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TWAS newsletter

THE NEWSLETTER OF THE THIRD WORLD ACADEMY OF SCIENCES

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Trieste, as many readers of the TWAS Newsletter *know, is home to a group of organizations that are involved – both individually and collectively – in efforts to promote scientific capacity building in the South.*

TWAS, for example, through its research grants and South-South exchange programmes, provides funds that help scientists from the developing world to conduct research either at their own institute or at centres of excellence in other developing countries.

The Third World Network of Scientific Organizations (TWNSO), established in 1988, is an alliance of over 150 scientific institutions, ranging from ministries of science to research centres. TWNSO's goal is to assist science-based economic and sustainable development in the South, particularly by building bridges between leading scientific organizations and government ministries.

Science, Religion and Values

The Third World Organization for Women Scientists (TWOWS), launched in 1993, is dedicated to promoting the education and the careers of women scientists, who are often under-represented in classrooms, laboratories and science ministries throughout the South. TWOWS' flagship programme provides research opportunities for female PhD students from Third World countries to study at centres of excellence at home or in other developing countries. The goal is to build scientific capacity in the developing world through support for promising young women scientists.

The most recent addition to the 'TWAS family' is the InterAcademy Panel (IAP). Created in 1993, the Panel relocated to Trieste in 2000 and now operates under the administrative umbrella of TWAS. IAP is a network of the world's merit-based science academies whose membership now totals 89 institutions in all.

Science academies share several goals, including providing independent advice to their respective governments on policy issues pertaining to science. Academies also play a role in developing scientific curricula for schools and universities and increasing the public's understanding of science – both of which are particularly important in many developing countries where science education is often under-supported. Academies also acknowledge the exception-

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TWAS NEWSLETTER
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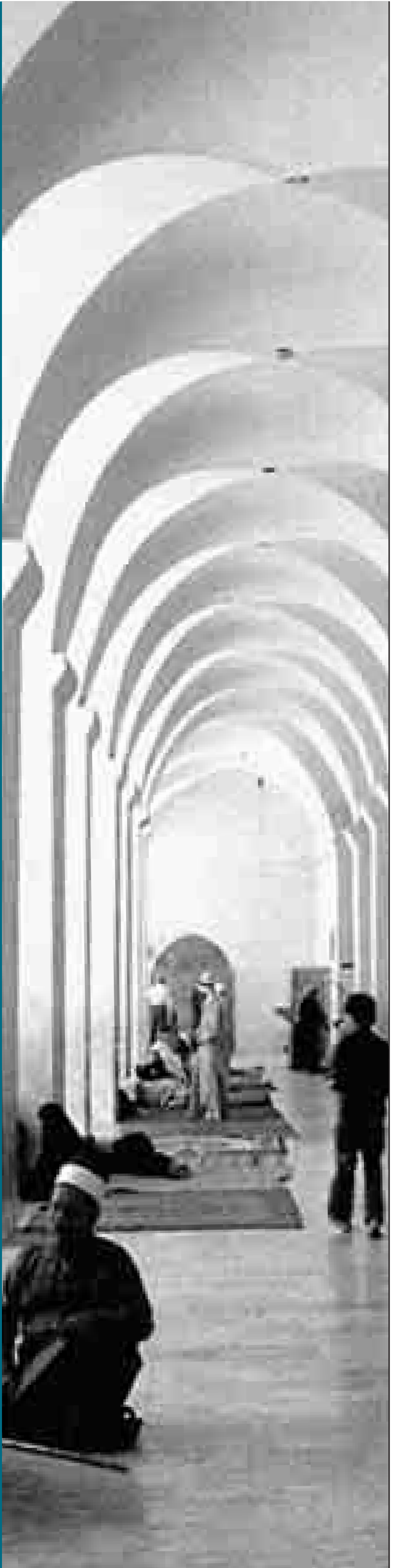

al work of scientists by awarding meritorious researchers medals and prizes. The latter has the added benefit of helping to build the esteem of scientists both within their countries and around the world.

It is in their efforts to provide independent scientific advice to governments, however, that science academies can be most influential in driving the sustainable development agenda of Third World countries. Unfortunately, many academies in the South fail to fulfil this responsibility due to inadequate resources, insufficient prestige, or both.

For the past several years, IAP has been actively addressing this problem, in particular by organizing a series of workshops aimed at boosting both North-South and South-South collaboration among merit-based academies worldwide.

To date, IAP has organized four workshops on capacity building for science academies functioning in various regions of the developing world. The first workshop focusing on science academies from sub-Saharan Africa, was held in Trieste in May 2001. A follow-up event in Nairobi, Kenya, in December 2001 led to the formation of the Network of African Science Academies (NASAC) dedicated to fostering cooperation and the exchange of ideas among academies throughout the continent. IAP has also provided advice and resources – including a one-time US$10,000 contribution – to help underfunded academies throughout Africa. The third workshop, focusing on science academies in Latin America and the Caribbean region, was held in Rio de Janeiro in September 2002. This workshop has led to a greater sense of camaraderie among science academies within the region and efforts to launch a number of cooperative activities.

The most recent IAP capacity building workshop for science academies focused on academies in countries with predominantly Muslim populations. It was held in Trieste on 5-6 March 2003 and sponsored by the Islamic Educational, Scientific and Cultural Organization (ISESCO), the Organization of Islamic Conference Standing Committee on Scientific and Technological Cooperation (COMSTECH) and the US National Academy of Sciences (NAS). Participants from 13 Muslim countries discussed the generally poor state of science in the Islamic world and, more importantly, examined strategies for improving science within their nations. Particular attention was paid to the role that science academies throughout the Muslim world could play in efforts to enhance science – either individually or in partnership with TWAS and IAP member institutions.

To achieve a greater role within their own nations, academies throughout the Islamic world need to be strengthened on a number of fronts – for example, in terms of the quality of their membership, their funding levels, the range and depth of their programmatic initiatives, their skills in dealing with science policy issues, and the degree of interaction that they have with scientific organizations in other countries.

Participants agreed that IAP and TWAS could assist them in these efforts but that a large share of the responsibility for improving both their science academies and, more generally, the state of science within their countries rests with the countries themselves. At the conclusion of

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the workshop, participants agreed to a set of recommendations designed to direct their future efforts (see page 33).

The two-day workshop on capacity building for academies in countries with predominantly Muslim communities was followed by one-day symposium on 7 March at which participants discussed issues related to the sensitive topic of the relationship between science, religion and values.

A sampling of the presentations and comments made during this symposium form the core of this special issue of the TWAS Newsletter*, which includes articles by Atta-ur-Rahman, chairman of the Higher Education Commission, Pakistan, and president of the Pakistan Academy of Sciences; Çigdem Kagitçibasi, professor of psychology, Koç University, Turkey, and founding member of the Turkish Academy of Sciences; Ehsan Masood, former director of Communications for Leadership for Environment and Development (LEAD) International, London; Fraser Watts, Starbridge Lecturer in Theology and Natural Sciences, University of Cambridge, UK; and Moneef R. Zou'bi, director general, Islamic Academy of Sciences.*

The nature of the relationship between science, religion and values has always been intriguing and often contentious. We hope the articles that follow will help to provide a sound foundation for discussing this relationship at a time increasingly characterized by rising suspicions and misunderstandings between Muslim and non-Muslim societies.

Regardless of how the current debate unfolds, two factors seem beyond doubt. First, the scientific community should have an active voice in the discussions that take place and, second, countries with predominantly Muslim populations would benefit enormously from increased financial support for science as well as efforts to give science a higher profile within their societies.

Hopefully, the recent workshop in Trieste has provided a valuable framework for helping science academies in Muslim countries, working together with universities, research institutes and governments, to lend a hand in building the capacity of their nation's scientific communities. Such capacity building efforts, workshop participants agreed, will likely be an important prerequisite for successful sustainable development strategies. The efforts may also help ease tensions between societies that have recently chosen to emphasize their differences instead of their commonalities.

FAITH, REASON AND SCIENCE

A THOUSAND YEARS AGO, THE ISLAMIC WORLD WAS AT THE FOREFRONT OF SCIENTIFIC DISCOVERY. WHY HAS IT FAILED TO KEEP PACE FOR SO LONG? AND WHAT CAN BE DONE TO RE-ESTABLISH THE ROLE OF SCIENCE IN THESE SOCIETIES?

For six centuries Islam presided over a dazzling period of scientific creativity marked by seminal contributions to the natural sciences as well as to mathematics, medicine and philosophy. This is sometimes difficult to comprehend if you look at countries with predominantly Muslim populations today.

Take the Arab states, for example. Collectively they spend around 0.2 percent of their gross domestic product (GDP) on research and development; the average worldwide is 1.4 percent. More worryingly, they account for less than 1 percent of world scientific publications. Only two Muslim countries, Egypt and Pakistan, lay claim to a Nobel Prize in any scientific subject.

Muslim countries contain large numbers of people who take their faith very seriously – even in countries with secular governments. Is it fair to conclude, then, that strong religious faith impedes scientific creativity?

Alternatively, does faith help to make for better science? Or should faith and science be kept at a respectable distance?

Opinions are divided, of course, but can probably be grouped into four main categories:

• Those who believe that science can be a bridge to faith and that academies of science can help forge a deeper understanding of why people believe.

• Those who believe that some aspects of traditional Islam are incompatible with modern life and that academies of science – either on their own or with others – should seek to reform traditional Islam.

• Those who would like to see faith and science kept apart, believing that faith is a private matter and has no role to play in the pursuit of scientific excellence.

• And those who see no conflict between science and faith. For example, many of those who are Muslim cite verses from the *Quran* as evidence that Islam encourages learning. They argue that the presence

Ehsan Masood

of 'scientific information' on subjects such as human reproduction and astronomy in the *Quran* strengthens their belief that the book is of divine origin.

On the broad question of faith and science, the relatively popular practice of going to church does not seem to have dimmed the US's ability to be the world's largest producer of research, far ahead of the more agnostic Europe. At the same time, we know that countries with large numbers of observant Muslims also happen to be at – or near – the bottom of global indices of research output.

Why should this be so?

Part of the answer must lie in the largely ineffective education

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systems that litter not just the Muslim world, but most of the South. Such systems of teaching were inherited from colonial times when rote learning was the principal method of acquiring knowledge. Pakistan's end-of-school examinations, for example, are still broadly based on a system first introduced by the British.

Poor schooling invariably creates poor quality graduates. Poor quality graduates, in turn, become lousy researchers.

