

ASPECTS OF NATO

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Scientific Cooperation

Science and security

There is a vital need for international cooperation in science and technology in an increasingly interdependent world. Concepts of mutual security have to be expanded to include a broad range of security concerns of a global nature, including the protection of the environment, the management of natural resources and the welfare of peoples. The philosophy upon which the work of the Science Committee is based appears even more compelling now than in 1957, when the NATO Science Programme was established. National and international security are directly related to progress in science and technology, and it is in this awareness that NATO continues to support different types of international scientific collaboration.

Origins of the NATO Science Programme

The Report of the Committee of Three, submitted to the Council in December 1956, stated that "one area of special importance to the Atlantic Community is that of science and technology". The Committee found that progress in this field "is so crucial to the future of the Atlantic community that NATO members should ensure that every possibility of fruitful cooperation is examined." Against the background of the more general need for individual member countries to adopt more positive scientific policies, the Committee of Three pointed to the central and urgent problem of improving recruitment, training and utilisation of scientists, engineers and technicians.

The Council adopted the recommendations of the Committee of Three, and a Task Force on Scientific and Technical Cooperation was appointed in June 1957. The Task Force found that "the future of the West is dependent to an ever-increasing degree on the rate at which science and technology advance". While emphasising that national efforts must continue to form the basis of any general action, the Task Force believed NATO had a constructive role to play. This lay in encouraging member governments to carry out national programmes for the development of scientific and technical resources; organising international activities with a view to economising national resources and stimulating exchanges; and cooperating with other agencies active in the scientific field.

The Task Force carried out its deliberations with an urgency which was emphasised by the launching of the first Soviet Sputnik in October 1957. The political and scientific implications of this event resulted in the Task Force Report being presented directly to the Heads of Government of the Alliance at

their meeting in December 1957. The Heads of Government adopted two specific recommendations made by the Task Force. Firstly, a Science Committee was established to develop its own programme in the light of circumstances, and with the broad responsibility of advising the Council on how NATO could fulfil the role ascribed to it by the Task Force Report. Secondly, the position of Science Adviser was created on the International Staff to give impetus and direction to the work of the Committee, and to act as the Secretary General's adviser on scientific questions. The work of the Science Committee rapidly increased in importance, and it was not long before the Science Adviser was made Assistant Secretary General for Scientific Affairs, with a staff of scientists forming the Scientific Affairs Division of the International Staff. As the Division also became involved with environmental affairs with the establishment of the Committee on the Challenges of Modern Society¹, the title was changed in 1973 to Assistant Secretary General for Scientific and Environmental Affairs.

The NATO Science Committee

The NATO Science Committee, which meets three times a year, and is chaired by the Assistant Secretary General for Scientific and Environmental Affairs, is composed of national representatives qualified to speak authoritatively on science policy in the name of their respective governments. However, they have insisted upon being considered not only as government representatives, but also as scientists in pursuit of knowledge. The Science Committee is charged with the overall task of stimulating and strengthening science within the Atlantic Alliance; the Assistant Secretary General for Scientific and Environmental Affairs, with the aid of his scientific staff, is responsible for promoting cooperative action and implementing the Committee's decisions, administering the science programmes, and advising the Secretary General of NATO on scientific matters. He is assisted in this work by groups or panels of individual experts in the different areas of the science programmes. The willingness of these high-level scientists to put their professional expertise at the disposal of the Scientific Affairs Division has been of inestimable value in arriving at, and maintaining, a high scientific standard in the NATO Science Programmes.

The first meeting of the Science Committee was held in March 1958. During its first year of existence, the Committee examined a large number of proposals for strengthening science in the NATO countries. Three main programmes were established, which remain the backbone of the NATO science activities; the Science Fellowships Programme, the Advanced Study Institutes Programme, and the Research Grants Programme. Activities have also been initiated in several scientific fields in need of special attention or of more immediate short-term interest to the Alliance. These programmes have never been static, but have continuously been reassessed both in relation to other activities in NATO and in relation to the wider area of international and national support of science. Nevertheless, their predominant characteristics have remained an

emphasis on cooperation and catalysis, and a capacity for rapid response to new developments. Each of the programmes has been consciously designed, and deliberately implemented to identify research priorities, stimulate cooperative activities and improve the exchange of information which is a key requisite for scientific progress.

