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NATO'S SCIENCE PROGRAMME AND THE COMMITTEE ON THE CHALLENGES OF MODERN SOCIETY - International Collaboration in Technoscience

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"If politics is the art of the possible,
research is surely the art of the soluble."

Peter Medawar (1969)

In the sixties while reading Sir Arnold Toynbee's 12 volume work, A Study of History, I noticed that he made only six passing references to Newton, while referring at least ten times as frequently, and often at great length, to Napoleon. As I was heavily involved in space communications work for NATO at the time I was particularly astonished at Toynbee's lack of historical perspective, because I believed then as now that Newton's impact upon history was greater than Napoleon's.

Not withstanding the above, few people would deny that the achievements of science and technology have changed our lives in the past century; much of that change being to our benefit. Just consider the transformation of domestic life that technology has produced, the progress of modern medicine, and the green revolution in food production, without which an even larger fraction of the world's population would now be starving

How can we explain the curious contradiction in the public attitude to science? How can we account for the combination of respect and indifference? I wonder if this is due to what social psychologists call cognitive dissonance. Whenever people perceive a discrepancy between one of their attitudes and another, an unpleasant state of dissonance results. The discrepancy that accounts for the confusion in public opinion about science may be the contrast between the undeniable evidence, all around us, of the power of science, combined with ignorance of the nature of science and suspicion about its claims and motives.

We must be clear in our minds as to what science really is and what distinguishes it from other human activities. Then we can address questions such as how important science is for the public and public affairs and why science is important for NATO, an organisation founded fifty years ago "to safeguard the freedom and security of all its members by political and military means in accordance with the principles of the United Nations Charter".

WHAT IS SCIENCE?

The word 'science' is commonly used, yet most of us would be hard pressed to give a precise definition of this common activity.

The dictionary definition of science is: “The study through observation and experiment of the structure and behaviour of the physical and natural world and society including a particular area of this such as the science of engineering, medical science, computer science, etc.”.

How useful this definition is in differentiating between what counts as science and what does not, is questionable; this distinction between the use of an expression and the analysis of its meaning is not easy to grasp. We may shed some more light on the subject by considering the different features and characteristics of the word ‘science’ and the associated word ‘technology’.

Actually science is not an activity but a product of a human activity called research, just like the other commonly used word ‘technology’, which is the product of another human activity called development. The two words ‘science’ and ‘technology’ (S&T) and the words ‘research’ and ‘development’ (R&D) often go together and are sometimes used interchangeably; the word ‘science’ is used to mean knowledge but sometimes it refers to the human activity itself which is research. Development is associated with engineering and technology and generally with problem solving. The word ‘research’ is often prefixed nowadays with words like ‘pure’, ‘basic’, ‘applied’, ‘directed’, ‘military’ or ‘civil’, or ‘government-’ or ‘privately-funded’.

Notwithstanding the prefixes, research and development have several important features in common; they both involve something done and understood for the first time, they both carry out experiments, make predictions and explain the results obtained by reference to the Laws of Nature. Another fact well known to the worker in R&D is that R&D activities do not always produce the results expected and are therefore uncertain and risky.

R&D always constitutes the smallest portion of all the activities in an establishment and society; R&D expenditures hardly exceed three per cent of a country’s GNP and vary between one and 15 per cent of industrial sales. These percentages for developing countries are often an order of magnitude less than those for advanced countries. It is ironical that developing countries pay much less attention to and make much less use of science and the scientific method in government, industry and in decision making in general than do the more advanced countries. This may partly be due to the difference between what may be called ‘a politician’s time constant’, which is the time span between two consecutive elections, and the time difference (often measured in tens of years) between an investment in science and its return in the form of a product.

After this diversion as to what science is and is not we may conclude that notwithstanding the different aspects and shades of meaning that science and technology have, they are essential and vital for our well-being as well as for our defence. This logically leads us to accept the proposition that there is good justification in investing not only in technology (technology often builds on technology) but also in basic research, sometimes called fundamental and speculative science, which underpins the spectacular advances in application of technology and understanding.