Likewise, the relatively weak standards of democracy in Muslim nations cannot be ignored. It is by no means a coincidence that countries with high standards of research tend to have strong parliaments, genuine protection of civil liberties, and vibrant civil society organizations. In much of the Muslim world, by contrast, these factors are all relatively weak.

Some of this undoubtedly can also be attributed to the current practice of Islam, in which followers accord the highest respect to parents, grandparents, teachers and elders – all intended to shore up the stability of families and communities and to maintain the existence of social mores. As a result, young people in Muslim countries grow up in environments where they are encouraged to conform and follow, not to question and challenge – important prerequisites for research creativity to flourish.

Islam often is described as a complete code of life – a set of rules laid down in the *Quran* and exemplified in the life of the Prophet Muhammed.

In many ways, this is true. The book contains detailed advice on a multitude of issues and on a multitude of scales. Among other things, it outlines the rudiments of a social security system, and lays out the "do's" and "don'ts" of engaging in warfare. There's also advice for couples who want to divorce, and a detailed account of penal codes that in some quarters have remained in place until this day.

In most Muslim countries today, religious leaders aim to interpret Islamic teachings to the letter of the law. But invariably, there are issues, questions and contexts not covered in either the *Quran* or the life of the Prophet. Muslim jurists generally agree that the practice of Islam can be distilled from four sources: the *Quran*, the Prophet's life, scholarly consensus (a kind of peer review), and independent reasoning.

However, most traditional scholars today accord only a small role to independent reasoning. Throughout the Muslim world, this view, and the broader role and position of religious leaders largely, goes unchallenged. That's partly because most intellectuals lack the knowledge to engage in debate, but also because of a fear of being labelled enemies of faith – something that carries heavy personal consequences.

Intriguingly, however, for the first six centuries after the death of the Prophet in 632 AD, there was a vigorous scholarly debate, particularly on the question of the place of reason in interpreting revelation.

Two hundred years after the death of the Prophet, a rationalist movement began in Islamic countries, which lasted until the 12th century. For much of that time, the movement also had the backing of political authorities. Rationalists argued – against the view of most Muslims – that the *Quran* was a 'created' work and not necessarily of divine origin. Some also argued that reason alone should be the basis for making decisions.

But rather than letting the debate take its course, rationalists used the force of their political power to insist that citizens bow to their views. Dissenters were punished, and prisons were full of scholars and ordinary folk who chose to disagree. Torture was widespread.

As we now know, in the end the rationalists were defeated. Crucially, when opposition to their ideas became a mass movement, they lost their political patronage. With the exception of a brief period at the turn of the 20^{th} century, talk of rationalism and reform within Islam has since been isolated to a few individuals.

The point of this foray into Islamic history is threefold. First, it indicates that Muslim societies have a strong tradition of rational thought; second, that the engagement of faith and reason has not been an altogether happy one; and third, that if research and creativity are to be revived in Muslim countries, revivalists and reformers will need to re-engage with theologians.

Cast a gaze at the map of Muslim countries, and you will find few places where this is happening. Iran is an exception. There, academics such as the philosopher of science Abdolkarim Soroush have a large readership, especially among the young. Soroush is a strong proponent of a greater role for reason within Islamic theology (see www.soroush.org).

But Iran is unusual in the Muslim world in that it is an Islamic state, a theocracy, and a largely Shiite one at that. In recent years, Shiite theologians have traditionally been more receptive to new and different interpretations of faith compared to their majority Sunni counterparts.

While Abdolkarim Soroush has not had an easy time at home, his mostly clerical detractors are at least willing to engage in debate because they recognize that his arguments have historical validity.

A 'Sunni Soroush' would face a potentially more hostile audience. At best, his or her motives would be questioned. At worst, he or she may even be branded an apostate – a person regarded as having betrayed their religion – a label that would immediately ruin any chance of building public trust. In many Muslim countries today, apostasy still carries the death penalty.

One researcher who is courageously willing to live with such a risk is Morocco's Fatema Mernissi (see www.mernissi.net). Mernissi, a sociologist and historian of gender relations in Islam, is well-equipped to debate and engage in dialogue with the Islamic faith establishment on its own terms.

For much of the 1990s, she focused her work on the erosion of women's rights in Muslim societies, arguing that it is often misogyny, rather than Islamic teachings, that has led to such a situation. She is currently exploring the relationship between access to information and communications technologies and the rise of civil society movements in Morocco.

Researchers such as Mernissi and Soroush are not, however, the tip of a large iceberg. They are relatively rare. Only time will tell whether they have blazed a new trail, or are isolated, one-hit wonders.

More Mernissis and second-generation Soroushes are more likely to flourish in institutions that encourage creativity and original thinking. Developing such institutions, perhaps, is the biggest challenge for science academies in countries with predominantly Muslim populations. ■

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ACADEMIES OF SCIENCE: DEFINING PRINCIPLES

MONEEF R. ZOU'BI, DIRECTOR GENERAL OF THE ISLAMIC ACADEMY OF SCIENCES, URGES SCIENCE ACADEMIES TO BECOME MORE INVOLVED IN THEIR SOCIETIES.

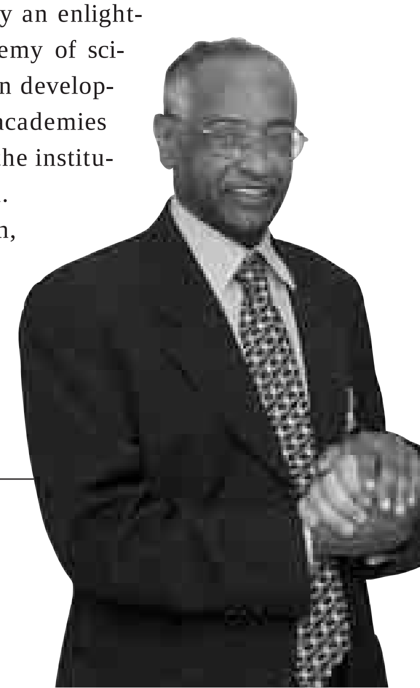
What is an academy? Definitions vary widely: from a school devoted to such specialized training as art or music; to an intellectual retreat resonating the ambiance of Plato's ancient garden near Athens; to a non-descript brick grammar school building in Scotland.

Not surprisingly, diverse images of academies are accompanied by varied perceptions of what they represent. In many parts of the developing world, for instance, academies carry a military connotation largely due to the fact that many of the United Kingdom's generals who oversaw the nation's 19th century empire were educated at the Sandhurst Royal Military Academy in England. More recently, the word academy has gained a 'star-struck' Hollywood image due to the Oscars that are awarded by the Academy of Motion Picture Arts and Sciences in the United States each year.

Yet for all the assorted definitions and perceptions of an 'academy,' the one that often draws the most puzzled look is the academy of science. Is an academy of science a primary or secondary school? A university? A specialized training institute? A policy research centre? A think-tank? All of the above? None of the above?

The truth is that even in countries with strong science academies only an enlightened few know what an academy of science is and what it does. And, in developing countries, where science academies often have much less visibility, the institutions remain virtually unknown.

Indeed, in much of the South, political leaders – the very people needed to ensure the success of science academies – often remain unaware of the potential role that these



institutions can play in their nations. In fact, the development and success of academies of science, particularly youthful academies in developing countries, usually depends on the political support and patronage of high level political officials. History shows that it is often the head of state who determines whether an academy gains stature in the policy-making arena or languishes in obscurity.

Some of the most successful academies in the developing world – for example, in Brazil and Malaysia – owe their success to strong and sustained financial support from the government matched by the government's willingness to detach itself from influencing academy affairs. Such a strategy has allowed these academies to enjoy both adequate levels of funding and independence. Academies prosper in such an open environment while governments benefit from the objective and unbiased advice that they receive from expert institutions that they have decided to fund but not control.

In many Islamic countries today academies are weak institutions.

In many Islamic countries today, academies are weak institutions. That, however, was not always the case. Indeed the Arab word, *majma*, meaning assembly, dates back to the 7th century. Moreover, Al-Ghazali's Nizamiyah Academy in Baghdad, catering to all fields of knowledge, including science, was one of the world's most renowned seats of learning at the turn of the first millennium. That's some 400 years before the creation of the West's first science academy, *Accademia Nazionale dei Lincei*, in Italy.

The glorious history of academies in the Arab world has been largely lost to history. For nearly 1000 years now, the concept of an assembly of intellectuals or fellowship of scientists dedicated to the advancement of knowledge within their societies has remained relatively obscure throughout the region, even among the region's political elite.

The word *majma* itself has lost its original meaning and with it the energy and vitality inherent in the historic roots of the word. Today *majma*, if it is known at all, refers to national language academies that are primarily concerned with *Arabicizing* international scientific terms. That may be a worthy goal but one that is much more restricted than the goals of academies that are dedicated to the promotion and advancement of science both within their nations and on a global scale.

A common feature of all the world's science academies – whether the 55-year-old Chinese Academy of Sciences with a staff of 50,000 or the four-year

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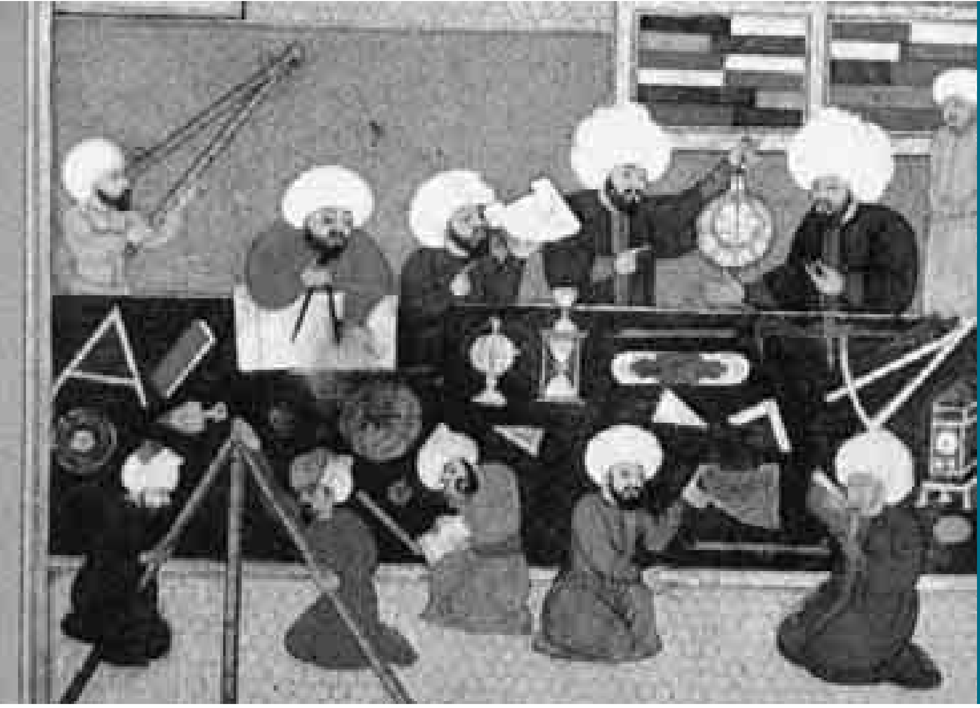

old Senegalese National Academy of Science with just a handful of members – is to seek nationwide economic and social advancements through wise applications of science and technology.

