

Science Valued!

NWO Strategy 2007–2010



Publication

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for Scientific Research

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Professor Frits van Oostrom
President of the Royal Netherlands Academy of Arts and Sciences (KNAW)

"Science in the Netherlands will benefit from a coordinated interaction of strong and vigorous direct and indirect government funding."



Dr. Tini Colijn-Hooymans
Member of the board of the Netherlands Association for Applied Research in the Natural Sciences (TNO)

"This plan offers much scope for joint initiatives in executing innovative scientific research."



Ed d'Hondt, L.M.
President of the Association of Universities in the Netherlands (VSNU)

"Our association applauds the ambitious NWO plan for enhancing academic research and welcomes the fact that universities have been emphatically involved in the choice of themes."



Bernard Wientjes, L.M.
President of the Confederation of Netherlands Industry and Employers (VNO-NCW)

"It is fortuitous that NWO has consulted partners in society in the process of developing this plan, and that the commitment of these partners – manifested in a new advisory board – will be palpable in its implementation."



Loek Hermans
President of the Royal Association for Medium and Small sized Business Companies (MKB)

"It is excellent that NWO endorses an explicit policy for ensuring that the members of our association can exploit the outcomes of scientific research."



Preface

The future of the Netherlands will be determined by knowledge. Economic growth, technological innovation and social dynamics are all dependent on the extent of our ability to develop and exploit new kinds of knowledge. Current problems in society also urgently require an input based on innovative, multidisciplinary research. The need for cutting-edge research of world class standards therefore, will fuel the growth of the Netherlands as a 'knowledge society' operating in the international field.

With a large number of eminent scientists and scholars who are globally recognised for their excellent research, Dutch science has a great deal to offer. However, if our optimal performance is to continue in the future, then certain problems in our knowledge system which currently form a serious threat to our scientific potential will have to be tackled collectively. In close consultation with its partners in the domain of knowledge, NWO has, therefore, opted for an ambitious strategy aimed at providing this essential injection to science in the Netherlands, so as to contribute to the highly innovative knowledge society for which the Netherlands has both the potential and the ambition. Within ten years, the Netherlands should be amongst the front-runners of Europe.

As the national organisation for research, NWO has the responsibility to strengthen the overall high standards of Dutch research and to encourage innovation. Mediating between science and society, NWO also is well positioned to consider and relate the interests of both parties carefully. This forms the point of departure for the tripartite strategy chosen to strengthen our nation's scientific potential: *Opportunities for researchers*, *Consolidating strengths* and *Science for society*. *Opportunities for researchers* is a strategy geared towards the growth of talented researchers and the stimulation of excellent frontier research. *Consolidating strengths* is aimed at concentrating human and material resources. *Science for society* will zoom in on a refined attuning of groundbreaking research to social issues.

It goes without saying that NWO will exert all its strength and expertise to stimulate research in the Netherlands and advance our country to the front league of knowledge. This requires an in-depth investment in science. Therefore, a request is made for an annual structural addition of 433 million euros on top of the current budget for indirect government funding. Certainly, this is no pittance. As we will clarify in this strategy paper, this is an indispensable investment if we indeed agree, collectively, that the future of the Netherlands is dependent on the success of 'the Netherlands, a knowledge society.'

This publication presents an ambitious strategy, designed by NWO in order to give a powerful boost to the second flow of funds*, to be utilised to maximum profit for the period of 2007–2010. Naturally, it is focussed on the field in which NWO operates, namely scientific research. This strategy can only be successful, however, if substantial investments are made in other (related) domains too and when NWO can rely on strong partners.

The present strategy results from close cooperation with each of NWO's stakeholders in science and scholarship, the government, the business world, and other relevant areas in society. They were invited to assist in plenary and bilateral discussions. Several questionnaires recorded their vision on developments in science and society and on the function of NWO in directing this process. As the outcome of a shared discursive process this strategy is, therefore, broadly supported. In addition, the partners of NWO are not just involved in this initial stage. The implementation of the strategy set out in this paper shall be carried out in collaboration with our partners.

The time has come for the Netherlands to invest in the best it can offer. The time has come for its science to be valued!

Peter Nijkamp – Chair of the NWO governing board



Summary

Science as cultural and public good

Scientists are continually advancing the limits of our knowledge and capabilities. Motives for their groundbreaking research are on the one hand fascination for unravelling complex processes and, on the other hand, the search for applications directing technological and scientific innovation and improvement. What are the fundamental building blocks of the microcosmos? What may replace oil as an energy source and when? How do deaf people learn languages? Why do humans have so few genes? What is the relationship between religious beliefs and cultural or political identity? And thousands of other fascinating questions. The history of science is a continuous cycle of posing and answering novel questions. Advancing science is indispensable in solving the issues our society faces, concerning the ageing population, social cohesion, security, health care, life-long learning, climate change, energy, innovation, or new forms of governance. Both motives are prerequisites for a strong knowledge society, necessary, if the Netherlands are to survive as a small country in a global playing field.

Increasing pressure on science

The Netherlands have no choice but to dedicate itself to advancing science and its utilisation. In recent years the pressure on science to contribute to utilisation of science, has strongly increased. The applicability of research results plays an increasingly important role in the selection of research topics. Knowledge directs the development of our society and it is an important, if not the most important product our society operates on. If Dutch science is to satisfy the high expectations, and if the Netherlands is to contribute to realising the Lisbon objectives, as agreed within the EU, various bottlenecks in its knowledge system must be rigorously tackled. The strong global position that Dutch science has acquired due to investments of several decades ago, might otherwise be lost. A strongly enhanced knowledge society is key to a better future for the Netherlands. Top-quality universities and scientific institutes are needed to meet this objective. The Netherlands should aim for a leading position in Europe.

Challenges and bottlenecks

In the past years the investments in higher education, scientific research and innovation have however structurally failed to meet the ambitions in the Netherlands. Many parties have called for more investments. Recently the Council of Economic Advisors (advisory body to Dutch House of Representatives) stated that additional investments in the order of 10 to 15 thousand million euros annually are required in the entire knowledge system, to meet the objectives the Netherlands has set itself. The national Innovation Platform* is also formulating its knowledge investment agenda 2006–2016, as a guideline for future investments by public and private bodies in education, science and innovation.

As a consequence of these investment shortfalls and other weaknesses in science and new challenges in society, the Dutch knowledge system currently faces various bottlenecks. For example, the influx of young research talent is much too low to maintain the level of science, once the baby boomers have retired. Moreover, the requisite research facilities are often outdated, which further constrains the possibilities of researchers to do their work. The brain drain is one of its results.

Internationally, the competition to acquire a leading position in the global economy is increasingly fierce. With the advent of a European Research Area and the rise of emerging economies, researchers have to compete and perform at top level, like never before. Dutch research efforts are however often undermined by fragmentation: research programming lacks sufficient synergy and the available strengths are underutilised, causing a shortfall on the return on investments. Focus and critical mass, as well as improved cooperation will be necessary if the Dutch knowledge system is to play a significant role within Europe.

The emphasis on innovation increases the demand for short-term applications. Yet all too often the available results are not translated into useful solutions. The need for multidisciplinary and interdisciplinary research as a source of scientific and social innovation is growing, but in the Netherlands science has traditionally been organised in a disciplinary way.



NWO: guardian of quality and intermediate between science and society

If the Netherlands must continue to compete at the international level, it must have a powerful knowledge system with strong universities and research institutes. As a distributor of indirect competitive government funds, NWO is one of the organisations expected to contribute significantly to the strengthening of the Dutch knowledge system. NWO can meet this expectation as promotor of the quality of Dutch science, its role (together with the research institutes) in guiding scientific research by its research programmes, and as mediator between science and society.

With its careful selection procedures, NWO aims to protect and strengthen the quality of Dutch science. Responding to new possibilities, NWO stimulates innovation that benefits the knowledge society as a whole. Over the next years NWO will mainly enhance its mediation.

The foundation of NWO's work is the cooperation with (individual) researchers, universities and other public research institutes: they formulate scientific questions, carry out research and, moreover, provide NWO with the quality and manpower needed to carry out the selection procedures. Strengthening of the mediation role will also lead NWO to maintain intensive contact with government departments, the private sector and other public agencies, who submit their research questions to NWO as departure for (thematic) research programmes. These partnerships with parties inside and outside the scientific arena are essential for NWO to carry out its duties properly.

An ambitious strategy for government funding

NWO has now formulated its strategic plan for the period 2007–2010. NWO's basic ambition is for the Dutch research system – building on the strengths of university research and with government funding as key – to attain a leading position in Europe within ten years. With its strategy NWO wants to assist Dutch researchers to acquire a strong position for attracting additional resources from the European Research Council (ERC), which is currently being established. Looking to the future, choices have therefore been made based on the considerable scientific potential in our country, bearing in mind the aforementioned challenges and bottlenecks. NWO is grateful for the input received from

many different partners during the process which culminated in this strategy; the support from these parties is vital for its successful implementation. The result of this process is an ambitious plan of action along three strategic lines: 'Opportunities for researchers', 'Consolidating strengths' and 'Science for society'.

Line of action 1: Opportunities for researchers

Excellent researchers in the Netherlands often have insufficient scope to perform at their best and to present themselves at an international level. Innovative, curiosity-driven research is under considerable pressure and the lack of modern research facilities limits researchers' options. Too few young people opt for science, mainly because they believe it does not offer enough career opportunities. From the view that investment in research is necessary to sustain the strengthening of science in the future, NWO will place a strong emphasis over the next few years on 'Opportunities for researchers', making use of the following instruments:

- improving the career prospects for talented scientists, by realising talent programs for each phase of the scientific career, with special attention to diversity;
- increasing the possibilities for curiosity-driven research by guaranteeing more resources in open competition, and by ensuring that possibilities for pilot research are incorporated in research programs;
- ensuring state-of-the-art research facilities by doubling the budget for the Investment Subsidy Schemes NWO Large and NWO Medium, without imposing matching requirements from the institutes concerned;
- attracting talent from abroad by facilitating participation of foreign researchers in NWO talent programmes and by establishing a special fund to attract top international researchers (back) to the Netherlands;
- reducing bureaucracy further for researchers by on line applications and reviews, standardising procedures, using preliminary proposals and continuous submission.