In the NATO context and elsewhere we find the two words ‘science’ and ‘technology’ often used together, not because of a wrong habit but with some justification based on the observation that old divides between S&T and even between academic and industrial science are disappearing. It would therefore be appropriate to regard both science and technology as part of a single methodology which some call ‘technoscience’.

Science activities are supported in NATO through the NATO Science Programme and the applications of S&T are used in order to find solutions to the social problems which are brought to CCMS by the member countries.

For the sake of completeness we should add here that while the NATO science and CCMS programmes deal essentially with civil R&D, there are, in NATO, other bodies which address the purely military aspects of R&D. The following are examples of such bodies in NATO:

- The NATO Research and Technology Organisation (RTO),
- SACLANT Undersea Research Centre (SACLANTCEN),
- NATO Consultation, Command and Control Agency (NC3A).

The rest of this article will be devoted to discussing the civil technoscientific activities of the science programme and CCMS, which are both managed by the Division of Science and Environmental Affairs in NATO.

SCIENCE IN NATO

What NATO objective is served by non-military science in an organisation that is so overwhelmingly dedicated to security? Part of the answer is embedded in Article 2 of the North Atlantic Treaty. This enshrined the non-military dimension of security and part of it is contained in the 1956 report to the North Atlantic Council of the Three Wise Men—the then foreign ministers of Canada, Italy and Norway—which recognised the special importance to the Atlantic Community of science and technology and asserted that progress in the field of science and technology can be decisive in determining the science of nations and their positions in world affairs.

In accepting the report of a subsequent Task Force on Scientific and Technical Co-operation, the heads of government of the Alliance, at a meeting in December 1957, approved the establishment of a NATO Science Committee. The Science Committee met, almost ten years after the founding of NATO, for the first time in March 1958.

The first meeting of the NATO Science Committee took place however in an atmosphere overshadowed by events of the previous October in which Western science had been dramatically eclipsed by the launch of Sputnik and in which President Eisenhower and Prime Minister Macmillan, in a joint communiqué, had urged the North Atlantic Council to undertake an enlarged Atlantic effort in scientific research and development in support of greater collective security.

The Science Committee was urged by the North Atlantic Council to explore ways of more fully developing science and technology in the Atlantic Community. As a means to this end, it recognised that the training of young scientists and engineers was of paramount importance. It agreed that NATO-financed science fellowships should be provided and that post-graduate international summer study institutes should be established. Proposals for other aids to scientific education were also agreed upon and the Committee discussed ways of furthering research in all fields of natural science of interest to member countries. In keeping with the truly international nature of science and with the principles that gave birth to it, the Committee agreed that the results of NATO-sponsored research would not be confined to NATO countries but would be extended as a cultural bond to peoples in different countries.

The Science Committee conducts activities that accord with four overarching themes. These comprise: (1) improving solidarity among all NATO countries; (2) strengthening the transatlantic relationship; (3) reaching out to Partners; and (4) furthering a relationship with Russia. In addition, engaging in a dialogue with Mediterranean countries is emerging as a theme of future activities.

The Science Programme contributes towards these themes by promoting high quality interactions in pure and applied science. The programme bases its appeal among scientists upon its scientific excellence and its lack of bureaucracy. It draws its support from member nations for the solidarity it engenders in the Alliance and the means it offers to reach out and consolidate relationships with Partners.

The NATO Science Programme is in a period of fundamental change. In March 1998, the Council agreed that the Science Programme should involve a progressive shift of priorities from intra-Alliance to outreach activity. This decision was the culmination of a process begun in 1991 involving a steadily increasing level of Partner participation.

Prior to this decision by the Council, the NATO Science Programme consisted of two components: (1) a series of activities primarily involving co-operation among Alliance scientists, known as 'Intra-Alliance' activities, and (2) those involving co-operation between scientists in the Alliance and scientists in Partner countries known as 'Outreach' activities. The Intra-Alliance component is now being transformed in favour of a Science Programme that is progressively directed to co-operation between Partner and Alliance scientists.

The NATO Science Programme today offers under the aegis of the NATO Science Committee, support for international collaboration between scientists from countries of the Euro-Atlantic Partnership Council (EAPC). Awards are made, in the area of general science or in selected priority areas, following consideration of applications received from individual scientists in EAPC countries. The support for collaboration is channelled through a range of different mechanisms or activities that are designed both to create enduring links between researchers in different countries and to stimulate the co-operation that is essential to progress in science, with the objective of contributing to overall stability and peace.