To fully realize this goal, academy representatives must get their message across to both public officials and the public at large. Those living in Muslim countries, moreover, must let their political leaders and people know that such knowledge-based institutions, which date back to the earliest days of the Islamic religion, constituted one of the major defining elements of Muslim society during its 'golden age' – a time when Muslim culture dominated the world and stood at the forefront of progress and development.

Science academies have a critical role to play as a strong voice for the promotion of scientific excellence.

One of the oldest definitions of 'academy' may thus be one of the least appreciated today. It's a definition that dates back to Plato's time; it is one that took root in the Arab world during an era of great intellectual ferment and economic progress; it then re-emerged in western Europe during the Renaissance; and it continues today, in part, as the organizing principle for the world's science academies – in the North and South and the East and West.

While the educational functions that often shaped academies in the past now largely reside with schools and universities, today's science academies have a critical role to play as a strong public voice for the promotion of both scientific excellence and science-based development. Science academies, in fact, shoulder primary responsibility within their nations for showing – and indeed convincing – the public that an intricate relationship exists between home-grown science and sustainable growth at home. In other words, science academies must demonstrate that a strong scientific community strengthens communities throughout the nation by enabling citizens to address critical economic, environmental and social issues in systematic and effective ways.

Stated more succinctly, the function of science academies in the Islamic world should be to act as nationally recognized organizations devoted to the promotion of science and its applications to human welfare and material well-being. The developing world – and more specifically, the Arab world where I live and work – would benefit enormously if science academies were to become more vigorously engaged in their nation's larger efforts to address critical economic and social problems. ■

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BRINGING SCIENCE BACK TO THE MUSLIM WORLD

ATTA-UR-RAHMAN, ONE OF THE DEVELOPING WORLD'S LEADING SCIENTISTS, CONTENDS THAT MUSLIM COUNTRIES MUST EMBRACE SCIENCE AND TECHNOLOGY IF THEY HOPE TO SUCCEED IN TODAY'S WORLD.

There was a time, not long ago, when nations needed to possess a treasure trove of natural resources within their borders to succeed economically.

But the world has undergone a dramatic make-over during the past few decades. Today, the driving force behind the global economy is knowledge – and, more specifically, knowledge of science and technology. This means economically successful nations rely more and more on the quality of their human resources, rather than their natural resources, to compete in an increasingly competitive world.

Two statements from Western politicians highlight the importance of knowledge. Former US president Bill Clinton, in his January 2000 'state of the union address' said: "In the new century, innovations in science and technology will be key, not only to the health of the environment, but also to miraculous improvements in the quality of our lives and advances in the economy."

And, in a policy announcement in 2000, UK Prime Minister Tony Blair affirmed that: "The three top priorities of my government are… education, education, education."

Such perceptions are largely missing in the Islamic world – a factor that helps to explain the widening gap between Islamic countries and much of the rest of the world when it comes to science-based development.

Development is a complicated process requiring a number of factors to converge before it can be sustained. One of these factors is education, especially higher education. While many Muslim countries have populations with high levels of literacy, the vast majority have failed to develop sufficient networks of high quality universities and research centres to

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ensure strong and enduring foundations in science and technology. As a result, economic development has stagnated.

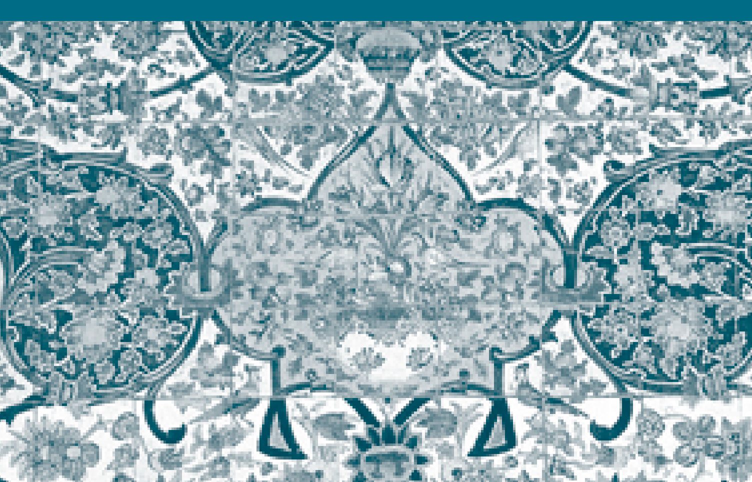
One of the keys to economic progress lies in a nation's ability to manufacture goods and services with added value. Such goods and services are intimately linked to the quality of a nation's scientific and technological institutions. Success, moreover, requires an intricate national system of public and private enterprise to ensure that advances in science can be embraced and then transformed into new products and processes. Most member states of the Organization of Islamic Conference (OIC), which includes 57 nations stretching from Morocco in the west to Indonesia in the east, have failed to put such a system in place.

Educational systems, meanwhile, must adhere to high standards and the curriculum must be structured in ways to ensure that the information conveyed and lessons taught are relevant to the needs of society.

Yet, in many OIC member states, the quality of education, especially in universities, remains low and the relevance of higher education to such critical concerns as economic development and environmental management difficult to detect. Funding for education in general, and science education in particular, remains woefully inadequate. For example, the United Nations Education, Scientific and Cultural Organization (UNESCO) calls on nations to invest a minimum of 2 percent of gross domestic product (GDP) on research and development (R&D). Most OIC member states spend less than 0.2 percent of their GDP on R&D.

Over the past several decades, some developing countries have successfully transformed their economies into knowledge-based economies. For example, in 1960, agriculture accounted for more than 50 percent of GDP in South Korea, Malaysia and Taiwan. By 2000, in each of these countries, the percentage of agricultural output to total GDP had fallen to less than 10 percent. Meanwhile, such high-value-added sectors as electronics and engineering, virtually nonexistent in 1960, are now responsible for goods and services that contribute more than 50 percent to GDP. Such trends have translated into dramatic increases in GDP in all three nations.

The key role that knowledge plays in developed countries can be highlighted by comparing the economies of small western European countries with the economies of OIC member states. For example, the populations of Austria, Belgium, Denmark and Norway range between 5 and 10 million, while their annual GDPs vary between US$152 and $248 billion. In contrast, Pakistan has nearly 140 million people, Iran



nearly 70 million, and Saudi Arabia nearly 20 million; yet, their annual GDPs vary between US$58 to US$139 billion. In fact, only Turkey's annual GDP, which is US$185 million, falls within the range of the four western European nations cited above. Turkey, however, has a population of more than 65 million people, more than twelve times the population of Denmark and six times the population of Belgium.

Meanwhile, global science continues to advance at a pace unprecedented in human history. We are, for example, witnessing the rapid development of nanotechnology, which promises to transform our material world; genomics, which will radically alter both medicine and agriculture; and hydrogen fuel cells, which will have a significant impact on energy production and consumption.

Even 'rich' Arab countries prefer to buy technology from others instead of creating new scientific knowledge.

However, even 'rich' Arab countries prefer to buy technology from others instead of creating new scientific knowledge and developing new technologies on their own. As a result, economic growth in these countries has been slow and uneven.

To reverse this downward spiral in material well-being, the Muslim world must build a strong foundation in science and technology. As the experience of other nations shows, science provides a platform from which to launch sustained efforts for economic development.

Today 6 billion people inhabit the earth. About 1.3 billion of the world's people (22 percent of the total) live in OIC member states. However, scientists in Muslim countries contribute just 1 percent of the articles published in refereed international science journals. This paltry figure is due to two interrelated factors: the poor quality of science in OIC member states and the small number of scientists who live and work there. A recent survey of 22 Islamic countries determined that there are only about 226 scientists per million of population. In South Korea, the figure is 2235 per million; in the United Kingdom, 2448; in the United States 3676; and in Japan, 5368.

Similarly, OIC countries are home to some 550 universities. Japan, in comparison, has more than 1000 universities; Tokyo alone 120. The annual budget of the University of Singapore's science and technology departments stands at US$750 million. That is equal to one-half of the combined annual budgets for science and technology departments in all 550 universities in OIC member states. Shortfalls in numbers and funding are matched by shortfalls in quality. Indeed the quality of education at universities in OIC countries falls well below the quality of education in universities, not only in the western world, but in many developing countries.

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The collective annual GDP of the 57 countries that are part of the Islamic world totals about US$1150 billion. That is less than half the GDP of Germany and less than a quarter the GDP of Japan. Such discrepancies in wealth are disturbing. Yet, equally disturbing is the manner in which Islamic countries choose to spend their limited financial resources.

OIC countries in Africa, which include some of the world's poorest nations, spend about 3 percent of GDP on defence, just over 2 percent on health and a scant 0.1 percent on R&D; OIC countries in Asia spend more than 4 percent of GDP on defence, 1.5 percent on health and 0.3 percent on R&D; and OIC countries in the Arab region spend a startling 7.1 percent of GDP on defence, 1.25 percent on health and 0.2 percent on R&D.

R&D investment will likely become an even more critical factor over the coming decades.

An assessment of 65 studies focusing on the relationship between investments in R&D and the state of the economy – conducted in the West where nations spend between 2 and 3 percent of GDP on research and development – shows that the rate of return on such investments runs between 20 and 80 percent.

R&D investment will likely become an even more critical factor over the coming decades as the world confronts a host of daunting challenges that can only be addressed with the help of science and technology. By 2050, global population is expected to rise from 6 to 9.5 billion exerting enormous pressure on global resources; fossil fuel reserves are expected to fall by 80 percent requiring the global community to develop alternative sources of energy; and life expectancy is likely to increase to nearly 100 years of age, creating a global demographic profile that contains an unprecedented number of older people with special health needs.

