4

YEAR 2001
OCT-DEC
VOL.13 NO.4

TWAS newsletter

THE NEWSLETTER OF THE THIRD WORLD ACADEMY OF SCIENCES

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

What Can We Do?

On the morning of September 11th, I was watching CNN in a hotel room overlooking the Copacabana in Rio de Janeiro, Brazil, when the drumbeat of ordinary news was interrupted by a news bulletin announcing that an airplane had struck the north tower of the World Trade Centre in Manhattan. Along with millions of viewers worldwide, I was wondering what could have caused such a terrible accident. Even the newscaster speaking from CNN headquarters in the United States was perplexed.

Twenty minutes later, a second plane flashed across the screen and smacked into the south tower. What I and others had believed (perhaps hoped is a more accurate description) to be a tragic accident was transformed unmistakably into a deliberate act of terrorism right before our eyes.

I left Rio that evening to return to India, where I learned that my wife's nephew, an Indian national working in New York, had been killed in the attack.

As the scenes of fire and smoke and chaos and heroism have slowly faded from our television screens and into our memories, an increasing number of articles in newspapers and magazines have discussed at length what should be done to prevent such horrific episodes from recurring. These discussions have focused primarily on issues related to politics, diplomacy and economics.

All of these issues, without doubt, deserve the attention that they have received. We are, after all, facing an international crisis fuelled by a complex set of volatile conditions. The terrorist attacks were indeed a surprise but the factors that led to such desperate and violent behaviour have been simmering for some time.

Despite the endless stream of newspaper and magazine articles, television reports and documentaries, speeches, lectures and street talk, it is somewhat surprising that so little attention has been paid to the role that science – and, more generally, science education – could play in defusing the forces that have led to this unsettling moment in our history. Even articles in Nature *and* Science*, published in the aftermath of the 11 September attacks, have focused on such near-term issues as the disruptions that this tragic event caused in North-South and South-South scientific exchanges. Questions related to more general concerns dealing with the relationship between science and society as keys for trying to understand what happened and*

[CONTINUED PAGE 3]

CONTENTS

TWAS NEWSLETTER

PUBLISHED QUARTERLY WITH THE SUPPORT OF THE KUWAIT FOUNDATION FOR THE ADVANCEMENT OF SCIENCES (KFAS) BY THE THIRD WORLD ACADEMY OF SCIENCES (TWAS)

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why – and what can be done to prevent it from happening again – have been largely ignored.

I would prefer not to interpret the terrorist attacks as a problem related solely to the Islamic world. I am convinced that whenever and wherever fundamentalism dominates, blind faith clouds objective and rational thinking. When such forces take hold, they create a mindset that allows people to do unusual – indeed sometimes unspeakable – things.

That's where science – and more generally scientific education – come into play. My point is that fundamentalism separates science from society and that the big loser in this dynamic is always the society in which the separation takes place.

That is because science is an international enterprise. As a result, gifted individuals, who are also the beneficiaries of a little luck and generosity, often can find their way to other societies where they have an excellent chance of succeeding. Moreover, as the late Abdus Salam, Nobel Laureate and the driving force behind the founding of the Third World Academy of Sciences (TWAS), often stated, "science is the heritage of all humankind." While this overriding principle carries enormous benefits, it also means that if one country or culture foregoes its involvement in the pursuit of science, others that embrace science enthusiastically are likely to continue to partake of the benefits derived from such pursuits to advance their own well-being.

Some of the news stories have emphasized that the Islamic world led the world in science at the turn of the first millennium. The names of al-Khowarizmi (780-850), whose name has been commemorated by the mathematical term "algorithm;" Ibn-Sina (980-1037), the renowned medical doctor and researcher who is known in the West as Avicenna; and Omar Khayyam (1048-1122), an incomparable mathematician and poet, to name just a few, are all testimony to this fact.

But the sad truth is that, in today's world, too many Islamic countries have sometimes forsaken their interest in science and, in fact, have allowed fundamentalists to hijack a good portion of their educational system in general. In the process, governments have failed to provide a nurturing environment for their young people, leaving it to others to shape the minds and values of their most prized resource.

How can any society or culture function in our world in the absence of scientific knowledge? More importantly, how can any society or culture confront the social, economic and, yes, ethical challenges that it faces at the dawn of the third millennium if science is viewed as a foreign pursuit antithetical to its values?

The adverse impact of the absence of science on a society's material well-being is obvious. What is equally important to observe is the impact that the absence of science has on a society's and a culture's thought process. It is my firm belief that the absence of science – and scientific education – leave a void in analytical thinking that is often filled with

[CONTINUED PAGE 4]

parochial and antihuman sentiments that can (when mixed with other factors) ultimately drive fundamentalists to ram airplanes into buildings.

A scientific temperament – marked by analytical reasoning, a willingness to test one's principles and viewpoints, and an openness to change one's opinions and beliefs if the facts and circumstances suggest that such changes are warranted – are crucial for the well-being of all societies and cultures. Every individual benefits from being exposed to and challenged by scientific principles and training. And every society benefits from having a scientifically literate population.

As a result, it is essential that governments throughout the world invest in science education – most importantly, in primary schools – not because it is necessary for large numbers of young people to become scientists, but because all people must understand and appreciate science if a society is to function well. It's a mind set, not technical skills, that should be our goal.

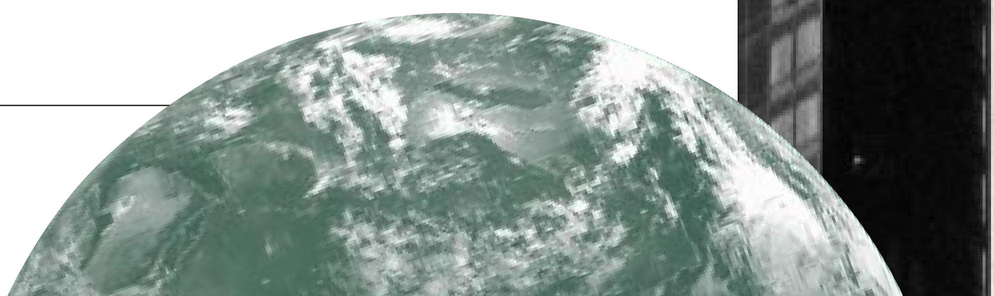
Put another way that may be more appropriate for the tenor of the times, all nations must develop and fund a broad, scientifically based curriculum if the world is to overcome narrow ideologies and prejudices that tend to impair a society's and culture's analytical abilities and understanding. Such efforts, on a global scale, would benefit not just the Islamic world, where so much attention is now focused, but the non-Islamic world as well. After all, prejudice and small-mindedness are as much a global phenomenon as scientific and rational thinking. No country, no culture, is immune from either.

It is my fervent hope that some good may emerge from the evil that has taken place. We must rid the world of terrorism. Of that there is no doubt. But we must also seek to use the broad-based international effort that has been mounted against terrorism to foster better understanding and harmony among countries in both the North and South.

One of the primary roles of TWAS, indeed a central part of its mandate, has been to promote science and technology in the developing world. Much of the Academy's effort has focused on the need to help individual scientists and to build the capacity of scientific institutions.

TWAS is proud of its accomplishments in both of these areas. Yet recent events indicate that we must do more: Scientists, particularly scientists from the South, now have an obligation to speak about science not only in terms of our membership and disciplines but in terms of the larger society and culture in which we live and work. We must give greater attention to the role of scientific education in nurturing the principles and beliefs of our citizens. At the same time, we must talk about science not just as a tool for social and economic development but as a bulwark against fundamentalist thought, which can, against all logic and reason, fuel irrational and violent behaviour capable of undermining the stability and harmony that all fair-minded, clear-thinking people seek.

C.N.R. Rao
President
Third World Academy of Sciences



11 SEPTEMBER: ISLAM AND SCIENCE

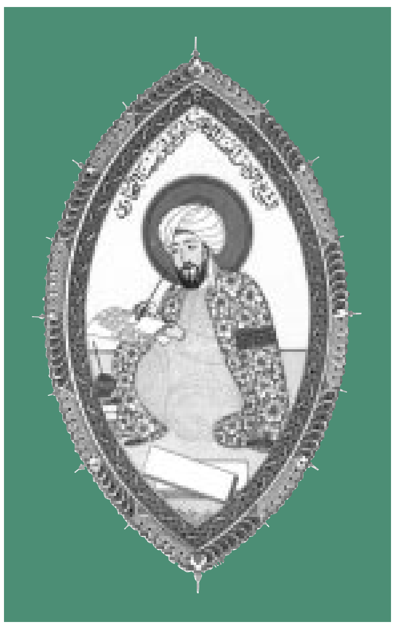
ISLAM AND TERRORISM

In the aftermath of the terrorist attacks of 11 September, we have read much about the linkage between Islam and terrorism.

