Twenty - Twenty Vision

The 20th anniversary of TWAS is certainly an occasion to celebrate the accomplishments of the Academy. Who could have imagined that the 'foundation meeting' of the Academy, held in Duino Castle, near Trieste, two decades ago, would have brought us to the prominent position in which TWAS finds itself today? I do indeed feel honoured to be a founding member of TWAS and I am indeed honoured to serve as its president today.

Today, we are an Academy whose membership exceeds 650. We are an Academy whose core programmes – our research grants, our awards and prizes, our fellowships and associateships, and our support for meetings and lectures throughout the South – have benefitted thousands of scientists in the developing world. We are an Academy that has been instrumental in the creation and development of the Third World Network of Scientific Organizations (TWNSO) and the Third World Organization for Women in Science (TWOWS) – scientific organizations that, in their own right, have made significant contributions to science in the South. And we are an Academy that has recently assumed administrative responsibility for the InterAcademy Panel on International Issues (IAP), a global network of more than 90 merit-based science academies.

In short, we are an Academy that is being increasingly recognized as the leading voice both for science and science-based development in the South.

Proud of our accomplishments we should be. Nevertheless we should also view the Academy's 20th anniversary not only as an occasion to look back but also as an opportunity to look ahead – in effect, to examine the past with an eye towards the future, focusing on the challenges that lie ahead as we take pride in the success of our previous undertakings.

The future challenges are many. When, under the leadership of Abdus Salam, we decided to explore the possibility of creating an academy for scientists from the developing world, science throughout the South largely faced similar conditions: underfunding, understaffing and not having a proper place in the value system. A broad-based campaign to lift the capabilities and raise the profile of science throughout the South was the best strategy to pursue.

Efforts to continue to build scientific capacity in the developing world remain a high priority. Yet, the situation today is much different. Science in the South, like the South itself, dis-

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plays a wide diversity of experience and accomplishment – a trend that carries significant implications for science throughout the developing world. In a sense, science in the South no longer resembles a single shade of grey, but is now represented by a mosaic of colours that defies a singular description.

China, the host of the Academy's first General Conference outside of Trieste in 1987 and the venue for our 20th anniversary celebration, has emerged as a prominent scientific player in a variety of different fields. My own country of India, too, has made great strides in the development of its scientific infrastructure – an investment that has paid off handsomely in the creation of dynamic scientific enterprises (as highlighted at sessions at the TWAS's 8th General Conference held last year in New Delhi). In Latin America, Brazil has taken significant steps to improve its scientific and technological capabilities with encouraging results, not only for science and scientists, but also for its wider population. South Korea has travelled further along the road to science-based sustainable development to the extent that it now belongs to the Organisation for Economic Co-operation and Development (OECD), the world's exclusive club of wealthy countries with average annual per capita incomes of US$22,000. (Korea's annual average per capita income now exceeds US$10,000 and is expected to top US$20,000 by 2012.)

Most observers agree that South Korea's sustained commitment to the development of science and technology within its borders has played a significant role in its success. Malaysia and Indonesia have devised similar strategies in an effort to emulate the progress that has been made by their east Asian neighbour. These are a few examples of the changing scenario and there are many more.

As the Academy looks ahead, it must recognize and respond to the dramatic changes that have taken place in science throughout the developing world over the past 20 years. Equally important, TWAS must anticipate the dramatic changes likely to unfold over the next 20 years. That is why TWAS has recently embarked on several measures that the Academy hopes will increase its future effectiveness.

Last year, the Academy launched the TWAS Research Units in the Least Developed Countries (LDCs), a scheme designed to support scientific and technological development in the South's poorest countries. This new programme is designed to build and sustain scientific excellence at universities and research centres in LDCs that have done good work under extraordinarily difficult circumstances.

The long-term goal is to help the LDCs train a critical mass of highly qualified scientists capable of addressing the real-life problems facing their countries. Grants of US$30,000 a year for up to three years are available to the selected research groups. During the first round of competition, we received more than 100 applications and were able to fund six groups. Now, we hope to expand this effort in the years ahead. We can think of no better way of promoting both equity and excellence as part of a larger effort to ensure the advance of science and science-based development in the South. However, for this worthwhile project to succeed, we do need help and financial support from all concerned.

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TWAS has gained a well-earned reputation for the effectiveness of its core programmes that are designed to build scientific capacity in the South. Moreover, as the Academy becomes increasingly concerned with the application of science to address critical issues in the South, we have come to realize that we need to work more closely with our fellow researchers and scholars in such fields as economics, sociology and political science.

Prior to 2001, only two members of TWAS were from disciplines other than the natural sciences: Federico Henrique Cardoso (TWAS Fellow 1984), who early in his career was as a professor of political science at the University of São Paulo, and between 1995 and 2002, served as president of Brazil, and the late Arthur Lewis (TWAS Associate Fellow 1985), who was awarded the Nobel Prize in economics in 1979.

In 2001, the Academy elected five members in the fields of 'social science and economics.' Our goal is not only to broaden the reach of TWAS but also to create greater synergy between our knowledge of the natural world and our understanding of human nature and behaviour. We are keen to examine the key elements that lie behind healthy and successful institutions, which the Academy now believes are central to enduring advances in science-based development.

The Academy will continue to expand its partnerships with international scientific organizations, working closely with its affiliated institutions – TWOWS, TWNSO and IAP – as well as such like-minded institutions as the International Council for Science (ICSU), the US National Academy of Sciences, and Harvard University's Kennedy School of Government, with which we have already developed strong ties. And we will continue to strengthen our relations with members of the United Nations family – the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). Again, the work we have done together in the past should serve as a strong platform from which to launch even more effective programmes in the future.

None of TWAS's success in the past 20 years would have been possible without the generous support of our benefactors, beginning, of course, with the Italian government, but also including UNESCO, which also serves as our administrative agency, the Department for Research Cooperation of the Swedish International Development Agency (Sida-SAREC), the Kuwait Foundation for the Advancement of Science and the OPEC Fund for International Development. TWAS has depended on their support in the past and is likely to rely on their generosity in the future in order to continue to advance our agenda.

The Academy's endowment fund, which now totals US$7.4 million, is likely to reach its original US$10 million target in the years ahead, serving as a source of financial stability in a world marked by uncertainty and risk. We thank all the developing nations and the scientists that have invested in the endowment fund for their generosity and for the expression of support and confidence that their contributions represent. I feel that, considering the situation of the world economy and our own requirements, we should try to reach a target US$15 million in the next 3 years.

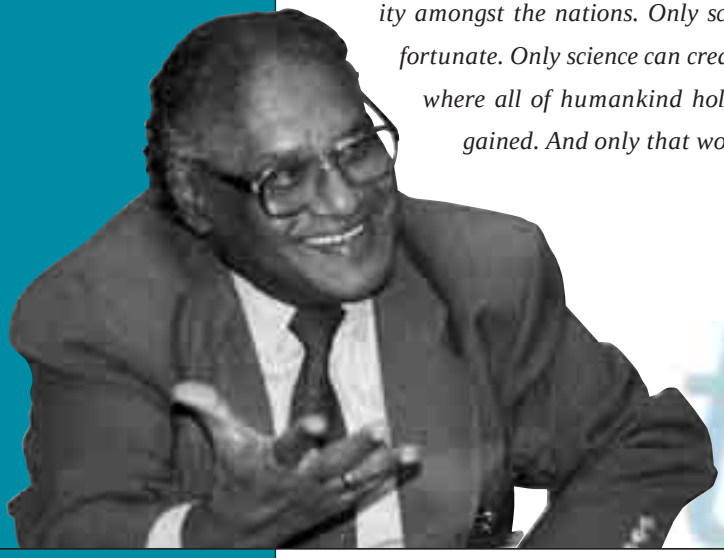
Whether we can achieve this is just one of the questions facing the Academy in the years ahead. Others include: What will the Academy look like 20 years from now? Will its growth be as spectacular as the first 20 years? Will it continue to expand its presence in the world of science in both the South and North? Will it continue to serve as the voice for science in the developing world – both as a repository of scientific knowledge and as an advocate for the developing world's future?

Only time will tell. But this much we do know. Because of the success it has achieved over the past 20 years, the Academy is poised to make an even greater contribution to science and society in the next 20 years. With a growing membership; with direct ties to the world of economics, sociology and political science; with a full range of strong partnerships with other scientific institutions and international organizations; with the synergistic strength provided by its administrative responsibilities with TWNSO, TWOWS and IAP; and with a stable budget and an endowment fund, which will hopefully reach US$15 million, there is reason to believe that the Academy's future will be even more fruitful than its past.

The Nobel Prize was Abdus Salam's greatest scientific reward and the International Centre for Theoretical Physics (ICTP) his most renowned creation. But TWAS is the institution that embodies his loftiest dreams: a tight-knit community of the developing world's most eminent scientists working together not only to advance the frontiers of science but to make science more relevant to society. It was, after all, the unity of scientific excellence and social good that served as Salam's most ambitious goal.

Let us celebrate the 20th anniversary of TWAS by rededicating ourselves to the principles that shaped Salam's grand vision of better future – a vision that he most clearly articulated in a statement he made in 1983 – the year of the Academy's birth: "Scientific knowledge is a shared heritage of all mankind. East and West, South and North have all equally participated in its creation in the past, and we hope, they will in the future. This joint endeavour in sciences remains one of the unifying forces among the people of this globe."

I personally have no doubt that it is scientific knowledge that will eventually bring equality amongst the nations. Only science can uplift the dignity of those who have been less fortunate. Only science can create a world, where equality and social justice prevail, and where all of humankind hold their heads high because of the self-esteem they have gained. And only that world will have peace and harmony. ■



C.N.R. Rao
President
Third World Academy of Sciences
Trieste, Italy

THE MINISTER IN THE MIDDLE

JOSÉ I. VARGAS, BRAZIL'S MINISTER OF SCIENCE AND TECHNOLOGY FROM 1992 UNTIL 1999, ASSUMED THE TWAS PRESIDENCY FROM ABDUS SALAM IN 1996. HE WOULD LEAD THE ACADEMY FOR THE NEXT FOUR YEARS. AS THE SECOND OF TWAS'S THREE PRESIDENTS, VARGAS – THE MINISTER IN THE MIDDLE – OVERSAW KEY STRATEGIC DEVELOPMENTS IN THE ACADEMY'S EVER-EXPANDING OPERATIONS.

When Abdus Salam, TWAS's founding president, resigned due to ill health, he left behind an organization that carried many of his most enviable qualities: intelligence, commitment, passion, and a deep sense of humanity. It was, therefore, an honour to have assumed the presidency from him.

Throughout the 1970s and 1980s, Abdus Salam often urged governments in the North's industrialized countries to invest 0.75 percent of their gross domestic product (GDP) on overseas development assistance. He also pushed for Southern nations themselves to invest 2 percent of their GDP on research and development. Few countries on either side of the North-South divide have ever reached these targets.

This modest goal became even more remote with the collapse of communism in 1991. In fact, one of the unforeseen consequences of the end of the Cold War was that impoverished Asian and African nations lost their strategic roles in international politics. As a result, international aid soon slipped to an average of just 0.25 percent of national GDP. For developing countries, the anticipated global 'peace dividend' turned out to be an international 'peace withdrawal.'