The impact of aging populations will be felt most acutely in the North. That is because more than 95 percent of world population growth is now taking place in the developing world. As a result, the developing world – despite anticipated increases in life expectancy – will have many more young people than the developed world.

Discrepancies in population growth between the developing and developed worlds, combined with a lack of job opportunities in the South, will likely exacerbate the 'brain drain' phenomenon that has plagued developing countries, including OIC member states, for more than 50 years.

As the Muslim world's 'best and brightest' leave for better career opportunities in countries other than their own, not all is lost, however. Indeed it is better to have well-trained, motivated people working in fields

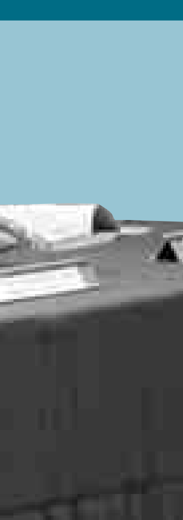
of their choosing than not working at all. But the fact remains that scientists and technologists who migrate to the West are largely a lost resource that the Muslim world can ill afford to do without.

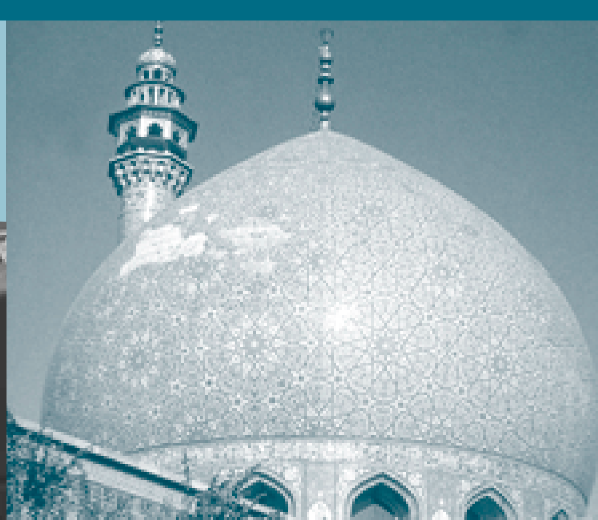
One of the keys to future development in the Muslim world, therefore, is to create a hospitable environment for their most educated and talented citizens. The best way to achieve this goal is to nurture a vibrant economy that puts educated people to work in well-paying, meaningful jobs. Muslim countries must create such conditions if they hope to make the best use of their indigenous resources.

For example, about a quarter of the world's medicines are derived from plants that are found in developing countries, including OIC member states. Yet, not a single drug sold in global markets has ever been developed by a group of scientists solely from the Muslim world. Instead the plants invariably have been sent to the West where multinational pharmaceutical firms develop the medicines that eventually earn a handsome profit in the international market place. Indeed Muslim nations, which are sometimes the source of the plant responsible for the medicines, often find themselves importing such drugs at a high cost. Thus, while OIC member states often have valuable natural resources within their borders, they have not profited from these resources because of their weak scientific base.

The Ministry of Science and Technology in Pakistan has tried to counteract the 'brain drain' problem by establishing a 'research productivity allowance' for its brightest scientists that can increase a researcher's base salary several times over. Every scientist in Pakistan is now rated in terms of various factors, including the number of times that his or her research papers are cited by other scientists and the number of doctoral students studying under his or her supervision. Today, because of the allowance, a bright, young scientist in Pakistan can earn much more than a senior colleague who is less productive. Such a merit-based system has long been overdue.

A rigorous rating system should also be used for the election of fellows to academies of science, where in the Muslim world, cronyism and contacts have too often held sway. Unless academies include their nation's best scientists, they will not have the credibility they need to function at their full potential. Both the academies and, more importantly, the nations in which the academies are located will be short-changed as a result.





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Many OIC member states also do not have viable national science and technology policies. At their best, these policies usually are nothing more than paper exercises that carry little political clout. At their worst, they often amount to rhetorical 'feel good' flourishes devoid of meaning. Here is another critical science-related area where science academies, with the help of such organizations as OIC's Standing Committee on Science and Technology (COMSTECH), the Third World Academy of Sciences (TWAS) and the Inter-Academy Panel on International Issues (IAP), can play a significant role.

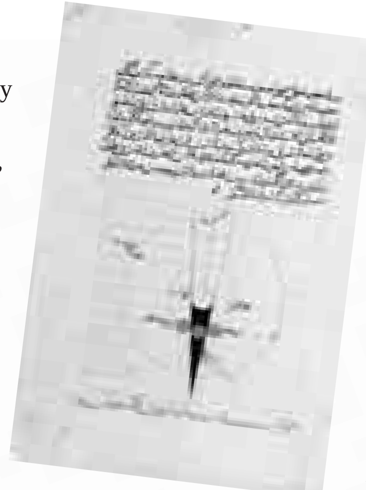
Science academies could also prove instrumental in the development of satellite-based science curricula that can be made available on television and via the internet to universities throughout the Muslim world. The initiative, modelled after the Open University in the United Kingdom, could take advantage of the emerging communication technologies that have been slow to come to the region but are now finally taking hold.

Scientific communities in the Muslim world need to strengthen their contacts with their international counterparts.

For example, Pakistan's first communications satellite, launched earlier this year, can transmit 250 television channels. By adding a new dynamic dimension to the regions' communications systems, it has already left a visible 'information footprint' on large portions of the Middle East and southern Asia. More importantly, systems like this have already put in place a communications infrastructure for educational use. We need to work together to ensure that we take advantage of this unprecedented opportunity to educate our citizens, both young and old.

Finally, science academies in OIC member states have a responsibility to convince their citizens and governments that scientific excellence is not just a pathway to prosperity but, in fact, a means of survival. Efforts to promote science education and, especially, the teaching of science, is essential. Science academies – again with the help of IAP, TWAS and COMSTECH – can play a central role in improving the quality of science in their countries, most notably by supporting and participating in programmes for teachers of science.

As suggested by the discussion above, scientific communities in the Muslim world need to strengthen their contacts with their international counterparts by supporting and working more closely with such organizations as COMSTECH, TWAS and IAP. Such efforts will help ensure that young scientists who return home from their studies abroad do not soon feel isolated from the latest developments in their fields. At the same time, national systems must be developed that enable scientists, particularly young scientists, to lend their expertise to science-based



development issues that are critically important to their nation's future.

For their own part, Islamic countries, must identify and vigorously support centres of scientific excellence within their own borders. There have been encouraging signs in recent years of greater South-South cooperation in science led by such organizations as TWAS and COMSTECH. However, we must also forge stronger South-North initiatives that not only tap the enormous scientific talent that exists in the North but also enables scientists in the South to work as true partners on global scientific issues.

Such efforts would help Northern scientists learn more about scientific issues of critical importance to the South and also to become more familiar with the pool of scientific expertise that is available in the developing world. The H.E.J. Chemistry Institute in Karachi, Pakistan, which I have been honoured to head for the past several decades, and the King Abdulaziz City for Science and Technology in Saudi Arabia are just two examples of scientific institutions in the Muslim world that have made special efforts to encourage scientists from the developed world to visit their facilities and participate in their research activities.

At the most recent COMSTECH general assembly held 18 months ago, the President of Pakistan, Pervez Musharraf, wrote a letter to the heads of governments of the OIC member states recommending that they spend at least 1.1 percent of their GDP for the creation of a central fund for the promotion of science and technology. The proposal calls for each member state to lodge these funds with an external financial institution such as the Islamic Development Bank. Although the funds would be placed in this institution, only the governments responsible for the investments could withdraw them. COMSTECH, meanwhile, has pledged to mobilize the best scientific minds, both in the Muslim and non-Muslim worlds, to help the governments set research priorities and implementation strategies for the fund's utilization. There is some hope that this initiative will be formally approved at the next general meeting of OIC to be held in Kuala Lumpur, Malaysia, this autumn.

Muslim countries do not have the critical mass of scientists that they need to address the compelling economic, environmental and social problems that they face. Indeed a lack of well-trained scientists has made it much more difficult, if not impossible, to address these problems in a coherent and effective way.

Yet, if scientific communities – and especially science academies – throughout the region display a new dynamism, it is conceivable that science in Islamic countries could grow in stature and impact. Indeed, in time, we may even be able to recreate another 'golden age' for science in the Muslim world – like the one that existed 1000 years ago – when the East, not West, led the world in astronomy, mathematics, medicine and a host of other scientific disciplines.

One thousand years is a long time to be left behind. Catching up will not be easy but taking the first steps in the right direction may prove the best way to proceed. Let us commit ourselves to taking those steps now. ■

Atta-ur-Rahman
Chairman
Higher Education Commission
President
Pakistan Academy of Sciences
Islamabad, Pakistan

THROUGHOUT THE TWO-DAY WORKSHOP ON CAPACITY BUILDING FOR ACADEMIES IN COUNTRIES WITH PREDOMINANTLY MUSLIM POPULATIONS AND THE ONE-DAY SEMINAR ON SCIENCE, RELIGION AND VALUES THAT FOLLOWED, SOME OF THE ISLAMIC WORLD'S MOST PROMINENT SCIENTISTS AND SCIENCE ADMINISTRATORS GRAPPLED WITH A HOST OF FUNDAMENTAL CULTURAL AND POLICY QUESTIONS.

WORKSHOP BRIEFS

These questions are rarely discussed in laboratory settings but nevertheless have a great bearing on the nature and depth of science that is done in a country. Here is sampling of what some of the participants had to say concerning the relationship between science and religion in the Islamic countries in which they live and work.

