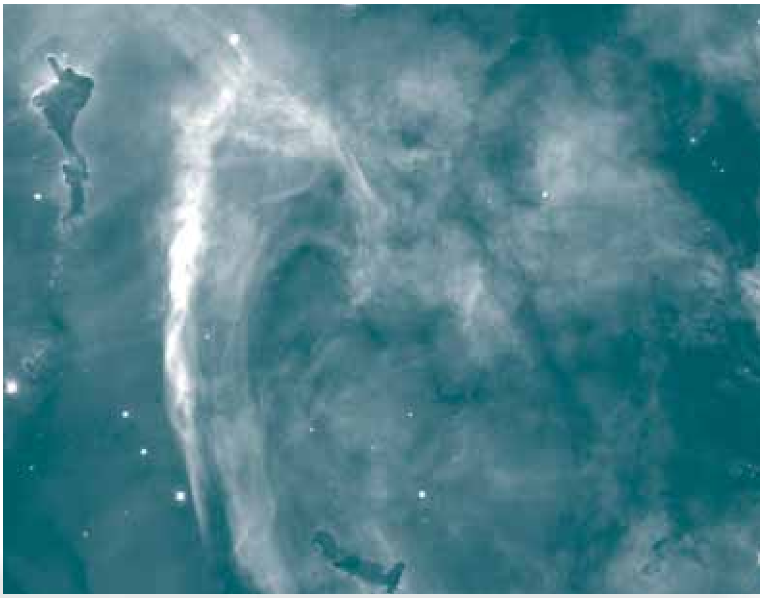
Yet, while the current situation for researchers in his country is far from ideal, Chamoun is confident that it can be changed for the better. "Many students are keen to study modern physics. Hopefully, postgraduate programmes in theoretical physics will eventually become common in Syria. And, eventually, with more students studying the subject, new research groups will spring up."

Enriching experience

"Working with scientists from other countries," Chamoun says, "is always a very enriching experience." In addition to being "introduced to new methods and techniques," his trips have allowed him to learn new languages. To his mother tongues, Arabic and Chinese (his father is Syrian, and his mother Chinese), Chamoun has added a knowledge of English, French, Italian and Spanish.

While his language skills have no doubt facilitated his studies and research abroad, Chamoun believes that "scientific culture overrides any regional differences." The international languages of science and mathematics, he explains, give scientists an advantage in cross-cultural communication.

"Scientists, no matter where they come from, all aspire towards a common goal: understanding the workings of the universe and using that for the advancement of human civilization," says Chamoun. "Working in science, I think, helps us to be more open to new cultures and ways of life, and to foster cultural exchange."



Spreading the word

As well as continuing his research and teaching of undergraduate courses, Chamoun would like one day to start a "theoretical physics group in Syria, with masters and doctoral students and researchers, analyzing data and writing scientific papers." Having co-translated Brian Greene's popular string-theory book *The Elegant Universe* into Arabic, he hopes to do "more translating, as well as writing original popular articles and books on modern physics, and presenting lectures with the aim of popularizing science."

In addition to the recognition from TWAS, Chamoun has also been named a junior associate of ICTP and was awarded the Salam Prize for young researchers in Syria in 2005. ■

ZAYED PRIZE

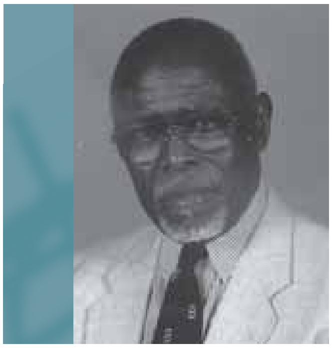
• The government of the United Arab Emirates has awarded **Veerabhadran Ramanathan** (TWAS Associate Fellow 2005) and **Jane Lubchenco** (TWAS Associate Fellow 2004) the Zayed International Prize for the Environment. Ramanathan is distinguished professor and director of the Center for Atmospheric Sciences, Scripps Institute, University of California at San Diego. He has gained an international reputation for his significant contributions to our understanding of the impact of chlorofluorocarbons, stratospheric ozone and other pollutants on climate change. He has won the Buys Ballot Medal, the Rossby Award and the Volvo Prize. Lubchenco is distinguished professor of zoology at Oregon State University in Corvallis, Oregon. She serves as a special envoy on climate change for UN Secretary General Ban Ki-moon. Her research on the interaction of animals, plants and aquaculture in complex coastal systems has led to a better understanding of factors affecting the distribution, abundance and biodiversity of species. Her other awards include a MacArthur Fellowship, Pew Fellowship, eight honorary degrees, the Heinz Award in the Environment and the Nierenberg Prize for Science in the Public Interest from the Scripps Institute of Oceanography. The Zayed Prize, established H.H. Sheikh Mohammad Bin Rashid Al Maktoum, carries a US$1 million cash prize, making it the world's most valuable environmental award.