With the exception of a number of science fellowships, the NATO Science Programme is now dedicated to collaboration between scientists in Partner countries and scientists in NATO countries. Applications for collaboration between NATO-country scientists only can no longer be considered for support.

This shift is reflected in the NATO science budget. While in 1991 only about three per cent of the total science budget of about $28m was allotted to the Outreach Programme, at present it is more than half of the total science budget of about $31m.

In line with the decision to direct support toward collaboration between Partner-country and NATO-country scientists the NATO Science Programme is now grouped into four sub-programmes as follows:

- Science Fellowships: The objective of the Science Fellowships sub-programme is to prepare for the long-term future by training young researchers. Four types of fellowship are generally offered: Basic, Advanced, Senior Fellowships and Senior Guest Fellowships.

• Co-operative Science and Technology: The objective of this sub-programme is to initiate co-operation and to establish enduring personal links between scientists of NATO and Partner countries.

• Research Infrastructure Support: The objective of this sub-programme is to support Partner countries in structuring the organisation of their research programmes and creating required basic infrastructure.

• Science for Peace: The objective of this sub-programme is to support applied science and technology projects in Partner countries, as well as in Turkey and Greece, which are associated with industrial, environmental or security-related problems in Partner countries.

In the four decades of its existence the Science Committee has overseen scientific programmes that have left an enduring mark on science and technology. Many thousands of scientists have been trained under NATO auspices. NATO sponsored Advanced Study Institutes have provided forums in which some of the world's leading scientists have imparted to others their knowledge, ideas and enthusiasm while NATO-sponsored Advanced Research Workshops have often provided mustering points for successful assaults on the frontiers of many disciplines.

Today about 13,000 scientists from NATO and Partner countries take part in the NATO science programme each year, as grantees and meeting attendants, or as referees and Advisory Panel members.

More applied efforts, such as the Science for Stability Programme, have helped to harness the scientific potential of Greece, Portugal and Turkey. The Science for Peace Programme, by means of co-operative scientific and engineering projects, promises to establish links between NATO and the Partner Countries where hitherto none existed.

We may sum up the benefits derived from co-operation under the Science Programme as:

• enhancement of the quality of science in all participating countries,

• the creation and strengthening of international networks of scientists, resulting in higher levels of knowledge exchange and trust among the participants,

• promotion of greater stability in science communities undergoing turbulent changes,

• contributing to public perceptions of NATO as being more than a military alliance alone.

Ulu¤ Bey, an astronomer and grandson of Timurleng, working in Samarkand in the fifteenth century, proclaimed that "Religions dissipate like fog, kingdoms vanish, but the works of scientists remain for eternity." Thus will many of the scientific fires that NATO has lighted burn and propagate. Scientific accomplishment and, more important, stability and security will serve as enduring testimony to the success of and justification for the NATO Science Programme.

THE CHALLENGES OF MODERN SOCIETY

It was almost exactly thirty years ago that NATO governments began to look seriously beyond the immediate economic and political problems of the post-war world, and to examine ways to improve the quality of life of their citizens. It was fortunate that governments took this step when they did: the skies were becoming polluted at an alarming rate; industrial and municipal waste was beginning to strangle the rivers, lakes and seas; transportation systems were becoming heavily congested; and ancient monuments were fast disintegrating under the onslaught of airborne chemicals. It was against this backdrop that the United States proposed, in April 1969, at NATO's twentieth anniversary meeting in Washington, that the alliance establish a new body to "explore ways in which the experiences and resources of the Western nations could most effectively be marshalled toward improving the quality of life of our people". Later that year, the North Atlantic Council agreed to establish the Committee on the Challenges of Modern Society (CCMS) as a regular committee of the council. CCMS together with the Science Committee thus became NATO's 'third dimension', complementing the alliance's already strong military and political roles.