Line of action 2: Consolidating strengths

A consolidation of strengths and resources at a national level is needed if scientific research in the Netherlands is to be boosted. Chances of scoring high in the global scientific arena will qualify the selection. Good examples of cooperation and consolidation are the NWO institutes as places for top research and as home for large-scale scientific research facilities. In the line of action 'Consolidating strengths' NWO will dedicate itself to the following:

- developing 'National Research Initiatives': programmes with a budget of 30-50 million euros, to consolidate research efforts in areas where the Netherlands occupies a global top position;
- realising interdisciplinary national cooperation together with the research establishment by thematic program lines of the NWO divisions;
- intensifying the cooperation of NWO institutes with university groups and other institutes;
- realising large-scale research facilities together with the innovation agency SenterNovem* by implementing the so-called 'BIG programme'* (budget 125 million per year) for investments of 25 million euros or more, and by contributing to the development of Dutch Road Maps for large-scale research facilities;
- stimulating and facilitating international cooperation by strengthening European research cooperation, in particular by actively contributing to European partnerships such as ERA-net, EUROCORES and Technology Platforms, by intensifying the cooperation with European sister councils and by selectively deploying resources for scientific cooperation with emerging economies;
- scaling up NWO grants by incorporating smaller forms of support in larger contexts and by using a larger proportion of the grants for projects in which several research groups cooperate.

Line of action 3: Science for society

Society's call for strengthening technological innovation increasingly demands rapidly applicable knowledge. This requires a better harmonisation between current, social issues and the available scientific potential. As a mediating organisation, NWO, on the basis of the open innovation model, brings together research requests and scientists under the slogan 'Science for society'. NWO is dedicated to:

- socially-inspired programmes, by cooperating with partners to translate social issues of government departments, the private sector and other public agencies into research questions, by devoting more attention to research that focuses on the translation of scientific insights into practical applications and by exploring how best to match research with questions from small and medium-sized companies;
- realising strategic partnerships in research utilisation, by example intensifying the shared partnership with the sister organisations TNO and SenterNovem;
- improving cooperation between scientists and professionals, by carrying out the so-called 'Smart Mix' programme*, by continuing the Casimir programme (encouraging the interface with industry) and by establishing the 'academic practice workshops';
- continuing research and innovation authorities as the boosters of new research initiatives, and selection of Social Top Institutes (MTIs*) as instruments for innovative research of social issues;
- enhancing researchers' awareness of research utilisation by integrating communication and knowledge dissemination in the programme development, organising workshops focused on utilisation, establishing a consultation for the utilisation of scientific knowledge via the Technology Foundation STW, and continuing to request special attention to utilisation in research proposals and monitoring.

Required: an additional fundamental investment of 433 million euros

The implementation of these ambitious plans requires a fundamental investment in science with direct government funding. NWO therefore requests of the government a structural increase of 433 million euros annually. This amount consists of two components. An amount of 150 million euros is needed to continue various successful initiatives, such as the Innovative Research Incentive Scheme and research and innovation agencies, as structural component of the existing – incidental – funding for innovative top research. In addition 283 million euros is needed annually on a structural basis to realise the intended jump forwards. In addition to strengthening of the open competition and talent policy, these additional resources will mainly be used for new modalities, such as National Research Initiatives (NRIs) and large-scale research facilities. Furthermore, the Ministry of Education, Culture and Science and the Ministry

of Economic Affairs have already allocated 100 million euros for the Smart Mix. Moreover, NWO has set itself the task of acquiring an additional 100 million euros.

Prerequisites for successful implementation

For NWO's strategy for the next few years to be successful, several prerequisites have to be met. The NWO strategy assumes a strong foundation, namely good education and strong direct government funding. Good education, from primary to tertiary level, will ensure the necessary supply of talent for science to draw upon. Strong direct government funding is necessary to ensure that universities can fully participate in indirect government funding. NWO contributes to the latter by financing the new instruments for the anticipated budget increase without any increase in the matching pressure for universities, whereas for the Innovative Research Incentives Scheme and the investment programmes for infrastructure (NWO Large and NWO Medium) universities will no longer be expected to contribute.

Furthermore, more national coordination is necessary for the implementation of the different financial instruments for innovation. The following also applies here: consolidation of strengths as a precondition for success. Part of this is a shared partnership between NWO, TNO and SenterNovem.

NWO: up to the challenge!

NWO is implementing various internal changes. For an improved connection between science and society, NWO proposes an advisory board at the management level as an initial step towards changes in its *governance*. Cooperation between divisions will be promoted, for example by a more flexible approach to the allocation of the basic budgets. NWO institutes and research authorities – important instruments for the implementation of the strategy – will be given a stronger foothold within the organisation. By providing transparent reports about the progress of the strategic plan, NWO will assure that its financing agents have the necessary guarantees that all investments are optimally used.

The Netherlands as front runner in Europe

In this strategic plan NWO presents an ambitious and concrete intention – with joint efforts from all partners – to give the Netherlands a leading position in Europe within ten years.



1 Opportunities and bottlenecks in scientific research

The boundaries of our knowledge and of our potential are constantly pushed back by scientists, who are driven by a fascination with complex processes and the challenge to unravel these, as well as by the desire to relate to innovations and improvements in technology and society. If a small country is to survive in the arena of global forces, it needs a dynamic knowledge economy. A prerequisite for a blossoming knowledge economy is a strong motivation for frontier research. Departing from this given, NWO perceives hitherto unrealised opportunities but also serious bottlenecks for scientific research in the Netherlands.

1.1 Towards the pinnacle of knowledge

The Netherlands, a knowledge society

The human history of science consists of an uninterrupted chain of posing questions and searching for answers. Up to today researchers have been kept in thrall by thousands of fascinating questions. How do the deaf acquire language? What genes are responsible for a serious disease? What is the connection between a religious conviction and cultural or political identity? Urgent and complex problems are also forced upon science by a society looking for solutions. Science, which is an important, if not the most important product of our knowledge society, propels the progress of our society. It is of the utmost importance for our prosperity

and well-being – now and in the future – that we manage to maintain our ability of developing and exploiting new and highly valid forms of knowledge. The 2004 budget of the Ministry of Education, Culture and Science has clearly set the tone for a new perspective on the significance of science for our society.

The Lisbon strategy

Three subsequent governments have rightly supported the political intention that the Dutch knowledge economy should be within the first league of Europe by 2010. This ambition had followed from the so-called 'Lisbon strategy' pledged by European prime ministers in 2000, when the alarm-bell was sounded over Europe's lagging performance in science and technology and the massive exodus of Europe's best scientists.

By 2010, the European Union should be the most dynamic and competitive knowledge economy in the world.

Fully aware of the fact that the capacity to develop and exploit advanced knowledge is the determining factor for the future of both Europe and the Netherlands, the second term of Prime Minister Balkenende endorsed this course unrestrictedly yet again in 2004, with the mid-term review¹ of the Lisbon strategy. The government subscribed to the conclusion that the key to success lay primarily with the member-states themselves. The consequence is that the Netherlands will have to spend substantially more on education, research and innovation. The Innovation Platform was requested to determine the strategies for fulfilling these ambitions.²

Excellent performance, keener competition

Time and again, comparative research has shown that the level of science in the Netherlands is very high.³ An excellent general performance, also in terms of international standards, is topped, in certain areas of science, by a position among the very best of the world, as for example with Astronomy, (Bio)Medical sciences, Clinical Medical

¹ This mid-term review was executed by a High Level Group led by the former Dutch Prime Minister Wim Kok. See the report of this commission, entitled *Facing the Challenge* (November 2004).

² See the reaction to the report of Kok by Balkenende's second government on November 29 (2004) as well as the report '*Vitalisering van de kenniseconomie*' of the Innovation Platform (November 2004).

³ See, among others, the most recent report of the Dutch observatory for science and technology (NOWT), '*Wetenschaps- en Technologie-indicatoren 2005*.'



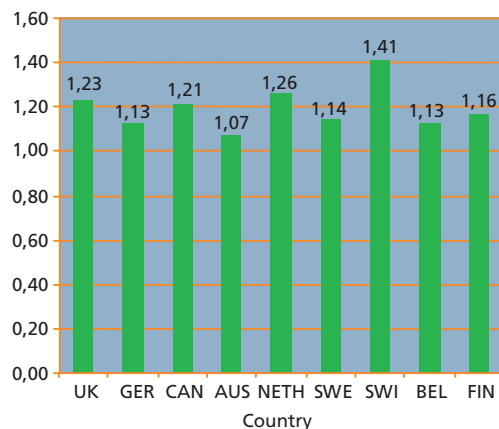


Figure 1.1 Citation-impact scores⁴
Source: *The Dutch observatory for Science and Technology, report 'Wetenschaps- en Technologie-indicatoren 2005,' November 2005.*

Sciences, Information and Communication Sciences, Neuropsychology, Chemistry and Physics.

Both the number of publications and the citation-impact scores of Dutch publications are above average (see Fig. 1.1 for citation-impact scores). The results of research audits confirm that as a rule the quality of research at the different knowledge institutes in the Netherlands is high. We are not, however, the only ones. Scientific research in the Netherlands is pressed to prove its worth

in the field of developing and applying advanced knowledge, while international competition is ever keener. Research is, in addition, increasingly organised along international collaborative networks, a movement compounded by the sheer independent trend of globalisation. Scientific quality is increasingly subject to international benchmarking. The strength of research programmes is automatically translated in terms of the possibility of acquiring international financial resources and of attracting world class scientists from elsewhere. In this respect, the rapid development of the so-called emerging economies should also be considered⁵. China and India are investing heavily in research and technology, and have quickly become dominant players in areas of science such as ICT and the biomedical sciences. The Netherlands is faced with the challenge to maintain and extend its relatively strong current position.