Some observers relate this linkage to a belief that conversion to Islam was enforced by the sword. Indeed, the sword was a tool when Islam was first introduced in the 7th century to tribes of Arabia who fashioned gods from clay and worshipped them. These tribes vehemently fought the idea of one, unseen God. Mohamed and his early followers resorted to the sword to spread the word of God among idolaters. It was then that the word "*jihad*" was used to mean "campaign for the sake of God."

After Islam took hold in Arabia, the faithful began looking outward, first toward Persia. But instead of sending an army, a letter was carried to the Persian king to explain the message of God. This was in keeping with a verse in the Quran that instructs: "If conversion can be done peacefully, that is better." Furthermore, the Quran declared that "people are equal, like the teeth of a comb; there is no difference between an Arab or a Persian except in piety."

Upon Mohamed's death in 632, Islamic conquests carried the religion westward to the Atlantic. In these lands, most people were



Christians and Jews. The Quran distinguishes them as "People of the Book," those who believe in the one God and abide by a divine message. To Muslims, Abraham, Moses, Jesus and Mohamed are all equal messengers of God. That is why Christianity and Judaism continued to flourish in Egypt and the Levant, among other places. Forced conversion of the "People of the Book" is strictly forbidden. A verse in the Quran states, unequivocally: "Let there be no compulsion in religion."

Evidence of this tolerance abounds in the history of Islamic civilization from the 8th through the 15th century. Islamic rulers respected their subjects of many cultures, regardless of race or religion. The general entrusted by the ruling Fatimids to invade Egypt and build Cairo in 969 was a Christian from Sicily (Jawhar Al Siqilli). Also, one of the greatest Jewish scholars and philosophers of all time, Maimonides (Mousa bin Maimon), thrived under Muslim rule in Spain and later became a leading physician in the court of Saladin in Cairo.

Rulers of Islamic civilization encouraged learning and investigation of the universe. The first word in the Quran is: "Read," because,

[CONTINUED PAGE 6]

Farouk El-Baz

"in everything you learn there are signs of the Creator." During 800 years of prosperity, the Islamic state thrived on ideas – while others feared them. Islamic civilization was the first to "globalize" knowledge, innovation, security and commerce. Muslim scholars kept knowledge alive and passed it on to others, making today's global civilization possible.

Islam is a religion of tolerance, not terror. The word "Islam" means submission to God. Every chapter (*sura*) in the Quran begins: "In the name of God the most compassionate and most merciful." Islam cannot be blamed as the root of intolerant acts by Muslims in a given place or time. Those who falsely claim to act in Islam's name, while preaching or practicing violence, are to blame.

Fanaticism, aggression, or terrorism in Islam, in the past or the present, are aberrations that occur in any religion or culture. Such aberrations usually surface at times of economic hardship. Today's fundamentalists preach that "living by the book" would distribute a country's wealth more equitable and that all would be well. This is a social not a religious phenomenon.

IMPACT ON SCIENCE

The social roots of the fundamentalist challenge are tied to chronic economic depression in most Islamic countries. The slow pace of economic development, in turn, is due to inadequate education and training and insufficient emphasis on science and technology. These conditions are partly the result of limited North/South cooperation in scientific initiatives and technological developments.

During the past few decades countries of the North began to realize the importance of assisting

those in the South. Such efforts, however, were not part of collective ventures with specific goals and timetables. Apart from aid that was directed toward furthering the goals of a donor country, these efforts represented the initiatives of interested scientists usually assisted by concerned international organizations.

The attacks of 11 September have halted most of these enterprises. They have clearly discouraged the forging of research partnerships between the North and South in general and in Islamic countries in particular. Scientists of the North have preferred to pursue research initiatives designed to be conducted either locally or jointly with colleagues in countries of the North.

If this trend continues, it would eliminate many of the venues of North/South cooperation in science and technology in the Islamic world. This would further aggravate the social ills that led to the terrorist attacks in the first place. It is important to recognize this fact if the situation is to be remedied in a timely manner.

What is needed at this time is a thoughtful analysis of the recent history of North/South cooperation in science and technology – what has worked and what has not. The approach of the North to

"help" the South, financially or otherwise, has proved to be marginally beneficial. Transfer of technology while withholding "know how" produces temporary benefits that usually end in disappointment.

Cooperative projects of everlasting benefit are ones that approach the activity as mutually beneficial. There are great scientific minds in the South; some scientists, in fact, are more innovative than their counterparts in the North, having learnt to make do with very little. As a result, international scientific cooperation can benefit scientists of the North as much as those in the South.

International professional organizations, moreover, have a significant role to play. These organizations can educate their membership to the value of cooperative research with colleagues in the South and they can raise more funds to finance joint research projects. The role of academies of science and technology is just as important on both fronts.

The burden does not fall on the shoulders of countries of the North alone. Islamic countries have an equal share of the responsibility.

First, it is imperative for Islamic countries to counter the misunderstanding that Islam is in conflict with science and technology advancements. As stated above, the Islamic state of the past emphasized science and technology transfer and innovation.

Second, the South in general, and Islamic countries in particular, must counter the misconception that "Western science" is alien to their culture. Science knows no boundaries and scientific discoveries help all humanity. There is nothing in scientific inquiry that should be feared. On the contrary, it should be nurtured and supported.

Third, Islamic countries should do a better job of integrating modern science and technology into everyday life. For instance, developments in information technology are rapidly changing the developed world. Islamic countries should not be left behind in this field. Efforts should be made in these countries to catch up with the rest of the world.

It is clear that the road to successful North/South cooperation in science and technology is long, hard and complicated. The events of 11 September have the potential of making it impassable. However, this road has been partly paved by thoughtful endeavours of scientists and organizations in the past. With additional sincere and concrete effort it can provide great benefits to all those who have the foresight and courage to travel it.

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S&T IN PAKISTAN: THE WAY FORWARD

PAKISTAN'S MINISTER OF SCIENCE AND TECHNOLOGY HOPES THAT HIS NATION'S GROWING INVESTMENTS IN SCIENCE AND TECHNOLOGY WILL SOON PAY ECONOMIC AND SOCIAL DIVIDENDS.

Much of the news coverage on Pakistan since the terrorist attacks in New York and Washington, D.C., in September, has focused on political and military affairs. Yet, there is another side to recent developments in Pakistan, agreeably less dramatic than the war-related events, that have understandably received scant media attention. These developments, nevertheless, promise not only to challenge long-standing aspects of Pakistani society but also to alter outside perceptions of a nation that for too long has suffered from anemic economic growth which has bred discontent and despair among its people.

This hidden revolution – based on economic growth fueled by scientific and technology know-how – has been led by Atta-ur-Rahman (TWAS Fellow 1985), who was appointed Pakistan's Minister of Science and Technology in 2000. Over the past two years, he has spearheaded a drive within his own government that has increased funding for the ministry by more than 5000 percent and spurred a dramatic transformation in priorities and goals. What follows is an outline of the principles that have guided his reforms and a discussion of the steps that his ministry has taken since his appointment to place science front-and-centre in Pakistan's overall strategies for economic growth.

Atta-ur-Rahman's efforts have taken on added significance since the events of 11 September 2001, not only for Pakistan but for the rest of the world. At the same time, his ideas and policy proposals offer an important counterpoint to the prevailing image of Pakistan found in newspapers and television programmes throughout the North.

Stunning advances in many fields of science and technology have had a profound impact on almost every sphere of human activity, including health, agriculture, communication and transportation – never more so than in the past few decades. These advances have been propelled by an ever-increasing succession of dis-

coveries largely emanating from universities and laboratories in the North. Such discoveries have often been transformed into new products or processes – in technology centres and state-of-the-art manufacturing plants also largely in the North.

Such breakthroughs have flooded world markets with an astounding array of new goods and services that have showered vast economic rewards on those nations with the courage and vision to make science and technology the anchors of their economic development programmes.

The days when a nation could depend on agricultural produce or low-value textiles and leather products for economic growth are long gone. It is only the world's poorest and most backward countries that are barely sustained by such low value-added produce.

The days when a nation could depend on agricultural produce or textiles for economic growth are long gone.

Let's illustrate this by taking the example of a European country at an average state of economic well-being, say Austria. Austria's population of 8 million people is about equal to the population of the city of Lahore in Pakistan. However, the gross domestic product (GDP) of Austria exceeds US$200 billion, more than three times that of the whole of Pakistan. If you divide the GDP of Austria by its population, it comes to about US$25,000. That's the sum every child, man and woman in Austria contributes to its GDP. A similar situation exists in most European countries.

In developing countries, this figure is only a few hundred dollars. For example, in Pakistan, with 140 million people, the per-capita GDP stands at US$470. Austria is 14th on the World Bank's international ranking of national economies. Pakistan is 160th.