From the start, it was understood that CCMS would be a new kind of organisation, revolutionary in mission and operational methodology. CCMS was to further the political aims and overall cohesion of the alliance, but focus tightly on a limited number of specific problems. Moreover, it would give experts in member countries sufficient latitude to go about their business without having to report to a cumbersome international bureaucracy. The concept seemed naïve to some at the time, but CCMS soon proved an effective tool for international co-operation, particularly in the public health and environmental realms, where most of its efforts were concentrated.

In its early days, CCMS played an important part in the development of treaty law. To cite one example, a CCMS technical study on oil spills, initiated in 1969, led to a NATO resolution calling for an international effort to prevent further degradation of the world's oceans. Subsequent negotiations produced the International Convention for the Prevention of Pollution from Ships (MARPOL), a landmark agreement in the field of international environmental law.

With the global environmental awakening of the 1970s, it became apparent that NATO was perhaps not the most appropriate forum for addressing the legal aspects of such far reaching global environmental problems as marine pollution, ozone depletion, climate change, and the loss of biological diversity. Nevertheless, its early and decisive leadership in some of these areas was to serve as a catalyst and inspiration for much of the work of other organisations that was to follow.

The 1970 Stockholm Conference on the Human Environment soon gave birth to the United Nations Environment Programme (UNEP), which became responsible for co-ordinating most of the international community's efforts to address global environmental issues. Other organisations such as the Organisation for Economic Co-operation and Development (OECD), the World Health Organisation (WHO), the International Maritime Organisation (IMO) soon found their own niche in this movement, and began to assume some of the important work that had previously been pioneered by NATO.

Taking advantage of the scientific, technical and organisational expertise found within the alliance, CCMS became a leading international forum for the exchange of information, research and new technologies on a wide-range of environmental and cultural matters. The list of environmental topics addressed by this Committee to name just a few is quite impressive: air pollution, water pollution, spill response, hazardous waste clean-up, disaster preparedness, noise abatement, indoor air pollution, risk assessment, pollution prevention, pollution from radioactive waste stored on land and sea, and the storage and dumping of chemical weapons.

CCMS has also had a seminal role in studies and action to protect our cultural heritage. Some of the earliest and best work on the preservation of historic monuments, buildings, and art was carried out by this Committee. Several current international initiatives to preserve our treasured cultural heritage are indebted to talented NATO country scientists for breaking new ground in this field.

CCMS continues to adapt and adjust as new challenges present themselves. One of the best examples of this is the Committee's focus, over the last several years, on defence-related environmental issues.

Examples include: pilot studies on 'Defence Environmental Expectations', resulting in guidelines on environmental training and principles which have been adopted by the North Atlantic Council; 'Environmental Aspects of Re-Using Former Military Lands', assistance for Partners converting former military bases to civilian use; 'Environmental Security in an International Context'; and 'Environmental Management Systems in the Military Sector'.

Two important concepts characterise the work of the Committee, namely, that the work should lead to concrete action and that its results should be entirely open and accessible to international organisations or individual countries elsewhere in the world. For each project embarked upon, one or more nations volunteer to assume a pilot role, which includes taking responsibility for planning and financing the work, co-ordinating its execution, preparing the necessary reports and promoting follow-up action.

At the May 1989 NATO Summit, the heads of state and government again highlighted the role of CCMS by recognising the importance of safeguarding the environment and by agreeing that the CCMS should expand its programme with new initiatives.

In November 1991 in Rome, the heads of state and government of Alliance countries issued a Declaration on Peace and Co-operation which defined the future tasks and policies of NATO in relation to the evolving partnership and co-operation with countries of Central and Eastern Europe. In this Declaration, co-operation and dialogue in scientific and environmental fields were outlined as follows: "Our new initiative will enhance participation of our partners in the Third Dimension of scientific and environmental programmes of our Alliance".

On 10 March 1992, the Workplan for Dialogue, Partnership and Co-operation issued at the meeting of the North Atlantic Co-operation Council (NACC) included enhancement of participation of Co-operation Partners' experts in CCMS activities. The first plenary meeting of NATO/CCMS with NACC counties was held on 23 February 1993 in Brussels. Senior officials of ministries of defence, foreign affairs and environment participated in this meeting. Co-operation Partner representatives listed many environmental challenges confronting their individual nations and expressed their interest in having NATO's Committee on the Challenges of Modern Society help to address these problems. All recognised that the CCMS represented a unique forum for the exchange of information, on both civilian and military environmental matters. It was agreed that Co-operation Partners could propose new pilot studies provided there is an Alliance country as co-pilot and at least two other Alliance countries as participants.