This was still the situation when, five years later, I took over the TWAS presidency from Abdus Salam. There was a distinct lack of investment in developing countries – investment that ought to be part of the North's larger effort to build a stable and secure world for everyone.

At TWAS, too, funds to give recognition, encouragement and support to scientific excellence in the South – the main aims of the Academy – had always been tight. Fortunately, since 1985, TWAS had received an annual 'voluntary contribution' from the Italian government of about US$ 1.5 million. Even so, during the early 1990s, one of the major goals of the Academy was to find a way of overcoming its budgetary constraints and uncertainties.

That is why I devoted so much time and energy during my tenure to transforming the Italian government's 'voluntary' contribution into a 'permanent' contribution written into Italian parliamentary law.

We made good progress in reaching this goal during my tenure, but ultimately fell short of having the signatures placed on the relevant documents. Now, I am told, the Academy is closer than ever to achieving this momentous event which will ensure TWAS's financial future.

Budgetary constraints and uncertainties had been the reasons behind the launch, in 1993, of TWAS's

endowment fund. This is one area where I think my presence as TWAS president made an important contribution.

The aim was – and is – to build a fund of US$10 million to US$15 million. I sincerely believe that the endowment is the key to the Academy's future well-being and independence. Most importantly, it will help smooth out the bumps in the road that inevitably surface during annual budget cycles.

Although the fund had got off to a good start, quickly reaching US$2.5 million, contributions had plateaued when I assumed the presidency in 1996. Indeed, no new substantial contributions had been received for several years.

Thanks, in part, to my close personal ties with Brazil's then-president, Fernando Cardoso, who is also a TWAS fellow, the Academy doubled the endowment fund to US$5 million within five years. Much of the credit for this must go to president Cardoso, whose tireless efforts on the Academy's behalf opened doors to high-level government officials. Brazil itself made an early contribution to the fund of US$500,000, and followed this up in 1998 with a further donation of nearly US$90,000.

Today, I am pleased to note that, as C.N.R. Rao reports, another milestone in the growth of the endowment fund – the three-quarter mark – has almost been reached (see article on page 2). All this has been achieved with donations from developing country governments and private individuals.

With this magnificent effort behind it, TWAS is now confident it can reach its minimum target of US$10 million within the next few years and perhaps reach beyond this target to build a US$15 million endowment.

Over the years, the Academy's budget has also been supplemented by programme-specific donations from such organizations as the Department of Research Cooperation of the Swedish International Development Agency (Sida-SAREC), the Kuwait Foundation for the Advancement of Sciences (KFAS), the OPEC Fund for International Development and the United Nations Educational, Scientific and Cultural Organization (UNESCO).

I am pleased to note that, several years – and many successful programmes – later, these organizations are still fully involved in TWAS's activities. This is a sign, not only of the high-profile international links TWAS has developed over the past 20 years, but also of its relevance to scientific capacity building and sustainable development in the South.

During my presidency, we also organized three major international conferences – TWAS's 5th General Conference in Abuja, Nigeria, held in 1995; the 6th General Conference held in Rio de Janeiro, Brazil, in 1997; and, two years later, the 7th General Conference in Dakar, Senegal.

I recall saying at the Rio conference that: "Over the past two decades, Brazil has made great progress in the development of its science and technology capabilities. Yet much work remains to be done to ensure that the benefits of Brazil's science and technology infrastructure reach into every corner of society."

The same sentiments could have been used to describe the state of the science and technology enterprises in many of the developing world's most 'advanced' nations. These nations have become scientif-

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ically proficient but have yet to convert this strength into broadbased economic development policies that make a difference in the quality of life for all their citizens.

Indeed, tapping scientific progress as a wellspring for government policies and practices that lead to sustainable development is another aspect of Academy concern that grew during my presidency. This was not necessarily through anything I did *per se*, but can be traced to another of Abdus Salam's initiatives – the foundation of the Third World Network of Scientific Organizations (TWNSO). Among the organization's membership are 39 ministries of science, technology and higher education, positive evidence that TWNSO can reach into the decision-making core of governments in the South. A number of TWAS fellows, too, are either ministers of science, or are closely linked with government advisory bodies, including academies of science.

This connection between science and government is crucial, and is another key aspect that I tried to focus on during my time as TWAS president. Making this link depends, perhaps more than anything else, on developing effective systems of communication.

To render intelligent decisions one needs solid scientific information. However, as reported in a previous *TWAS Newsletter* article (vol. 12, no. 3, July - September 2000), I believed that this was one area that needed strengthening. We had yet to devise successful strategies for ensuring the sharing of information and networking on a consistent basis.

A current TWNSO project, sponsored by the Global Environemnt Facility (GEF) and executed in cooperation with TWAS, however, offers some promising answers. Under the 'Promoting Best Practices for Conservation and Sustainable Use of Biodiversity of Global Significance in Arid and Semi-Arid Zones' project, five scientific conferences, each held in a different developing country, have been organized. Not only that, but a volume of scientific papers emanating from these meetings has been published by Kluwer Academic Publishers. Another publication, this one by TWNSO, includes 21 case studies, and there are plans to produce a third volume for a more general, non-technical readership.

In this way, the scientific information garnered in the field and in laboratories is being made available to a wide audience with diverse levels of scientific understanding. Another feature of this dryland biodiversity project has been the setting up of a website where browsers can review technical reports and respond to issues raised by the authors. The website should also make it easier for scientists and other stakeholders from the world's arid and semi-arid regions to communicate effectively, helping each other to solve common problems.

Perhaps this project is the model to follow so that the good work of TWAS and TWNSO reaches beyond the scientific community into the homes of people in developing countries.

This, I'm sure, was Abdus Salam's ideal when he founded the Academy 20 years ago, and I have great confidence that, under its present president, C.N.R. Rao – and for many years to follow – this will be the aim the Academy.

The tool is science, the method is to build scientific capacity and knowledge networks, and the goal is sustainable development.

Once again, let me say that I am honoured to have served as TWAS president and, on the occasion of its 20th anniversary, I am delighted to see its fine works continuing. Long may they do so. ■

José I. Vargas
TWAS Past President
Brazil's ambassador to UNESCO
Paris, France

OUR ACADEMY

M.G.K. MENON, ONE OF TWAS'S FOUNDING MEMBERS, RECALLS HIS FIRST DISCUSSIONS ABOUT TWAS WITH ABDUS SALAM AND, TWENTY YEARS ON, GIVES A PERSONAL INSIGHT INTO THE EARLY DAYS OF THE ACADEMY.

M.G.K. Menon

Abdus Salam and I were both admitted as Academicians of the Pontifical Academy of Sciences in May 1981. In those days, for meetings of the Academy, the Academicians were put up in hotels outside the Vatican City, but near the Academy.

During one Academy meeting, some time after we were nominated, Abdus and I went out for dinner. I told him what a wonderful thing he had done for science in developing countries by establishing the International Centre for Theoretical Physics (ICTP) in Trieste which enabled scientists from developing countries, almost as a matter of right, to spend time regularly at ICTP and interact with the best scientists in the world. There, they could recharge their batteries before returning to their home countries where they faced many hardships and handicaps pursuing their scientific work.

I told Abdus that there was an additional problem. In many developing countries, the scientific community tended to be very small – too small to make an academy or society. Scientists in those countries, therefore, did not have any institution to which they could belong and which would confirm their academic credentials. There was also no group that could assume responsibility for the advocacy of science, establish standards of excellence, and promote social, cultural and economic development.

Scientists from such countries could only become members of academies or societies elsewhere in the world if they were of a very high calibre, in which case they could be inducted as foreign fellows or members of the Royal Society in the UK, the US National Academies, the USSR Academy of Sciences, the Royal Swedish Academy of Sciences, the Pontifical Academy of Sciences and the like.

The next morning we met for breakfast at the Pontifical Academy premises. He told me that he wanted to discuss further the matter that came up in our conversation the previous evening concerning scientists in developing countries. I said that since this related to developing countries it would be good if we could bring together all the academicians who were available that morning. We quickly arranged for a table around which we all sat. I recall that group vividly: there was Abdus Salam, of course, and also Carlos Chagas, Hector Croxatto, Johanna Döbereiner, Malu wa Kalenga, Thomas Odhiambo, Crodowaldo Pavan, Marcel Roche, Salimuzzaman Siddiqui and myself.

Abdus expounded the idea to create an academy of

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sciences for developing countries, to which eminent scientists from developing countries could get elected. This would help nurture a community of scientists around the world that, apart from providing the prestige of such an academy to its individual members, would promote research and exchange programmes and be a powerful advocate for science.

We were all very excited about the possibility and the opportunities this would open up. Abdus offered to host it at ICTP's headquarters in Trieste, Italy, and to provide it with the necessary wherewithal to get started.

It was a glorious autumn morning in Rome; the sun was shining onto the breakfast table around which sat this group of scientists from Asia, Africa and Latin America. The Third World Academy of Sciences had been born. Five of these founding members are no longer in our midst. They were all great pioneers in their own respective ways, leaders in their countries and in their disciplines, and internationally respected.

Abdus Salam has left behind a monumental achievement that is living and growing.

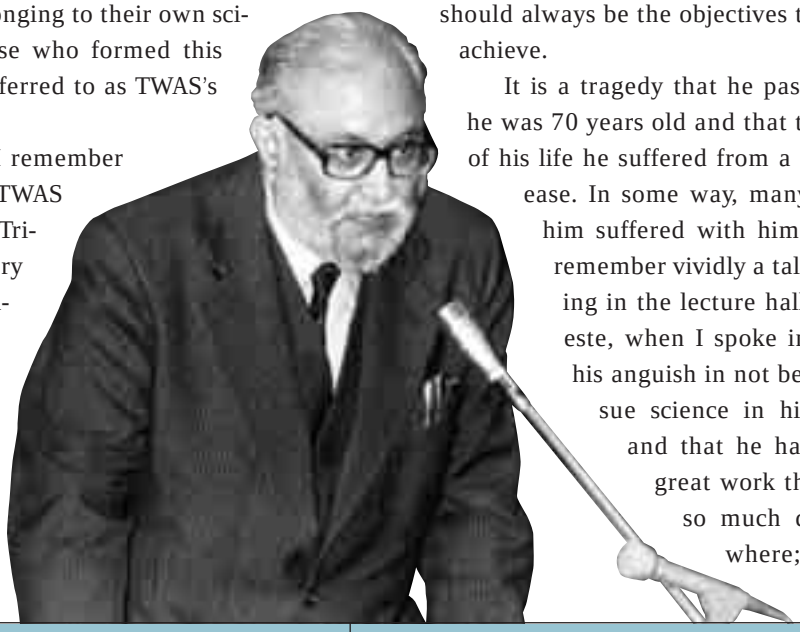
There was no stopping Abdus after that. It was agreed that we would constitute an electoral college of academicians of the new academy by including all scientists from developing countries who were either fellows, foreign fellows or members of the world's great science academies and societies. This provided the nucleus, bringing in a much larger number of eminent scientists who did not previously have the privilege of belonging to their own scientific academy. All those who formed this electoral college were referred to as TWAS's 'founding fellows'.