DOING WELL BY DOING GOOD

Mohammad Shamsher Ali

• From its inception, the Bangladesh Academy of Sciences has prided itself in sticking to its principles. Indeed throughout much of its history high principles have been its sole claim to fame – an enviable position to have, but in the Academy's case, not one with much clout. More recently, the Academy has expanded its mandate beyond principles to action. Simply put, it has begun to focus on issues of major concern to the government. The Academy took this new path not only to gain more attention but to become a greater asset to the nation. In fact, it fervently believes that the two goals are inextricably related.
The first expression of the Academy's new-found concern was expressed at a symposium on arsenic pollution in water organized in the late 1990s. Government officials invited to the symposium found themselves very much interested in what our members had to say. Surprised to learn that some of the nation's best brain's were in the Academy, policy makers in attendance were particularly pleased to hear the findings of one of our fellows, a chemist, who presented a comprehensive analysis of the nation's arsenic problem and a series of science-based options on how to solve it. The Academy then offered to evaluate more than 60 science and technology projects funded by the government's Ministry of Science and Information and Communication Technology. The successful completion of this evaluation earned more kudos for the Academy. More recently, the Academy held a symposium focusing on safe drinking water where scientists discussed the growing problem of falsification among so-called suppliers of spring water who claim that the bottled water they are selling is spring water when it is not. And so the Academy has discovered a valuable lesson: it not only has to think independently but must concentrate on problems that affect the lives of the people of Bangladesh. In

short, science academies must learn how to advise governments by addressing issues of national concern and then speaking a language that decision makers can understand. ■

Mohammad Shamsher Ali
Vice President
Bangladesh Academy of Sciences
Dhaka, Bangladesh

SCIENCE FOR DEVELOPMENT

Abdel-Salam Majali

• The Islamic Academy of Sciences firmly believes that it is time for decision makers in countries with predominantly Muslim populations to build sustainable economic development policies. The Academy, moreover, is convinced that such policies must be based on a science and technology template that decision makers can readily understand and follow. Such efforts, which should be put into operation in a matter of years not decades, must be designed in ways that allow decision makers to tap the scientific and technological expertise within their own borders. High priority should also be given to inter-Islamic collaboration but assistance from non-Muslim nations should not be dismissed.

Several member states of the Organization of the Islamic Conference (OIC) – for example, Jordan, Pakistan, Tunisia and the United Arab Emirates – recently have invested substantial resources in new information and communication technologies as part of a larger effort to make up for lost development opportunities. Other Islamic nations must adopt similar strategies if they hope to effectively pursue the science-based development strategies that now drive the economies of the globe's most successful nations. By pursuing such policies at both the national level and through South-South cooperation, the Islamic Academy of Sciences is convinced that much progress can be made in a relatively brief period of time. ■

Abdel-Salam Majali
President
Islamic Academy of Sciences
Amman, Jordan

BEYOND THE BLOC

• Over the nearly 75 years under which the Republic of Kazakhstan functioned as a satellite regime of the Soviet Union, the core of its scientific community largely consisted of 33 research institutes that operated under the direction of the Soviet National Academy of Sciences. This rigid system of science administration, of course, fell with the Soviet Union and nearly 15 years later it has yet to be entirely replaced. In 2003, a key problem for the scientific community in Kazakhstan and other former Soviet republics in central Asia remains the same: What kind of new system of governance should be created for the administration and management of science? Science administrators in Kazakhstan have found it difficult to change because they have wanted to institute progressive reforms without destroying the parts of the old system that have worked well. Thanks to the Soviet system, for example, Kazakhstan and other nations that belonged to the Soviet bloc enjoyed a well-educated citizenry that served as a valuable human resource. Spending on education has slowly but steadily increased over the past several years as post-communist economic conditions have stabilized following a lengthy period of chaos and uncertainty. Nevertheless Kazakhstan still spends only 0.2 percent of its GDP on science education – far too little to ensure that its strong scientific base, developed over decades of communist rule, remains intact. One reform that would mark an improvement over the previous system would be closer integration between scientific research and teaching, two interrelated endeavors that ran on separate tracks under the Soviet system: research institutes focused exclusively on research while universities focused exclusively on education. For Kazakhstan and other former Soviet bloc countries, the most critical issue is not the relationship between science and religion; rather, it is the ability to create an institutional bridge between Soviet science and science in the post Soviet era – an issue that continues to be problematic even after more than 10 years of reform. ■

Serikbek Daukeev

Serikbek Daukeev

National Academy of Sciences of the Republic of Kazakhstan

Almaty, Kazakhstan

TIME AND CIRCUMSTANCE

• Tajikistan does not have a ministry of science. As a result, the nation's academy of sciences shoulders many of the responsibilities assumed by science ministries in other nations, including overseeing the operation of Tajikistan's national research institutes. This organizational structure has been inherited from the Soviet era. Creating an independent academy of sciences would not be possible under the current administrative framework unless the government agreed to pay the salaries of academy scientists who would no longer be government employees. In the future, however, we hope to develop a system that enables research institutes to operate as agents free from direct government influence. Such reforms will enable these institutes

Ulmas Mirsaidov

to secure nongovernmental funding from private sources within the nation and foundations and funding agencies beyond the nation's borders. Tajikistan's civil war, which began soon after the fall of communism in 1991 and did not end until 1997, impeded the science community's efforts to wean itself from the government. External funding was virtually impossible to obtain as long as the violence continued and many foreign scientists refused to visit Tajikistan because of fears for their personal safety. The scientific community in Tajikistan would like to change the current situation but it realizes that reform requires outside help. The academy itself has begun to showcase its strengths in such basic fields of research as mineralogy and biotechnology in hopes of drawing attention to its scientific capacities as a prelude to fostering international collaboration. Like many former Soviet republics, Tajikistan has a competent but ageing scientific community that can still contribute to international scientific research in select fields but only if avenues of cooperation are made available. ■

Ulmas Mirsaidov
President
Tajikistan Academy of Sciences
Dushanbe, Tajikistan

PUBLIC WORTH, PRIVATE VALUE

Samsudin Tugiman

• While the Academy of Sciences Malaysia has made great strides over the past five years in gaining a higher profile in our society (thanks largely to a US$5 million endowment grant from the government), we have yet to forge strong links with the private sector and, most significantly, the technology sector. This weakness limits the Academy's development on two fronts. First, it widens the gap between science and technology and thus blunts the impact that we may otherwise have on society, and second, it keeps the Academy at arm's length from a potential source of valuable funding. We believe that the Academy and private sector share a common interest in scientific knowledge and technical know-how and that such a common interest should help foster future partnerships that will serve both sectors well. The Academy itself focuses on six fields of inquiry: medicine, engineering, biology, mathematics, chemistry and information technologies. It also has a division that operates under the broad rubric of science and technology development and industry. It is this latter focus that offers the most promise for establishing strong ties with the private sector – particularly among those technology-driven industries that depend on science to remain competitive in the global market place. While other academies, particularly in developing countries, may shy away from such efforts, believing it best to concentrate on building scientific capacities within their nations, the Academy of Sciences Malaysia is aggressively seeking to pursue such a strategy as a way of strengthening its voice in policy circles within Malaysia and demonstrating the valuable role it can play in efforts to promote sustainable economic growth. ■

Samsudin Tugiman
Executive Director
Academy of Sciences Malaysia
Kuala Lumpur, Malaysia



BREACHING BORDERS


Adnan Badran

• In Japan, the private sector is responsible for about 80 percent of the investment that the country makes in research and development (R&D); the remaining 20 percent comes from the government. In Germany, the private sector funds about 70 percent of the nation's investment in R&D; the government 30 percent. In the United States, the government and private sector each contribute about 50 percent to R&D. In all these cases, there is a 'push' and 'pull' effect of R&D funding. The 'push' effect is achieved through government spending that steers the nation's R&D in a particular direction. Such efforts, for example, were instrumental in shaping the research agenda in the United States and the Soviet Union during the cold war and space race. Today, market forces associated with private sector funding seem to be a more formidable force for setting science and technology policy agendas both in the United States and elsewhere, especially when it comes to such fields as pharmaceuticals and biotechnology. In contrast to developed nations in the North, 90 percent of R&D expenditure in Arab countries comes from the government and just 10 percent from the private sector. As a result, much of the research that does take place in Arab countries, which is under-funded to begin with, is not geared toward the market place. By encouraging at least a portion of its research to be product- and service-oriented, Arab countries could help scientific communities within their borders become valuable and respected entities. ■

Adnan Badran
President
Arab Academy of Sciences
Amman, Jordan

PHD AND COUNTING

Reza Mansouri

• Iran currently has a total of 12,000 PhD candidates studying in a broad range of disciplines, including the basic and medical sciences. Currently, about 400 university and research institute departments are awarding PhDs – a number that has increased by 10 percent each year for the past five years and is expected to continue to grow at that rate for at least another five years. This means that by 2010, Iran will have more than 800 higher education departments offering the country's rapidly growing university-aged population opportunities to earn doctorate degrees. At the same time, the number of scientific papers published by Iranian scientists in refereed international journals has increased by roughly 20 percent a year for the past 12 years. Between 2001 and 2002 alone, there was a 35-percent increase. Clearly, the Iranian government is making great strides in meeting the educational needs of its student population seeking advanced degrees. The critical challenge ahead is to create a sufficient number of jobs in scientific research and technological development that take full advantage of the knowledge and training that our students are receiving. ■

Reza Mansouri
Deputy Minister for Research
Ministry of Science, Research and Technology
Tehran, Iran

SCIENCE ON THE RISE IN TURKEY

A LEADING RESEARCHER IN TURKEY EXAMINES HER NATION'S RECENT PROGRESS IN THE PROMOTION OF SCIENTIFIC RESEARCH AND EXPLAINS WHY SO MUCH MORE REMAINS TO BE DONE IF TURKEY HOPES TO SUSTAIN ITS EFFORTS FOR ECONOMIC AND SOCIAL PROGRESS.

In many Muslim countries, science is undervalued and thus underfunded. As a result, the returns from science to the community are often minimal. However, there is one country with a predominantly Muslim population that is breaking this chronically closed cycle of minimal funding, minimal output and minimal impact. That country is Turkey, where a quiet revolution is unfolding regarding the relationship between science and society. In Turkey, the government's commitment to science is increasing, funding is on the rise, and public support for the role that science can play in economic development is strengthening. National newspapers have even carried stories featuring the country's ranking in the journals covered by the Science Citation Index, *the most authoritative assessment of the international importance of scientific articles based on how many times the articles are cited by other authors in their scientific papers.*

So how did Turkey turn its sedate scientific community into a dynamic network of researchers with ever-increasing influence on the global science scene? And what can other Muslim nations learn from Turkey's experience? Çigdem Kagitçibasi, a founding member of the Turkish Academy of Sciences, explains.

One key indicator of scientific productivity, the *Science Citation Index*, shows that some remarkable developments have been taking place in Turkey over the past 15 years or so.

In 1986, Turkish scientists published a total of 520 articles in journals covered by the *Science Citation Index*. That gave Turkey a ranking of 43 out of 72 countries in terms of scientific publications output. In 1992, the number of scientific publications produced by Turkish scientists climbed to 1354, raising Turkey's ranking to 36. By 1998, the number of articles by Turkish scientists rose to 3901 articles and Turkey was listed as 27th in the world. And, by 2002 the total skyrocketed to 9303, propelling Turkey to 22nd in the world. The 30 percent increase in scientific citations that Turkey experienced in 2002 alone not only marked the country's highest increase ever but also one of the highest increases in the world, exceeded

only by China. Today Turkey's scientists account for 60 percent of all international scientific publications emanating from Muslim countries.