Something has gone deeply wrong somewhere. A child born and bred in Europe is no more intelligent than a child born and bred in Africa or Asia. Why, then, is the GDP so low in the Afro-Asian world?

S&T'S MAGIC

Several factors must come into play before the magic of science and technology begins to hold. Sri Lanka, for instance, has a high literacy rate but it is not a developed country. Thus literacy alone is not the answer. The Soviet Union, conversely, during the mid 20th century, developed a worldclass science and technology infrastructure. Yet it collapsed largely for economic reasons. Thus scientific and technological know-how alone is not the answer either. The Soviet Union could launch a man into space and build a nuclear arsenal but it could not manufacture reliable automobiles, televisions, household appliances, phar-

[CONTINUED PAGE 10]

maceuticals or industrial machinery comparable in quality to those made in the West.

The lesson that these experiences teach us is this: Not only is it important to produce products and services of high quality but it is especially important to have aggressive innovation and marketing strategies that can capture world markets and bring in foreign wealth.

This is the arena in which the United States has excelled. No other country transforms good ideas into marketable goods and services so quickly and efficiently. The driving force behind this process has been a remarkable national system for innovation marked by wise long-term investments, fast-footed venture capital schemes and a patenting system that protects the ideas of investors.

The world today is sharply divided by a "technology boundary" that separates technologically advanced countries from technologically backward countries. The former have relied on scientists and engineers for rapid economic growth while so-called "developing countries" (many of which in reality are not "developing" at all) have been relegated to the role of consumers of technological products, almost totally dependant on advanced countries for most of their needs, including pharmaceuticals, chemicals, transportation and even national defence.

WHAT IT TAKES

Development is a multifaceted process and several factors must dovetail before sustained economic growth can take place.

In my view five key components must come together. First, the development process must rest on a high degree of literacy and quality education at all levels. Afro-Asian countries have vast populations. The challenge is to transform this irreplaceable resource into real wealth. To unleash the creativity of our people, we must expose our youth to a challenging educational environment that teaches them to think and find novel solutions to difficult problems.

At present our students are trained to memorize and reproduce facts in examinations often without coming to grips with fundamental principles and their applications to real-life challenges. The ability to train and then retain good teachers is the key to forging this transformation in learning. If we can lure our brightest graduates into the teaching profession by enticing them with attractive salaries and good working conditions, we will have taken a giant step forward.

The second important component for development is high level expertise in the sciences. We need to upgrade our universities and research centres to international levels of excellence through the development

and retention of world-class researchers and provisions for state-of-the-art research facilities that serve as focal points for the creation of new knowledge.

Basic and applied research go hand-in-hand. Developing countries must not ignore one at the expense of the other. For technology development to take hold, we must have a minimum number of trained engineers and scientists within our borders. Yet such skilled personnel is largely missing from Afro-Asian countries. This requisite manpower must be developed with a sense of urgency if we are to succeed because only when developing countries have high-quality basic and applied research taking place at the frontiers of knowledge will we be able to embrace cutting-edge technologies and adapt them for our own use.

The third important component of success focuses on the need to put applied research directly to work on development issues. Nations that are committed to science-based development must identify and launch projects that are designed to (1) enhance exports, (2) improve the quality and productivity of existing manufactured products, and (3) nurture new and better products by supporting the creative talents of technologists and engineers. This is a complex process that requires continual interaction among policy makers, scientists, technologists and economists. Such interaction is a critical prerequisite for developing and optimizing production processes on a reasonably large and economically viable scale.

Only developing countries with high-quality basic and applied research will be able to embrace cutting-edge technologies.

The fourth component of science-based development involves government policies and mechanisms that encourage sustained investments in the activities of entrepreneurs who are engaged in promoting the development of indigenous products and processes. Such mechanisms include enactment of tax incentives, ready access to risk capital by venture capitalists, protection of intellectual property rights, rationalization of import duty structures, banning of smuggling to protect local industries, and bolstering of investor confidence through stable long-term monetary and fiscal policies.

The fifth and most important component of success calls for strategies that encourage a country's most creative scientific and technological citizens to become involved in economic development issues of prime national importance. Success on this front entails the adoption of measures to attract the brightest students to pursue careers in science and technology. That means creating attractive job opportunities, on the one hand, and developing research and development centres of international excellence, on the other. Research grants must also be made available to meritorious scientists to enable them to make meaningful contributions both to their nations and the global scientific community. In other words, governments must build tough but transparent systems of accountability and rewards for their scientists, technologists and entrepreneurs.

INFORMATION PLEASE

The past five years have witnessed unprecedented advances in the field of information technology. In

[CONTINUED PAGE 12]

1994, a few hundred thousand pages could be found on the internet; today, there are about 2.5 billion web pages and more than 7 million new pages are added each day. An endless stream of innovations in computing hardware and software, microelectronics and optoelectronics have led to the rapid processing and distribution of vast amounts of information.

Breakthroughs in microprocessor technologies have allowed computing powers to double every 18 months and Gilders law now predicts the doubling of communication power every six months due to discoveries and applications in fiber optic technologies. At the same time, we are witnessing huge reductions in bandwidth costs accompanied by tremendous increases in carrying capacities and speed. Emailing a 40-page document from Pakistan to the United States costs less than PKR5 (Pakistan rupees) while faxing or sending it by courier costs between PKR500 and PKR1000. At current exchange rates, there are about PKR60 to US$1.

Geographic distances are increasingly losing their significance. Many companies headquartered in the United States and/or Europe now find it profitable to outsource segments of their information technology operations to developing countries that possess educated and skilled workers. Some 400 million people currently log on to the internet. That figure is expected to increase five-fold over the next 3 years. Economists project that information and communication technologies will grow from a US$2.2 trillion industry in 1999 to more than a US$3 trillion industry by 2003. Such growth is likely to provide large numbers of job opportunities for service providers in developing countries with educated and well-trained workers.

Internet access now takes place largely through computers, but access via wireless technologies, including mobile phones, is fast becoming the technology of choice. Indeed, by 2005, access via wireless devices is expected to outstrip access via personal computers. Such a development will allow both people and businesses in developing countries to browse internet-based information at a low cost. Business-to-consumer e-commerce on a global scale totalled US$25 billion in 1999; by 2004, it is expected to grow to US$230 billion. Meanwhile, by 2003, business-to-business e-commerce will become a US$5 to US$10 trillion enterprise.

Information technology is often defined solely as software development. Yet, in reality, it represents a technology that is transforming the entire industrial sector, because in this day and age it has become an all-pervasive force. A recent report by the U.S. Department of Trade and Commerce concludes that about 50 percent of the acceleration in growth of the U.S. economy during the economic boom of the 1990s was due to the integration of information technology in industry, which dramatically improved efficiency and productivity.

The government has been seeking to place Pakistan on a fast track for the development of home-grown information technologies.

IN PAKISTAN

For the past two years, the government of Pakistan has been seeking to place the nation on a fast track for the development of home-grown information technology capabilities. A multi-facet strategy has been adopted to overcome Pakistan's long-standing deficiencies in high-tech human resources and infrastructure. The government, for example, has initiated short- and long-term training programmes for both scientists and technicians, established several information technology universities and institutes, and strengthened existing computer science departments at public sector institutions.

Since 2000, training programmes, attended by more than 15,000 government employees have advanced, for example, the computer skills of medical and legal transcriptionists and data-entry operators. The initiative has not been confined to such major cities as Karachi, Lahore, and Islamabad. Computer science departments have been strengthened at such far-flung and less developed areas as Khuzdar, Nawabshah, Khanpur, Jamshoro, and Bahawalpur. The availability of trained medical transcriptionists, in turn, has sparked the development of a large number

of medical transcription companies in diverse regions of the country, illustrating that if requisite human skills are available, investment and economic activity will follow.

By offering short training courses in computer programming languages like JAVA, XML, and C++, the government hopes to successfully retrain unemployed graduates in science, medicine and engineering in fields related to information technology. This effort represents the first step in a process that is expected to lead to other training courses. The goal is to provide large numbers of educated but unemployed Pakistanis with the skills that they need to pursue potentially fruitful job opportunities in alternative fields.

While the government has created several new information technology campuses, its strategy has focused on developing such institutes within existing universities and centres to save both time and money.

For example, an information technology institute was launched within Abbottabad University this autumn. Plans call for it to be upgraded to a full-fledged university at a later date. Similarly, information technology institutes are being developed at existing universities in Lahore and Karachi, again with the intent of establishing independent universities later on. The most exciting education programme, however, may be the launching of a "Virtual IT University," a distance learning university that is designed to train tens of thousands of professionals across the country via the production and broadcast of high quality television programmes.