The next event that I remember in the early history of TWAS was the first meeting in Trieste. The group was very small and most of the scientists were accompanied by their spouses. There was a convivial atmosphere of informality, intimacy and the excitement of a new venture. Abdus had arranged for a gala event to be held at Duino Castle – he was already on his search for visibility, patronage and financial support.

Abdus worked ceaselessly for the Academy. With the prestige of a Nobel Prize behind him, he travelled all over the world seeking support for the Academy. He was received at the highest levels by presidents, prime ministers and royalty.

Abdus was a great physicist, and that is where his primary reputation came from. But he also wrote extensively about science for the developing world. He made impassioned pleas at international conferences and fora, where he spoke from his heart of the plight of scientists in the developing world; the need for science in the South; the lack of growth of science and support for science in developing countries; the glorious history of science characterized by great civilizations that are in areas now regarded as developing; and the relatively small efforts required to make science a truly international cooperative enterprise.

Had he lived, Abdus would have certainly been a very worthy candidate for a Nobel Peace Prize. For me, the word TWAS conjures up fond memories of this great person who did so much for the developing world, and of the wonderful moments that I have shared with him. For TWAS, his name will be etched in letters of gold. His hopes and ambitions for TWAS should always be the objectives that we strive to achieve.



It is a tragedy that he passed away when he was 70 years old and that towards the end of his life he suffered from a debilitating disease. In some way, many of us close to him suffered with him and for him. I remember vividly a talk that I was giving in the lecture hall at ICTP in Trieste, when I spoke in passing about his anguish in not being able to pursue science in his own country, and that he had to do all the great work that brought him so much distinction elsewhere; how this expe-

rience steeled his resolve so that others should be spared this anguish; and how magnificent institutions like ICTP and TWAS grew out of this pain. Abdus was visibly moved, and I had to completely change the direction of my talk.

With the foundation provided by Abdus Salam, TWAS has become increasingly successful. José Vargas succeeded Salam as president. Thereafter, C.N.R. Rao took over. Both have provided admirable guidance and direction to TWAS, assisted by a dedicated council. TWAS also owes a deep sense of gratitude to its executive director, Mohamed H.A. Hassan, who has provided first-class management and administration in the running of TWAS. He has travelled tirelessly around the world, so that the presence of TWAS became integral and essential at all fora relating to the development of science. His influence has been enormously important in forging new relationships with a range of institutions and organizations across the world, as well as in attracting money. One of the great successes of TWAS has been the creation and growth of its endowment fund, an investment that is hoped will reach US$10 million by 2005.

I had the privilege of being at TWAS's 2nd General Meeting in Beijing, held in 1987 – a high level affair that attracted officials from the highest levels of the government of the People's Republic of China. At that time, TWAS was still small, and there was a very intimate atmosphere of friendship.

Since then I have been to meetings in Trieste, Kuwait, Nigeria, Brazil and India. At each, there was a strong local flavour, with a depiction of the region's science. Furthermore, the successive conferences demonstrated how, as we have moved forward in time, TWAS has grown more representative of the developing world. Each one of us attending these meetings has been educated by getting to know scientists from other areas and knowing the problems of those areas.

Whilst there is strong representation in TWAS from countries such as Brazil, China, India and Mexico, there is now increasing awareness and significant promotional efforts towards bringing in fellows from the smaller, poorer and disadvantaged countries – which was one of the primary objectives of TWAS. C.N.R. Rao, as president, has done a great deal towards this goal.

TWAS membership also includes associate fellows – outstanding scientists from developed countries who are deeply committed to international science and the growth of science in the developing countries. Indeed, TWAS's first Abdus Salam Medal, awarded in 1995, was given to Federico Mayor, a native of Spain and then director general of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

TWAS has built itself a clearly recognized image as the voice of science of the developing countries. Through a variety of programmes and projects and through its affiliated partners (the Third World Network of Scientific Organizations (TWNSO) and the Third World Organization for Women in Science (TWOWS)), it has enlarged its coverage to areas of government policy and the role of women in science.

I can vividly recall Abdus at TWAS's 2nd General Conference in Beijing in 1987. In October 2003, on the 20th anniversary of TWAS, we go back to Beijing. We will miss Abdus Salam, but he has left behind a monumental achievement that is living and growing. That is our tribute to him. ■

M.G.K. Menon
TWAS Founding Fellow
New Delhi, India

TWAS AND SUSTAINABILITY: THEN AND NOW

MOHAMED HASSAN, TWAS EXECUTIVE DIRECTOR, REFLECTS ON THE ACADEMY'S TWENTY-YEAR HISTORY, ANALYSING HOW THE ORGANIZATION HAS EVOLVED IN ORDER TO ADAPT AND RESPOND TO THE CHALLENGES FACED BY SCIENCE AND SCIENTISTS IN DEVELOPING COUNTRIES.

Since its inception in 1983, TWAS has been involved in science-based sustainability issues. Of course, the Academy didn't use this term in the 1980s. No one did. Moreover, the core strategies developed by the Academy during its first decade of existence focused on building an enduring foundation for scientific excellence in the developing world rather than on using science to address critical social and economic issues.

Nevertheless all of the Academy's initiatives, in a real sense, have focused on science-based sustainability, including our efforts to honour eminent scientists in the South through their election to TWAS; our research grants programmes; our prizes and awards; our South-South scientific exchange programmes; our fellowships and associateships programmes (in partnership with the United Nations Education, Scientific and Cultural Organization (UNESCO) and the International Council for Science (ICSU)); and our books and journals donations programme (in partnership with the Abdus Salam International Centre for Theoretical Physics (ICTP)).

This focus on scientific capacity building is essential because nations without a strong foundation in science are unable to implement policies and participate effectively in programmes for sustainable development.

In many respects, therefore, throughout its existence, TWAS has been on the frontlines of the sustainability campaign. The contributions we have made to this campaign, by way of our core strategies, are reflected in our most recent annual report. For example, the Academy now has 662 members, more than 80 percent of whom live and work in the South. Over the past 20 years, more than 1100 scientists have taken part in our South-South scientific exchange programme (mostly young scientists at critical junctures in their careers), and more than 1600 have received TWAS research grants.

More recently, the Academy has embarked on a new series of projects that fit more directly into the

framework of 'sustainability science.' These projects focus on successful applications of science and technology in addressing critical issues in the developing world, and aim to combine scientific research and policy making in mutually beneficial ways.

The Academy began to move in this direction in 1999 with the publication of a monograph, *Sharing Innovative Experiences: Examples of Successful Initiatives in Science and Technology in the South*. The effort,

which was sponsored by the United Nations Development Programme's Special Unit for Technical Cooperation among Developing Countries (UNDP/TCDC), examined some 30 on-the-ground experiences in the use of science and appropriate technologies that have had a significant impact on the lives of people in the developing world. Examples ranged broadly, from the redesign of an ancient plough in Ethiopia that helped to improve crop yields in this nation that suffers chronic droughts, to the development of a nationwide state-of-the-art digital communications system in South Korea.

This initial effort has been followed by a series of projects with similar objectives that have explored specific themes of importance to the South: the conservation and wise use of medicinal plants; science-based strategies for improved access to safe drinking water; local- and community-based programmes for more effective application of renewable energy technologies; and concrete examples of the conservation and sustained use of biodiversity resources in dryland regions.

UNDP/TCDC has continued to be one of our main partners but other international organizations have joined us in these endeavours, including the Global Environment Facility (GEF), the World Meteorological Organization (WMO) and UNESCO. The project's goals, moreover, have been expanded to include the organization of workshops and the creation of institutional networks – all as part of a larger strategy to create a sustainable framework for advancing science-based sustainable development.

All of the Academy's initiatives, in a real sense, have focused on science-based sustainability.

In addition, the Academy has launched a *TWAS Research Report* series examining science-based solutions to critical problems in the developing world. The first report in this series, focusing on scientific and technical solutions for providing greater access to safe drinking water in rural areas in the developing world, has been broadly distributed. The Academy is now engaged in discussions with a number of governments and donor agencies in an effort to obtain funding for the development and implementation of an action plan designed to put some of the successful applications

[CONTINUED PAGE 14]

Mohamed H.A. Hassan

outlined in the report to wider use. Another *TWAS Research Report*, examining successful utilization of renewable energy systems at household- and community-levels, has been drafted and should be published later this year.

TWAS has also been a main partner in the Harvard University Kennedy School of Government Initiative on Science and Technology for Sustainability (ISTS) and with Harvard and the International Council for Science (ICSU) on the creation of a global consortium devoted to the issue of science-based sustainability. In addition, the Academy worked closely with a number of institutions – including ICSU, the InterAcademy Panel on International Issues (IAP), and the World Federation of Engineering Organizations (WFEO) – on the organization of the week-long Science Forum at the World Summit on Sustainable Development (WSSD), held in August 2002.

All of these new initiatives have helped extend the agenda and reach of the Academy. But I would be remiss if I didn't mention how two long-standing core activities of the Academy – its research grants and membership programmes – have also been reformed and broadened to help us in our overall efforts to promote science-based sustainable development.

For example, TWAS has launched a grant programme designed exclusively for scientific institutions in least developed countries (LDCs) that have done commendable work under trying conditions. The three-year grants provide sufficient resources for these institutions to take a significant leap forward in their scientific capabilities. Similarly, the Academy has started welcoming economists and social scientists into its membership ranks. Our objective is to create a forum for greater interaction between scholars and research in a wider range of fields of study – again with an eye to putting science to work to solve critical problems related to sustainability in the developing world (see 'Bridging the Discipline Divide', *TWAS Newsletter*, vol. 15, no. 1, 2003).

The concept of sustainability has been with us for some time – even if the term has not.

The Academy warmly welcomes – indeed embraces – the clarification that advocates of sustainability have brought to the broad concept of sustainable development and the rigour with which they have analysed the central role that science *can* (and indeed *must*) play in the process.

But I think it is important to recognize that many of the principles driving the concept of sustainability have been with us for some time – even if the term has not. Highlighting what's new while acknowledging the value of what's old may be the greatest challenge the advocates of science-based sustainable development face in gaining credibility both within and beyond the global scientific community. Now, as we celebrate our 20th anniversary, TWAS stands ready to help on both fronts. ■

Mohamed H.A. Hassan
Executive Director
Third World Academy of Sciences
Trieste, Italy

ON THE OCCASION OF ITS 20TH ANNIVERSARY, TWAS HAS RECEIVED MORE THAN 100 CONGRATULATORY NOTES FROM HEADS OF STATE, MINISTERS OF SCIENCE, AND INTERNATIONAL, REGIONAL AND NATIONAL ORGANIZATIONS, AS WELL AS MANY INDIVIDUALS.