The Euro-Atlantic Partnership Council (EAPC) was inaugurated following the ministerial meeting of the NACC, held on 30 May 1997. The EAPC is a new co-operative mechanism that replaces the NACC and builds upon the successful political and military co-operation established under the

NACC and Partnership for Peace. It provides the overarching framework for political and security-related consultations. The member countries of the Euro-Atlantic Partnership Council are the 16 member countries of NATO, plus the 28 former NACC or Partnership for Peace countries.

Since 1996 the Committee has introduced new tools for co-operation within the framework of the CCMS Programme. These include ad hoc 6-18 month projects focused on specific topics and workshops to disseminate information in well-defined areas. In this context, two projects have been completed: ‘Development of an Environmental Handbook’, co-directed by the United States and Sweden; and ‘Review of On-going Black Sea Projects for the Planning of Future Activities’, led by Turkey and the United States and one project is underway: ‘Review of Environmental Projects of the Caspian Sea for the Planning of Future Activities’, led by Turkey and the Russian Federation.

In accordance with the EAPC Action Plan for 1998-2000, the Committee on the Challenges of Modern Society is broadening its work to include joint meetings with NATO’s Partners and seminars on defence-related environmental issues, as well as new pilot studies on topics of particular interest to Partner countries. In future it will be possible for a Partner country to assume the role of co-director of a pilot study, working with a co-director from a NATO country. At least two other Alliance countries must be participants.

Meetings of the CCMS with EAPC Partner country representatives take place annually. Activities initiated or under discussion include pilot studies on aspects of cross border environmental problems emanating from defence-related installations and other activities, focusing particularly on: radio-active pollution; damage limitation and clean-up methodology for contaminated former military sites; protection of the ozone layer; environmental security; and work on the interrelationship of defence, the environment and economic issues. These are all designed to identify environmentally sound approaches to the operations of armed forces both in Alliance and Partner countries.

Since the start of CCMS activity, 56 pilot studies and two short-term ad hoc projects have been completed. Eighteen pilot studies and one ad hoc project are presently underway.

Right from the beginning Turkey took a special interest in CCMS. In fact the CCMS was established under the direction of Prof. Nimet Özda? who was then assistant secretary-general for Scientific and Environmental Affairs. Turkey hosted the CCMS pilot study on air pollution, a topic that still remains high on the environmental agenda of the Committee and many of the governments. The silver anniversary of CCMS was celebrated in Istanbul in 1994 on the occasion of the Committee’s plenary meeting. The following are some excerpts from the welcoming address made at the meeting by Mr. Murat Karayalç›n who was then the Deputy Prime Minister:

“I have been briefed by Prof. İnce on the past and present activities and projects of the CCMS, all of which concern the well-being of society and its environment, upon which my government, like the other governments, places vital importance. However, it is one of the great challenges of our time to find a proper and appropriate balance between rapid and effective economic growth on the one hand and a clean environment and healthy society on the other. In trying to find a path we, here in Turkey, have sometimes erred on the side of expediency and efficiency and caused some self-inflicted pollution to the environment and society. I would like to add, though, that we are doing our best to try and remedy some of the ill effects of the past actions.

However, not all our pollution–be it of the land, sea or air is of national origin. In fact quite a lot of it originates from other countries. We call this cross-border pollution, which due to callous and irresponsible attitudes of some industries and is propelled by various physical and chemical transport mechanisms.”...“It is for this reason that we very much welcomed the recent NATO agreement on a work plan for dialogue, partnership and co-operation with the Central and Eastern European countries, our Co-operation Partners, which includes, among other things, participation of their experts in CCMS activities. In this way I believe that the Committee has gained stature and effectiveness in dealing with the problems of society and the environment.”

TURKISH PARTICIPATION

Turkey participates fully and effectively in the activities of the NATO Science Programme and CCMS.