1.2 Threats to success in scientific research

The question, however, is whether we will be able to maintain these good marks. Scientific research in the Netherlands is grappling with a number of factors that threaten to undermine success, both in qualitative and in quantitative terms.

Underinvestment

It has been pointed out by various parties that the so-called Knowledge Investment Quotation (KIQ)⁶ needs to be raised significantly.⁷ Figure 1.2 shows a 0.58 % decline in the KIQ in the Netherlands – definitely not a good sign in light of the aims of the Lisbon strategy.

When we consider the world of science and scholarship, the precarious financial position of universities – the pivot of scientific progress with their combination of research and education – and other public knowledge institutes is palpable, as the result of a long series of cuts. This forms a real threat to the success of scientific research in the Netherlands. The universities have indicated that they often lack the means to provide those research groups that qualify for indirect government funding or external financial support, with the necessary basic investments. In addition, research has generally become more costly; world class scientific research requires a hitherto unparalleled degree of capital investment in modern research facilities. An omission of such investments in the necessary infrastructure, due to the limited budget of knowledge institutes, has led to a critical situation that urgently calls for a committed intervention.

⁴ Citation-impact scores: the number of citations in international scientific journals in relation to the average of citations in the field of research concerned, on a global level. The global score is equated as index to 1.0

⁵ An inventory of emerging economies is maintained by the Dutch government, based among others on data concerning growth and investments in *Research and Development*.
⁶ KIQ is the sum of all public and private investments as a percentage of the Gross National Product. Its main components are education at large, and R&D expenses in training and schooling.

⁷ See the advice of the council of Economical Advisors (REA, nr. 2005/4), the report *Tijd voor een opKIQer* (nr. 67, October 2005) brought forward by the Policy council for Science and Technology (AWT) and *Verkenning naar de kennisinvesteringquote (KIQ) en de prestaties van de kenniseconomie op hoofdlijnen*, a paper of the Ministries of Economic Affairs and of Education, Culture and Science (July 2005).



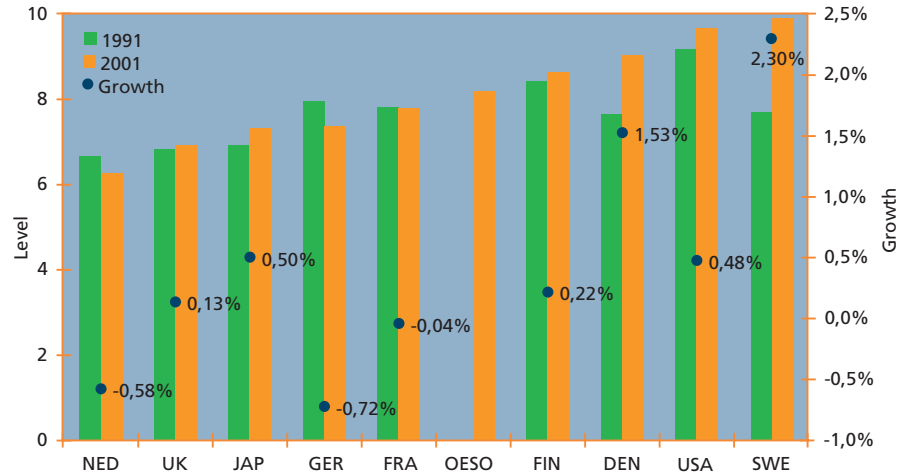


Figure 1.2 Level and growth of the Knowledge Investment Quotation (KIQ), 1991–2001
 Source: *OESO Main Science and Technology Indicators, OESO Knowledge Investment Database, OESO Education at a Glance, OESO Economic Outlook Database, Paris, 2004.*

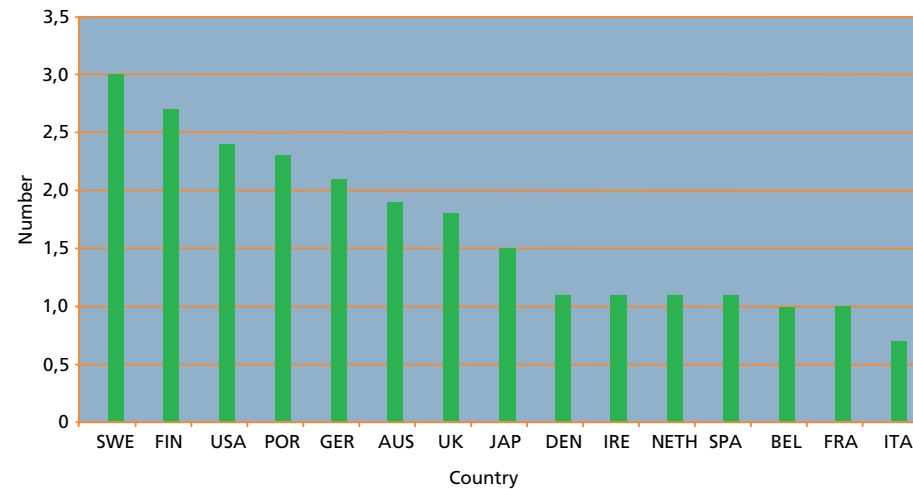


Figure 1.3 Number of PhD graduates per 1000 inhabitants between 25-34 years of age in the EU (15), the USA and Japan
 Source: *Eurostat 2002*

Limited scale

Universities and other knowledge institutes have been forced by both financial restrictions and a fierce international competition to opt for a concentration of their most successful or promising research. In some cases this has led to a favourable redistribution of research domains among universities. Consider, for example, the collaboration of the three technical universities in the Netherlands. The selection of potent research centres is a start, but a critical level of human and material resources is the prime prerequisite for such centres if they are to carry any weight internationally. Adequate financial means are indispensable.

Lack of appeal to young and talented researchers

The position of science in the Netherlands is not only threatened by continuous cuts. The limited growth of young talents poses another serious problem. Too few young people opt for a career in science or are in the position to do so. Our number of PhD graduates is among the lowest in Europe (see Figure 1.3)

In combination with the ageing of university personnel, a critical situation has developed in a number of disciplines. Within the course of ten years a large proportion of the tenured staff will have retired. The problem is even more acute in science and in technological disciplines, where the influx of students is exceedingly low.

Dwindling numbers of students and the limited appeal of research do not just jeopardise a flourishing research practice. The benefits of an academic education affect society at large. The concern for the new generation is everyone’s affair.

The fragmentation of financial arrangements

Aiming to expand the innovative potential of our country, the government has taken some initial steps towards boosting investments in scientific research. Additional means were granted to establish new practices of public-private collaboration in frontier research. These investments are evidently important for developing the knowledge economy in the Netherlands, but the scattered financial means and ever changing procedures to acquire these funds have become a drawback. A strategically envisioned national design for the system of knowledge in the Netherlands is called for. The present strategy plan intends to provide the groundwork.

1.3 Challenges to scientific research

Competition in Europe and across the world

Resulting from the Lisbon strategy, the concrete course of action embarked upon has been the expansion of European research activities into a *European Research Area* (ERA). The seventh EU frame programme will greatly influence (financing) research within Europe by means of a selection of themes and domains. Apart from such research as

the result of a European policy, there will also be room for science-driven research. The European Research Council (ERC) is currently being established to coordinate this type of research. For those research groups in the Netherlands that belong to the premier league in Europe or beyond, the ERC will become an important source of funding. One of the functions of NWO is to ensure that Dutch research is of a sufficiently high standard, and thus to ensure top scores for our researchers in the European field of competition. Such developments in the context of Europe, added to the increasingly keen competition across the world, including competition from emerging economies, will force Dutch scientists more than ever to perform competitively at the highest possible level.

Emphasis on innovation

Innovation, the keyword for 'The Netherlands, a knowledge society,' determines the direction of scientific research. The emphasis on innovation implies, among other things, that the outcomes of scientific research can be implemented as concrete, strategic innovations in business and government. This will lead, among other things, to a type of research in the academic world that is more attuned to social issues. Likewise, organisations such as TNO and SenterNovem will have to readjust their policies to become demand-driven.

Nowadays, innovation appears to occur mostly in networks, as the result of a proliferous interaction between players at different links in the chain of knowledge. This so-called 'open innovation model' involves a more intensive collaboration between university-

based scientists and representatives of the business world or other social agents. The pressure to be innovative will also require a smooth interaction between the purely fundamental sciences and the applied sciences.

Augmentation of multidisciplinary and interdisciplinary research

Scientific and technological innovations are increasingly produced at the cutting edge of different disciplines. The cross-pollination of perceptions and methods from different disciplines has become the rule rather than the exception. New important disciplines have emerged, such as Genomics, Nanosciences, Cognition Sciences and research in ICT, that cut right through the established boundaries of former disciplines. The convergence of perceptions and methods has not been restricted to closely connected disciplines but has involved ostensibly more disparate disciplines too, as developments in Cognition Sciences and research in ICT will testify. Such collaboration is designed to discover integral solutions for scientific questions, but also to find a way of embedding these solutions in society. Multidisciplinary and interdisciplinary research is no object in itself but an instrument for achieving new, groundbreaking outcomes.