Under the Universal Internet Access programme, internet access has been expanded from 29 cities in August 2000, to 540 towns, cities and villages today. Plans are now underway to extend internet access to more than 600 localities by June 2002, which will mean that 90 percent of the population will have easy access to the internet. Pakistan, moreover, now has a nationwide fiber optic infrastructure in place, and we are in the process of putting this infrastructure to work. One example: Fiber optic accessibility has been extended from 100 to 200 cities over the past year.

[CONTINUED PAGE 14]

Fiber optic rings, moreover, are being laid around Pakistan's major cities and towns to provide high speed internet access on demand to key businesses and educational institutions. The "last mile" high speed internet challenge is being addressed through use of DSL and ADSL technologies that will generate a 200-fold increase in the speed of transmission on existing copper lines.

A major programme has been launched to promote e-commerce in Pakistan. The State Bank of Pakistan now allows merchants to establish internet accounts. Meanwhile, both the National Bank of Pakistan and Habib Bank of Pakistan have established one-year deadlines for making e-commerce the normal method of economic transactions. E-commerce draft statutes, which have been prepared by the Ministry of Science and Technology and placed on the web for comments, will soon be submitted to the cabinet for approval. A project for electronic governance, which includes a programme for the training of government officials and computerization of government databases, has also been initiated.

Based on international market trends and Pakistan's labour skills, we plan to focus additional attention and resource on such areas as the establishment of call centres for credit card companies, the creation of medical and legal transcription services, and the development of software engineering firms. The estimated value of the global information technology market currently stands at US$560 billion: US$400 billion in services and US$160 billion in software development and distribution. By offering services that match the current skills of our workforce, we believe we can secure and retain an increasing level of this lucrative market. At the same time, our own in-house studies suggest that software development in Pakistan is likely to require 4 or 5 years to take off. Only then will the recently launched computer science institutes in the nation's universities and research centres have graduated a sufficient number of students with relevant skills.

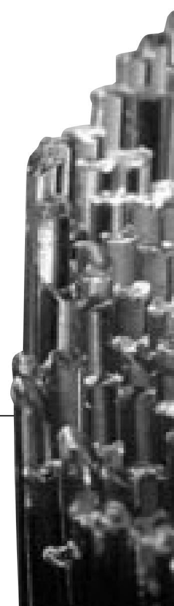
In 2001, Pakistan's government budgeted US$83 million for the Ministry of Science and Technology – a 5000-percent increase.

As a result of these initiatives, in the next 12 months alone Pakistan expects investments in the information and telecommunication sectors within the nation to exceed US$1 billion. A revolution is in the offing. However, such progress is only a beginning. We all know that we still have a long, long way to go.

I have unwavering confidence in the creativity of our youth, however. If the Ministry of Science and Technology, with the help of other government agencies and the nation's emerging private sector industries, can facilitate and nurture an enabling environment, I am sure that Pakistan will emerge as a power to be reckoned with in the field of information technology within the next few years.

BEYOND INFORMATION

In 2001, the government of Pakistan budgeted more than PKR5 billion (US$83 million) for the Ministry of Science and Technology. That represented a 5000-per-



cent increase, setting the stage for a large number of important new initiatives. One of these initiatives relates to the upgrading of Ph.D.-level research in universities. Pakistan produces only 50 to 60 Ph.D.s in sciences each year. In contrast, India produces more than 5000 Ph.D.s. in sciences each year.

One new programme calls for an additional 300 students each year to be given an opportunity to earn a Ph.D. in science. Under this programme grants will be given to each research supervisor (based on the number of doctorate students under his or her supervision). The grant money may be used to fund scholarships as well as to purchase supplies and equipment. The ministry expects to spend PKR600 million (US$10 million) over the next 4 years on this programme.

Under another initiative, teachers/researchers will be sent abroad for Ph.D.-level training in critically important scientific fields for which there are not adequate facilities in Pakistan. To ensure that they are gainfully employed once their training is complete, their institutions will guarantee jobs for them upon their return. In addition, "starter grants" will be made available to ensure that these young Ph.D.s have adequate funds for equipment.

Schemes have also been launched for post-doctoral training in key scientific fields and for the training of technicians. Other projects include the provision of spare parts for scientific instruments, strengthening of polytechnic institutes in Pakistan, and programmes aimed at encouraging expatriate Pakistanis to return to Pakistan for varying periods to contribute to the development of our – and their – country.

One initiative that could have a far reaching impact on economic development in Pakistan is the Science and Technology for Economic Development (STED) programme, which seeks to foster joint projects between research institutions and private industries focusing on the application of existing technologies for agricultural and/or industrial development. Each project, funded at a level of PKR30 million (US$500,000), will concentrate on setting up pilot plant commercial production units designed to test the economic feasibility of the project for entrepreneurs. Several projects are expected to be launched over the next year in such fields as biotechnology, pharmaceuticals, information technology and energy. The ultimate goal is to foster the development of high value-added goods for export.

Atta-ur-Rahman

About 850 project proposals have been received following a nationwide announcement of the STED programme made last year. Each project must have an industrial partner and is therefore demand driven. After a process of peer review, a number of projects will be selected for funding and then launched.

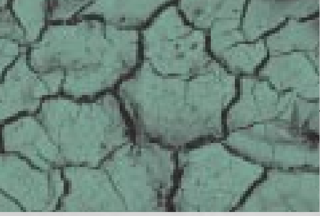
HIGH-TECH FUTURE

Pakistan's GDP stands at just US$60 billion. Production in low value-added goods in such sectors as agriculture, textiles and leather will not substantially improve the nation's overall economic well-being. To increase the GDP, Pakistan (like all developing countries) must develop its own high value-added technology-based sectors in such cutting-edge fields as information technology, pharmaceuticals and biochemicals.

The programmes and initiatives discussed throughout this article represent a turning point in the development of science and technology in Pakistan. At the very least, they should provide a much needed injection of funds and scientific expertise in our universities and research centres. Our fondest hope, however, is that the programmes will create an enduring foundation for a sustained science-based development effort that will ultimately break the cycle of poverty and hopelessness that has afflicted Pakistan for the past 50 years.

As recent events seem to indicate, the entire world has a stake in our efforts to achieve lasting success.

Atta-ur-Rahman
(TWAS Fellow 1985)
Federal Minister for Science and Technology
Islamabad, Pakistan



DRIP...DROP...DRY: A GLOBAL CONCERN

WATER RESOURCES WORLDWIDE ARE UNDER INCREASING STRESS. BUT CURRENT WATER-SAVING SOLUTIONS SUGGEST THAT THE FUTURE MAY NOT BE AS DRY AS WE THINK.

Clean drinking water is a birthright – as much a birthright as clean air. But many of the world's people – in fact, 1 billion of the 6 billion people on Earth – do not have access to clean drinking water. Another 1.5 billion people do not have access to adequate sanitation.

At the same time, water-borne diseases, usually the result of limited access to clean drinking water and the prevalence of poor sanitary conditions, are responsible for the death of more than 6 million children each year – that's about 16,000 children each day.

Water covers 70 percent of the globe's surface, but more than 95 percent of all water is saltwater. Freshwater, in fact, covers just 3 percent of the Earth and much of this water lies frozen in the Antarctica or Greenland's polar regions.

That leaves about 1 percent of the Earth's total water supply – located in rivers, lakes and underground aquifers – available for human consumption. Today nearly 30 countries, including China, India, Kenya, Ethiopia, Nigeria and Peru, which together are home to more than 2.5 billion people or 40 percent of the world's population, face chronic water problems. Many other nations, meanwhile, are likely to come up dry as global population continues to rise over the next quarter century reaching an estimated 8 billion people by 2025. In light of these trends, the world has no choice but to find new ways of saving, using and recycling water.

While the future may seem grim, several things can be done to stem the problem. The world has enough freshwater to meet its needs. In fact, there's plenty of freshwater in Latin America, the Caribbean, sub-Saharan Africa, Europe, and Central Asia. Moreover, it's important to note that some rich countries do not have much water at all, while some poor countries are blessed with a great deal of water, suggesting that the problem is indeed manageable. The Congo Republic, for example, has 290,000 cubic meters of water per capita and Papua New Guinea 170,000 cubic meters per capita. The United States, meanwhile, has 9,000 and Kuwait just 75 cubic meters of freshwater per capita.

Access to freshwater not only varies among nations but also within nations. In the water-rich Congo Republic, for instance, city and town villagers, who constitute 77 percent of the population, enjoy adequate access to safe drinking water, but only 17 percent of rural villagers do. The situation in the Congo stands in sharp contrast to the situation in the Lao People's Democratic Republic, where nearly all rural residents have access to safe drinking water while less than two-thirds of those in the capital city Vientiane do.

Clean drinking water is a birthright – as much a birthright as clean air.

Another part of the complex policy matrix involving freshwater is that consumption patterns vary from country to country. Among low-income countries, almost 90 percent of freshwater is devoted to agriculture, 8 percent to industry and 5 percent to households. In high-income countries, industry uses nearly 60 percent of the freshwater, agriculture 30 percent and households 11 percent.