Veerabhadran Ramanathan

Jane Lubchenco

ORDER OF THE VOLTA

• The government of Ghana has awarded **Felix Konotey-Ahulu** (TWAS Fellow 2000) the Order of the Volta for his outstanding contributions to sickle cell disease research. Konotey-Ahulu is the Kwegyir Aggrey distinguished professor of human genetics at the University of Cape Town, South Africa, and former director of the Ghana Institution of Clinical Genetics. He also serves a consultant/physician and genetic counselor in the United Kingdom. Konotey-Ahulu has received the Ghana Academy Arts and Sciences' Gold Medal, the Guinness Award for Scientific Achievement in the Commonwealth, and the Martin Luther King Jr. Award in the United States.



Felix Konotey-Ahulu

PFIZER AWARD

• **Hiba Mohamed**, TWAS Young Affiliate (2007), has been awarded the 2007 Royal Society Pfizer Award for her pioneering work on the genetic basis of susceptibility and resistance to leishmaniasis. Mohamed, who is an assistant professor at the Institute of Endemic Disease, University of Khartoum, Sudan, obtained her BSc and MSc from the University of Khartoum, Sudan, and a PhD from the University of Cambridge, UK. She is a member of the African Society of Human Genetics and the Sudanese Society of Clinical Biology and serves as a reviewer for the international journal, *Molecular Biology Reports*. The Royal Society Pfizer Award, which carries a US$120,000 (£60,000) cash prize, promotes scientific capacity building in the developing world by honouring scientists, based in Africa, at the outset of their careers.

CNR RAO PRIZE

• **Maurice Tchuente** (TWAS Fellow 1999), professor of computer science, Faculty of Science, University of Yaounde I, Cameroon, and board chairman of Cameroon's National Agency for Information and Communication Technologies and the Institute *Africain d'Informatique* (IAI) in Libreville, Gabon, has been awarded the 2008 CNR Rao Prize. Tchuente is considered one of the most prominent African researchers in the field of computer science, particularly in parallel processing and distributed automata theory.

Maurice Tchuente

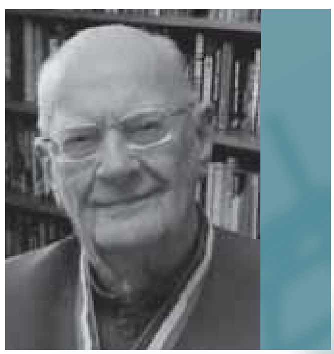
His other awards include the Boutros Boutros Ghali Award, Cameroon's *Chevalier de l'Ordre de la Valeur*, France's *Chevalier de la Légion d'Honneur* and *Commandeur de l'Ordre International des Palmes Académiques*, *Conseil Africain et Malgache pour l'Enseignement Supérieur* (CAMES). The CNR Rao Prize was created by TWAS's immediate past president to honour scientists in scientifically lagging countries.

TWAS-ROCASA PRIZE

- The TWAS-Regional Office for Central and South Asia (ROCASA) has awarded its 2008 prize for the development of educational material and school science curricula to **Arvind Kumar** from India. He is currently senior professor and director of the Homi Bhabha Centre for Science Education (HBCSE) at the Tata Institute of Fundamental Research in Mumbai, India. The award recognizes his work in developing materials and curricula for the teaching of science. He has authored or co-authored curricular and expository books in science and has been involved in India's National Council for Educational Research and Training (NCERT) curricular work for the last two decades. Kumar has also played a central role in launching the science Olympiad movement in India in 1997 and is still involved as chairman of the steering committees for science and astronomy Olympiads. Other accomplishments have included: Initiation of new programmes in science, mathematics and the history of science at HBCSE; assisting in the formulation of the 2005 National Curriculum Framework; and conceiving and launching of the National Initiative on Undergraduate Science (NIUS).

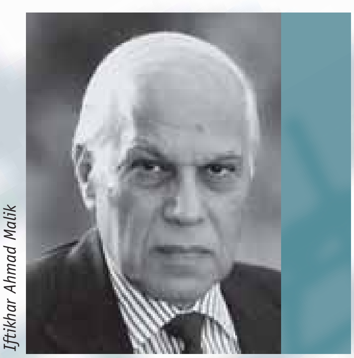
IN MEMORIAM

- **Sir Arthur C. Clarke** (TWAS Associate Fellow 1987) died on 19 March 2008 at the age of 90. Clarke was chancellor of the University of Moratuwa, Sri Lanka, and the International Space University, Strasbourg, France. Beyond the world of academics, Clarke was a renowned popularizer of science and media personality. He wrote and hosted the Yorkshire TV series 'Arthur C. Clarke's Mysterious World' (1980), 'World of Strange Powers' (1984) and 'Mysterious Universe' (1994). He is best known for his short story "The Sentinel" that was turned into the film *2001: A Space Odyssey* (1968). His intriguing notions about space travel and computing established him as a great visionary who inspired readers and scientists around the world, earning him such awards as a Distinguished Public Service Medal from the United States National Aeronautics and Space Administration (NASA), the Von Karman Award of the International Academy of Astronautics and the rank of Knight Bachelor by Queen Elizabeth II for services to literature in 1998.