Social questions

Welfare is not synonymous to well-being. The impact of scientific knowledge is not restricted to economic growth or to a firm, internationally competitive position. The Dutch require of their physical, cultural and social surroundings safety, health and the opportunity for all inhabitants to develop

their full capacities. We are struggling, however, with a number of social questions. Some are specifically Dutch, but most are increasingly global in nature. Consider for example the climate changes, the endangering of ecosystems or the rise of internet-related crime. Questions of social cohesion, lifelong learning, new role patterns for the government, the war against poverty and durable development reach beyond national borders, too. Such questions call for scientific research with a committed multidisciplinary or interdisciplinary approach. An appeal to science is made from different social echelons to contribute to solutions to these questions. The need for regulation and coordination of scientific contribution and social demands calls for the development of research programmes that are attuned to social challenges and exigencies. The pioneering work of the KNAW and the COS, and the Forward Looks of the ESF will be invaluable.

Embedding and innovations

On the one hand, the exigencies of society may guide the course of science towards new questions or views. On the other hand, the tempestuous effects unleashed by science may deeply affect society. Although new technologies may open up new vistas of possible applications, it is not certain that social acceptance will follow naturally. The complexity of our system of knowledge, and the speed with which new concepts and techniques are discovered and applied, give people the helpless feeling of being mere onlookers of scientific and technological developments. Science that appears to be 'too much, too fast, too opaque' prompts



In retrospect: Themes plus Talent 2002–2005
NWO's strategy paper for 2002–2005, *Themes plus Talent* was published in 2001. Two new strategies were unfolded in this paper: thematic programmes (often multidisciplinary in nature) and a policy for talented researchers. This policy, with the Impulse for Innovation as an important instrument, turned out to be very successful and was much praised by all parties.

The response mode funding this policy stood for was, however, continuously in jeopardy due to a lack of means. Furthermore, the budget was insufficient to support a thematic approach. In spite of these restrictions, however, the results have been considerable. NWO itself has undergone a process of re-orientation, to the effect that scientific research and society are now more closely interrelated. The so-called Smart Mix was launched in 2006, a programme designed to annually invest an additional 100 million euros in frontier research where scientific and social questions converge. When all is said and done, however, scientific research in the Netherlands still lacks the necessary force to take up a dominant position in the international arena. A substantial augmentation of resources is needed.

reaction of doubt and resistance. It also prompts justifiable critical and ethical questions whether capability necessarily involves exigency. This, in turn, underscores the necessity to adequately prepare the introduction of technological or scientific innovations to society. An open discussion between science and society is therefore of the utmost import.

1.4 Substantial investments in knowledge: indispensable

In short, it is clear that scientific research will be facing many different challenges in the years to come. It will have to be a strong player in the field of international competition, engage in innovation, connect with social questions, deliver an output of high standards, continue sheer curiosity-driven research, reconsider its mission and establish new networks of collaborative research. There is much to be done in Dutch science, and much that can be done, but if no action is taken, we shall not have the strength to throw a perfect pitch in the future. There is a discrepancy between the present practice and the ambition of the Netherlands to be front runner in European knowledge. Research performance in the Netherlands has not merely dropped below the level of the top 15 of European nations, but even below the average of the European Union (see Figure 1.4).

These data concern the sum total of private and public R&D expenditure. Public R&D-

investments should – according to the Barcelona targets – minimally constitute 1% of the Gross National Product (GNP); an amount easily attained by knowledge societies such as Finland or Sweden. Dutch public R&D investments constitute a mere 0.78% of the GNP (2003). If this country seriously aims for the premier league, a rise of public R&D expenditure to the level of 1% is a prime prerequisite.

being prepared by the Innovation Platform and will serve as a guideline for future investments by public and private parties in education, knowledge and innovation. The Committee for Dynamism* has recently argued for additional investments in scientific research to the amount of about 1 billion euros.⁹ It is no luxury but a bare necessity to raise investments in science.

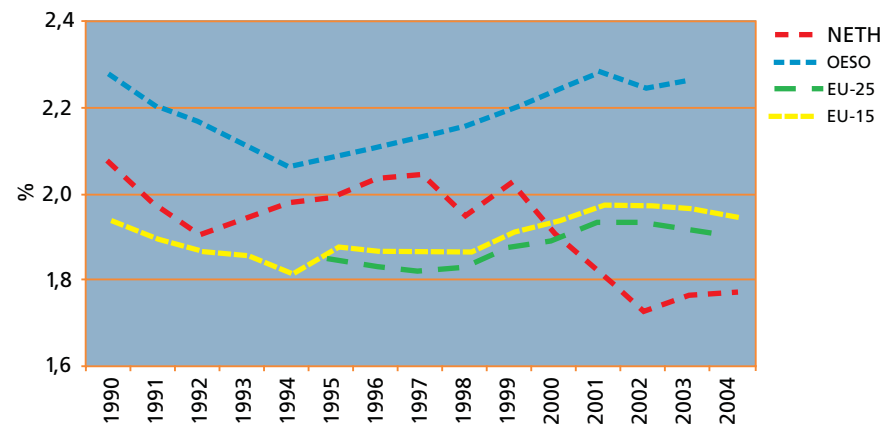


Figure 1.4 Percentage Gross National Product (GN) reserved for R&D expenditure
Source: *Feiten en cijfers wetenschappelijk onderzoek*, Ministry of Education, Science and Culture.

A substantial investment in Education, research and innovation is needed in order to achieve the Barcelona targets. A recent calculation by the Council of Economic Advisors (REA)⁸ estimates an injection of public and private investments at 10 to 15 billion euros per annum. The *Agenda for Knowledge Investments* for the period of 2006-2016 is

⁸ The REA is an independent advisory body to the Dutch Lower House on financial-economical affairs (advice nr. 2005/4).

⁹ Both the content and the financial claims that inform the present NWO strategy have been developed in close association with the recommendations of the Committee for Dynamism, as stated in their final report, *Investeren in Dynamiek* (April 2006).

Prospect

After many intensive and penetrating discussions with all our national knowledge partners, NWO has come to the conclusion that a radical change of course is essential. It is necessary to bring the ambitious but realistic scientific aims of the Netherlands up to the front league in Europe. This will involve a thematic approach, a policy for talented scientists and scholars, response mode funding, a policy concerning the research infrastructure, a policy for 'brain gain', as well as a policy for excellent researchers for the very best groups. Chapter 3-6 will detail this course of action.



2 NWO: Consolidating expertise in a knowledge society

If the Netherlands is to retain its competitive potential in the international arena, a strong system of knowledge is required with excellent universities and knowledge institutes. NWO is expected to participate extensively in fortifying the national system of knowledge, and is in a position to meet those demands. NWO finances excellent research nation-wide, aims to guard the quality of Dutch science, is involved in setting the direction of research by means of research programmes, and acts as an intermediary between science, universities and society. In the period to come, NWO shall accentuate its function as an intermediary with its knowledge partners.

2.1 Mission and core qualities

As an intermediary between science and society, NWO is at the intersection of knowledge questions from society and research. It is involvement with different parties in society which adds to NWO's trusted part in catalysing and financing excellent and groundbreaking research.

In short: NWO has the expertise to advance quality and innovation in science, in research programmes, and in embedding science in society.

NWO will proceed as follows:

Booster of quality and innovation

Quality is the core criterion for NWO's mission and for each of its actions. What is good does not suffice: only the best of research in the Netherlands is eligible for funding by the

national research council. It is the moral duty of NWO to spend the taxpayer's money in the best possible manner. As an independent, non-commercial, national body, NWO is able to organise the continuous process of objective and transparent quality selection. The prior condition for true frontier research is, apart from the stimulation of excellence, alertness in taking up new possibilities and promising knowledge questions. NWO invests a great deal in medium-term projects, and is, therefore, in the position to boost innovation in research and give a focussed impulse to the development of science in specific subject fields.

Programmer of scientific research

Because NWO is anchored in the Dutch science community, it has the capacity to survey the national landscape of research. This attribute enables this council to boost existent qualities by bringing several (groups

of) scientists or scholars from different knowledge institutes together for a coherent and concentrated joint research effort. Because NWO has a pivotal function in programming research in close collaboration with actual researchers along the line of themes, it stimulates cutting-edge research at the universities.

Intermediary between the sciences and society

NWO aims to exchange knowledge obtained through scientific research with companies and social institutions. This is achieved by systematically involving different parties in society in the stage of programming a proportion of scientific research, by developing concepts and activities for knowledge transfer (often with partners such as SenterNovem), and by supporting researchers in the process of applying knowledge or conveying their findings to a larger audience.

2.2 Organisation, mode of operation, and instruments

With its knowledge partners from science and society, NWO gives shape to scientific questions and research programmes in response to the needs of society and research.



Concerning science, NWO:

- Invests in the best of human resources and advanced facilities for research so as to warrant a prime scientific position.
- Operates independently and objectively according to international, professional peer standards.
- Fortifies the quality of Dutch scientific research by maintaining international standards in the selection processes.
- Acts as a catalyst for innovation by reacting promptly to promising developments in knowledge.
- Attends to the national coordination, coherence and concentration of research, aided by the survey it has of the scientific landscape in the Netherlands against the backdrop of European and global developments.

Concerning society, NWO:

- Signals social challenges and the vital questions of the government, trade and industry and other social parties.
- Stimulates and coordinates the gathering and formulation of clear knowledge questions from these social agents.
- Will translate issues arising from society into scientific questions for thematically organised research programmes.
- Convenes researchers and other professionals for the distribution and application of scientific outcomes.
- Facilitates the exchange of knowledge between science and the public.

This partnership determines the way NWO is organised. Traditionally, the different NWO research divisions constitute the core of NWO.¹⁰ They dispose of a variety of instruments to meet these questions and tasks, specifically:

Funding programmes for frontier scientific research

The major part of research resources is invested by NWO in fundamental innovations in scientific thinking and practice. There is no evolution in knowledge without science that is intrinsically innovative. Several funding programmes have been developed to achieve this goal. First of all, there is a response mode funding programme for excellent research to be obtained in open competition. Then there are programmes devised to tackle specific policy questions, such as career support programmes for young researchers (the so-called Innovational Research Incentives Scheme), or to stimulate the development of a required research infrastructure (NWO Large and NWO Medium programmes). In addition, NWO has programmes for multidisciplinary research relating to specific themes.