Total freshwater withdrawals worldwide have doubled in the past 40 years largely due to rising global population and changing patterns of use. As a result, in parts of China, India, and the United States, water from groundwater aquifers is now being withdrawn faster than it is being replenished. Wasteful irrigation practices, moreover, degrade soil quality and curb farm productivity, threatening to undermine advances in agricultural productivity that have been the hallmark of the 'green revolution.' Meanwhile, growing population pressures in various parts of the world, particularly in developing countries, have exerted additional stress on existing water supplies. If, as expected, world population increases by 1.5 billion by 2025, the amount of freshwater available per person will drop from a global average of more than 8,000 cubic meters per year per person to about 5,000. That represents a 40-percent fall-off.

MEETING DEMAND

What can be done to meet growing freshwater demand? Experts propose a five-fold path to recovery:

- Seek new sources.
- Save and redistribute supplies.
- Reduce demand.
- Recycle.
- Make water supplies safe and potable.

Seek New Sources. Extraction of freshwater from saltwater is a time-honoured technique that can be made

[CONTINUED PAGE 18]

more efficient through greater use of new energy-efficient methods of desalinization. Earlier methods, based on evaporation and condensation of seawater, have proved too costly for wide-spread use. Reverse osmosis, an alternate technique, is cheaper and more energy efficient. In the latter technology, a thin, semi-permeable membrane is placed between a container of saltwater and a container of freshwater. Pressure applied to the saltwater container pushes water molecules into the freshwater container. The membrane allows water to pass while trapping salts and impurities. Development of sturdy, chemical-resistant membranes (thin, composite polyamide films), which have 10-year shelf lives, has made reverse osmosis an increasingly attractive and cost-effective technology for large-scale extraction of freshwater from the seas. Today less than 1 percent of the world's drinking water comes from the sea, but advances in reverse osmosis suggest that this percentage is likely to grow.

Freshwater withdrawals worldwide have doubled in the past 40 years, largely due to rising global population and changing patterns of use.

Save and Redistribute Supplies. The second path to saving and efficiently redistributing freshwater resources involves reaching those most in need of water in a waste-free and inexpensive manner. Such simple measures as plugging leaks in tankers, pipelines and taps could save a surprisingly large volume of water. Water expert Peter Gleick, president of the Pacific Institute, Oakland, California, USA, estimates that sealing the leaks in Mexico City's water system, which serves 17 million people, could save enough additional water to meet the needs of 3 million people. In many nations, more than 30 percent of the domestic water supply is lost because of leaky pipes, faulty equipment and badly maintained distribution systems. Repairing and upgrading these systems as well as making minor modifications in domestic water facilities (for example, installing low-volume flush toilets) could save substantial amounts of water. Meanwhile, harvesting rainwater in cisterns and catch basins, once a common practice among communities in developing countries, has declined because of overcrowding in tenement slums and apartment blocks. With the coming crunch in water supply, officials should seek to revive such simple time-tested methods of water collection.

Reduce Demand. In developing countries, agriculture on average accounts for 75 percent of total water use, while in developed countries, industry on average accounts for 60 percent of all water use. At the same

time, in countries throughout the North and South, domestic use accounts for less than 15 percent of total water use. These statistics indicate that individual and household water conservation measures alone will not ease water shortages. Real savings will be derived from conservation measures adopted by agriculture and industry. Newer, more efficient farm practices and manufacturing processes have been developed and put in place over the past 50 years. As a result, more steel can now be produced with less water and more rice can be grown with less irrigation. Additional improvements (for example, use of humidity-sensitive drip-water irrigation systems and the substitution of less water-intensive manufacturing processes) promise to allow water to be used even more efficiently in agriculture and manufacturing in the years ahead.

Recycle. Terrace farming, commonly practiced in hilly rural communities, is one of the oldest, simplest, yet most efficient, methods of water recycling ever devised. The concept is indeed straightforward: Water flowing from the terrace's upper levels runs downhill to irrigate plants grown on the terrace's lower levels. A diverse group of countries, including Israel, Namibia, India and Singapore, have developed extensive recycling programmes that extend far beyond terrace farming to even include the recycling and reprocessing of wastewater or sewerage. Such measures can help recharge aquifers, slow salinization and provide much-needed water resources both for farmland irrigation and the maintenance of wetlands and wildlife sanctuaries.

Make Water Safe and Potable. Each year contaminated water kills more people than cancer, AIDS, wars and accidents combined. As a result, every nation has a moral obligation to make access to clean water a priority for all its citizens. Yet, because more than 80 percent of the world's people come from developing countries, methods used to achieve this worthy goal must be both financially affordable and culturally acceptable – that is, strategies must meet the pocketbook needs and conform to the behavioural patterns of the people they are seeking to serve. Water management programmes fall into two broad categories: Those overseen by municipal authorities at central distribution points and those practiced by individual homes and families in dispersed decentralized settings. Chlorination is the most common and effective method for the purification of water.
Even among places troubled by poor sanitation and unhealthy hygienic conditions, chlorinated water dramatically reduces the incidence of water-borne dis-

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eases. The experience of the island-nation Maldives, whose territory is peppered across the Arabian Sea and Indian Ocean, offers a vivid example of the impact that chlorination can have on the safety of drinking water. Use of a solar water disinfection technique (SODIS), which relies on sunlight and plastic containers to kill water-contaminating pathogens, has helped make clean water available to nearly all of the nation's residents. And because there are more than a dozen methods available, families and communities can choose the technique most suitable to their circumstances.

Future efforts to provide safe drinking water to the world's growing population may prove more successful than recent reports forecast.

THE GOOD NEWS

Finding new sources of water is typically a large-scale exercise involving large sums of money. Such efforts, as a result, must be shouldered by national or even transnational institutions. Nevertheless, effective methods for bringing a healthy supply of clean water can also be advanced at the family and community level. Here are some "good news" examples of what is happening, both on a large- and small-scale, around the world.

Nepal has always had a water problem. People reside in far-flung isolated communities where rainfall is often restricted to just 3 months each year. The terrain and climate, moreover, make it unfeasible to supply water via pipelines. Consequently, the Nepalese have devised innovative micro-level methods to capture and harvest rainwater from rooftops, soak pits and ponds. Such community-based rainwater harvesting schemes, which local residents call *Baresiko Pani Thapne*, have not only eased water-shortage problems in an economically efficient manner, but have also empowered local residents through their direct participation in these projects.

Kenya has established a nationwide 'rainwater association.' In many communities, association-sponsored projects have enabled residents to harvest rainwater in large 200-litre drums for human and livestock consumption as well as small-scale vegetable and fruit cultivation. Water runoff associated with terraced agriculture, meanwhile, has helped increase the efficiency of water used in agriculture. These advances, which have been implemented during the past decade, have improved both agricultural productivity and living standards.

Singapore has developed what may be the world's most comprehensive strategy for capturing and channelling rainwater for human use. The multi-faceted initiative represents a simple, cost-effective and virtually permanent solution to a vital problem facing many cities. Each high-rise apartment building must have a rooftop water collection and recycling system. Educational institutions, meanwhile, are required to collect rooftop rain water and channel it to chambers for sedimentation and chlorination. Another huge catchment area is Changi Airport, where the runoff from runways and rooftops serves as an important source of water.

India, in the arid province of Rajasthan in the northeast corner of the country, has devised a successful plan for harvesting and distributing water to meet domestic and community farming needs. Nongovernmental agencies have recruited both school-age children and adults in some 150 rural schools and 50 community centres as a "water brigade" to help construct 200 underground tanks. The tanks, built by local masons and labourers with local materials, have provided jobs and training for 6000 people. Nearly 12 million litres of rainwater have been collected in the tanks over the past decade. Other initiatives in Rajasthan include the construction of check-dams and water-harvest structures, again using local money, expertise and labour. These efforts have helped raise the water levels in wells and turn seasonal rivulets and tributaries into perennial sources of water.

ACTION PLAN

Future efforts to provide safe drinking water to the world's growing population may prove more successful than recent reports forecast. No single policy is likely to solve the world's water crisis. Indeed each nation will need to pursue a suite of remedies requiring the active participation of federal, state and local governments, nongovernmental organizations, international aid agencies, private industry, and individual households.

D. Balasubramanian

Recent experience shows that the effort will not be easy but progress is possible by pursuing strategies based on a common set of straightforward principles that emphasize political commitment, coordination and cooperation; the strengthening of legal and regulatory frameworks; the encouragement of community-based solutions and local participation; improved access to appropriate technologies; and the promotion of public education programmes that highlight the benefits derived from conservation.