Turkish scientists and engineers take an active part in nine of the 18 on-going CCMS pilot studies and two ad hoc projects. Turkish Directors lead the following three of these projects:

- Ecosystem Modelling of Coastal Lagoons for Sustainable Management (with the USA as co-director),

- New Agricultural Technologies (with Belgium and the USA as co-directors),

- Review of Environmental Projects of the Caspian Sea for the Planning of Future Activities (with the Russian Federation as co-director).

The cost of this rather substantial participation is met nationally mainly from the budgets of the Turkish Scientific and Technical Research Council (TÜBİTAK) and of the universities. Turkish scientists also receive research grants from the CCMS Fellowship Programme (on average three per year) and from the CCMS Study Visit Programme (several per year). These grants enable the recipients to contribute to the work of CCMS pilot studies by conducting research under the guidance of pilot study directors or working as members of the CCMS pilot study teams.

As far as the NATO Science Programme is concerned, Turkey, along with the other NATO and Partner Countries, benefits from the following programmes:

- Science Fellowships,
- Advanced Study Institutes (ASI),
- Advanced Research Workshops (ARW),
- Collaborative Linkages,
- Expert Visits.

All these programmes aim at raising qualitatively and quantitatively the level of technoscience in the country. It is said that science has only one method but many techniques, the mastery of which is not confined, fortunately, to one or two countries. The global movements of the NATO fellows in 1997 were as follows:

Intra-Europe	20 %
Europe to USA	41 %
US to Europe	6 %

PC to Europe	30 %
PC to US	3 %

Accounts of the lives of scientists often describe how they gained their more specialised skills. For example, Jim Watson, an American Nobel Laureate, has recalled how, as a young man, he was sent from Indiana to Copenhagen to learn some biochemistry, and from there went to Cambridge to learn the techniques of X-ray diffraction analysis. A surgeon keen to learn a new operation, a physicist wishing to master a new instrument, or a biologist anxious to learn how to culture fragile cells, will all probably be sent to distant laboratories to acquire their novel skills.

In passing, it is interesting to note that nothing comparable seems to happen in learning scientific method. Promising students are not sent to the seminars of a Rudolf Carnap or a Karl Popper to master the rudiments of methodology. The very most they can expect would be an ancillary course provided by an adjacent philosophy department. Method as such, they are presumably expected either to arrive with or to absorb spontaneously as they go along!

The above programmes enable the scientists to acquire and create new knowledge and skills by visiting laboratories and working together with other scientists abroad. The fact that several Nobel Prize winners get involved in these various activities and roles attests to the success of these programmes. Half of the NATO science budget is allocated annually to the programmes above and Turkey receives about one-tenth of this. It is interesting to know that NATO allots as much as one fifth of its total civil budget of about $30m to its Science Programme.

About 250 Turkish scientists participate in some 50 ASI/ARW's annually. The NATO Science Fellowship programme is administered by TÜBİTAK in Turkey. They award about 350 science fellowships annually for research abroad at post-graduate and post-doctoral levels. That this NATO contribution is significant for Turkey may be seen from the research grant expenditure of TÜBİTAK, which is about 10 per cent of its total annual budget and twice the amount received from NATO.

Turkey also benefits from the NATO Science for Peace (SfP) programme, which succeeded the Science for Stability (SfS) programme that had run for ten years. SfS has objectives similar to those of SfP, of supporting applied science and technology projects that relate to the industrial and environmental problems of Greece, Portugal and Turkey. Turkey received over $10m from NATO for the procurement of equipment and software as well as much needed expert advice and know-how from various member countries.

Among the projects undertaken under SfS and now SfP with the widest scope and impact on the Turkish economy and science-base and involving collaboration between literally hundreds of scientists from NATO and the Co-operation Partner (CP) countries we can mention the following projects related to the Black Sea:

I) Fish Stock Assessment Studies for the Turkish Black Sea Coast,

II) Ecosystem Modelling as a Management Tool for the Black Sea:
A Regional Programme of Multi-Institutional Co-operation,

III) Wave Climatology for the Turkish Coast: Measurements- Analysis-Modelling,

IV) Black Sea Ecosystem Processes, Prediction and Operational Data Management.