ANNIVERSARY MESSAGES

*Abridged versions of these messages have been published in a book to coincide with the 9th General Conference in Beijing being held on 16 - 19 October 2003. Full texts of the messages are available on the TWAS website (*www.twas.org*) by clicking on the 'Anniversary Letters' link. Here's a sampling of what you will find.*

• Two decades ago, a group of dedicated and distinguished scientists from the developing world met in Trieste, Italy, and pledged to create a forum to facilitate the exchange of scientific knowledge, expertise and information. They also agreed to develop human resources in the South through the utilization of the capacity present within the Third World, while taking advantage of assistance provided by those in the North.

This welcome initiative, under the leadership of the late Nobel laureate Abdus Salam, has addressed the wishes of many governments and scientists in the South and has since produced results beyond our original expectations. We have witnessed the extended participation of many Third World countries in resolving some of their burning issues, and the development of knowledge networks in the South. Multinational and regional participatory programmes have also been developed with immensely helpful outcomes.

We therefore applaud and uphold the mission of TWAS and its leadership. We look forward to wider participation and an enlarged membership of scientists from Third World countries, and the continued and expanded role of relevant institutions in the North for a mutually beneficial future.

I renew my support of TWAS and hope that the Academy can continue to promote even higher levels of scientific cooperation in the future. ■

Benjamin William Mkapa
President
United Republic of Tanzania
Dar es Salaam, Tanzania

• I wish to congratulate TWAS on the occasion of its 20th anniversary. There is no doubt that TWAS and its affiliated organization, the Third World Network of Scientific Organizations (TWNSO), have come a long way in making their voices heard in the hallowed circles of science and technology. A substantial

portion of the Third World, especially African countries, still struggle to create the basic scientific and technological infrastructure required to achieve self-sufficiency in areas of pressing need, including food and nutrition, access to safe drinking water, energy, shelter, population control, security and defence.

While appreciating the vision and the sense of purpose of TWAS in marshalling and harnessing human and material resources for science- and technology-driven development in the Third World, I hasten to add that partnerships among scientists, politicians and policy makers, captains of industries and other stakeholders are more imperative now than ever. All hands, therefore, must be on deck to achieve our desired goals.

Once more, I wish TWAS a happy anniversary. ■

Olusegun Obasanjo
President of Nigeria
Abuja, Nigeria

• TWAS has always been ahead of its times – practising networking before the word was in common usage; promoting South-South scientific cooperation but not at the expense of North-South cooperation; and placing the concerns of women scientists at the top of its agenda. Over and above its lofty ideals, TWAS has been most generous in the awarding of its prizes and grants and the implementation of its plans and programmes.

It is in this practical realm that TWAS could do more in the next 20 years. It can forge action plans for solving the most pressing problems of our age. To this end, task forces should be formed among the scientific communities in the South and more attention should be paid to humanitarianism, culture and ethics. ■

HRH Prince El Hassan bin Talal
Amman, Jordan

• In the two decades since its foundation, TWAS has enjoyed remarkable achievements in promoting South-South scientific cooperation and fostering the training of science and technology personnel. The success of its programmes has earned TWAS commendations from all developing countries. China treasures its excellent relationship with TWAS and all its members. It is our ardent hope that we can enhance our collaboration in the future, helping to advance the careers of scientists and technologists throughout the Third World. ■

Xu Guanhua
(TWAS Fellow 2001)
Minister of Science and Technology
Beijing, China

• TWAS has succeeded in many areas, including the creation of networks; assistance for the mobility of Third World scientists; formation of partnerships among developing countries for promoting excellence in scientific research; provisions for research facilities for outstanding scientists; and sponsorship for advanced research, education and training. In India, policies and programmes for technical cooperation among developing countries are also a priority, and I wish to reaffirm that our views find expression in TWAS's actions.

In the future, TWAS may consider intensifying its efforts to find scientific and technological solutions to societal problems common to countries of the South. It is the moral obligation of science and scientists to enhance the well-being of these societies that so wholeheartedly support their endeavours. ■

Murli Manohar Joshi
Minister of Science and Technology and Ocean Development
New Delhi, India

• We thought it appropriate on the 20th anniversary of TWAS for South Africa to pay tribute to the dedicated people at TWAS who have, over the years, devoted their efforts to the advancement of science in the developing world.

I would like to applaud TWAS for its efforts to recognize, support and promote excellence in scientific research and to build scientific capacity. We trust that scientific achievement will not only contribute to development but will also assist in restoring pride and dignity among the peoples of the developing world.

I wish TWAS the greatest success in the next 20 years of global scientific cooperation. ■

B. S. Ngubane
Minister of Arts, Culture, Science and Technology
Pretoria, South Africa

• Over the past 20 years, TWAS has made a niche for itself in international science. It is now a partner to be reckoned with in stakeholder dialogue on science issues on the world scene. Its membership, made up of world-class scholars and scientists from many developing countries, is constantly sought after for reliable opinions and expertise on science-related development issues seen from a Southern perspective. The United Nations Educational, Scientific and Cultural Organization (UNESCO) has been happy to associate itself closely with the birth and development of TWAS, and pays tribute to the efforts of its leadership down through the years for this significant achievement.

UNESCO's cooperation with TWAS has taken many forms. As UNESCO itself engages in reform and refocusing, our cooperation is set not only to continue but to expand significantly, exploiting to the full our strengths and complementarities.

On behalf of UNESCO, I send warm greetings to the TWAS scientific community on its 20th anniversary, and a commitment to a continued and strengthened partnership in the future. ■

Koïchiro Matsuura
Director-General
United Nations Educational, Scientific and Cultural Organization
Paris, France

• On behalf of the World Meteorological Organization (WMO) and the meteorological and hydrological communities of the world, I wish to congratulate the officers, executive director and staff of TWAS on the occasion of the Academy's 20th anniversary. Their commitment and dedication have contributed to TWAS's remarkable achievements. My tribute also goes to the founding fathers of TWAS, including the late Nobel laureate Abdus Salam and his colleagues, for their foresight in promoting science and technology in the developing world.

WMO's collaboration with TWAS serves the aspirations of the South for socio-economic development through meteorology, hydrology and related geophysical sciences. As a scientist and vice-president of TWAS, I believe that the Academy remains a driving force for scientific cooperation and excellence in areas that are critical to humanity.

On this memorable occasion, I wish TWAS many more years of successful contributions to the advancement of science and technology in developing countries. ■

Godwin O.P. Obasi
(TWAS Fellow 1996)
Director-General
World Meteorological Organization
Geneva, Switzerland

• Science and technology have always been central to prosperity and poverty alleviation. Today the accelerating rate of technological progress creates both tremendous opportunities and significant risks for developing countries. Too many countries still cannot access and utilize advances in scientific and technological knowledge, and thus fail to capture the benefits that have become commonplace in the rest of the world. TWAS is working to change this. Whether in agriculture, health, water resources, energy or the environment, evidence suggests that developing countries which succeed in exploiting their science and technology capacity realize concrete economic returns and tangible social benefits. Achieving these benefits requires a constant commitment to human resource development, an innovative private sector connected to the academic community, public support for science and technology, and the global exchange of knowledge.

TWAS members exemplify a vision in which every country seeks to fully understand, interpret, select, use, transmit, diffuse, produce and commercialize scientific and technological knowledge that can bring prosperity and an end to poverty. ■

James D. Wolfensohn
President
The World Bank
Washington, DC, USA

• On the event of its 20th anniversary, the Swedish International Development Cooperation Agency (Sida) would like to congratulate TWAS on its excellent work during the past two decades and to recognize its prominent role in the promotion of scientific excellence and the development of scientific capacity in developing countries.

Sida's support for TWAS dates back to 1993 and TWAS is a central actor in Sida's efforts to support the basic sciences. We are very pleased to see how well the organization, over the years, has fulfilled the aim of providing support to young scientists working in the basic sciences in the developing world. These scientists have contributed to the creation of research environments in many countries.

High on our agenda for the future are concerted efforts in building the basis for research in the world's least developed countries and we are counting on TWAS to be an important partner in these efforts. ■

Berit Olsson
Head
Swedish International Development Cooperation Agency – Department for Research Cooperation
Stockholm, Sweden

• The OPEC Fund is pleased to have been associated with TWAS virtually from its inception. We have witnessed the institution grow from a struggling, fledgling body to a major player in the science and technology research and development field, doing what we could to be present when called upon and to extend assistance, when necessary, to support some of the Academy's diverse projects and programmes.

Today, by any measure of scientific excellence, TWAS ranks among the best institutions of its kind worldwide. It supports research in more than 100 countries in the South and aids initiatives for promoting indigenous capacity. The Academy has not only succeeded in its undertaking to inform the South and advise decision makers on the scientific aspects of critical global issues; it has, with its affiliated organizations, helped to demonstrate that the South can take care of its own, finding home-grown remedies for its problems while simultaneously advancing global science and technology.

At the OPEC Fund, we do not, as a contributor, aim to share the limelight with TWAS. Neither do we, in any way, seek to claim any part of this huge accomplishment. Instead, we look forward, in all modesty, to continuing this close association. ■

Y. Seyyid Abdulai
Director-General
OPEC Fund for International Development
Vienna, Austria

• Over the 20 years of its existence, TWAS has gained worldwide recognition as a leading voice for the promotion of science in the developing world. The United Nations Conference on Trade and Development (UNCTAD) was also created to assist countries in the South in their development aspirations. I believe, therefore, that there are many ways the two organizations could build partnerships aimed at ensuring the full realization of the benefits of technological and scientific advances for people in the developing world while minimizing the risks associated with such advances.
Close collaboration between TWAS and UNCTAD in the development of the Science and Technology Diplomacy Initiative, established to assist policy makers and trade diplomats from developing countries to make informed decisions at international forums where science and technology are discussed, marks an important step in advancing this partnership. Best wishes for your future success. ■

Rubens Ricupero
Secretary-General
United Nations Conference
on Trade and Development
Geneva, Switzerland

• The future of the developing countries – and here I refer to their ability to create a fair society and to promote social and economic development – depends, to a large extent, on their capacity to guarantee, through quality education, universal access to science. It also depends, in an extremely competitive international environment, on their endogenous capacity to develop new technologies and their ability to absorb, master and adjust to their needs the technological innovations generated in industrialized countries. Democratizing scientific knowledge thus represents a major challenge. Fulfilment of this pledge has been a quest to which TWAS has long been committed. Long may it continue. ■

Eduardo Moacyr Krieger
(TWAS Fellow 1995)
President
Brazilian Academy of Sciences
Rio de Janeiro, Brazil

• Despite all the work done by TWAS, the number of scientists in proportion to population is 10 to 30 times smaller in developing countries than in developed countries. Also, 95 percent of science in the world is still carried out in institutions in industrialized countries. There is no time to relax or rejoice. The 20th anniversary of TWAS provides an opportunity to look back with pride on TWAS's accomplishments, and to look forward towards the challenge of increasing political and public support for fostering a culture of scientific excellence in Third World countries. ■

M.S. Swaminathan
(TWAS Founding Fellow)
Chairman
MS Swaminathan Research Foundation
Chennai, India

S&T PROGRESS IN CHINA

THIS YEAR, AS TWAS CELEBRATES ITS 20TH ANNIVERSARY, THE ACADEMY RETURNS TO CHINA TO HOLD ITS 9TH GENERAL CONFERENCE. TO COMMEMORATE THE OCCASION, YONGXIANG LU, PRESIDENT OF THE CHINESE ACADEMY OF SCIENCES, EXAMINES HIS NATION'S CONTRIBUTION TO THE WORLD OF SCIENCE.