A number of policies supporting science education from high-school to doctoral levels have played a role in this increased productivity. One was the formation of 'science lycées,' or 'science schools,' an educational reform measure that has since helped nurture a new generation of well-motivated and well-trained Turkish scientists. In 2003, some 4,400 students will be admitted to Turkey's science lycées.

Turkey's scientists account for 60 percent of all international scientific publications emanating from Muslim countries.

High school students attending science lycées are selected through competitive examinations. The Scientific and Technological Research Council (TUBITAK), the government agency responsible for developing and coordinating research and development in Turkey, has worked closely with other agencies, including the Turkish Higher Educational Council and the Turkish Academy of Sciences, to develop a first-rate curriculum for the science lycées. This has helped to ensure that the nation's most promising science students find school intellectually challenging and not mind-numbing. Placing the best science students in the same classrooms, moreover, not only helps to ensure excellent instruction but also motivates students through daily contact with peers of equal talent. In addition, TUBITAK operates a 'Science is Fun' programme that is reaching large numbers of secondary school students through an extensive network of publications and science fairs.

In the past two years, the Turkish Higher Education Council, which oversees the nation's network of 53 state-supported universities, has established more stringent requirements for the promotion of non-tenured assistant professors to tenured positions. The reward system, which provides deserving candidates with guaranteed employment, is now linked directly to the number of papers a scientist publishes in peer-reviewed international journals that are listed in the *Science Citation Index*.

Although many professors complained about the stringency of these reforms when they were initially put in place, most observers now agree that the measures have played a critical role both in increasing research productivity and raising the standards for tenure. Professors fully understand that they will now be judged on and rewarded for their output, especially the number of papers that they publish in international scientific journals.

The reforms that Turkey has introduced apply not only to individual scientists but to institutions of higher education that are now also ranked by the Turkish Higher Education Council in terms of the total number and quality of publications generated by their scientific staff. This effort has fostered a more competitive atmosphere both within and between institutions.

[CONTINUED PAGE 26]

Among Islamic countries, Turkey has a very high percentage of women holding academic posts.

It is important to note that the reform measures designed to provide incentives for increasing the number of articles published by Turkish scientists in international journals has been accompanied by steps to increase the resources that are available for scientists to do research.

Most significantly, the Scientific and Technological Research Council has developed a series of competitive funding programmes, including research and travel grants, scientific exchange programmes, and awards (including an award issued in cooperation with the Third World Academy of Sciences), that provide scientists throughout Turkey with the opportunity to secure funds and valuable recognition for their work. Again the competitive nature of these efforts helps to ensure that the best scientists receive the largest amount of funding.

On another front, the Turkish Academy of Sciences, which is only 10 years old, has developed a wide range of activities to assist the nation in reaching new levels of scientific productivity and excellence. For example, the Academy has launched a research funding programme designed to support and honour young scientists. In addition, in order to promote social science research, which is crucially important for social development, the Academy has launched a doctoral fellowship programme in the social sciences that enables doctoral students enrolled in Turkish universities to conduct a part of their studies in universities in foreign countries – with all expenses covered by the Turkish government. Nearly 150 doctoral students have taken advantage of this opportunity to study abroad. The Academy also sponsors post-doctoral social science fellowships in foreign institutions. To date, 90 fellows have benefitted from this scheme.

From its beginning, Academy membership included a broad spectrum of the scientific community. Indeed four of the 10 founding members of the Academy were social scientists and, today, over 10 precent of its 119 members are professors of economics, history, sociology, psychology and political science.

Because of its broad-based orientation, the social sciences have enjoyed a larger presence within the Turkish Academy of Sciences than in many other science academies found throughout the world. This presence must be strengthened even more in the future if the Academy hopes to play a central role in larger development issues.

The fact is that no country – and particularly no country with a predominantly Muslim population – can hope to achieve sustainable economic or social development by relying solely on the natural and physical sciences. While such a reliance may play a critical role in the advancement of technology, the social sciences remain instrumental in addressing issues related to the human condition. Such critical issues – for example, economic equity, gender equality and human well-being – cannot be addressed in a systematic scientific way without sound research in the social sciences.

In addition to the large number of social scientists, the Turkish Academy of Sciences also has a high percentage of women members. Indeed, women comprise more than 13 percent of the Academy's membership, one of the highest percentages among academies worldwide. In fact, the global average of female membership in science academies is just 3 percent; in Europe it is 5 percent; and in the United States it is 6 percent. Among Islamic countries, Turkey also has a very high percentage of women holding academic posts

– a respectable 37 percent, higher than in most European countries.

Despite this encouraging news, it nevertheless remains critical for Islamic countries, including Turkey, to confront the low status by women within their societies. Both public officials and the public at large have displayed too much caution and timidity when dealing with this issue and this is one of the main reasons why Islamic societies find themselves in such poor states of development today. Girls' and women's education is crucial for the well-being of society – for scientific education, for the nurturing of critical thinking skills and for the human capacity needed for sustainable development.

Several religious principles regarding women in Islam, although progressive at the time they were first presented a millennium ago, are no longer compatible with today's economic realities and lifestyles. Women, in fact, must now have equal status with men in society, not just for their sake but for the sake of society itself. Social scientists within Muslim countries, in particular, have an obligation to address this issue in order to provide a sturdy intellectual framework for moving this issue ahead as a counterpoint to more fundamentalist interpretations of the role of women in the Islamic world.

Muslim countries must also make a concerted effort to promote women's literacy, the education of girls at all grade levels, and their entry into scientific and managerial positions in society. Having more women actively involved in scientific professions and leadership positions in the Muslim world would go a long way towards building the human capital that is necessary for the overall advancement of these societies.

A recent study of 192 countries, conducted by the World Bank, has shown that human and social capital accounts for no less than two-thirds of a nation's growth in gross domestic product. This human factor, which is often short-changed in the West, has been truly neglected in the non-Western world – particularly when it comes to women in countries with predominantly Muslim populations. Societies that fail to educate girls and do not give women ample opportunities to develop and advance their careers are failing to exploit 50 percent of their human resource potential. This is a handicap that no society can overcome.

What should the role of science academies be in promoting a culture of scientific excellence in Muslim societies, particularly when it comes to science education and the promotion of science within their societies?

Religious education cannot – and should not – replace basic academic education that is designed to instil critical thinking skills in young people. Although cultural values should be integrated into education, careful assessments should be made on whether these values are compatible with the forces shaping modern societies worldwide. Countries with predominantly Muslim populations should be ready to discard those practices and patterns of behaviour that are clearly behind the times and detrimental to their nation's economic and social well-being. Behind Turkey's progress lies its secular laws, ensuring secular scientific education and upholding gender equity and the right to education for all.

Social and natural scientists, historians, economists, philosophers – and not just theologians – should all become involved in this critical discussion, which is, after all, shaping perceptions not only of our current society but also the options that lie before us as we seek to meet the challenges of an ever-changing world. Knowledge of other religions and not only of Islam should be part of religious education in Muslim societies. Emphasis should be placed on moral thinking and not on dogma.

Academies of science in Muslim societies can and should be prominent participants in these discussions and, at the same time, serve as centres of change and progress. The contributions that academies can make to the promotion of reform in Islam and to the creation of pathways for modern interpretations of the Quran could prove instrumental in our societies' efforts to remain true to their religious and cultural heritage while simultaneously sensitive – indeed receptive – to the changing world in which we all live. ■

Çigdem Kagitçibasi
Turkish Academy of Sciences
Professor of Psychology
Koç University, Istanbul, Turkey

CONFLICT OR HARMONY?

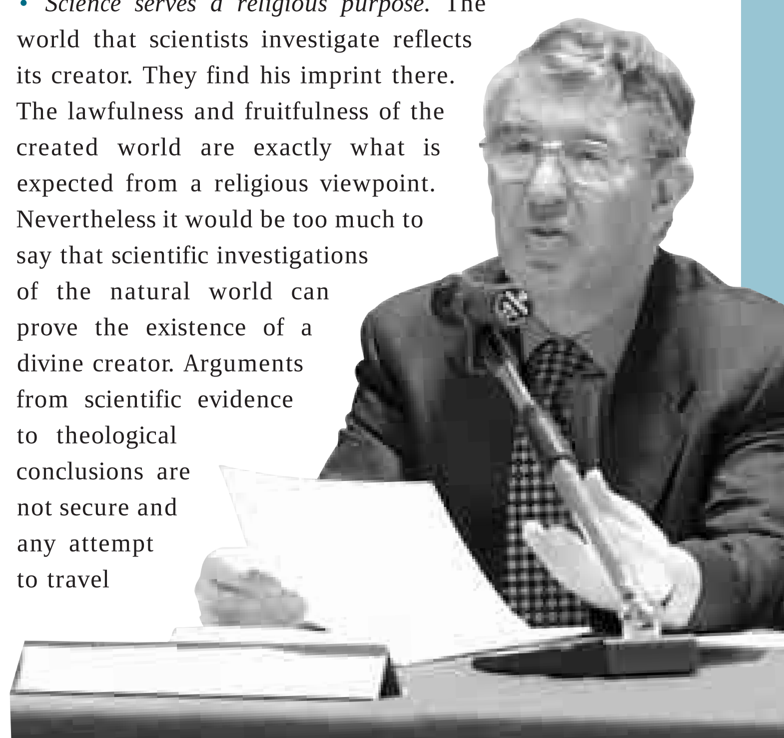
FRASER WATTS, AN INTERNATIONALLY RENOWNED SCHOLAR, CALLS FOR A HARMONIOUS RELATIONSHIP BETWEEN SCIENCE AND RELIGION BASED ON MUTUAL RESPECT AND UNDERSTANDING FOR THE WONDERS AND MYSTERIES INHERENT IN OUR NATURAL WORLD.

Proponents of both science and religion have sometimes seen a conflicting relationship between these two global forces.

There are those, for example, who see the revelations of their own religion as absolute, and science as something that cannot be accommodated with it. Conversely, there are those who see science as the modern path to truth, and religion as irrational and obsolete.

I do not believe there is conflict between science and religion. Indeed here are some reasons for assuming a positive relationship between the two.