Such proverbs as "waste not, want not" and "little drops of water make the mighty ocean" reflect simple yet enduring truths. Water is in plentiful supply. We need to ensure that we do not waste water, but treat, purify and make it available in a fair and safe manner.

The task is doable thanks to nature's hydrological cycle. The Earth does not let a drop of water escape but wraps each drop tightly within and around itself. We who live on Earth and benefit from its enormous bounty should do the same. ■

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The above article is based on a report, Safe Drinking Water *(Trieste: TWAS, October 2001). For the complete text of the report, please contact* ***Sandra Ravalico****, TWAS Secretariat, phone: +39 040 2240 327, email: info@twas.org*

CLIMATE CHANGE SPARKS NEW TWAS PARTNERSHIP

TWAS HAS JOINED A HOST OF OTHER INTERNATIONAL ORGANIZATIONS TO BOOST THE INVOLVEMENT OF DEVELOPING WORLD SCIENTISTS IN ISSUES RELATED TO CLIMATE CHANGE. A BRIEF DESCRIPTION OF THE PLAYERS AND PURPOSE FOLLOWS.

With funding from the Global Environment Facility (GEF), the Global Change System for Analysis Research and Training programme (more commonly referred to as START), TWAS and the United Nations Environment Programme (UNEP) have launched a 4-year, US$7.5 million project that is designed to address a pair of critical issues related to global climate change.

First, project officials hope that the initiative will expand both the base and range of information on climate-change related subjects in the developing world. Second, they hope that the project will boost scientific capacity for addressing issues related to climate change – again in developing countries.

Like START itself, the project carries a long and complicated title: Assessments of Impacts and Adaptation to Climate Change in Multiple Regions and Sectors (AIACC). Yet, its goals are fairly simple and straightforward: to enable scientific communities in developing countries to develop the skills and tools that they need to confront one of the most critical environmental problems of the 21st century: the wide-ranging environmental and social impacts associated with climate change.

"Over the past decade," says Hassan Virji, START's deputy director, "reports issued by the Intergovernmental Panel on Climate Change (IPCC) have made it clear that developing countries, especially island countries and countries in low-lying coastal regions, are extremely vulnerable to the environmental risks posed by climate change."

"What has been made less clear in the assessments," Virji continues, "is the level of vulnerability that is likely to be experienced at both regional and local levels. In other words, when it comes to climate change impacts, we know that many developing countries face substantial risks, but we have yet to devise detailed assessments of those risks at the scales for which effective policies can be formulated. That is one of the crucial information gaps that this project hopes to fill."

Mohamed Hassan, TWAS's executive director, adds, "Many developing countries have yet to build the internal scientific and technical capacities either to assess or address the environmental and economic risks related to climate change. As a result, they have been forced to rely on Northern data and expertise. That is another gap we hope to fill through the successful implementation of this project."

The centerpiece of the initiative," notes Neil Leary, the project's science director, "will be a series of regional studies that will be researched and prepared by scientists from the developing world – specifically, Africa, Asia, Latin America and small island nations."

Last fall, project staff, with the assistance of a 16-member advisory committee and a panel of more than 80 expert peer-reviewers, agreed to fund 20 proposals from a pool of 140 submissions. Among those chosen were proposals to assess the potential impact of extreme weather events on water resources in Central America (University of Costa Rica); a plan to devise sustainable livelihood strategies for human adaptation to climate change in Sudan (Sudan Higher Council for

Environment and Natural Resources in collaboration with the Stockholm Environment Institute); and an effort to develop models for coastal vulnerability and adaptation in Pacific island countries (Pacific Centre for Environment and Sustainable Development, University of the South Pacific, Fiji). Each of the projects, which are expected to last three years, will receive about US$200,000 in funding.

To ensure that the studies are based on the most up-to-date information available, project participants will attend intensive workshops designed, for example, to enhance skills in investigating the impacts of climate change on physical and biological resources, understanding a community's and region's vulnerabilities to the climate-change phenomenon, and evaluating the potential effectiveness of proposed adaptive response measures. The workshops, by bringing participants together in one setting, will have the added benefit of providing a forum for the exchange of ideas and experiences.

"The UNEP secretariat in Nairobi, Kenya, will serve as the site of the all-participants 'kickoff' meeting in February," says Leary. "This will be followed by two workshops: the first examining 'climate scenarios' scheduled to take place at the Tyndall Centre for Climate Change Research in Norwich, UK, in April, and the second assessing 'climate change vulnerability and adaptation' scheduled to take place at the TWAS secretariat in Trieste, Italy, in June." In addition, regional workshops, intended to provide an opportunity for project participants to present their preliminary findings while their research is still in progress, are planned for 2003 and 2004.

"Climate change is one of the global communities' most compelling issues," observes Virji. "Yet virtually all of the research to enhance our understanding of this phenomenon, as well as the majority of the proposed strategies to mitigate its possible impacts, have taken place in the developed world. A major goal of this project is to redress some of the imbalances in research capacity and public policy that currently exist between the North and South."

"The degree of our success," Virji adds, "carries obvious importance for scientists and decision makers in the developing world. But I think it's also fair to say that the entire world has a stake in our efforts. That's because if the issues related to climate change are to be adequately addressed, we must mount a worldwide effort that is based on the most current scientific data and information and that relies on the most talented and well-trained scientists in both the South and North."

For additional information about the project,
contact ***Neil Leary*** *or* ***Sara Beresford***
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SUSTAINABILITY DRIVES TWAS WORKSHOP

TWAS HAS JOINED AN INTERNATIONAL INITIATIVE DESIGNED TO EXPLORE THE INTRICATE RELATIONSHIP BETWEEN SCIENCE, TECHNOLOGY AND SUSTAINABILITY.

How can science and technology be put to better use in promoting research and development that improves human health and well-being while protecting the earth's life-support systems?

That's the challenge to be addressed by an international initiative on science and technology for sustainability. While the secretariat is located at the Kennedy School of Government at Harvard University, the initiative, which recently received a US$1.4 million grant from the David and Lucile Packard Foundation, is directed by a steering committee of independent scholars, researchers and administrators from around the world (see box, "Steering a Course for Sustainability" for the complete list of committee members). TWAS has been asked to be a major partner in the initiative.

"The complex array of issues that we hope to explore," says director William C. Clark, Harvey Brooks Professor of International Science, Policy and Human Development at Harvard's Kennedy School of Government, "are nothing less than the core issues that the global community is expected to confront in the 21st century – peace, freedom, development and environment. This web of concerns has become even more compelling and intricate since the tragic events of 11 September."

A major step in this effort will take place in Trieste from 6 to 9 February when TWAS hosts an international workshop on Science, Technology and Sustainability: Harnessing Institutional Synergies.

"The ultimate goal of the project," explains Calestous Juma, Director of the Science, Technology and Innovation Program at Harvard's Kennedy School of Government and a critical player in the development of the initiative, "is to advance ongoing efforts to devise and implement knowledge-based strategies for enhancing the quality of life without placing the long-term health and vitality of the environment at risk." The roots of the initiative lie in the publication of a re-

TWAS Newsletter, Vol. 13 No. 4, Oct-Dec 2001

port by the U.S. National Academy of Science's (NAS) Board on Sustainable Development, *Our Common Journey: A Transition Toward Sustainability*, issued in 1999.

Following the publication of this report, similar ideas and concerns focusing broadly on the intricate relationship between science, technology, the environment and development have been articulated and refined at a series of high-profile events that included the Conference of the World Scientific Academies Transition to Sustainability in the 20th century, held in Japan in May 2000, and the Friibergh Workshop on Sustainability Science, held in Sweden in October 2000.

"At the heart of these events," says Clark, "has been a growing conviction among a broad range of researchers that the World Summit on Sustainable Development, scheduled for Johannesburg, South Africa, in August/September 2002, represents a unique opportunity to shape the relationship between environment and human development in the decade ahead and that the concepts and ideas that our group and other researchers have been recently exploring could have a significant impact on the conference's agenda and outcome."

The project will seek to transform the lofty vision of sustainability science into an effective programme for action. Proponents hope to advance the project's goals through the following strategic principles:

- Expand and deepen the research and development agenda for sustainability science and technology.
- Strengthen the infrastructure and capacity for conducting and applying science and technology to sustainability issues with a special focus on bridging the North-South divide.
- Connect science to policy more effectively than in the past by fostering closer cooperation between scientists and policy makers and improving the timeliness and application of international scientific assessments.