Participating in (European) consortia

The fulfilment of NWO's mission also involves the initiation of or participation in

(international) consortia, designed to deal with scientific questions that reach beyond the boundaries of national knowledge institutes. NWO domains participate for example in ERA-net, Technology Platforms or EUROCORES.¹¹ These consortia extend the possibilities for Dutch researchers – at present, or in the long run – to create resources and international cooperation.

Promoting the distribution of knowledge

In addition, NWO is concerned with the conceptual development and practical execution of communicating the outcomes of research to other branches of society. Technology Foundation (STW) has 25 years of experience in sharing knowledge with society, and the medical domain has established connections between medical research and care systems since 2001. Other NWO domains such as ICT and the chemical sciences have recently developed similar activities. NWO is also involved in different strategies and projects for relating to the population at large, such as joint projects in the media (the national science quiz, for example), or close collaboration with the Dutch science museum NEMO and other science centres.

Apart from these, the organisation of NWO includes several research institutes, foundations and research authorities, each concerned with specific missions:

¹⁰ Earth and Life Sciences, Chemical Sciences, Physical Sciences, the Humanities, Social Sciences, Physics, Technical Sciences, Medical Sciences.

¹¹ ERA-net is an EC policy instrument intended for the coordination of research programmes within Europe. Primarily, it consists of a number of networks designed to explore the possibility of programmes. In Technology Platforms, knowledge institutes and business companies joint collaborate, in order to amend the position of European industry in terms of international competition. The EUROCORES scheme is a European grant system encouraging, operated by the European Science Foundation (ESF), multinational 'science-driven' collaboration of European research organisations.



NWO institutes

The NWO institutes¹² are in control of large research facilities. Serving as the gateway to international facilities such as ESA, ESO, CERN, ESRF, ILL, ITER, they bring focus and critical mass to Dutch research. The existence of these institutes is justified by their excellent scientific performance, which is internationally audited every six years. All institutes received the predicate 'very good to excellent' in the most recent audit (2005).

Foundations

Two foundations are part of the NWO organisation. The National Computing Facilities Foundation (NCF) serves to enhance the quality of scientific research by providing the best computer infrastructure and ensuring that these facilities are optimally exploited. The Foundation for the Advancement of Tropical Research (WOTRO) stimulates innovative research relating to developmental issues, with special focus on the UN *Millennium Development Goals*.

Temporary taskforces

The three most recently established temporary taskforces in NWO are the Netherlands Genomics Initiative (NGI), the Advanced Chemical Technologies for Sustainability (ACTS) and the National Research Authority for ICT Research and Innovation (ICTRegie). With to-the-purpose financial injections they enhance scientific research in the national strategic knowledge areas of Genomics, Chemical Technology and ICT. These bodies are also specifically concerned with creating a platform for the questions arising from society and science, and with enhancing the exploitation of scientific insights in the fields of industry and government.

¹² Netherlands Foundation for Astronomical Research (Astron), National Research Institute for Mathematics and Computer Science (CWI), FOM-institutes for Atomic and Molecular Physics (Amolf), for Plasma Physics Rijnhuizen, for Subatomic Physics /Nuclear Physics and High Energy Physics (SAF/NIKHEF), Institute for Dutch History (ING), Royal Netherlands Institute for Sea Research (NIOZ), Netherlands Institute for the Study of Crime and Law Enforcement (NSCR), SRON Netherlands Institute for Space Research.

A complex field of force

NWO consults with many different bodies in science and society – an indispensable condition for carrying out its main tasks. A large amount of these organisations have been closely involved in the processes leading up to this strategy paper.

Researchers and knowledge institutes

The input of researchers is at the heart of the NWO operative force. They are the ones to render research questions and perform actual research. They are directly involved in the necessary procedures of selection. Researchers are employed in departments, research schools or research institutes at universities or other public knowledge institutes, and may be represented by (members of) university executive boards, the boards of university medical centres, faculty boards, the boards of research schools, and so on.

There are in addition several national research associations, such as the Royal Netherlands Academy for the Arts and Sciences (KNAW), The Young Academy (DJA), the Spinoza club, the Association for Innovative Research Incentive Researchers (VVViO), the National Post-doctorate Platform (LPP), the Netherlands Post-graduate Network (PNN), and the National Women Professors Network (LNVH).

Other (intermediary) organisations in science and higher education have also been consulted, such as the Association of Universities in the Netherlands (VSNU), the Netherlands Association for Applied Research in the Natural Sciences (TNO), the Council for Higher Vocational Education, and the Advisory Council for Science and Technology Policy (AWT). Just like NWO, each has a distinctive mission is concerned with subjects related to the knowledge system as a whole.

Science does not stop at the national borders. Researchers and knowledge institutes from abroad, as well as (European) umbrella organisations are of increasing importance for science in the Netherlands. NWO is therefore in close consultation with related national research councils in Europe and with diverse European organisations such as the European Science Foundation (ESF) and the European Heads of Research Councils, a consultative body of the heads of national research councils in Europe (EUROHORCs).

Society

Science is the concern of the entire population of the Netherlands. Through taxes they contribute to science, they profit from its spin-off and cannot escape or ignore its findings and applications. As an intermediary, NWO consults with many different social bodies as well.

At a national level there is a number of important agents influencing the course of science, because they are involved in financing, facilitating, or advising on research and are keen on the results. NWO is primarily accountable to the Ministry of Education, Culture and Science. Other departments and ministries too have distinct policy questions that involve science, such the Ministry of Economic Affairs, the Ministry of Health, Welfare and Sports, the Ministry of Housing, Spatial Planning and the Environment, the Ministry of Agriculture, Nature and Food Quality, the Ministry of Justice, and the Ministry of the Interior and Kingdom Relations.

Besides the Dutch government, the European governmental body is involved in determining the frameworks for research and the distribution of subsidies as well. The 7th EU Framework programme (2007–2013) will set the targets for scientific research in Europe.

Furthermore, a great number of public bodies have a stake in knowledge and science, such as the Innovation Platform, SenterNovem, The Consultative Committee of Sector Councils (COS), the Scientific Council for Government Policy (WRR), the Social Economic Council (SER), the trade unions FNV and CNV, the Centre for National Planning (CPB), the Centre for Social and Cultural Planning (SCP), the Centre for Spatial Planning (RPB), the Centre for Environment and Nature Planning and many other organisations.

Evidently, an important party in scientific research serving our knowledge economy is represented by trade and industry. These range from small, specialized companies to multinationals and their respective branch organisations and cumulative national associations, such as the National Association of Employers (VNO-NCW) and the Association for Small and Medium-sized Companies (MKB-Nederland).

Finally, NWO is also involved in a wide range of social bodies, private institutions such as patient associations, funds, museums, libraries, action groups, NGO's, science centres and related centres for communicating science, each with a distinct input and set of expectations.

3 Strategic choices 2007–2010

In response to opportunities and threats which have been observed in Dutch science, NWO has, in the capacity of its specific role, charted a strategic course for the period 2007–2010. The point of departure for NWO aspirations is that the knowledge and research system in the Netherlands – building upon the strengths of university research and with indirect funding as the key strategy – will occupy a leading position in Europe within ten years. On the basis of the great scientific potential in the country, choices in relation to the future have been made. The contribution of many different partners in the strategy process has been of inestimable value for NWO. The support created by these partners is essential to its successful implementation. As a result a plan - which in a historical context can be considered to be very ambitious - has been drawn up along three strategic lines: *Opportunities for researchers, Consolidating strengths, and Science for society.*

3.1 New knowledge, new applications

Science forms the foundation of our knowledge society. Furthermore, society demands good and varied education, an inviting establishment climate for companies, a flexible transfer of knowledge to small and medium-sized enterprises, and a high level of education for the professional population. For the knowledge economy of the Netherlands to acquire the desired leading position in Europe, action will have to be undertaken in all these areas. Since NWO cannot achieve this single-handedly, cooperation is required.

The point of departure for NWO's contribution is naturally in science. NWO regards it as its task in the coming strategy period to

be, via indirect funding, robustly dedicated to research which will result in innovation in scientific, economic, technological and social areas. Top quality is – as always – of major importance. More than ever before, creativity and daring are required to push back the frontiers of science. The challenge is to explore new areas of knowledge, to develop new methodologies and - sometimes in the process of doing it – to offer society new perspectives with concrete applications.

This implies that fundamental and applied research will become much more cyclically interlinked, rather than following each other lineally. As a rigid division between fundamental and applied research is no longer feasible, NWO rather refers to cutting-edge research. This refers to high-quality scientific

research which pushes back the frontiers by exploring new areas in science and by offering new perspectives with concrete applications. Such innovative research can occur in all areas of science.

3.2 Three strategic lines

Investments in research constitute a good indication of the progress a country is making in its transformation into a knowledge society.¹³ The unabridged advice of Lewis Carroll may be applied to science in the Netherlands today: *'It takes all the running you can do, to keep in the same place. If you want to get somewhere, you must run at least twice as fast as that!'*¹⁴ It is with this awareness that NWO presents a strategy for realising the intended strengthening of science in the Netherlands according to three lines of action:

- Opportunities for researchers
- Consolidating strengths
- Science for society.

¹³ Source: *Het Financieele Dagblad* (3 February 2006, a daily newspaper on finance).

¹⁴ As the Red Queen says to Alice in *Through the Looking Glass*.



A brief explanation of the above-mentioned strategic lines can be found below. In Chapters 4 to 6 the three lines of action are dealt with independently, and include a balanced, matching set of instruments. The budgetary explanation of the policy proposals may be found in Chapter 7.