- *Notions of conflict are recent.* Science flourished during the golden age of Islam as well as the so-called 'scientific revolution' in Christendom. Moreover, many of the world's greatest scientists – Isaac Newton, for example – were deeply religious.
- *Religious traditions helped give rise to science.* Religious principles assume that the world is orderly and lawful, reflective of its creator, and so amenable to systematic investigation. Religious principles also assume that the world is contingent and reflects the absolute free will of its creator. These two assumptions, lawfulness and contingency, set the stage for making science a fruitful pursuit.
- *Science serves a religious purpose.* The world that scientists investigate reflects its creator. They find his imprint there. The lawfulness and fruitfulness of the created world are exactly what is expected from a religious viewpoint. Nevertheless it would be too much to say that scientific investigations of the natural world can prove the existence of a divine creator. Arguments from scientific evidence to theological conclusions are not secure and any attempt to travel



such a path is to misunderstand the nature of faith.

What kind of relationship can there be between science and religion? One solution, which I reject, is the 'apartheid' solution of separate, independent development.

People sometimes imagine that science and religion each occupy their own territory, and that if each stays within its proper borders, a harmonious relationship between the two is possible.

However, neither can be content with this approach. Both science and religion, in different ways, have something to say about everything.

A better solution is to see science and religion as complementary forces that examine fundamental factors from different perspectives – answering different questions but focusing on the same reality.

The relationship between science and religion must be based on mutual respect. Science is not a religion and should not be turned into one. Elements of faith certainly exist within science overall and, perhaps, in particular theories. But science is not a religion.

Equally important, religion is not science. However lofty a view we have of the scriptures, they do not constitute a scientific textbook. As Galileo quipped, the scriptures "teach us how to go to heaven, and not how the heavens go." A fruitful and harmonious relationship between science and religion must be based on recognising the distinctiveness of each.

Both science and religion, moreover, should remain humble pursuits.

The grandiose view of science associated with logical positivism has been progressively abandoned. Many observers now agree there are no raw facts – that everything is selected and interpreted within a theoretical context. Many observers also recognise there is no linear, inexorable progress in science, but only complex historical developments that include periodic paradigm shifts. There is agreement, too, that there is no dependable logic by which scientific conclusions are reached. As Karl Popper, one of the 20th century's greatest of philosophers of science, noted: The only sure things that drive science are "conjectures and refutations."

Both science and religion, in different ways, have something to say about everything.

Religion is also most true to itself when it is humble. Religious truth takes us into the realm of mystery where we need to tread softly out of respect for the world we are entering. It is arrogant for humans to imagine they can grasp spiritual truths completely. When tinged with arrogance, religion does no good. It no longer provides people the space they need to move and grow towards divine truth and fulfilment. Instead religion makes them closed and stunted.

The relationship between science and religion has been explored most vigorously within the context of Christianity. However, those who have pursued the relationship within this context have much to learn from people of other faiths.

We live in a time of growing and understandable concern about the peace and stability of the world order. It is important to think about science and religion in this context, especially in relation to these two propositions:

• Science is the world's most genuinely international movement and therefore a force for peace and stability.
• Religion is closely associated with national, racial and cultural identity and therefore a source of tension and instability in the world.

There is obviously much plausibility in these propositions. But the world is not so simple, and thus it is

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worth considering both science and religion more closely.

SCIENCE

Science is not as culturally neutral and value-free as is sometimes supposed. The United States and other Western countries dominate contemporary science. This alone is enough to suggest that science is not always perceived as culturally neutral. But more is at stake here than global politics and how science is viewed beyond the developed world.

Science has arisen out of what is sometimes called modernity. The roots of early modernity lie in the 17th century and have continued to develop in a slightly different form in the more secular post-Darwinian terrain of the 19th century. A key aspect of modernity has been the search for objectivity – a neutral, value-free vantage point that sheds cultural contexts.

If it is objective in that sense, science should be invariant and unchanging. Third World science should be no different from science in the developed world, and there should be no difference between the science of Islamic and Christian countries.

Philosophers of science, like historians of science, have become skeptical of these claims. Indeed philosophers have become skeptical about the very idea of being free of any particular vantage point. As Thomas Nagel, professor of philosophy, New York University, USA, put it, "there is no view from nowhere." Background assumptions always creep in. Let me cite two brief examples of how such background assumptions are never far from the foreground.

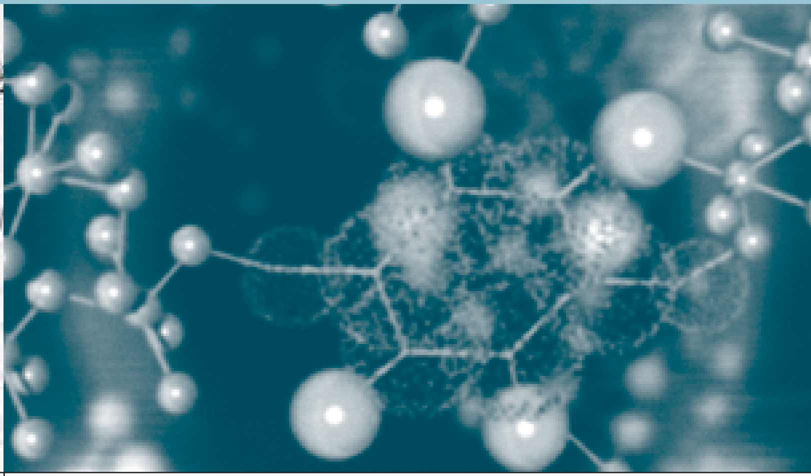
First, science often proceeds by models and analogies. How we understand the world depends on the analogies we have developed. Science fosters technological innovations that, in turn, provide the basis for models which spur subsequent scientific inquiries. For example, clockwork mechanisms served as models in early modern science. Similarly, computer networks often serve as models in contemporary science.

Second, science is driven by the needs of the broader society. Notoriously, warfare drives scientific advances, channelling it in certain directions. If the world had been peaceful in the 20th century, science would certainly have proceeded along a different path.

I continue to believe, however, that science is a supreme achievement of human rationality.

True, rationality is not a matter of cold logic, but of human judgment. True, it can be distorted by the career-building needs of scientists and other non-rational factors. And true, scientific progress is not inexorable. What seem secure findings today may need to be reconsidered in light of future paradigm shifts. Nevertheless science remains a paradigm of human rationality and the world's most compelling force for progress.

Despite its unquestioned impact, science has in some ways been unnecessarily narrow in its approach.



Does that mean we should abandon the hard-won quest for objectivity that has proven so fruitful, even when this quest has not been as pristine as sometimes claimed? I would say "no", but I do believe there should be a broadening of science, both in method and theory.

Methodologically, the human element in science should receive greater recognition. Specifically, more respect should be paid to the imaginative enterprise that science is. Because scientific enterprise depends on human judgment and imagination, it can never be purely mechanical. Too little attention has been given to how scientific discoveries are made, as opposed to how they are demonstrated.

Theoretically, I would like to see an emancipation of the range of entities and processes that science is prepared to postulate. Physical science has already moved a long way from assuming that all scientific explanations need to be framed in terms of micro-particles, to postulating fields and forces, and then onto the strange world of quantum mechanics. Another broadening urgently needed is to give more weight to top-down explanations in biology, such as those derived from ecology, to balance the current emphasis given to bottom-up explanations derived from molecular biology and biochemistry. Science needs to move beyond the reductionist mindset which, if pushed too far, becomes inhuman and distasteful.

It is also important to have a humble view of science. My own intuition is that we are merely at the foothills of scientific inquiry, and that the scientific world view in a few centuries will be radically different from our own. That we have yet to put together relativity theory and quantum mechanics suggests this is the case, as is the absence of a viable neural theory of consciousness.

Science must be further emancipated, both methodologically and theoretically, to facilitate scientific progress and foster a humane science more congenial to the faith traditions of the world.

Secularisation may be occurring in parts of Europe, but most of the world remains deeply religious.

RELIGION

The current, apparently divisive, impact of religion on the world order undermines the idea that the world is becoming more secular. Secularisation may be occurring in parts of Europe, but this is the exception not the rule. Most of the world remains deeply religious.

While there are common elements in the world's religions, there are important differences too. The important point is that the world's religions are not the same; nor should they be.

Moreover, it would be a mistake for religion to try to imitate the objectivity and internationalism associated with science. People adhere to religious traditions in part because they are *their* religions, not someone else's. There would be no more enthusiasm for a neutral world religion than there is for speaking *Esperanto*.

Indeed it may be misleading to talk about 'religions' at all. The world's faiths differ from one another in too many important ways.

For example, some religions are more elective than others, in that people choose to join them (Buddhism in the West, for example). Others are more intertwined with cultural identity. To ask a Hindu or a Jew what is

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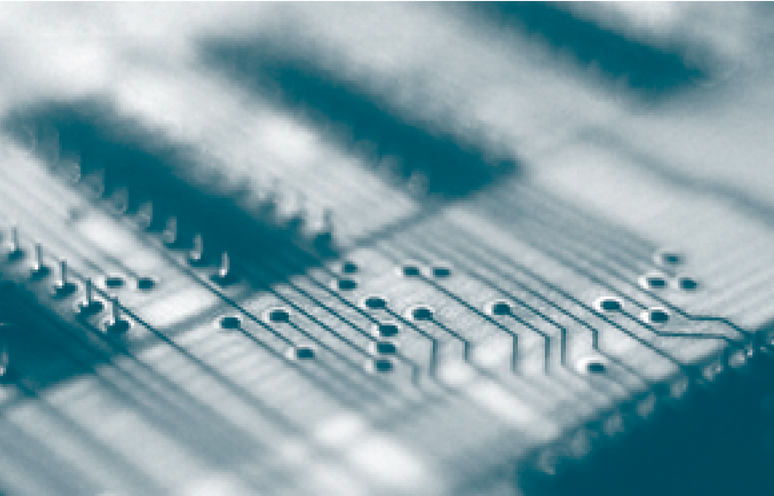


his or her ‘religion’ is a strange question. Such faiths are concerned with cultural identity as much as private experience, morality and salvation.

A key question is exactly what is the relationship between faith, cultural values and identity. Religions certainly arise from, and give expression to, cultural identity. But at their best, they help people to transcend their cultural identity and reach out to those beyond their own faith. In short, at their best, religions help humanity move beyond cultural specificity.

Science’s achievements are as much spiritual as theoretical and technological.

Let us look at the teaching of Jesus, for example, who is widely revered as a prophet, even in the Islamic world. Ancient Jews embraced a strong tradition of neighbourliness toward their own people but Jesus challenged them to expand their concept of neighbourliness to non-Jews. Jews also had a strong sense of being a chosen people but Jesus taught them that God’s salvation was for Samaritans and others, not only for themselves.