In 1978, the Science Committee commemorated its 20th Anniversary by organising a major conference aimed at taking stock of the impact of science and technology on Western societies, and examining future challenges to the Western scientific establishment, including how to interact in more meaningful ways with increasingly complex societal issues. Such topics as global energy and demand systems, the impact of technology on standard of living, employment and labour relations, the significance of the approaching "information society", long-term economic policies, and international relations were discussed and analysed. The conference was attended, not only by scientists, but also by national delegations from the Alliance countries, which included Ministers of Science, senior parliamentarians, senior officials responsible for science policy, heads of national research councils and prominent industrialists.¹

The Science Committee has become deeply concerned about the growing disparity in scientific and technological capabilities within the Alliance. Accordingly, the Committee decided to set up, in 1980, a special programme of about five years' duration designed to help Greece, Portugal and Turkey in the development of their scientific and technological capabilities. The programme is called "Science for Stability". The objective of this fixed-term cooperative programme of self-help projects is to enable sufficient research and development management experience to be acquired at the local level, by the time the projects are completed, to facilitate expansion into other problem areas of national importance.

The NATO Science Programme

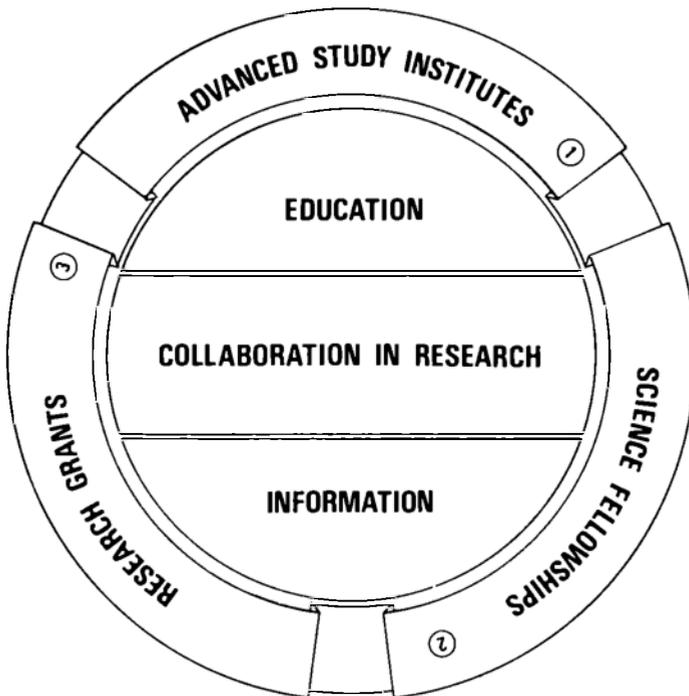
General

The NATO Science Programme is the only cooperative international effort embodying multilateral government support for advancing the frontiers of modern science through high-level basic research. This activity -- in which scientists of both the advanced and the developing nations of the Alliance can and do participate on an equal basis -- is of real benefit in strengthening science in all the member countries of NATO. It has shown itself to be an extremely useful vehicle for trans-Atlantic communication, and has perhaps been especially valuable in fostering intra-European cooperation where surprising insularity has been found.

¹ An account of the issues covered at the Commemoration Conference, including recommended directions for scientific cooperation, has been published in two volumes with the overall title of "Science and Future Choice", by Oxford University Press (1979). Volume 1 is subtitled "Building on Scientific Achievement" and Volume 2 is subtitled "Technological Challenges for Social Change".

General Programmes

Over the years, the Science Committee has supported endeavours in almost all fields of science, stressing scientific education at advanced levels, collaborative research between scientists in Alliance countries, and the exchange of information. It has supported initiatives in these areas, through programmes of research grants, fellowships, and advanced study institutes.



- ① **Advanced study institutes**
1,000 advanced training courses attended by 80,000 scientists; 700 scientific books published.
- ② **Science fellowships**
13,000 fellowships awarded for postgraduate study or research.
- ③ **Research grants**
2,000 research grants awarded for international collaborative research resulting in several thousand joint scientific publications.

The number of people who have directly participated in these programmes now totals over 100,000 individuals, of which some thousands come from countries outside the Alliance, including several hundred from Eastern Europe. These participants, members of the international scientific community, are engaged in professional work of national concern and play an increasingly significant role in decision-making in their countries. The ties engendered between them, brought about by the close cooperation implicit in the NATO programmes, have endured and grown through the years. In addition, more scientists have been served by the widely disseminated publications which have carried the results achieved through the NATO programmes far beyond their immediate participants.