3.3 Opportunities for researchers

Investing in people, ideas and equipment

An absolute basic condition for qualitatively strong, innovative research, which NWO has striven for from time immemorial, is the presence of a sufficiently large number of researchers who are provided with the opportunity of giving substantial form and content to their passion for the profession. To that end, in recent years NWO has invested in a number of specific instruments. We refer here, for example, to human resources programmes such as the Innovative Research Incentive, Aspasia and Mosaic, but also to the subsidisation of excellent research via response mode funding, and to the programmes for investments in small and medium-sized research facilities.

However, the task that science in the Netherlands is dedicated to – contributing to the knowledge society, performing in the European vanguard and society-orientated programming – requires much more. For young researchers, for women, or for talented researchers from ethnic minorities, science does not yet offer sufficient possibilities. In addition, unrestricted,

risk-taking research is increasingly being pushed aside, while it is this very research driven by curiosity which is in the long term essential for innovation. To add to all of this, many research facilities no longer satisfy the requirements for current scientific practice. It is therefore clear that science in the Netherlands has to recover lost ground in a number of areas.

With the strategic line of Opportunities for researchers, NWO wishes to further eliminate any obstacles in the way of high-quality scientific practice. This means robustly continuing and expanding upon the policy which NWO has successfully pursued for some time: investing in people, ideas and equipment. At present, NWO invests 178 million euros in this annually. To be able to realise the essential expansion of this policy an extra 108 million euros is needed annually.

3.4 Consolidating strengths

Creating focus and critical mass

The Netherlands is a small country. To enhance its scientific output, NWO will have to consolidate strengths on a national basis. This means opting for the very best research groups to provide ‘critical mass’. But it also involves harmonisation and bringing together research groups that are performing well in more or less institutionalised forms of cooperation.

In consolidating research efforts, the intensive international competition will have to provide the lead, much more than is currently

the case. In other words, we have to achieve prominent peaks in the qualitative heights which are also conspicuous in the international scientific arena. To realise this, NWO will have to divide its available means into larger units than ever before.

The availability of various types of large scale research facilities is indispensable for cutting-edge research. If these are realised, they will also serve to draw top talent from abroad. Because the investments required for these sorts of research facilities far exceed the spending capacity of individual knowledge institutes, we will have to join forces in this area on a national basis too.

With the strategic line ‘Consolidating strengths’ NWO wants to achieve more ‘focus and critical mass’ in research in the Netherlands. More than ever before, NWO will work towards combining promising research in centres of excellence. The chances of attaining a European or worldwide top position will be a considerable factor in selecting these. The objective is to strengthen the scientific domains so that the Netherlands achieves high scores on a global basis and to invest substantially in domains which have the potential to acquire a leading edge position within the foreseeable future. To also give the selected centres of excellence international importance, they will naturally have to be considerable in size. To seriously follow this line of action, 250 million euros are needed annually, beyond the amount of 165 million euros that NWO is currently investing.



3.5 Science for society

Socially inspired programming – Embedding research in society

Today's society is complex and permanently in a state of flux. Amongst other things, this requires the scientific world to take into account the impact that new discoveries and possible applications of knowledge can have on people and society. In its turn, society expects science to provide substantial help in solving complex problems. In the coming strategy period, social issues will resound more robustly in NWO's programming. With 'social issues' we refer to social problems and economic challenges in which high quality knowledge and/or technology can contribute to working towards a solution. To determine which social issues have priority, NWO will, in the interests of making a careful appraisal, continually maintain contact with actors such as departments, the Innovation Platform, the business world and social organisations.

In actual practice, the 'knowledge producing' sciences and the various 'knowledge users' in society have insufficient contact with each other. Because of this, valuable knowledge remains unutilised or reaches a potential user too late or in an undesirable manner. This phenomenon is also known as the 'knowledge paradox'. In the concerted action between science and society, NWO sees it as its task as initiating the development of knowledge and organising the transfer of knowledge. In this aspiration, NWO can be sure of support by various cooperative partners who contributed to the strategy process, but does not pretend that it can organise the

entire process from knowledge development to the utilisation of knowledge. NWO aspires to give shape to this task in cooperation with other, possibly intermediary, organisations.

With 175 million euros annually in addition to the current spending of 130 million, NWO will selectively invest in the coming strategy period in socially inspired theme programmes and in the development of programmes and other concepts for facilitating the transfer of knowledge between the sciences and society. NWO will do this in cooperation with other intermediary organisations such as SenterNovem and TNO.

3.6 Close cooperation with knowledge partners

NWO can only implement a strategy such as this in cooperation with its partners in science and society. For this reason, NWO will enter into strategic alliances with these partners. This will, in particular, be in conjunction with the following activities: strengthening the so-called tripartite talks with the partners *KNAW* and *VSNU*, having structured talks with *SenterNovem* about programmatic cooperation, strengthening the strategy function of the so-called *Manifest* parties, having systematic talks with the *TNO* about substantive cooperation, as well as regular talks with various governmental departments that also facilitate the research via NWO, along with, naturally, having structural and intensive talks with the Ministry for Education, Culture and Science. The setting up of an advisory board with representatives from the public

sector, industry and society would be helpful in anchoring the NWO policy to a broader social orientation.

3.7 Adapting instruments to strategic choices

In view of the strategic choices for 2007–2010, NWO has, of course, examined its current instruments. The existing instruments that would also be valuable in the coming strategy period will be continued. To make NWO's strategies concrete, a number of new instruments will be developed in addition. At the same time, instruments not in keeping with the new strategy will be discontinued. Thus the efforts regarding 'focus and quantity' imply, amongst other things, that NWO will primarily provide grants of substantial quantities. This means that the smaller forms of support – such as travelling grants and publication costs – will be discontinued or, wherever possible, be brought under larger modules. This approach will result in a balanced mix of instruments per line of action, which will be further explained in Chapters 4 to 6.



4 Line of action 1: Opportunities for researchers

Excellent researchers in the Netherlands have insufficient scope for performing at the optimum. Innovative, risk-taking research is strongly under pressure and the lack of modern research facilities limit the possibilities for researchers. Too few young people choose to work in science. This is primarily because they think that it lacks career prospects or exciting tasks. Realising that investment in research talent is necessary for the durable strengthening of science in the future, NWO will, in the coming years, be dedicated to creating *Opportunities for researchers*.

4.1 Improving the career prospects for academic talent

The vitality of science is dependent on sufficient possibilities for researchers to grow and develop. In the coming years, NWO will therefore provide excellent researchers – from PhD students to highly qualified senior researchers – with the opportunity of building up challenging academic careers. This will of course be in cooperation with universities and other knowledge institutes.

Action:

- Continuing and expanding tailor-made human resources programmes, for each phase of the scientific career, from graduation up to a possible professorship. In recent years, NWO has built up a portfolio of human resources programmes with the Innovational Research

Incentives Scheme as the main feature. These programmes will be continued in the coming period.

- Increasing diversity within science. It is therefore of great importance to promote the intake and promotion of under-represented groups such as women scientists and researchers from ethnic minorities. The successful programmes Mosaic and Aspasia will thus be continued. Incentive programmes directed at women scientists such as FOM/v and More Women Researchers as University Lecturers (Meervoud) will also be continued. In addition, NWO is dedicated to increasing the participation of women and researchers from ethnic minorities in all NWO programmes, amongst other actions, by explicitly requesting women researchers to submit applications. Finally, NWO wants to make

a contribution to the visibility of women and people from ethnic minorities in science, amongst other actions, by devoting explicit attention in all communications to the scientific performance of ‘role models’ from these groups.

4.2 Creating more possibilities for risk-taking research

At times scientific research progresses gradually, while at other times it advances in leaps and bounds. Pioneering ideas are prerequisite for innovation and therefore for the viability of the sciences. NWO wishes to provide extra support for risk-taking research in the coming period.

Activities:

- Strengthening response mode funding, by making greater means available and by spending a fixed percentage of the NWO research division budgets within NWO on this. Response mode funding gives researchers the possibility of developing new areas of research according to their own discretion, without thematic restrictions.
- Grafting response mode funding onto risk-taking research by explicitly



The **Innovational Research Incentives Scheme** was established by NWO, together with the KNAW and the universities, in 2000. In 2002 it was endowed with the specific categories of *Veni*, *Vidi* and *Vici*. It is the aim of the programme to give an extra incentive to innovative research. The Innovational Research Incentives Scheme is a personal grant and offers talented, creative researchers the opportunity to execute their ideas for research in practice. Thus, they give shape to their career in science. In addition, the programme contributes to the influx and flow of young talent at the universities. Over 4000 researchers applied for this grant in the 2002-2005 period, and about 900 of these proposals were awarded with a *Veni*, *Vidi* or *Vici* subsidy.

The **Aspasia programme** is geared to stimulating the promotion of women university lecturers (UL) to positions of university senior lecturers (USL). In 1999, when Aspasia started, 20% of the ULs were women and only 7% of the USLs. In the rounds in 2000 and 2002, NWO received a total of 280 proposals and 70 Aspasia grants were awarded. In addition to these 70 Aspasia laureates, the Universities themselves promoted another 70 candidates who were judged to be 'good'. The percentage of women USLs thus doubled in three years to 14%. This breaking through the glass ceiling subsequently continued in the promotion to professorial positions. In the meantime, 18 Aspasia laureates have become professors.

The **Mosaic programme** stimulates a better flow of graduates from ethnic minorities to PhD positions. Ethnic minority groups are very seldom represented in science, while the number of students from these groups is in fact increasing. In the first pilot scheme in 2004, NWO made 10 PhD places available. With 190 applications of extremely high quality, the interest in the programme was unexpectedly high. With the support of the Ministry for Education, Culture and Science, 21 positions were awarded and it was decided to continue the programme. In 2005, 22 positions were awarded. A number of universities even created PhD positions for very good Mosaic candidates who, due to insufficient funds, were unable to receive a NWO grant. In the meantime the universities in the Randstad, the urban agglomeration of Western Holland, are actively participating in the programme by scouting around for research talent from ethnic minority groups.