"TWAS is particularly pleased about the commitment to addressing the North-South divide," says Mohamed Hassan, the Academy's executive director. "The project will seek to advance this goal through broad-based geographical representation that sets the

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STEERING A COURSE FOR SUSTAINABILITY

The steering committee for the Initiative on Science and Technology for Sustainability includes a prominent list of scholars, researchers and administrators well versed in issues related to science, technology, environment and development. Robert Kates, former Director of the World Hunger Program at Brown University, USA and Akin Mabogunje, Director of the Development Policy Center, Nigeria, serve as Co-Conveners. The Steering Group consists of William Clark, Professor at Harvard University's Kennedy School of Government; Robert Corell, Senior Research Fellow at the American Meteorological Society and Harvard University; Nancy Dickson, Senior Research Associate at Harvard University's Kennedy School of Government; Robert Frosch, Senior Research Fellow at Harvard University; Gilberto Gallopín, Regional Advisor on Environmental Policies at the Economic Commission for Latin America and the Caribbean; Mohamed H.A. Hassan, Executive Director at the Third World Academy of Sciences; Jill Jäger, Executive Director of the International Human Dimensions Programme on Global Environmental Change; Narpat Jodha, Policy Analyst at the International Centre for Integrated Mountain Development; Calestous Juma, Director of the Science, Technology and Innovations Program, Harvard University; Louis Lebel, Science

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Coordinator for the Global Change System for Analysis, Research and Training's (START's) Southeast Asian Regional Committee and a faculty at Chiang Mai University; Jane Lubchenco, Professor of Zoology at Oregon State University and President of International Council for Science (ICSU); Pamela Matson, Professor of Geological and Environmental Sciences at Stanford University; James McCarthy, Professor at Harvard University; José Sarukhán, Special Advisor for Social Development to Mexico's president Vicente Fox; and Hans-Joachin Schellnhuber, Director of the Potsdam Institute for Climate Impact Research.

stage for the active participation of scientists and science administrators throughout the developing world." The upcoming Trieste workshop is designed to:

- Review current trends in the use of scientific and technological knowledge in promoting a transition to sustainability.
- Identify networks of actors and organizations playing critical roles in bridging gaps between science, technology and sustainable development.
- Showcase case studies in such fields as global change, energy, agriculture, forestry, fisheries and water management that may serve as models for facilitating the use of scientific and technological knowledge.
- Analyze the obstacles and opportunities facing efforts to improve the contributions of global research and development institutions toward a transition to sustainability.

As Clark notes, "The Trieste workshop will explore what can be done to encourage the building of institutional arrangements that seek to promote an exchange of information and ideas across disciplines, sectors, geography and timeframes." About 50 experts from around the world, many of whom rank among the most prominent practitioners in their fields, have agreed to participate. A follow-up workshop at Harvard University in April will explore how to address the challenges discussed in Trieste and outline priorities for institutional reform.

"With the Johannesburg conference some six months away," Clark notes, "we hope that the Trieste workshop will prove instrumental in helping to create a strategic roadmap for advancing the principles of sustainability that we all share."

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In Memoriam

ZAFAR H. ZAIDI

PAKISTAN'S ZAFAR H. ZAIDI (TWAS FELLOW 1990) POSSESSED A RARE COMBINATION OF SCIENTIFIC INTELLECT AND SOCIAL PURPOSE.

Born on 4 March 1939 in Bulandshahr, Uttar Pradesh, India, Zafar Zaidi accompanied his parents to newly created Pakistan in 1947, where he completed his primary and secondary education. He received a bachelor of science degree from Government College Hyderabad and a master's in science degree from the University of Sindh in 1963. He subsequently moved to the United Kingdom, where he obtained another master's degree – this time in chemistry – in 1965 and then a doctorate degree in protein chemistry in 1968, both from the University of Leeds.

Zafar H. Zaidi

With his doctorate in hand, he joined the Pakistan Council of Scientific and Industrial Research as a research officer in 1969. He assumed a faculty position at the newly created University of Karachi's Post Graduate Institute of Chemistry the following year, working with TWAS Founding Fellow Salimuzzaman Siddiqui. The institute later became the H.E.J. Research Institute of Chemistry.

Zaidi's research focused on the protein chemistry of such unusual yet valuable biochemical products as snake venom, avian hemoglobin and camel's milk. At the same time, he gathered around him a group of dedicated and distinguished researchers who helped put biochemistry on the scientific map in his home country and then guide the discipline into the international scientific arena. For example, he led the drive to construct the first protein chemistry laboratory in Pakistan.

By the late 1980s, Zaidi's protein research group was not only considered one of the finest in the Asian subcontinent but provided a training ground for many of Pakistan's brightest young chemists and biochemists. In fact, more than 25 scientists completed their Ph.D's under Zaidi's supervision. In addition to his research and teaching responsibilities, Zaidi was one of the institute's most active faculty members, organizing national and international conferences and serving as founding co-editor-in-chief of the *Journal of the Chemical Society of Pakistan* since its inaugural issue in 1979.

Zaidi was elected to TWAS in 1990. His decade of service to the Academy reflected the enthusiasm and dedication he displayed for every institution and activity in which he was involved. For example, he urged individual members of the Academy to contribute to the TWAS endowment campaign and then set the example by making the first personal contribution to the fund (a generous donation of US$500, which equalled one month of his annual salary). He also launched the TWAS spare parts programme that has proven so helpful to scientists in the poorest developing countries. And perhaps most importantly, he remained an active participant in TWAS's general meetings and conferences believing that a primary goal of the Academy was to nurture an environment where scientists from the developing countries could share their research findings and, yes, their camaraderie and friendship. He was always seeking ways to strengthen TWAS to ensure that the voice of its members was heard both within and outside the Academy's corridors.

Zaidi received many national and international awards and honours, including the Tamgha-e-Imtiaz

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and Sitara-e-Imtiaz prizes from the government of Pakistan in 1989 and again in 1998, and the Al-Kharizmi Award from the government of the Islamic Republic of Iran in 1992. He was elected vice chancellor of the largest academic institution of Pakistan, the University of Karachi, in 1997, where he rendered valuable administrative service and helped to establish new institutes in fields ranging from biotechnology to mass communications to computer science.

Beyond science, Zaidi was involved in a host of socially minded projects, including the creation of orphanages and the improvement of primary schools. He loved Urdu poetry and literature and other forms of art and music. He himself wrote many poems.

Zaidi was a humble, hard-working and honest individual. His life's work represents a portrait of a scientist with a sturdy and enduring moral character. He embraced the highest moral values both in his personal life and professional work and he sought to use science and the resources at his disposal for the benefit of the people of Pakistan and the developing world. He was both a proud Pakistani and an engaged global citizen committed to the common good of humankind. His death is a profound loss to the scientific community of Pakistan and the South. ■

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In Memoriam

XIE XIDE

XIE XIDE (TWAS FELLOW 1988) WAS BORN IN 1921 IN FUJIAN PROVINCE, CHINA – THE ONLY DAUGHTER OF XIE YUMING, A PIONEERING CHINESE PHYSICIST IN HIS OWN RIGHT.

Xie graduated from Xiamen University in 1946 and began her teaching career in physics at Hujiang University the same year. In 1947, she was admitted to a masters' degree programme in physics in Smith College, USA, and in 1949 to a doctorate programme at Massachusetts Institute of Technology (MIT), earning her degree in 1951. At the invitation of J.C. Slater, professor of physics at MIT, she became a postdoctoral fellow there concentrating on solid state and molecular physics research. Xie returned to Shanghai in 1952 to assume a teaching position in physics at Fudan University. Higher education was then in its early stages of development in Shanghai and the work environment was often plagued by poor facilities and a lack of books and journals. As a result, Xie wrote or edited her teaching material.

In addition to teaching, Xie assumed responsibility for two major projects: In 1955 she helped establish a solid state physics teaching and research group within Fudan University and in 1956 she helped launch a network of physics teachers and students in five Chinese universities specializing in semiconductor theoretical and experimental research. Xie also co-authored a monograph on semiconductor physics that served as a primer for many of China's young semiconductor researchers and technicians during the 1950s and 1960s. In 1962, Xie led another group of scientists that successfully pushed for the creation of a solid state research and training programme at Fudan University focusing on the study of paramagnetic resonance, semiconductor infrared spectrum, and optical as well as semiconducting properties under strong magnetic fields and low temperatures. Meanwhile, she wrote course texts and taught courses about semiconductors and group theory.

Xie Xide

During the same period, Xie was appointed deputy director of the newly created Shanghai Institute of Technical Physics, where she would remain until 1966 playing a key role in the institute's early development. She selected applied semiconductor technology as the core research activity and urged faculty to participate in the development of trial materials and devices to help boost Shanghai's fledgling semiconductor industry. Her guidance and strong will enabled the institute to emerge as one of China's leading research centres. Many students involved in the program back in the 1960s have since become the backbone not only of the institute but of Shanghai's semiconductor industry.

During the years of turmoil associated with China's Cultural Revolution, Xie, like her peers, found it difficult – indeed sometimes impossible – to continue her work. To make matters worse, she was stricken with cancer. Despite such professional and personal setbacks, she continued to purse her teaching and research goals with a single-mindedness and determination that was the hallmark of her entire career. In 1977 she submitted a proposal for developing a surface physics programme at Fudan University, which received favourable reviews from both the State Commission of Sciences and the Ministry of Education.