The Institute of Marine Sciences (IMS) of the Middle East Technical University (METU) has played a leading role in the above projects which have involved TÜBİTAK, the Ministry of Agriculture and the State Planning Office on the Turkish side, as well as several research institutes of the Black Sea countries and some US Universities such as the Massachusetts Institute of Technology, Harvard University, the University of Washington and Virginia Institute of Marine Sciences. The results obtained from the project work have been used in literally hundreds of articles mostly published in cited journals and as subjects for Ph. D. studies. Scores of scientists have gained experience in collaborative research.

In conclusion a few words on the impact of the NATO Science Programme and CCMS on the Turkish technoscientific system would be in order. The level of science reached in any country may best be assessed in relation to the stage of development attained in other systems. When we look at the problem in this way we find that the infrastructure required for the support and development of the R&D activities is made up of several factors. These are:

I) Organisation of the R&D activities,

II) Technoscientific manpower (quantity, quality and distribution),

III) R&D expenditure,

IV) Economic performance,

V) Technoscientific information and documentation system and, finally,

VI) The country’s international relations.

For healthy national progress it is imperative that all these six systems are developed in parallel otherwise efforts to develop one system would be left without support by the other systems.

Without elaborating further on the subject, I venture to suggest here that compared to more developed countries, Turkey as a country has been very late in recognising the vital role technoscience plays in national development and well-being, and has failed to give it the priority it deserves. Even today, we cannot say that Turkey gives due priority to R&D and technoscience when the national R&D expenditure is about 0.4 per cent of our GNP and the number of full-time researchers is only four in 10,000 of the working population. The corresponding figures are ten to twenty times higher in the more developed countries. Under these circumstances, out of the six factors mentioned above the last one on international relations assumes even greater significance for Turkey than would be the case otherwise. Another aspect which should be pointed out here is that, barring a few advanced countries who are more givers than receivers in NATO, Turkey is unique in the Alliance in not being able to benefit, like Greece and Portugal for instance, from the substantial R&D programmes of the European Union. Moreover, the fact that Turkey is not a participant (except in Eureka) in other European R&D institutions, such as European Space Agency (ESA) European Nuclear Research Centre (CERN) makes the NATO science programme an important factor in the development of the Turkish science-base, and in the long-term, hopefully, even in the industrial and economic life of the country.

Activities such as the NATO fellowship programme, which aim, inter alia, at educating and training scientists and engineers are vital for all countries and more so for developing countries who must compete in the international markets with industrialised countries. We therefore need to strengthen the science base in the country by all means possible, generally by having more science in schools, more science on television and radio, and more science museums and centres.

We must add here that scientific programmes in schools and in the media must be simple. Einstein said that we must be as simple as possible but no simpler. We must also be honest, and we must relate to familiar things and people. The American Nobel Laureate, Richard Feyman, had a superb way of talking about difficult scientific matters in a familiar way, for example the neutron: "Imagine something that really does not do anything, a particle that has mass, has weight, but actually does not achieve very much. Think of it rather like your son-in-law!"

It is an unhealthy aspect of the education system in general that it produces half-educated people and non-scientific nations. Why should it matter if the people are ignorant of science? It matters because the people include those who are in power, people who lead us in politics, in the civil service, in the media, in mosques and churches, often in industry and sometimes even in education. I firmly believe that it is only through education that we can ultimately achieve a proper public awareness of science.

Our dependence on technoscience for the advancement of our industry, and consequently our economy will increase as the scientific revolution continues and as many areas of science are at a more exciting and productive stage than ever before. The potential benefits of this scientific revolution will only be realised, however, if we have a numerate, literate and 'sciencate' (knowledgeable about science) population prepared to take advantage of a full and productive life at home, at work, and at play in our modern society.

EPILOGUE

In conclusion I offer my congratulations to NATO on its golden anniversary and my deep felt appreciation of the political leaders and dedicated scientists who had the foresight to cultivate within the Alliance the notion that there is more to defence than military preparedness. For those of us who have been fortunate enough to participate personally in the technoscientific activities of NATO, one of the real joys has been the friendships forged and the barriers to understanding that have been removed as a result of working together.

In a real sense we are the beneficiaries of the wisdom and steadfastness of all those who have helped build and sustain the NATO Alliance over the years. I hope their example will continue to help guide us as we consider ways to improve, together with our common defence, the quality of life for future generations.