What will Opportunities for researchers provide?

- 1,000 positions for world class talent at universities and knowledge institutes in the Netherlands.
- 2,000 world class research projects for cutting-edge and risk-taking research in all areas of science.
- 50 PhD places for researchers from ethnic minorities.
- 80 promotions for women (from UL to USL and/or from USL to professor).
- 6 absolute world class researchers who were previously working abroad.
- 20 new national research facilities thereby improving the national research infrastructure (NWO Large).
- 80 medium-sized facilities representing local and/or regional interests (NWO Medium).



adapting the evaluation process to accommodate this. Furthermore, the possibility of short-term grants will be incorporated in response mode funding to arrive at a tried and tested approach.

4.3 Creating state of the art research facilities

World class research not only requires the best people, but also the most advanced research facilities. In many scientific disciplines, progress may even be dependent on the accessibility of high quality equipment. The best research infrastructure is not only a necessary prerequisite for world class science, but also an important driving force for innovation. Therefore NWO has placed innovation and expansion of the research facilities in the Netherlands high on the investment agenda*.

Action:

- Doubling the budget of NWO programmes for investment in research facilities, namely NWO Large and NWO Medium. When the budget is doubled, the university's own contribution to these research facilities will no longer be required.
- Strengthening the application of ICT and the further development of Grid in particular, as a state of the art instrument for collecting and processing scientific data.

4.4 Attracting talent from abroad

Focusing on a new intake and maintaining home-grown talent is not always enough give the sciences in the Netherlands an impetus where necessary. It will also be necessary to attract 'outside' talent: both foreign researchers as well as scientists from the Netherlands who are working elsewhere due to greater opportunities.

Action:

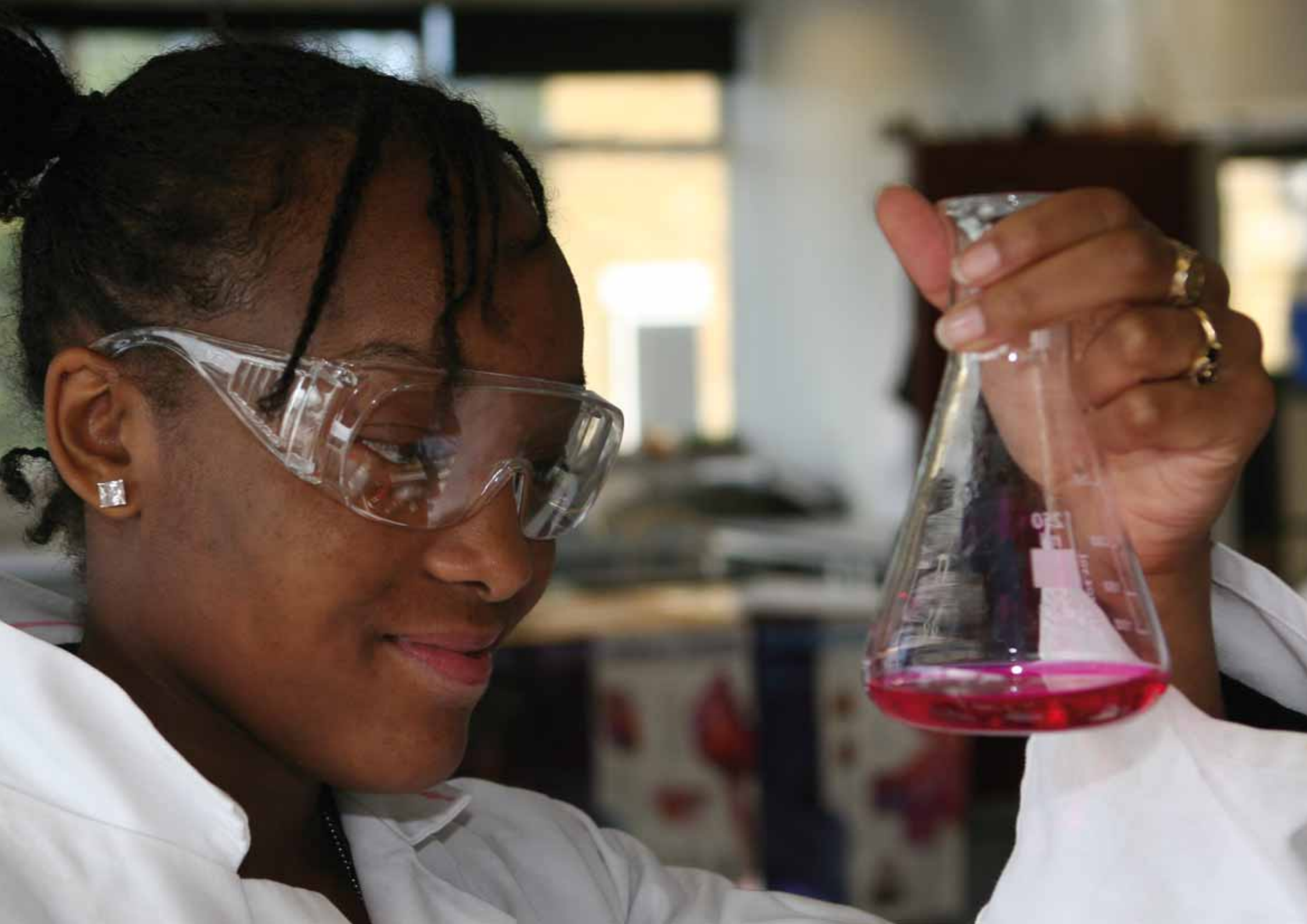
- A brain-gain grant of a significant amount with the objective of bringing world class researchers, whether from the Netherlands or not, to stay in the Netherlands on a long-term basis. Universities can nominate candidates for this; in grants made from this fund a balanced division will be taken into account of the various scientific clusters, namely the natural and technical sciences, the biological and medical sciences, and the humanities and social sciences.
- Open up all human resources programmes to foreign researchers, under the condition that the research is conducted at an institute in the Netherlands. By means of an offensive information policy these human resources programme will be brought to the attention internationally.

4.5 Decreasing the administrative burdens for researchers

Finally, not as an objective in itself, but as a means of unburdening researchers, in the context of *Opportunities for researchers* NWO will press for a reduction in the administrative burdens for scientists. In the past strategy period results have already been achieved in this, amongst other things, by computerising the application process.

Action:

- Making all evaluation processes as transparent and efficient as possible.
- Computerising the application and evaluation process further, so that the entire process is carried out electronically.
- Working as much as possible with preliminary applications. These are brief applications, on the basis of which an initial selection takes place.
- Working as much as possible with continuous submissions, so that researchers are not committed to a deadline and may submit their applications as and when it suits them.
- Harmonising procedures and forms further.



5 Line of action 2: Consolidating strengths

To strengthen scientific research in the Netherlands, it is necessary to consolidate strengths at national level. To introduce focus and critical mass, NWO wishes to concentrate world class research in centres of excellence on a scale in keeping with international competition. The chances of scoring high in the global scientific arena will determine the selection. In addition, the availability of large scale research facilities is a prerequisite for being able to remain a player in the international field. NWO is therefore focusing on the line of action *Consolidating strengths*.

5.1 Realising national programmes and national cooperation

The increased competition on a European level and the fact that science is becoming increasingly multidisciplinary and interdisciplinary in nature, require research groups in the Netherlands to cooperate with each other more than ever before. In the next period, NWO will opt for the best research in a number of promising, multidisciplinary areas of science and, simultaneously, will see whether and how a significant contribution can be made from these domains to solving social problems.

Action:

- Developing the National Research Initiative (NRI), which is a new instrument intended for those scientific areas where the Netherlands already occupies a top position. The objective is to further

strengthen the world class position of prominent research groups in a selected domain. The past performance of the participating research groups, as well as the highest conceivable scientific performances in the near future, will determine the financing decisions. To carry out an NRI, collaboration between various research groups and institutes is, without saying, essential. In the selection, the primary criterion is scientific excellence. The collaboration has to provide a synergy which is greater than the sum of the individual, excellent groups. An NRI has the duration of about six to eight years and is financed on the basis of a full-cost principle. For the integral financing of an NRI, NWO wishes to make a total amount of 30 to 50 million euros available.

- Establishing national cooperation by fleshing out the thematic programme line of the areas of NWO in close consultation with the research world.

This primarily concerns scientifically motivated programmes with a multidisciplinary or interdisciplinary formulation. The selection of thematic programmes will be made in cooperation with university partners and on the basis of social priorities.

- Intensifying the cooperation of NWO institutes with university groups and other institutes. As focus points for world class research in specific domains and as havens for large scale research facilities, NWO institutes have long provided good examples in *Consolidating strengths*. NWO will support substantive scientific collaborations of institutes with university groups and other institutes with extra means.

5.2 Realising large scale research facilities

Advanced large scale research facilities with international appeal are needed in the Netherlands, both to enable local researchers to push back the frontiers of science, and to make the Netherlands more attractive to foreign researchers. The best facilities attract the best researchers (such as CERN in Geneva). Because the Netherlands is too small to independently finance all the expensive



NWO and the European Research Council (ERC)

The foundation of a European Research Council (ERC) has been included in the seventh Framework Programme of the EU. The ERC will not be directed towards policy-motivated research. The primary selection criterion is scientific excellence. The ERC thereby acquires a great level of responsibility for financing top class science in Europe. For groups in the Netherlands who belong to the world class in Europe, the ERC will become an important source of funding. It is expected that national research organisations such as NWO will increasingly acquire a responsibility for strengthening national excellence, with the objective of acquiring a higher international plan for them. Amongst other things, this will require choices on the basis of strengths and opportunities for a place in the world class.