Yongxiang Lu

China's history, traditions – and its scientific advances – go back to ancient times. Inventions such as paper, gunpowder and the use of silk as a lightweight fabric, for example, are attributed to the Chinese civilization. Around the end of the 16th century and the beginning of the 17th century, trading routes with the West began to open up. As well as goods, scientific ideas began to flow between Europe and China. Later, around the middle of the 19th century, the 'Westernization Movement' took hold and the practice of what we recognize as modern science and technology began to take root. Western-style science has since been promoted by successive Chinese governments. In particular, over the past 20 years, a more forward-thinking and modernizing Chinese government has increased funding for science and technology, and recent years have seen the rapid development of scientific advances in China.

Over the past 20 years, national policies have emphasized the strategy of advancing China's prosperity through education and science, and have made the development of science and technology a major priority. Now, China is making great strides forward in turning scientific and technological achievements into commercial successes.

Although still considered a developing country, China has successfully used science and technology to improve significantly the well-being and prosperity of its citizens. With the improvement of crop varieties and the adoption of more efficient cultivation techniques, 1.2 billion people now have ample food and adequate clothing (mainly from cotton), even though the amount of land per head of population in China is only a third of the world average. Developments in medical sciences and improvements in the country's healthcare system also mean that the average life-span of the Chinese is now a respectable 72 years. Industrial technologies have been established, and the technology level of the country as a whole has been lifted to the equivalent of the technology present in developed countries during the 1980s.

Advances by Chinese scientists and engineers working in various academic disciplines not only serve

China, but have made significant contributions to world science.

PHYSICAL SCIENCES

The physical sciences, including physics and chemistry, focus on the study of structures and interactions of matter and form the basis of all scientific disciplines. Their study can lead to the development of novel materials and new technologies.

Among the milestones of Chinese scientists was the prediction, in 1933, of the existence of the transuranic elements (elements heavier than uranium), and the proposal, in 1941, of an experimental protocol to search for neutrinos (rare sub-atomic particles that were eventually detected some 15 years later in the USA).

Advances by Chinese scientists and engineers not only serve China, but have made significant contributions to world science.

In the second half of the 20th century, China began constructing its own modern experimental facilities, including an experimental nuclear reactor built in 1958. This was followed by the Beijing electron positron collider and the Lanzhou heavy ion accelerator system, suitable for low-energy nuclear physics research, both of which came on-line in 1988, and a multi-channel solar magnetic field telescope, built in 1994.

Many other key laboratories have also upgraded their facilities, giving China better equipment and experimental conditions than ever before. Chinese physicists have thus been able to make numerous contributions in the areas of quantum field theory and particle physics, atomic and nuclear physics, condensed matter and statistical physics, astrophysics and the theory of gravitation.

Among the advances made by Chinese scientists in theoretical research, Huang Kun (a member of the Chinese Academy of Sciences, CAS) and colleagues presented the Huang-Zhu model of semiconductor superlattice theory in 1988, and, in 1990, Ouyang Zhongcan (also a CAS member) formulated his liquid crystal model of biological membranes.

Among Chinese successes in experimental and observational studies, there are many significant results. These include the discovery of the fifth order of symmetry in a quasi-crystal (1984) and, between 1986 and 2000, the synthesis of more than ten new nuclides (atoms with an unusual atomic mass different from their stable state) in a heavy ion accelerator.

Among the advances in theoretical and experimental chemistry is Lu Jiaxi's (CAS member) model, derived using atomic cluster structural chemistry. The model, published in 1973, simulates the action of an enzyme present in the nitrogen-fixing bacteria that live symbiotically in the root nodules of leguminous plants.

In more applied research, techniques for extracting potassium from brine and ways of obtaining boron and lithium by distillation have meant that the saline lakes

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in China's northwestern regions could provide jobs and income security for many workers. The importance of the industrial-scale production of lithium was enhanced in 1996 with the successful development and production of the lithium ion battery – a breakthrough that has aided the development of many countries' technology industries, including Japan's, as the lightweight battery is used in such portable electronic devices as laptop computers.

Chinese scientists have also carried out studies related to the industrialization of a high temperature superconductor. By producing a 100-metre long superconductor tape, superconductor research in China advanced from the laboratory to the production phase. Also, in 2000, Chinese nanotechnology researchers produced a coaxial cable that could lay the foundation for producing the next generation of fibre optics. Other nano-scale developments have potential applications in material-processing and electronic technology.

Chinese biologists were the only group of scientists from the developing world to participate in the Human Genome Project.

LIFE SCIENCES

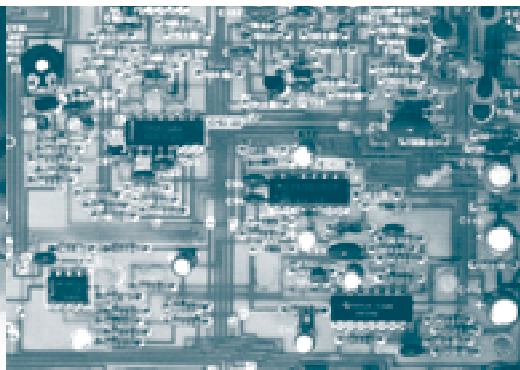
In the second half of the 20th century, Chinese scientists began to apply modern molecular biology techniques to their life science research. Initial successes included the synthesis, in 1965, of crystalline insulin with an activity almost as high as the natural product and, in 1981, the artificial production of transfer ribonucleic acid (tRNA) – a molecule involved in protein synthesis within cells – that had the identical chemical structure and biological activity as the original molecule.

More recently, Chinese biologists made international headlines when they were the only group of scientists from the developing world to participate in the Human Genome Project. The first draft of the complete sequence of the human genome was published in 2000. As part of this effort, Chinese scientists completed the draft sequence of the 30 million base pairs of chromosome 3. Although this was only a small part of the working draft of the whole genome, their involvement showed that Chinese scientists are capable of playing their part in major international projects.

Research into *Drosophila* – the fruit fly that scientists have used for nearly 100 years in their genetics experiments – has also led to interesting insights regarding the molecular basis of learning, memory and decision-making in vertebrate animals, including humans.

The past 50 years have also seen advances in the quality of varieties of many of China's staple crops, including cotton, maize, rice, soybean and wheat. The increase in yield brought about by cross breeding paddy rice now provides enough food for tens of millions of people. Further breeding work is now benefitting from the construction of a high-resolution map of the paddy rice genome completed in 1996, and the draft of the complete genome sequence of indica rice published in 2001 – the first crop plant to be fully sequenced. Since then, Chinese biologists have worked out the precise sequence of rice's chromosome 4. This, and subsequent work, will not only help researchers understand the secrets of rice, but will help in the study of other grain crops such as wheat and corn.

Chinese scientists have also learned many techniques for transferring genes from one species of plant or animal to another – the process of genetic transformation used to produce genetically modified organisms. In 2000, Bt-cotton, genetically modified to be resistant to such insects as the bollworm, was being grown on 700,000 hectares, or 20 percent of the land down to cotton in China. With reduced pesticide and labour inputs, the cost of producing a kilogramme of cotton has been cut by 28 percent, making the Chinese cotton industry more competitive on the world market. Indeed, by 2002, 31 genetically modified crop varieties had been approved for commercial release and China's plant biotechnology capacity ranked second in the world, behind only the USA's.



Biotechnology is also being applied in the medical field. Although medical biotechnology in China did not start until the late 1970s, progress has been made on several fronts. In 1992, for example, new techniques of applying the anti-cancer drug, interferon, were developed. This was followed in 2001 by the discovery of a gene, known as IHH, confirmed to be the cause of the genetic disease Brachydactyly Type A-1, a disease that causes an abnormal shortness of the fingers. There have also been important developments made in the fields of microsurgery and liver and gall bladder clinical science.

INFORMATION SCIENCE AND TECHNOLOGY

Having been identified as major weaknesses in Chinese research programmes, studies on electronic, computer and semiconductor science have been carefully planned and deployed since the start of China's Twelve-Year Plan (1956 - 1967). As early as 1957 the first transistor was successfully developed in China, and China's first electronic computer was produced in 1958. By 1973, China was developing its own small-scale integrated circuit computers and entered the era of ultra large-scale integrated circuit computers at the beginning of the 1980s. The rapid development of China's computing technology is obvious when comparing the operation speeds (or 'FLOPS') over the past few years. In 1997, the Milky Way Series Parallel Vector Supercomputer reached a maximum operating speed of 13 gigaFLOPS (or 13 billion FLOPS) whereas,

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just five years later, the latest computer models are reaching speeds more than a thousand times faster. These computers now play major roles in Chinese weather forecasting, oilfield surveys and scientific data analysis.

Chinese scientists have also developed intelligent English/Chinese translation software, while a Chinese text conversion system and Chinese intelligent interface mean that Chinese culture will not be lost as the technological revolution rolls on. A Chinese laser typesetting system developed by Wang Xuan (CAS member) in 1985 also brought the Chinese printing industry into a new era.

ics and many other fields, and has also stimulated many subsequent research efforts.

Development of systems science in China, which has relied on the country's engineering science capacity, began with studies on operations research and cybernetics. Qian Xuesen (Tsien Hsue Shen), another CAS member, first applied systems science to the fields of engineering, and his 1954 '*Engineering Cybernetics*' monograph is regarded as a classic. Chinese systems science studies also produced many practical applications, including a Population Forecast Model (1980) and the National Grain Output Forecast Model (2001), that are important for long-term predictions of the Chinese economy.

MATHEMATICS AND SYSTEMS SCIENCE

China has a strong tradition in mathematics. Recent advances have taken mathematical studies in China beyond the field of pure mathematics and into the fields of scientific computing and engineering design.

The Chinese Academy of Sciences established the Institute of Applied Mathematics and the Institute of Systems Science in 1979, and the Institute of Computational Mathematics and Science Engineering Computation was launched in 1995. These institutes were then merged into the Academy of Mathematics and Systems Science in 1998.

Among the current crop of renowned Chinese mathematicians is CAS member Feng Kang who solved a long-standing computational problem concerning long-term predictions. Feng's method has since been successfully applied to astrophysics, molecular dynam-

ADVANCED MANUFACTURING TECHNOLOGY

Manufacturing technology is the backbone of human civilization and allows nations to compete on the world stage. In recent years, as in many other countries, Chinese manufacturing has embraced advances in mechanization, automation, intelligent systems and robotics.

The concept of a 'computer integrated manufacturing system' (CIMS) was put forward by US researchers in 1973. Chinese scientists embraced this idea and, by the late 1980s, had moulded it into a 'contemporary integrated manufacturing system.' This more modern version of CIMS uses information technology to optimize the management and operation of businesses, improving their efficiency and market competitiveness.

These developments have been recognized by the world's academics and China has won three major

prizes for its CIMS system from the American Manufacturing Engineer Society: Tsinghua University won the 'leading university award' in 1994, Beijing No.1 Machine Tool Factory won the 'leading factory award' in 1995, and Huazhong University of Science and Technology won the 'leading university award' in 1999.