In implementing its various programmes, the Science Committee had a budget in 1980 of some BF 423.5 million (about US \$ 14 million) divided as follows:

Science Fellowships Programme	55 %
Advanced Study Institutes Programme	21 %
Research Grants Programme	14 %
Science Policy and Programme Development	10 %

The Science Fellowships Programme is administered by national authorities. The remainder of the programmes are administered by the NATO Scientific Affairs Division; their activities are guided by panels of scientists, who serve for a period of three to five years. Representation on the panels from different countries of the Alliance is on a rotating basis.

The NATO Science Fellowships Programme

The need for new scientists to be trained, and established scientists to be given the opportunity to further and renew their specialised education and scientific training, was recognised by the NATO Heads of Government when, in December 1957, they agreed that "more should be done to increase the supply of trained men in many branches of science and technology". A training period abroad for young scientists and an opportunity to engage in research outside their own countries, is recognised as a normal and effective way of pursuing a scientific career. The possibilities for obtaining scholarships for such training were very limited in many countries and the Science Committee therefore established the NATO Science Fellowships Programme.

The main purpose of this programme is to stimulate the member countries to enlarge the exchange of post-graduate and post-doctorate students, as well as senior-level scientists in the pure and applied sciences. The Science Committee exercises general supervision over the programme, but the detailed administration is carried out in each country by a national agency; in many cases, the same agency administers national fellowship schemes. The selection of fellows is based on scientific merit and ability, but the criteria vary from one country to another. Some limit the awards to senior-level scientists, others to post-doctoral research workers, while others emphasise post-graduate training and research.

The NATO Science Fellowships Programme started in 1959; no fellowships programme on the same scale had previously been undertaken by an international organisation. Experience has shown that the NATO programme has favourably stimulated an active national fellowships programme of at least comparable magnitude in most member countries.

During the early 1960s, some 1,000 Science Fellowships were awarded annually. As the amount of each stipend has increased, owing to inflation and the rising standard of living in the member countries, the number of fellowships has levelled off at between 700 and 750 per year. Since the programme started, over 13,000 scientists have benefited from NATO Science Fellowships, enabling them to study overseas for periods of about one year or longer. The United States receives about half of all the fellows, with the United Kingdom, France and Germany being other popular host countries. The fellows study a large number of subjects, with chemistry and physics as the most popular, while biology and engineering also attract a large percentage.

The Advanced Study Institutes (ASI) Programme

A major factor in pursuing the goal of furthering national collaboration amongst scientists from member countries has been the wide-reaching and perhaps the most successful programme of the Science Committee, the Advanced Study Institutes Programme. Each year, the programme sponsors about 75 institutes, with 50 to 130 scientists attending each meeting. The purpose of the programme is to contribute to the dissemination of advanced knowledge and the formation of contacts among scientists from different countries. A NATO Advanced Study Institute is primarily a high-level teaching activity, at which a carefully defined subject is presented in a systematic and coherently structured programme. The subject is treated in considerable depth by lecturers eminent in their field and normally of international standing; it is presented to other scientists specialised in the field or with an advanced general background. Advanced Study Institutes are aimed at audiences of approximately post-doctorate level; this does not exclude post-graduate students, and it may well include senior scientists of high qualifications and notable achievement in the subject of the Institute or in related fields.

Subjects treated at the institutes vary as widely as the nationality of participants, and institutes have been arranged in subjects from mathematics and astronomy through biological and medical topics, to embrace such areas as psychological measurement theory and language programming for computers. Of particular interest are the institutes organised as an interdisciplinary meeting. In such cases, the didactic aspect of the institute consists of scientists specialised in one field teaching scientists highly qualified in a different area. The role of the lecturer and student will then be interchanged during the meeting as the theme of common interest is developed from the viewpoint of different sciences.

The Advanced Study Institutes Programme seeks to improve the general level of scientific competence throughout the NATO area, and provides the extra benefit of high-level scientific exchange in interdisciplinary areas which are

rarely found in university curricula. The programme is considered unique and is highly regarded in the scientific community. Since its inception in 1959, the programme has supported more than 1,000 Advanced Study Institutes, in which over 80,000 scientists have participated, many of them leaders in their respective fields. Added benefits of the ASIs are the proceedings, of which about two-thirds appear in book form. These have been generally recognised as authoritative surveys of their subjects, and have reached a very large audience, both inside and outside the Alliance. In 1973, an agreement was reached with four international publishers to publish a uniform NATO Advanced Study Institutes Proceedings series. Over 180 books have been published in this series, which is growing by about 50 books a year.