The result was the creation of a research institute specializing in surface physics, which Xie headed from 1978 to 1983. The institute has made significant contributions to our understanding of the electronic structures of both compound semiconductors and strained superlattices. It has also provided valuable theoretical insights into the behaviour of semiconductor surfaces, silicon/silicide and metal-semiconductor interfaces.

Xie, who served as vice-president of the Chinese Physical Society from 1978 to 1990 and as a member of the division of mathematics and physics of the Chinese Academy of Sciences from 1981 to 1996, received a dozen honorary doctorate degrees from universities in the United States, United Kingdom, Canada, Japan and Hong Kong. She was a fellow of the American Physics Society and served on the advisory or editorial boards of six international journals.

In addition to her research and professional accomplishments, Xie was an able administrator, serving as Fudan University's vice president from 1978 to 1983 and president from 1983 to 1988. Under her leadership, the university enjoyed unprecedented growth culminating in its listing as the nation's top-priority institution for development from 1985 to 1990. She helped to modernize Fudan University by advocating programmes in arts and sciences, management and economics. She also promoted continuing education, a concept alien to most institutions of higher education in China at the time. Finally, she placed great importance on the quality of both undergraduate and graduate teaching and called for more scholarly exchanges within China and abroad.

In fact, Xie directed Fudan University's Center for American Studies, working painstakingly for Sino-American greater cultural and scientific interactions and for mutual understanding and friendship between the two peoples. She received many foreign dignitaries, including French President D'Estaing and U.S. presidents Ronald Reagan and Bill Clinton.

Her extraordinary life will be honoured and celebrated for decades to come.

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PEOPLE, PLACES, EVENTS

ZEWAIL IN *NATURE*

• TWAS Fellow (1989) and Nobel Laureate (Chemistry 1999) **Ahmed Hassan Zewail** has published a "concepts" article, "The Fog that Was Not," in *Nature* (July 2001). In the article, Zewail contends that

Ahmed Hassan Zewail

the notion of coherence applies to the fast-moving microscopic worlds of molecules and subatomic particles. He says that such coherence, most visibly displayed on a localized scale, is accommodated by "two powerful and yet indigestible concepts: the uncertainty principle and the particle-wave duality of matter." He notes that: "As we cross the femtosecond barrier into the attosecond regime for studies of electronic dynamics, we must recall the vital role of coherence; otherwise the specter of quantum uncertainty might veil the path to new discoveries." Zewail, who received the Nobel Prize for the development of a laser technique capable of detecting the behaviour of atoms during a chemical reaction, is a professor at California Institute of Technology (USA). He was born in Egypt and educated at Alexandria University (Egypt) and the University of Pennsylvania (USA). Zewail was the first Arab and second Muslim scientist (Abdus Salam was the first) to win the Nobel Prize.

CHINA PRAISES TWAS

• An edition of China's *Peoples Daily* included a feature article on TWAS highlighting the close relationship between the Academy and scientific institutions throughout China. Drawing on a statement that he prepared for the TWAS endowment campaign brochure, President Jiang Zemin notes that TWAS has made important contributions to the development of science and technology in the developing world. He also expresses confidence that TWAS will continue to play a key role in advancing scientific research, the training of young scientists, and cooperation among universities and research centres throughout the South. Seventy-two Chinese scientists have been elected members of TWAS and 16 Chinese scientists have won TWAS basic science awards. Lu Yongxiang, president of the Chinese Academy of Sciences, currently serves as a vice president of TWAS. China will host the 8th General Meeting of TWAS, scheduled to take place 15–21 October 2003. The meeting will also mark TWAS's 20th anniversary. For a full text of the article, "Jiang Zemin Writes Paean for Third World Academy of Sciences," *Peoples Daily*, see http://english.peopledaily.com.cn/200105/23/eng20010523_70771.html.

CHINESE ACADEMY TWAS WEBSITE

• The Chinese Academy of Sciences has announced the launching of a website featuring information about the TWAS Chinese Chapter. The site, which includes text copies of the TWAS Beijing Office newsletters, as well as general information about the activities of TWAS members and staff at the Chinese Academy of Sciences, can be found at www.twas.org.cn.

ACCESS IN AFRICA

• The International Network for the Availability of Scientific Publications (INASP) has announced the completion of the first phase of the Programme for the Enhancement of Research Information (PERI), which seeks to provide wider access to scientific and scholarly information to researchers in developing and transitional countries. Researchers in Ghana, Tanzania and Uganda are now invited to access current awareness databases, full-text online journals and document delivery free of charge. Developed with support such development programmes as the Danish International Development Assistance Agency (Dainda) and the Department for Research Cooperation of the Swedish International Development Cooperation Agency (Sida-SAREC), the programme pro-

vides access to more than 5000 full-text journals in science, technology, medicine, social sciences and the humanities. For additional information, contact Carol Priestly, (INASP),

inasp@ gn.apc.org or visit the website at http://www.inasp.info/peri/.

HASSAN ELECTED

• **Mohamed H.A. Hassan**, TWAS executive director, has recently been elected a corresponding member of the *Academié Royale des Sciences d'Outre-Mer*, Belgium, and a foreign member of the Pakistan Academy of Sciences. Hassan, who received a bachelor of science degree in mathematics from Newcastle University, UK, a master's degree in advanced mathematics and a doctorate in plasma physics from Oxford University, has been with TWAS since its inception in 1983.

Mohamed H.A. Hassan

During TWAS's formative years, Hassan worked closely with the Academy's founding president, the late Nobel Laureate Abdus Salam. Since 1988, Hassan also has served as secretary general of the Third Network of Scientific Organizations (TWNSO) and since 1999 as the president of the African Academy of Sciences. He is a fellow of the Islamic Academy of Sciences and an honorary member of the Columbia Academy of Sciences. His major fields of interest are theoretical plasma physics and the physics of wind erosion and sand transport.

OPEC FUND

• The OPEC Fund for International Development has approved a US$100,000 grant in support of TWAS's Associate Membership Scheme at Centres of Excellence in the South. The scheme, which was launched in 1994 to promote South-South cooperation, has since grown from 16 to 88 participating centres, making it one of the most successful initiatives of its kind. Scientists selected to participate in the programme are entitled to visit a participating centre twice over a two-year period for two to three months each time. During their stays, they may pursue their own research interests and/or collaborate with the centre's research teams. The appointment is renewable for an additional three-year period. This marks the third time that the OPEC Fund for International Development has awarded a grant to TWAS. In 1988, the OPEC Fund supported a wind and sand transport laboratory in Sudan and in 1992 it helped finance an exchange programme for scientists and researchers. For additional information about the Associate Membership Scheme at Centres of Excellence in the South, please visit http://www.twas.org.

EYE IN THE SKY

• The India Institute of Astrophysics in Bangalore has announced that the Hanle Observatory on Mount Saraswati, located in the Changthang region of Jammu and Kashmir State near the border with China, is now operational. The facility, resting on a vast mountain plain some 4500 metres above sea level, is the world's highest astronomy observatory. Its US$8 million telescope, with a mirror more than 2 metres in diameter, is the most sophisticated sky-gazing tool in Asia. The telescope has been nicknamed "Chandra" in honour of Indian-born astrophysicist and Nobel Laureate, the late Subrahmanyan Chandrashekhar (TWAS Associate Founding

Fellow). For additional information about the Hanle Observatory and Chandra, see http://www.iiap.enet.in/iao/iao.html.

ENDOWMENTS IN INDIA

The Indian Institute of Chemical Engineers has created several new endowments, including 14 Chemcon Distinguished Speaker Awards, four of which will carry the names of TWAS Fellows: C.N.R. Rao (Founding Fellow and President), M.M. Sharma (1990), L.K. Doraiswamy (1997), and R.A. Mashelkar (1993). The endowments, derived from private sources, will fund some 40 national awards, prizes and lectures for the promotion of chemical engineering in India. For more information, contact G.D. Yagdav, President, India Institute of Chemical Engineers, yadgav@mailhost.egr.msu.edu.

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.

At present, TWAS has 583 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 154 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.

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 the research efforts and training opportunities of women scientists in the Third World and to strengthen their role in the decision-making and development processes. The secretariat of TWOWS is currently hosted and assisted by TWAS.

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 82 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.

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 TWAS Fellowships: .../Fellowships.html

GRANTS

Need funding for your research project? Take a look at the TWAS Research Grants: .../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

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: .../SP_form.html

TRAVEL

Would you like to invite an eminent scholar to your institution, but need funding for his/her travel? Examine these pages, then:
.../Lect_form.html
.../Prof.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: .../SM_form.html