Since 1987, CIMS has also been applied to hundreds of businesses in China, including enterprises engaged in aerospace, chemical manufacture, electronics, petroleum production and textiles. Many of these forward-thinking businesses have played leading roles in the modernization of Chinese manufacturing industries.

Chinese manufacturing has embraced advances in mechanisation, automation, intelligent systems and robotics.

EARTH AND ENVIRONMENTAL SCIENCES

Several research projects conducted under the Twelve-Year Plan and the country's sustainable development strategy have provided the scientific basis for the exploitation of natural resources and the protection of the environment. Among other projects, Chinese Earth scientists have studied the effects of the uplift of the Qinghai-Tibet plateau (1979) and calculated the rotation speed of the Earth's inner core (1995). Successful exploration and development projects have made great contributions to the exploitation of China's oil and gas fields and helped China avoid a potential crisis due to a lack of energy resources. More recently, geological and environmental research have contributed to the Yangtze River Three Gorges water conservation and hydroelectricity generating projects.

Alongside the application of Earth sciences for industrial development, in the 1950s China also began work on efforts to conserve soil and water resources in its largest river basins, to measure the history of climate change, and to forecast such natural hazards as earthquakes.

Of particular importance has been the reconstruction of the history of East Asian atmospheric circulation based on studies of dust accumulation in the Loess Plateau. This research has been critical for the recovery and management of the plateau's fragile ecosystem, and has provided input into efforts to prevent sand storms, water loss and soil erosion – all symptoms of desertification. Along with deep-sea sediments and polar ice cores, knowledge of the ancient history of the Chinese loess dusts is also one of the three pillars on which studies of global environmental change are based.

In the field of palaeontology, many important fossils have been discovered and studied. Ancient hominid fossils found in Zhoukoudian of Beijing Province, Lantian of Shaan'xi Province and Liyang and Yuanmou of Yunnan Province, for example, have provided important pieces of evidence for the understanding of human origins and evolution. Also, since 1987, many bird and animal fossils have been discovered in Liaoxi. Among them are fossils, aged between 80 and 150 million years, which have filled a gap in the knowledge of early birds – from the archaeopteryx, that appeared late in the Jurassic Period (208 to 144 million years ago) to those of the Cretaceous Period (144 to 65 million years ago) – a gap that had existed for more than 100 years. Thanks to these fossils, China

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has become centre of world research on the origin and evolution of prehistoric birds.

SPACE TECHNOLOGY

With the launch of the first Sputnik satellite by the Soviet Union in 1957, space science and technology became a reality. Satellite research and manufacture in China began soon after, and the first Chinese satellite was launched successfully in 1970. Since then, China has launched more than 40 satellites and has mastered the technology of launch-and-recover satellites, and satellites with geo-synchronous and sun-synchronous orbits.

From the late 1980s, China started using its launch-and-recover satellites as a research platform for micro-gravity research. In addition, a 'dropping tower' was constructed to serve as a more Earth-bound micro-gravity laboratory.

Today, China is implementing two main space programmes: the Double Star Programme and a manned spacecraft test programme. Together, it is hoped that these initiatives will propel Chinese space technology to a new stage.

The launch of the manned Shenzou 5 spacecraft is scheduled for later this year.

The Double Star Programme includes an equatorial satellite and a polar area satellite, both of which are located in the active region of the near-Earth magnetosphere – the Earth's magnetic environment in space. Together with four European Space Agency satellites, six-point triangulations in geospace can now be made for the first time. These hyper-accurate measurements assist research into the variations of the Earth's magnetosphere and the mechanism of storm events.

China's manned flight programme dates back to the early 1990s and, since 1999, four unmanned 'Shenzhou' series test spacecrafts been successfully launched. The payload of Shenzhou 4 included a 'simulation man' and 52 pieces of scientific monitoring equipment. Its success has advanced plans for the launch of the manned Shenzhou 5 spacecraft, which is scheduled for later this year.

INTERNATIONAL SCIENTIFIC EXCHANGE

Although China is still regarded as a developing country, its scientists have become an integral part in many of the world's mainstream science programmes. Chinese research establishments, too, are becoming increasingly involved in the international academic exchange environment.

Collaborative scientific research between Chinese scientists and international colleagues has expanded from dealings with some 30 countries in the 1950s to about 200 countries today. By 2000, there were nearly 20,000 cooperative projects being carried out with other countries, with the participation of approximately 50,000 Chinese scientists and 20,000 foreign scientists.

Among the collaborative research projects already underway are the Sino-European Double Star space programme mentioned above. In 2002, Chinese scientists also took the lead in establishing the International Digital Earth Association, which aims at producing high-resolution satellite maps of the entire globe.

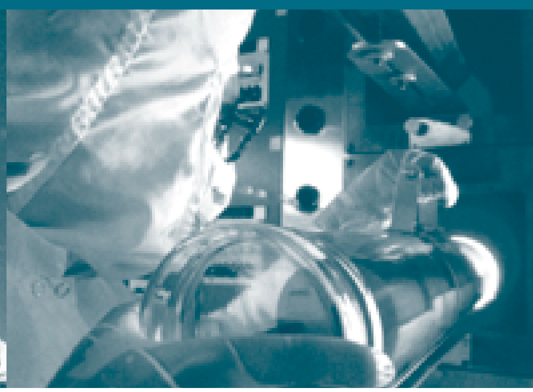
Many such cooperative projects have already produced remarkable results. For example, in 1983, Chinese scientists successfully manufactured a germanate bismuth crystal, which colleagues at the European Organization for Nuclear Research (CERN) used to make ultra-sensitive energy detecting devices. In 1997, China also supplied large-scale permanent magnets for an alpha magnetic spectrometer – used to detect dark matter and antimatter – that was launched on board the USA's *Discovery* space shuttle. Another collabora-

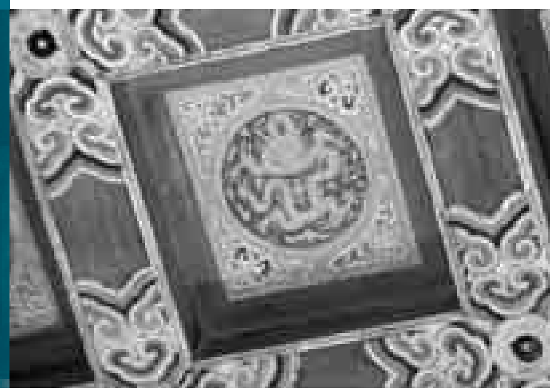
tion between Chinese and American scientists involved extracting nearly 20,000 ice cores from a glacier on the Qinghai-Tibet Plateau. These cores are now being used to diagnose environmental changes. More recently, also as mentioned above, Chinese scientists played a significant role in producing the draft sequence of the human genome.

International collaborative efforts specifically with other developing countries include the China and Brazil Earth Resource Satellite No.1 (CBERS-1). Jointly manufactured by these two nations, and including an array of sophisticated light and infrared sensors, the satellite was successfully launched in October 1999. The satellite is currently being used for investigating natural resources and environmental monitoring not only by China and Brazil, but also many other countries.

China shares many of the problems of other Third World countries. As a result, Chinese scientists have always sought South-South scientific cooperation. To improve friendship and to seek collaboration, Chinese scientists often visit countries of the Third World. Chinese scientists also try to use available South-South cooperation funds to support scientists from other Third World countries to participate in courses and workshops, and to attend international conferences.

Indeed, TWAS has played its part in enabling many of these exchange visits to take place. Of 900 awards under TWAS's South-South fellowship and associateship schemes, 85 have allowed Chinese scientists to travel to other developing countries, while 150 awards have permitted scientists from other countries in the South to come and work in Chinese laboratories.





SCIENCE EDUCATION

China's support for high-quality science education has helped narrow the technology gap between itself and the world's more advanced countries. Now, several million scientifically trained personnel have made contributions to their country's economic and social development. In addition to the many technicians and support staff, lecturers and researchers, several outstanding scientists have made world renowned scientific and technical contributions. Chen Ning Yang and Tsung-Dao Lee, for example – who together won the Nobel Prize for physics in 1957 for their "investigation of the so-called parity laws which led to important discoveries regarding the elementary particles" – obtained their higher education in their native China.

Despite these successes, science education in modern China is facing severe challenges. The Chinese government is aware that, for sustainable development to continue at pace, there is a critical need for more scientific and technological innovation. It is therefore making efforts to promote scientific creativity through a series of educational reforms. Research-oriented universities and research institutions engaged in high-level academic research are recognized as the cradle for fostering innovative talents, and China is now undertaking to combine the two related disciplines of

[CONTINUED PAGE 28]

teaching and research. Science education is also being expanded to include the history of science, the philosophy of science, sociology and social science to help students obtain a more all-around and balanced view.

CONCLUSION

The 20th century witnessed extraordinary advances in scientific and technological developments, and we continue to confront a rising tide of innovation in this new century.

However, during the 20th century, the people of the Third World suffered from their lack of science and technology capacity. Indeed, differences in the level of science and technology capacity represent one of the major factors deepening the divide between the 'poor South' and the 'rich North'.

Now, more than ever before, in this age of globalization and the knowledge economy, prosperity for Third World countries depends on science and technology. Many countries, however, lack the ability and expertise to achieve such development on their own. Scientific exchange and cooperation between Third World countries, therefore, has a special significance – a situation that makes TWAS's efforts so vital.

In this age of globalization, prosperity for Third World countries depends on science and technology.

Collaboration is also important as many scientific issues transcend national boundaries. Problems such as combating desertification, the exploitation of underground and deep-sea resources, the exploration of outer space, the construction of the information superhighway, and the analysis of the human genome sequence, to mention just a few, cannot be solved by any one country acting alone. Cooperation between countries is necessary – in fact, it is vital. The international exchange of science and technology is especially important for Third World countries. TWAS, and other like-minded institutions, act as important bridges linking scientists from developing countries.

Let us scientists of the world, therefore, commit ourselves to building TWAS into an irreplaceable bridge promoting North-South and South-South cooperation and exchanges. Only by working together can we create a brighter future for human kind. ■

Yongxiang Lu
President
Chinese Academy of Sciences
Beijing, China

DIVIDE NO MORE

THE 'DIGITAL DIVIDE' IS PERHAPS THE MOST WELL-KNOWN OF ALL THE DIVIDES BETWEEN THE NORTH AND SOUTH. YET THIS GAP IN ACCESS TO INFORMATION TECHNOLOGIES IS REALLY PART OF THE SCIENCE AND TECHNOLOGY DIVIDE.

In the 1960s, the scientific and engineering community began to conceive and create new information and communication technologies (ICTs), largely drawing on advances in the emerging field of computer science. One of their main objectives was to facilitate the exchange of data between scientists. The new network proved so successful that, in the early 1990s, this technological revolution entered the public domain. The internet, or world wide web, had been born.