These are lessons that Christians have been slow to learn. Instead they have often seen themselves as a chosen people. I suspect Jesus would say to the Christian church, as he said to his own people, that it should look beyond its own community.

Increasingly, we also need to make a distinction between healthy and unhealthy forms of religion. What form a person’s religion takes may be more important than the faith to which he or she adheres. Unhealthy religion is socially exclusive, with in-groups and out-groups. It is closed and dogmatic in its thought and leaves people with no space in which to grow spiritually.

We should not seek to abandon particular religious traditions. That would be both futile and inappropriate. Proponents of different faiths, however, should be open and flexible, both socially and cognitively.

Here science may help. While the objectivity of science can be exaggerated, it remains one of humanity’s greatest achievements. Science’s achievements, moreover, are as much spiritual as theoretical and technological. It represents one of the pinnacles of humanity’s search for truth, humility, open-mindedness, and tolerance.

The spiritual achievement that science represents poses a challenge to the world’s religions: Can the world’s different religions embrace a search for truth, humility, open-mindedness and tolerance without abandoning their distinct identities?

I care deeply about the dialogue between science and religion, first because I hope it will lead to a less arrogant, more religiously sympathetic science, and second because I hope that science can help religion to become more open and humble. ■

Fraser Watts
Starbridge Lecturer in Theology and Natural Science
University of Cambridge
Secretary, International Society for Science and Religion
Cambridge, United Kingdom

WHAT'S NEXT ?

PARTICIPANTS AT THE WORKSHOP ON CAPACITY BUILDING FOR ACADEMIES IN COUNTRIES WITH PREDOMINANTLY MUSLIM POPULATIONS, HELD IN TRIESTE ON 5–6 MARCH 2003, ISSUED THE FOLLOWING STATEMENT AT THE END OF THE EVENT.

The statement offers a roadmap for enhancing the role of science within their societies and, more specifically, examines how science academies may help in this effort. Here's how they summarized what they discussed at the workshop and what participants plan to do next.

Participants agreed that their discussion emphasized that:

- Science and technology play key roles in enhancing education, building knowledge-based economies, and promoting poverty alleviation and sustainable development.
- Human resource development in science and technology has become an imperative for all countries.
- Positive interactions with, and contributions from the private sector are critical elements both for building the scientific and technological capacities of nations and for wealth creation.
- Members of the Organization of Islamic Countries (OIC), while presenting a varied picture, in general seriously lag behind in science and technology investments and in relevant indicators.
- Science academies can play, and in several countries have played, useful roles in encouraging scientific excellence and providing a service to their nations.
- Communication and cooperation, both among OIC countries and between them and other countries, is critical for scientific advancement and for successfully meeting national and global challenges, as well as for encouraging mutual understanding.

As a result, participants agreed to work toward the following goals:

- Sciences academies in OIC member countries should continue to develop the key factors of quality of membership; inclusion of the full range of natural, technological, and social sciences; involvement of women; and excellence in service to their countries and humanity at large.
- OIC member countries that do not have a science academy are encouraged to establish academies in their respective countries when their scientific community reaches a feasible size, and to use regional approaches to help in other cases.
- Academies should develop the ability to provide advice to governments, the private sector and other stakeholders, calling on expertise within and outside their membership, so that they can play a pivotal role in contributing to national development plans and in providing inputs to policy development in areas of science and technology critical to innovation and economic growth.
- Academies should provide critical and constructive contributions to the development of national human resources in primary, secondary, and higher education, and in the public understanding of science.

Furthermore, participants recommended that the governments of OIC member countries:

- Identify areas for which they believe that science academies can provide expert input or otherwise be of service to their nations and their publics.
- Create sizeable endowments and/or provide other forms of support to science academies, commensurate with the growing role of science and technology in our global society.

Ana Maria Cetto Kramis

CETTO TO IAEA

• **Ana Maria Cetto Kramis** (TWAS Fellow 1999) has been appointed Deputy Director of Technical Co-operation for the International Atomic Energy Agency (IAEA) in Vienna, Austria. Cetto graduated from the *Universidad Nacional Autónoma de México* (UNAM) with a degree in physics, received an MA degree in biophysics from Harvard University, USA, and then returned to UNAM to obtain an MSc and PhD in physics. At UNAM's *Istituto de Fisica*, her research in theoretical physics included studies on the interaction of light and matter, the foundations of quantum mechanics, and the theory of stochastic electrodynamics. Cetto Kramis previously served as a consultant with the Science Sector and member of the International Scientific Advisory Board of the United Nations Educational, Scientific and Cultural Organization (UNESCO) in Paris, France. She is a founding vice-president of the Third World Organization for Women in Science (TWOWS).

CHAUDHARI TO BROOKHAVEN

• **Praveen Chaudhari** (TWAS Associate Fellow 1988) has been appointed Director of the US Department of Energy's Brookhaven National Laboratory in Brookhaven, New York. Chaudhari holds a BS degree from the Indian Institute of Technology and MS and PhD degrees from the Massachusetts Institute of Technology (MIT), USA. He joined IBM's Research Division in 1966 and, after serving as Senior Manager of Research, was appointed Director in 1981 and then Vice-President of Science in 1982, remaining in that post until 1991. Under his leadership, IBM scientists were awarded two Nobel Prizes in

Praveen Chaudhari

physics, and materials research conducted at IBM became the basis of the $2 billion-a-year optical disk industry. As a scientist, Chaudhari has received a number of national and international awards for his research on the structure and properties of amorphous solids, the mechanical properties of thin films, and quantum transport in disordered systems. For the past four years, he has been the head of the Scientific Council of the Abdus Salam International Centre for Theoretical Physics (ICTP) in Trieste, Italy. Chaudhari begins his duties in Brookhaven on 1 April.

UNESCO/L'ORÉAL AWARDS

• Members of both TWAS and TWOWS (Third World Organization for Women in Science) are among the 2003 L'Oréal-UNESCO Awards for Women in Science.

Fang-Hua Li

Fang-Hua Li (TWAS Fellow 1998), Institute of Physics, Chinese Academy of Sciences, Beijing, was honoured for her work on the electron microscopy of crystals. More specifically, she has developed a computer programme, "deconvolution," that eliminates distortions and artefacts in high-resolution images caused by interference and diffraction. The L'Oréal/UNESCO awards committee also honoured **Karimat**

Karimat El-Sayed

Credit: Micheline Pelletier/Corbis Sygma

El-Sayed (TWOWS member), professor of solid state physics, Ain Shams University, Cairo, Egypt. El-Sayed was chosen for her research examining how the distribution of atoms and impurities inside metallic and semi-conductor materials affects the physical properties of such materials. In addition, El-Sayed has done extensive studies on the status of women scientists in Egypt, showing that the low number of female researchers in physics does not arise from a lack of talented students or even from discrimination on the part of the teaching staff, but is due instead to unending tensions between career and family. Established in 1998, the UNESCO/L'Oréal Award for Women in Science, which carries a US$100,000 cash prize, has become the world's most prestigious award for women scientists. For additional information see www.forwomeninscience.com.

BARRANTES INTERNATIONAL FELLOW

• **Francisco J. Barrantes** (TWAS Fellow, 1993), head of the *Instituto de Investigaciones Bioquímicas de Bahía Blanca* (INIBIBB), and holder

Francisco J. Barrantes

of the UNESCO Chair of Biophysics and Molecular Neurobiology in Bahía Blanca, Argentina, has received one of the International Fellowships of the Sarojini Damodaran International Trust, an international programme administered by India's Tata Institute for Fundamental Research. Former awardees include the internationally renowned cosmologist Stephen Hawkins of Cambridge University and Baldomero Olivera, a world renowned marine toxicologist from the University of Utah, USA. As an award recipient, Barrantes will present a series of lectures in India in 2003 on subjects related to his main field of research, neurotransmitter receptors.

Peter Raven

RAVEN HEADS SIGMA XI

• **Peter Raven** (TWAS Associate Fellow 1993) has assumed the post of president of Sigma Xi. Founded in 1886 as an honour society for science and engineering, Sigma Xi, which is headquartered in Research Triangle Park, North Carolina, USA, is today an international research society with 75,000 members. Raven is director of the Missouri Botanical Garden and Engelmann Professor of Botany at Washington University, St. Louis, Missouri. One of the world's most noted botanists and environmentalists, Raven is former president of the American Association for the Advancement of Science (AAAS), a recipient of Japan's International Prize in Biology, and a winner of the Volvo Environment Prize (1992). He is the co-founder of the Flora China project, an effort to produce an encyclopaedia of China's 30,000 plant species. His major fields of interest are plant systematics and evolutionary ecology, biodiversity, and conservation and sustainable development.

TWAS AND IAP IN THE NEWS

• *Nature* (13 March 2003, Vol. 422, pages 99 and 101-102) published both a news article and an editorial based on discussions and observations made at the Science, Religion and Values workshop held in Trieste, Italy in March 2003, which is the focus of this edition of the *TWAS Newsletter*. The *Nature* articles can also be downloaded in pdf format from the InterAcademy Panel website at www.interacademies.net/iap.

Ehsan Masood, the London-based journalist who contributed the article on page 5 of this edition of the *TWAS Newsletter*, also published a brief news item about the Science, Religion and Values workshop on *SciDev.net*, a web portal devoted to science and development issues that is co-sponsored by *Science* and *Nature* in cooperation with TWAS. See www.scidev.net.

Nature, 13 March 2003, Vol. 422

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

The main objectives of TWAS are to:

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

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

TWAS also played a key role in the establishment of the Third World Organization for Women in Science (TWOWS), which was officially launched in Cairo in 1993. TWOWS has a membership of more than 2000 women scientists from 87 Third World countries. Its main objectives are to promote research, provide training, and strengthen the role of women scientists in decision-making and development processes in the South. The secretariat of TWOWS is hosted and assisted by TWAS. ···> **www.twows.org**

Since May 2000, TWAS has been providing the secretariat for the InterAcademy Panel on International Issues (IAP), a global network of 85 science academies worldwide established in 1993, whose primary goal is to help member academies work together to inform citizens and advise decision-makers on the scientific aspects of critical global issues. ···> **www.interacademies.net/iap**

WANT TO KNOW MORE?

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

FELLOWSHIPS

Want to spend some time at a research institution in another developing country? Investigate the fellowships and associateships programmes:
www.twas.org/Fellowships.html
www.twas.org/AssocRules.html

GRANTS

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

EQUIPMENT

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

TRAVEL

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

CONFERENCES

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