Sir Arthur C. Clarke

- **Iftikhar Ahmad Malik** (TWAS Fellow 1997) died on 7 May 2008 at the age of 72. Malik was an eminent Pakistani scientist who devoted his life to promoting science and his own fields of medicine and pathology in his native country. He was secretary general of the Pakistan Academy of Sciences (PAS) in Islamabad; distinguished national professor of the Higher Education Commission, Pakistan; professor emeritus and dean of the College of Physicians and Surgeons, Baqai and Hamdard Medical Universities; and professor of medical research sciences, Pakistan Institute of Medical Sciences, in Islamabad. For his work in the field of medicine/pathology, he received a number of honours including: Gold medals for Research, PAS and Pakistan Association of Pathologists; Sitara-i-Imtiaz; Hilal-i-Imtiaz; and Sitra-i-Imtiaz in medicine. He was a fellow of PAS and the Islamic Academy of Sciences.



Iftikhar Ahmad Malik

WHAT'S TWAS?

TWAS, THE ACADEMY OF SCIENCES FOR THE DEVELOPING WORLD, IS AN AUTONOMOUS INTERNATIONAL ORGANIZATION THAT PROMOTES SCIENTIFIC CAPACITY AND EXCELLENCE IN THE SOUTH. FOUNDED AS THE THIRD WORLD ACADEMY OF SCIENCES BY A GROUP OF EMINENT SCIENTISTS UNDER THE LEADERSHIP OF THE LATE NOBEL LAUREATE ABDUS SALAM OF PAKISTAN IN 1983, TWAS WAS OFFICIALLY LAUNCHED IN TRIESTE, ITALY, IN 1985, BY THE SECRETARY GENERAL OF THE UNITED NATIONS.

TWAS has more than 850 members from 90 countries, 73 of which are developing countries. A 13-member Council is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a secretariat, headed by an Executive Director and located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. The United Nations Educational, Scientific and Cultural Organization (UNESCO) is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Italian government.

The main objectives of TWAS are to:

- Recognize, support and promote excellence in scientific research in the South.
- Provide promising scientists in the South with research facilities necessary for the advancement of their work.
- Facilitate contacts between individual scientists and institutions in the South.
- Encourage South-North cooperation between individuals and centres of science and scholarship.

In 1988, TWAS facilitated the establishment of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of some 150 scientific organizations in the South. In September 2006, the foreign ministers of the Group of 77 and China endorsed the transformation of TWNSO into the Consortium on Science, Technology and Innovation for the South (COSTIS). COSTIS's goals are to help build political and scientific leadership in the South and to promote sustainable development through broad-based South-South and South-North partnerships in science and technology. **costis.g77.org**

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2,500 women scientists from 87 developing countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 98 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. **www.interacademies.net/iap**

The secretariat of the InterAcademy Medical Panel (IAMP), a global network of 65 medical academies and medical divisions within science and engineering academies, relocated to Trieste in May 2004 from Washington, DC, USA. IAMP and its member academies are committed to improving health worldwide, especially in developing countries. **www.iamp-online.org**

WANT TO KNOW MORE?

TWAS and its associated organizations offer scientists in the South a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS website: **www.twas.org**

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes: **www.twas.org/Exchange.html**
TWOWS offers postgraduate fellowships to women from least developed countries (LDCs) and other countries in sub-Saharan Africa: **www.twows.org/postgrad.html**

GRANTS

Are you a scientist seeking funding for your research project? Then take a look at the TWAS Research Grants scheme: **www.twas.org/mtm/RG_form.html**
Is your research group seeking additional funds? See if it is eligible to apply under the TWAS Research Units programme: **www.twas.org/mtm/research_units.html**

EQUIPMENT

But that's not all TWAS has to offer. For instance, do you need a minor spare part for your laboratory equipment – no big deal, really – but you just can't get it anywhere locally? TWAS can help: **www.twas.org/mtm/SP_form.html**

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Check out the Visiting Scientist Programme: **www.twas.org/hg/vis_sci.html**

CONFERENCES

Are you organizing a scientific conference and would like to invite guest speakers from developing countries? You may find the help you need here: **www.twas.org/mtm/SM_form.html**