In less than a decade, the internet has revolutionized the way people communicate – and, in the process, changed the way we live. Governments, businesses, international and nongovernmental organizations – not to mention individuals – all quickly incorporated internet technologies into a broad range of their day-to-day activities. Considering how widespread internet usage has become, we often forget that the technology was not a part of our lives until the early 1990s. Today we can't live without it; ten years ago, most of us did not even know it existed.

Among the many benefits of the internet are increased communication, more efficient management, and easy access to information. In effect, the world has become a smaller place. This trend has opened new, and still unknown, perspectives in almost all areas of human activities, including politics, economics, science, technology, education, arts and culture. The world, in short, is being transformed into a global village.

This communications revolution differs from previous technological advances, though. The decentralized open architecture and the creation of networks without geographical boundaries permit the transfer of all types of information across the globe within seconds, making current ICTs some of the main engines behind the process of globalization.

INTERNET BOOM

Since the home computing and internet boom of the mid 1990s, the number of people connected to the world wide web has virtually doubled every year. In 1999, for example, an estimated 150 million people were 'connected', a figure that grew to more than 600 million, or nearly 10 percent of the world's population, by 2002. However, as would be expected, there are many more internet users in North America and

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Europe compared to Africa, Latin America and the Middle East (see figure, page 33). In fact, 72 percent of internet users live in the world's high-income countries, the populations of which account for just 14 percent of the global population.

Hundreds of millions of people from developing countries, meanwhile, remain excluded from the 'information society.' The 'digital divide', therefore, is very much a part of the science and technology gap that exists between developed and developing countries. Indeed the digital divide is both a reflection of the science and technology divide and a primary source of its continuing existence. In this age of high technology, it is sobering to think that 80 percent of the world's population has never even heard a dial-tone.

However, there are signs that, as the market in the developed countries begins to reach saturation, countries in the South are beginning to catch up. In 1998, for example, South America accounted for just 3 percent of global internet users, a figure that increased to 5.5 percent by 2002. In China, it is estimated that 20 percent of the country's 1.3 billion people are on-line, and in South Korea there are more internet users per person than in the USA.

Naturally, many more people in the urban areas of developing countries are connected to the internet compared to rural areas and, indeed, universities and research institutes were among the first internet users in the South. A TWAS survey, conducted this year, focused on almost 400 scientific institutions in developing countries and found that more than 70 percent now have their own website.

This high rate of internet connection allows scientists in developing countries access to information that would previously only have been available in obscure publications or from expensive scientific journals – even if this access is often slowed by narrow bandwidths and poor telecommunication infrastructures.

In 1999, an estimated 150 million people had internet access, a figure that grew to more than 600 million by 2002.

WORLD SUMMIT

As UN Secretary-General Kofi Annan has noted: "Timely access to news and information can promote trade, employment, healthcare and education. The openness that is another of the hallmarks of the information society is a crucial ingredient of democracy, good governance and accountability."

The digital divide, however, continues to impede the work of Third World science, business and government. Though many individuals, organizations and institutions might be connected to the internet, the speed and reliability of the connections is often poor and software packages are frequently out of date and incompatible with more modern versions used elsewhere.

As a first step to reducing the digital divide, the International Telecommunications Union (ITU), the UN agency responsible for examining global communications issues, is hosting the World Summit on the Information Society (WSIS). The event will take place in two phases at two separate locations. The first phase will be held from 10 - 12 December 2003 in Geneva, Switzerland, and the second from 16 - 18 November 2005, in Tunis, Tunisia.

The objective of WSIS is to provide an opportunity for a wide range of stakeholders to develop a better understanding of the infor-

mation revolution, to examine its impact on the international community, and to lay foundations for global rules regarding its future use.

Among the anticipated outcomes of the WSIS will be the recognition of the central role of science in the information society, as well as the need for universal and equitable access to scientific knowledge. WSIS will also recognize the central role of universities and research institutions in knowledge production and dissemination, and the need for developing innovative technologies and training protocols as integral parts of the information society.

Regional preparatory conferences have already been convened, giving stakeholders the opportunity to formulate the WSIS agenda. Thus far, discussions have centred on a range of issues, including the role of governments in providing access to the new information technologies, capacity building and obstacles to infrastructure development, and the need to address issues related to cultural identity and linguistic diversity in this new information age.

In addition to its involvement in preparing the Draft Declaration of Principles and Draft Plan of Action for the WSIS, TWAS and its partners (ICTP, ICSU, UNESCO and CERN) are also involved in organizing a discussion meeting – 'The Role of Science in the Information Society' – in Geneva on the 8-9 December, immediately before the WSIS Geneva conference.

The meeting, which takes advantage of CERN's Geneva location, will examine how science has laid the foundations of today's information society and the role that science will continue to play in the future. Parallel sessions will examine the potential contributions of science to information and communication issues, focusing on economic development, education, environmental stewardship, healthcare and enabling technologies. The conference's conclusions will be discussed at a UNESCO roundtable on science to be staged during the WSIS itself. (See rsis.web.cern.ch *for further details).*

TWAS'S ROLE

TWAS and WSIS have complementary mandates: To address the enormous gap in scientific research capacity and to promote the diffusion of technology between countries in the North and the South. Therefore it should come as no surprise that TWAS has become fully engaged in WSIS's preliminary discussions.

Through the TWAS / ISTS (Initiative on Science and Technology for Sustainability) Project, the Academy has also been involved in the organization of symposia, roundtables and public awareness events that have taken – and will take – place before and during the actual summits in Geneva and Tunis.

Last year, for example, the International Centre for Theoretical Physics (ICTP) and TWAS hosted a roundtable discussion in Trieste that produced a set of recommendations in the critical areas of infrastructure (including connecting research establishments to the internet), content (including reducing barriers to scientific literature), and licensing arrangements (including access to copyrighted material). The goal of these recommendations is to make full use of the potential of digital communications for bridging the scientific divide. A follow-up roundtable – Developing Countries' Access to Scientific Knowledge: Quantifying the Digital Divide – will also be held in Trieste, in October 2003 (see *www.ejds.org/meeting2003*).

In May 2002, TWAS, together with ICTP, the European Organization for Nuclear Research (CERN), the International Council for Science (ICSU) and the United Nations Educational, Scientific and Cultural Organization (UNESCO), agreed a set of specific proposals for the Draft Declaration of Principles and Draft Action Plan that were jointly submitted to the WSIS secretariat.

These proposals place science and the interests of the scientific community firmly at the centre of the WSIS debate, and contain details of how decisions made at WSIS, and their implementation, can help build scientific capacity in developing countries, promote sustainable development, and expand the information society to include the people of the South – all with the purpose of reducing the digital divide.

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RECOMMENDATIONS

The general background to the Draft Declaration of Principles and Draft Action Plan, as compiled by TWAS and its partners, affirms that:

- The digital world offers novel opportunities for involving scientists in developing countries in global scientific endeavours, but only if basic ICT tools are placed at their disposal. The good news is that many of these tools are now more affordable and accessible.
- Existing systems for the publication and dissemination of scientific information do not provide sufficient access to knowledge originating from many developing countries. Steps must be taken to close this South-North information divide.
- While scientific data and information from one country may or may not be relevant to another country's needs, all countries must be able to develop and communicate their own knowledge.
- To reduce inequalities in access to information, and to achieve sustainable development, science and technology need to play a fundamental role that will maximize the possibilities and benefits of ICTs in basic and applied research, agriculture, education, health, economic development and government.
- Ensuring equitable access to scientific knowledge and to software tools for analysing and disseminating this information is essential, as is making available networking infrastructure, information-processing equipment, software and training that is affordable to universities and research institutions worldwide.

OPEN ACCESS

Digital technologies have already altered conventional ways of creating and disseminating scientific data. This, in turn, has strengthened the trend towards the increasing privatization of knowledge and the predominance of corporate interests over the general interests of societies.

This process not only affects the development and diffusion of science everywhere, but hinders the potential of science and technology to address basic human needs and sustainable development problems in the developing world. TWAS, CERN, ICSU, ICTP and UNESCO, therefore, have proposed that the following actions be included in the WSIS Draft Declaration of Principles and Draft Plan of Action:

- Any legal regime on database protection should guarantee full and open access to data created with public funding.
- Scientific knowledge should be recognized as a public good, and scientific data and information should be made as widely available and affordable as possible.
- Restrictions on proprietary data should be avoided to maximize its availability for academic research and teaching.
- Provisions should be made in all countries for long-term support for the systematic and efficient collection, preservation and provision of essential digital data, related, for example, to population trends and climate change.
- Funding should be made available to enable all universities worldwide to gain access to the internet by 2005.
- Development and deployment of open-source (i.e. non-proprietary) software should be encouraged.
- Electronic publishing and affordable pricing schemes that make scientific information accessible and affordable in all countries should be promoted.
- Initiatives to increase scientific literacy and consumer awareness of how to select and interpret scientific information published on the world wide web should be encouraged.

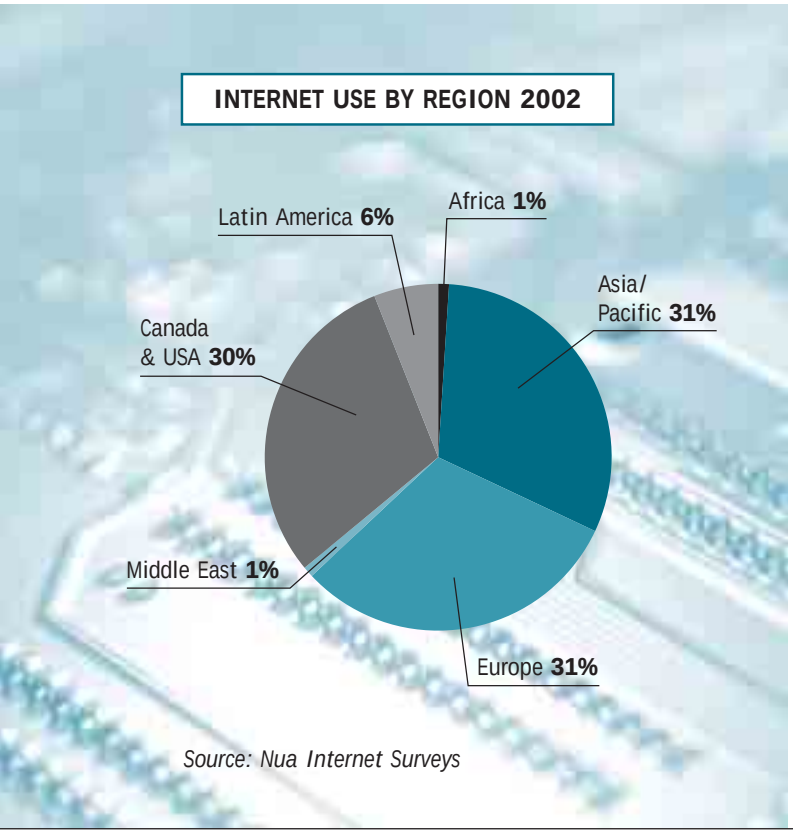
FUTURE FORWARD

Despite the broad-ranging issues raised during the run up to the WSIS, a host of critical questions remain unaddressed.