The Research Grants Programme

Economic and social progress depend upon scientific research, which can be enhanced by the pooling of the capabilities and resources of different groups of scientists. This programme contributes to the advancement of fundamental knowledge by stimulating collaborative research carried out by scientists in different member countries.

NATO Research Grants assist projects which rely mainly on national funding, but where the international collaboration to be promoted entails costs that cannot be met from other sources. The specific research projects supported under the programme are carried out as joint efforts between teams in university, government, and other non-profit-making research institutes.

The main support provided under this programme includes travel and living expenses for investigators working in each other's institutions abroad; 85 % of the total awards are used for this purpose. Running expenses to allow flexibility in carrying out the project, including consumable supplies required for effective collaboration, can also be covered. Exceptionally, for research groups in the scientifically less-developed areas of the Alliance, a contribution is made towards equipment essential for implementing the project.

Most fields of science are eligible for support, emphasis being given to fundamental aspects rather than to technological development, although projects in the basic and applied sciences with promising applications area are also funded. At present, support is not provided to very large projects in some fields (e. g. nuclear physics, experimental high energy physics, space research, and clinical medicine), or in areas where other international agencies are already active. Both theoreticians and experimentalists are involved in most projects, and a sizeable amount of the research is of an interdisciplinary nature.

Grants are awarded for an initial period of one year. Upon demonstration of significant progress, these may be renewed, but projects are supported for a limited period, and after about four years they are expected to have reached a conclusion.

Since its inception in 1960, this programme has funded well over, 2,000 projects. At the present time, about 250 new projects receive support each year, with an average initial award of \$ 5,000. Over 600 publications of research results appear each year, made possible through NATO's support.

Science policy and programme development

Science Policy

In addition to establishing scientific programmes designed to overcome the more immediate deficiencies, the Science Committee has concerned itself with studying the long-term aspects of scientific development in the Western world. In early 1959, the Committee set up a special study group chaired by M. Louis Armand, and including some of the most distinguished scientists in the NATO countries, to examine the factors tending to retard the development of science in the Western world. The factors impeding science are often political and administrative, and they may result from a failure to appreciate the nature of science and of the conditions necessary for its growth. The Armand Report, published in 1969 under the title "Increasing the Effectiveness of Western Science", addressed itself primarily to such matters. Many of its recommendations have been translated into general practice, and it has also served a more general purpose of inducing governments to give serious thought to the problems discussed.

Following the 20th Anniversary Commemoration Conference in 1978, the Science Committee decided to hold more frequent discussions on policy issues, intended to focus on problems, needs and trends in the support of a dynamic research system in NATO countries. This decision reflects the Committee's evolving attitude to its role vis-à-vis questions of national and international science policy, and what the Committee can do to influence this policy and its effects on the development of science and technology in member nations. The Committee has instituted a series of regular Forum Discussions, at which a particular topic is introduced for critical comment. Such assessments provide the Committee with the means of advising science bodies and research organisations in national governments on the maintenance and improvement of scientific and technological capabilities, as well as assisting it in reviewing its own programme, and in carrying out its advisory role to the North Atlantic Council. Attention has lately been devoted to the negative consequences of the sudden halt in the rapid growth of recent years which led to the establishment of the present research system; in particular it has focused on an examination of the resulting decline in the international mobility of scientists and engineers.

Programme Development

The Science Committee has at its disposal a means of pursuing certain activities outside its normal programmes. Such activities are considered under the heading of Programme Development, and are approached through the medium of Special Programmes, Science Committee or Research Evaluation Conferences, ad hoc advisory reviews, commissioned studies and the recently constituted Science for Stability Programme, which is directed towards the needs of the developing member countries of the Alliance and is mentioned above.

The main purpose of Science Committee or Research Evaluation Conferences is to identify particularly fruitful research areas requiring attention. The

resulting recommendations are directed both to those having a responsibility for selecting and supporting research programmes, and to the Science Committee itself, and provide guidance on an appropriate allocation of human and material resources. Twelve conferences have been held on such topics as High Temperature Materials, Software Engineering, North Sea Science, Catalysis, Technology of Efficient Energy Utilisation, Ecological Toxicology Research, the Benthic Boundary Layer and Thermal Energy Storage.