Who, for example, should have responsibility for cataloguing information that belongs to everyone? Will scientists in developing countries be able to send and receive information and get easy and affordable access to scientific publications? After years of rhetorical debate on science and technology transfer, are governments and businesses ready to provide the incentives and investments to tackle these essential needs?

There is also uncertainty over the very nature of science and how it will be produced and disseminated in the future. In 2001, for example, TWAS and ICTP launched their eJournals Delivery Service (see *www.ejds.org*), which permits scientists in the South to receive up-to-date scientific publications by email from a growing list of publishers, including Academic Press, Elsevier, World Scientific Publishing Co., the American Physical Society and the Optical Society of America.

As the internet dramatically reduces the cost of disseminating published information, other services offering free or reduced cost access to scientific publications are also becoming available. Are we, therefore, heading towards new systems of journal distribution organized by scientific societies and not by publishers?



Source: Nua Internet Surveys

One example is the new Public Library of Science project launched with funding from the Gordon and Betty Moore Foundation, the Irving A. Hansen Memorial Foundation and the Howard Hughes Medical Institute. This nonprofit scientific publishing venture aims to provide scientists with high-quality, high-profile journals in which to publish their work, and makes the full contents freely available on the internet (see *www.publiclibraryofscience.org*). Another example is the Directory of Open Access Journals hosted by Lund University, Sweden (see *www.doaj.org*).

The WSIS alone will not solve the digital divide. There are many critical negotiations (starting with World Trade Organization's (WTO) Doha Development Round of negotiations launched in 2001) and national and international policies and actions (good governance, increased aid and investment, and science and technology creation among many others) that must be implemented at all levels if the summit's objectives are to be attained.

But this year's WSIS meeting in Geneva – and the follow-up in Tunis in 2005 – can outline guiding principles on these issues. WSIS will not produce an international treaty containing binding obligations, but it will likely develop a high-level political agreement expressing the common will of the international community. The scientific community is eager to contribute with resources and ideas and is looking forward to a successful World Summit on the Information Society. ■

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For further information on the World Summit on the Information Society, see www.wsis.org.

AFRICA'S SCIENCE STATESMAN

THE THIRD WORLD ACADEMY OF SCIENCES IS MOURNING THE LOSS OF ONE OF ITS FOUNDING FELLOWS. LAST MAY, THOMAS R. ODHIAMBO, BORN IN MOMBASA, KENYA, IN 1931, DIED AT AGE 72. PERHAPS MORE THAN ANYONE ELSE, ODHIAMBO HELPED RAISE THE PROFILE OF SCIENCE IN AFRICA.

Among the anecdotes that surround the life of Thomas Odhiambo, one says he was born holding a small microscope in his left hand. As a young boy, he became fascinated by wasps, spending hours observing their intricate behaviours. Even from an early age, Odhiambo had a well-developed sense of curiosity about the natural world. He wanted to know how things worked, what made things tick, and what effects small changes could have on large, complex systems.

This was equally true not only of the insects he studied, but also of scientific institutions and the scientific infrastructure of Africa as a whole.

Odhiambo, the son of a telegraph clerk, was educated by missionaries and, by his own admission, the *Encyclopaedia Britannica*. After graduating from Makere University College, Uganda, he went on to serve in Uganda's Ministry of Agriculture for several years before heading to Cambridge University, UK, to study entomology. In 1965, he graduated with a PhD in insect physiology and, a year later, while still at Cambridge, he obtained an MA in natural science.

With his qualifications in hand, he returned to his native Kenya and took up a position teaching zoology at the University of Nairobi. Shortly afterwards, in 1967, he published a landmark paper in the prestigious *Science* journal ("East Africa: Science for Development," *Science*, vol. 158, page 876). In the article, he argued that Africa had to embrace the scientific method to develop its own capabilities, and not just 'buy into' technology developed in the North. He also called for the establishment of scientific 'centres of excellence' in Africa that would help nurture and develop not only the continent's young scientists, but also its scientific capacity.

Just three years later, these ideas came together in perhaps Odhiambo's most high-profile achievement, the establishment of the International Centre of Insect Physiology and Ecology (ICIPE).

Founded in 1970 the ICIPE was Odhiambo's response to what he was seeing in Kenya's agricultural fields. Poor farmers were being forced into debt by being persuaded to buy insecticides from Europe and elsewhere. However, by killing beneficial insects along with the target pest species, these insecticides often had adverse effects and pest populations would soon bounce back to problematic levels.

"At that time, there was no knowledge of how to control, on a sustainable basis, the major tropical pests," Odhiambo said in a 1988 interview for the *TWAS Newsletter*. ICIPE's initial focus, therefore, was to study and improve local farmers' traditional methods of pest control. These practices were then refined into low-cost technologies that could easily be adopted by African farmers.

Hard work and quality science soon brought Odhiambo's reputation to the world stage but, even when accepting the many prestigious honours that had been awarded to him, he never forgot the relevance of his work at grassroots levels.

During his acceptance speech for the first Africa Prize for Leadership for the Sustainable End of Hunger, presented to him in 1987, for example, he said: "The link between research and the farmer is vital. Only when new technologies for sustainable agricultural production

are adopted by the resource-poor farming households in the continent will the action affirm that the research and development effort has been worthwhile."

With over 350 staff from more than 20 countries, ICIPE has developed into one of the internationally recognized centres of excellence that Odhiambo had said were required in Africa.

Indeed, ICIPE scientists are currently collaborating with over 80 institutions and governments from around the world. Its major research areas include the mosquito vectors of malaria, the tsetse fly vectors of sleeping sickness and various livestock diseases, and pests of crops such as bananas, cowpeas and sorghum. Thanks to Odhiambo's vision of 'holistic' science, ICIPE scientists are also carrying out research into beneficial insects such as the natural predators of pest species, pollinating bees and silkworm moths.

After 26 years as director, Odhiambo relinquished his leadership of ICIPE in 1993. Part of the reason was that, having achieved what he could for the practice of science in Africa, he was now focusing his efforts on science policy.

In 1983 he became one of the 'founding fathers' of TWAS, serving as vice-president until his death. He was also instrumental in founding the African Academy of Sciences (AAS) in 1995. As the AAS's first president, Odhiambo dedicated his efforts to identifying Africa's scientific talent, and helped increase membership from the initial 32 fellows to over 130. He was tireless in promoting the potential of this talent for assisting national development programmes.

"We want to send a message to the scientific community that they have to pick up their courage, state what they can do, and start doing it so that people can see that scientists can make a difference to the national development plan," he said.

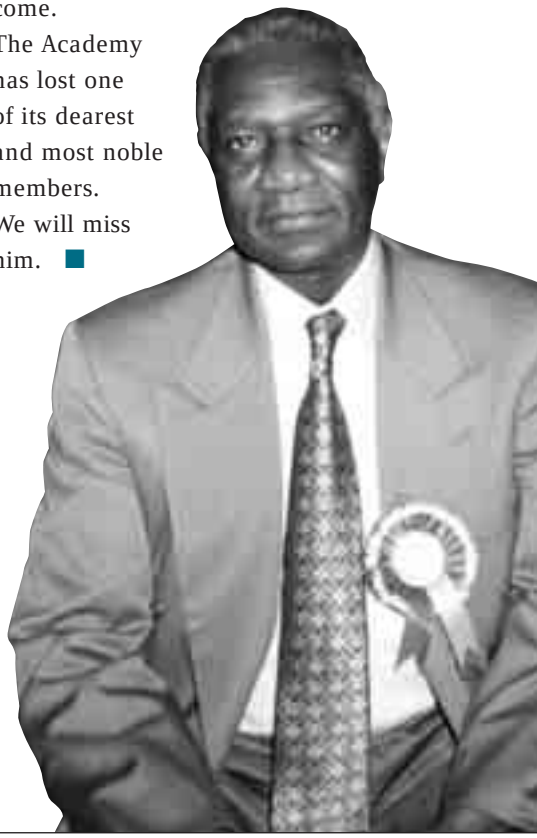
But promoting the role of science in national development is a two-way street – and Odhiambo recognized the importance of also getting his message to the politicians.

In 1993, Odhiambo convened a meeting of stakeholders of the Research and Development Forum for Science-led Development in Africa (RANDFORUM). According to Odhiambo, this meeting in Botswana was a breakthrough that enabled participants to discuss how Africa, by using science and technology, could escape from further economic marginalization. Heads of four African countries, as well as three former leaders, attended a presidential forum, arranged for immediately after the RANDFORUM meeting, to discuss scientific issues with the continent's leading researchers. Since then, the RANDFORUM has met twice more, and later this year, will meet again in Nigeria. Via the RANDFORUM, Odhiambo managed to get his message – that science and technology form the foundation stones of economic development – across to the highest echelons of power on the African continent.

Even while dealing with heads of state, however, Odhiambo was remembering his childhood curiosity and working out ways to stimulate similar feelings in today's children. In fact, he became chairman of the of the Council for the Promotion of Children's Science Publication promoting the development and delivery of scientific publications designed for children in Africa. Odhiambo himself wrote six science books for children.

These six books, together with his more than 130 research papers and monographs, are Odhiambo's written legacy. But the research and policy organizations that he was instrumental in establishing represent his most enduring contribution to science and society, and will continue to be felt by all the people of the African continent for decades to come.

The Academy has lost one of its dearest and most noble members. We will miss him. ■



WHAT'S TWAS?

The Third World Academy of Sciences (TWAS) is an autonomous international organization that promotes scientific capacity and excellence in the South. Founded in 1983 by a group of eminent scientists under the leadership of the late Nobel Laureate Abdus Salam of Pakistan, TWAS was officially launched in Trieste, Italy, in 1985, by the Secretary General of the United Nations.

TWAS has more than 660 members from 76 countries, 62 of which are developing countries. A Council of 14 members is responsible for supervising all Academy affairs. It is assisted in the administration and coordination of programmes by a small secretariat of 9 persons, headed by the Executive Director. The secretariat is located on the premises of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. UNESCO is responsible for the administration of TWAS funds and staff. A major portion of TWAS funding is provided by the Ministry of Foreign Affairs of Italy.

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 scholarship.

TWAS was instrumental in the establishment in 1988 of the Third World Network of Scientific Organizations (TWNSO), a non-governmental alliance of more than 150 scientific organizations from Third World countries, whose goal is to assist in building political and scientific leadership for science-based economic development in the South and to promote sustainable development through broad-based partnerships in science and technology. ···⁘ **www.twnso.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 2000 women scientists from 87 Third World 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 85 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**

WANT TO KNOW MORE?

TWAS offers scientists in the Third World a variety of grants and fellowships. To find out more about these opportunities, check out the TWAS web-pages! Our main page is at:
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/Fellowships.html
www.twas.org/AssocRules.html

GRANTS

Seeking funding for your research project? Take a look at the TWAS Research Grants:
www.twas.org/RG_form.html
TWNSO runs a similar scheme, for projects carried out in collaboration with institutions in other countries in the South:
www.twnso.org/TWNSO_RG.html

EQUIPMENT

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

TRAVEL

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

CONFERENCES

You're organizing a scientific conference and would like to involve young scientists from the region? You may find what you are looking for here:
www.twas.org/SM_form.html