Another illustration of work under the Programme Development item is the setting up of the Committee's Study Group on the Rational Use of Potentially Scarce Metals. The Study Group produced its findings in the form of a small booklet of that title in 1976.

Special Programmes

The Science Committee has frequently identified specialised scientific areas as deserving particular encouragement or preferential support for limited periods. The objective is to provide catalytic support to neglected, usually multidisciplinary, fields until other means of support can be secured. Such support usually takes the form of research-oriented meetings on topical subjects and training schemes in promising areas. At present, Special Programmes are underway in the areas of Marine Sciences, Air Sea Interaction, Eco-Sciences, Human Factors, Systems Science and Materials Science. Programmes in Meteorology, Radiometeorology and Stress Corrosion Cracking were terminated when the Science Committee believed that the programmes had achieved their objective. Further periodic changes in the subjects treated under this Programme are planned.

Marine Sciences

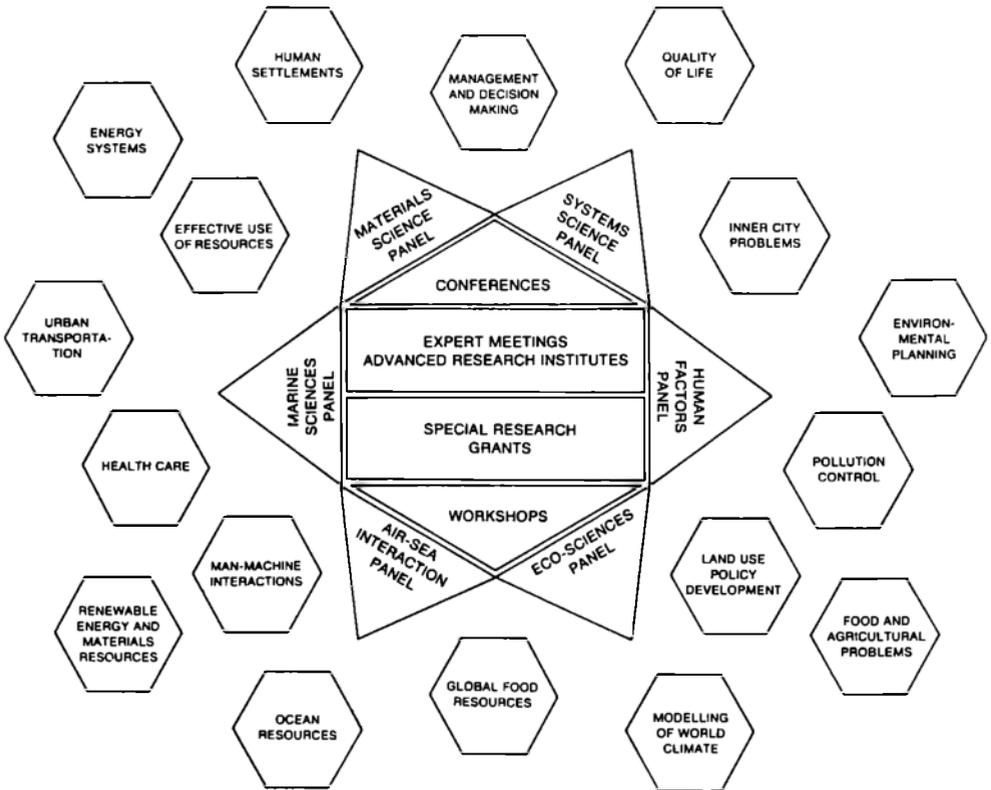
The Marine Sciences require a high degree of international collaboration and joint research, as no one nation can hope to support the scale of exploration and experimentation required for progress in modern science. With this in mind, the NATO Science Committee, in 1959, decided to set up a Sub-Committee on Oceanographic Research, which was transformed in 1974 into a Special Programme Panel on Marine Sciences. The Panel chose to direct its resources into workshops and colloquia in the forefront areas of marine science, such as marine modelling and the inhomogeneous distribution of marine organisms. Important contributions to marine science have resulted from the publication of these conference proceedings.

Air-Sea Interaction

Air-Sea Interaction is the study of transfer processes at the air-sea boundary. At the time the Panel was founded by the NATO Science Committee in 1972, air-sea interaction research was confined to a few laboratories which possessed great expertise. Under the auspices of the Panel, significant advances have been made in: linking large global atmospheric models to ocean models;

Special Programmes

The broad range of expertise of its members has enabled the Committee to identify a few areas of high scientific priority and urgent concern for special encouragement. Each of these is entrusted to a special programme panel of experts who recommend new directions which NATO might follow profitably to enable it to contribute more effectively to the solution of some of the global problems now being faced by mankind.



preparing theoretical and experimental descriptions of the processes occurring in the upper 50 metres of the ocean; understanding wave generation, wave prediction and modelling; representing the effects of the complex exchange process of momentum heat and some gases in terms of easily measured quantities; and the mounting and analysis of data from large-scale ocean/atmosphere interaction experiments.

Eco-Sciences

When the Special Programme Panel on Eco-Sciences was formed in 1972, the members considered a broad range of ecological research areas of priority significance, and proceeded to build a programme around them. The Panel has paid particular attention to environmental toxicology, rehabilitation of devastated ecosystems and data and information management, and has organised several conferences and workshops in this field. Linked to these concerns were other exploratory programme elements, including research grants and fellowships. In addition, coordination of programme efforts with other Special Programme Panels (i. e. Human Factors, Marine and Systems Sciences) has been carefully watched so that NATO funds are channelled into areas where new knowledge is needed.

Human Factors

A new Special Programme Panel on Human Factors was formed in 1973, to replace an advisory group that had been set up in 1959. The Panel directed its attention to a better understanding of human behaviour, in individuals or in groups, by initiating programmes encouraging the dissemination and application of existing knowledge, furthering research in those areas where it is urgently needed, and enhancing international scientific cooperation in the Human Factors area, now defined so as to include social, educational, environmental, experimental, physiological, and industrial psychology and human engineering/ergonomics.

Systems Science

In 1960, the Science Committee established an Advisory Panel on Operational Research, which was transformed in 1973 into a Special Programme Panel on Systems Science. Attention was directed towards a wider range of dynamic and ever-pressing problems of society. The Panel has maintained the objective of the further development and application of systems science (system analysis, operational research, management science, system engineering, cybernetics, etc.) in member countries through training systems scientists and encouraging research in those areas where systems science is most needed. The Systems Science Panel has supported conferences and symposia, study visits, development of educational capabilities, graduate degree apprenticeships, advanced research institutes, and cooperative research on socio-technical problems.

Materials Science

The Special Programme on Materials Science and its Panel were created in 1977. The Panel decided to build its programme on a three-pronged framework that encompasses industrial materials, the materials aspects of energy generation, storage and use, and novel materials. For industrial materials, attention is being given to composites, such as concretes and cellulose. In the area of the materials aspects of energy generation, storage and use, attention is being concentrated on chemical generation and storage, and corrosion/erosion problems related to energy use. With respect to novel materials, attention is being given to molecular metals and the glassy state.

The von Karman Institute for Fluid Dynamics

The NATO scientific community maintains close contact with the von Karman Institute (VKI) for Fluid Dynamics, an international non-profit-making scientific organisation whose activities are dedicated to post-graduate training and research in fundamental and applied fluid dynamics. It was founded in 1956 under the auspices of NATO-AGARD and with the inspiration and leadership of Dr. Theodore von Karman, who served as the Chairman of the Board of Directors until his death in 1963. The Institute has a number of closely inter-related academic and research programmes aimed at providing post-graduate education, encouraging research, and contributing to the dissemination of knowledge in the field of fluid dynamics. These activities are summarised below:

- VKI Diploma Course in Theoretical and Experimental Fluid Dynamics: a nine-month programme involving lectures, laboratory work and research studies is offered to students with a university degree in engineering. During the past twenty-three years, 479 engineers and scientists from fourteen countries have received the Diploma.
- Doctoral Programme: opportunities are provided for young engineers to carry out an important programme of research which can be submitted as a doctoral thesis to either a Belgian university or a university abroad. Since the granting of the first D. Sc. degree in 1965, forty-six candidates have successfully completed this programme.
- Lecture series: one-week courses on advanced topics in fluid dynamics are organised each year with the aid of internationally-known experts. The programme was initiated in 1963 and since then has served nearly 7000 attendees.
- Short Training Programme: undergraduate training for university students from a number of countries is carried out in various programmes of one to three month's duration. Approximately 700 students have participated since 1963.
- Research Programmes: The facilities and equipment at the VKI cover a comprehensive area in the field of fluid dynamics, ranging from low speed to hypervelocity regimes. Many areas of direct interest to the industrial sector – e.g. aeronautics/aerospace, energy conversion, environmental problems, industrial processes – can therefore be studied.