What will *Consolidating strengths* provide?

- 4 National Research Initiatives.
- 15 research facilities with a pan-European character.
- 15 transnational research programmes for strengthening the distinct international character and cooperation.
- New collaboration with a number of rising economies.
- NWO grants worth a minimum of 300,000 euros on average.
- A 75% decrease in the number of awards under 100,000 euros.



facilities, cooperation and strategic programming on the basis of road maps is therefore necessary.

Action:

- Developing a funding programme for large scale research facilities, in cooperation with SenterNovem, as a structural continuation of the national programme for investments in large scale research facilities from 2005. The objective is to invest in the development and utilisation of research facilities of international significance. It concerns facilities of 25 million euros or more.
- Developing national road maps for large scale research facilities, in close interaction with all relevant partners and linked to international initiatives in this area. This concerns prioritised investments in a large scale infrastructure, each of which essentially adds to the European research scene and which is of great national significance for the knowledge and innovation system in the Netherlands.

5.3 Stimulating and facilitating international cooperation

Consolidating strengths goes beyond the national borders. The Lisbon strategy and advancing internationalisation also require a strengthening of international cooperation.

Action:

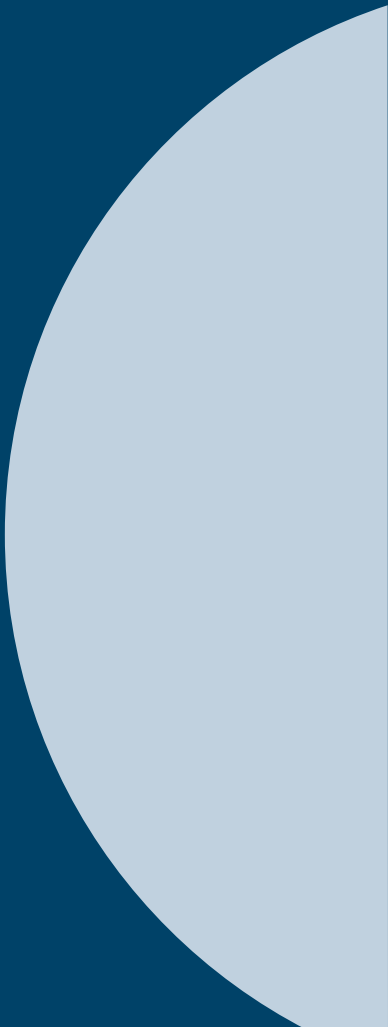
- Contributing to strengthening European research cooperation, in particular via active contributions to EUROCORES, ERA net and Technology Platforms – instruments of respectively the EUROHORCs in cooperation with the European Science Foundation (ESF) and the 7th Framework Programme of the European Union.
- Intensifying the cooperation with the European partner organisations, in particular through the development of transnational European research programmes.
- Selectively investing means for the development of scientific collaboration with a limited number of rising economies, such as China and India. Because these countries are rapidly growing into important players in science, the Netherlands should strengthen its relations with those countries. Organisational incentives are therefore necessary to establish new connections.
- Contributing to the Millennium Development Goals of the United Nations via WOTRO. WOTRO, which is partially financed by the Ministry of Foreign Affairs in the Netherlands, is focusing on four research themes: Poverty and Hunger, International Relationships, Global Health and Sustainable Environment. These will serve as a guideline for the interaction within NWO and with external partners.

5.4 Creating focus and critical mass within existing grants

NWO will be engaged with both streamlining and expanding its existing set of subsidy instruments to create greater 'focus and critical mass' in this way too.

Action:

- Incorporating small forms of support for specific activities, such as travel grants or publication costs in a wider context. This means that grants for these modules can no longer be applied for separately, but only as part of a project or programme.
- On average awarding larger grants, by reserving a larger part of the grants for modules in which a larger number of researchers or research groups are cooperating.



Thematic programmes 2007–2010

Thematic programmes bring together NWO's ambitions for 'Consolidating strengths' and 'Science for society'. Following a broad consultation NWO has chosen thirteen subjects to support a thematic programme in the next strategy period. With this approach NWO is further building on the line set out in the previous strategy period in *Themes Plus Talent*. An important difference, however, is that on this occasion NWO has decided not to stipulate all of the subjects for the 2007-2010 period in advance. By doing this NWO will retain the freedom to respond flexibly to current issues in science and society, following prompts from groups within science and society.

New themes

- Conflicts and Security
- Creative Industry
- Cultural Dynamics
- Sustainable Earth
- Dynamics of Life Courses
- Brain and Cognition
- New Methods for Production, Storage, Transport and Use of Energy
- Knowledge Base for ICT Applications
- Responsible Innovation
- Dynamics of Complex Systems
- Use of Nanosciences and Nanotechnology
- New Instruments for Health Care
- Systems Biology

Strategy Themes Plus Talent

In the previous strategy period Themes Plus Talent, NWO had for the first time selected themes (nine in total) with the intention of creating focus and critical mass. These themes covered multidisciplinary research programmes in subjects which were then of scientific and/or societal importance. These themes provided the content for a renewal of the research agenda. Moreover, these thematic programmes were found to be an outstanding vehicle for multidisciplinary cooperation; thanks in part to such a thematic approach, crossdisciplinary cooperation within NWO has now become common practice.

New thematic programmes

Most of the thematic programmes for the period 2007–2010 are new. In opting for these programmes NWO has mainly allowed itself to be led by evident requirements in science and society. NWO has proceeded as follows:

- Firstly, an extensive list was made of the priorities of various societal and intermediate organisations, in particular the key areas of the Innovation Platform, the focus areas of The Confederation of Netherlands Industry and Employers (VNO/NCW*), the themes established by TNO and the Large Technology Institutes (GTIs), the priority areas of SenterNovem, the overall strategic agenda of government departments, and foresight studies such

as those of the Royal Netherlands Academy of Arts and Sciences (KNAW) and the Consultative Committee of Sector Councils for research and development (COS). This inventory resulted in a list of seventy subjects.

- Next, important international scientific developments and the scientific potential in the Netherlands within the areas concerned were examined.
- Finally, departing from these two perspectives, it was determined where the most fertile links could be realised.

The thematic programmes which emerged from this have the support of the universities and other external parties. The concrete details of the thematic programmes will be further agreed upon by relevant scientific and public parties and in relation to the available funding.

An interactive process for subsequent choices

For the thematic programmes not yet established, NWO wishes to realise a fruitful approach in consultation with all partners. Of course all international foresight studies and other priority areas chosen by external parties (for example, EU Framework Programme, VNO/NCW, Dutch government departments, charitable funds, etc.) will be included in this. NWO will also optimise its internal approach regarding the selection of thematic programmes, with the objective of optimising the embedding of crossdisciplinary and multidisciplinary themes in the organisation.

Brief description of the selected thematic programmes

Conflicts and Security

As a result of globalisation, transnational immigration and mobility, societies are becoming increasingly more diverse. This frequently leads to abrupt confrontations that are related to cultural, ethical, religious, class and language differences. Research within this theme will be focussed on the urgent societal problems arising from this. For example, ethnic, religious, and employment conflicts as well as international conflicts over raw materials and water may be considered. But also smaller scale problems such as tensions between young people on housing estates or in schools, as well as conflicts between parents and children or within employment organisations. Thus, new insights can arise with respect to urgent questions such as increasing violence, safety and terror, poverty and uncertainty, international law, and the societal costs and benefits of conflicts. This theme encompasses several different levels: personal, interpersonal, between groups, as well as the international level. It covers conflicts of interest, cognitive conflicts and normative conflicts and tries to determine the dynamics and functionality of conflicts using an interdisciplinary and comparative approach. This programme links up with the themes of TNO and the GTIs, the foresight studies of the COS and the strategic agenda of the government departments.

Creative Industry

Creativity is an important production factor and a source of product innovation: the knowledge economy is pre-eminently a creative economy. There are many opportunities for our country within the creative industries. That is why the creative industry was designated it as a key area by the Innovation Platform. More entrepreneurship in the culture sector and a better use of culture and creativity in the private sector are

the objectives where scientific research can make an important contribution.

The creative industries include a wide range of businesses, from the amusement industry to the performing arts, from multimedia in games to architecture and design, and from industrial design to fashion. The breadth of the subject is associated with a panoply of possible research subjects: the influence of ICT on creative content and the opening up of culture, the circulation of cultural products, multimedia as a factor in changing patterns of cultural consumption, the role of aesthetics, creativity as a factor in innovation, research into experiential value, business models, etc. This theme offers many opportunities for cooperation between the humanities, technical sciences, informatics and the social and behavioural sciences. This programme links up with the key area Creative Industry of the Innovation Platform, the priorities of SenterNovem and the foresight studies of COS.

Cultural Dynamics

Recent developments and events point to the problem of social and cultural integration in changing societies: The emergence of fundamentalist groups and transnational or rather regional movements, the riots in Paris and Sydney, the overwhelming rejection of the European constitution, or ethnic and regional conflicts such as in Sri Lanka or Sudan. They lead to discussions about (national) identity, about shared standards and values, and about cultural backgrounds. This illustrates the urgency of wide-ranging scientific research into cultural dynamics. Knowledge about the processes of cultural change is the key to solving a number of urgent social problems. The focus of *Cultural Dynamics* lies in the formation of cultural identity as a dynamic social process which is crucial for the (re)definition of the identities of individuals,

groups and nations. Insights into the complex process of forming cultural identity in the Western and non-Western world will make a significant contribution to the cohesion of society. Principal research lines in the intended programme are citizenship and identity; creative design and innovation; intermediality; popular culture; and canon formation. *Cultural Dynamics* is a new theme that is being developed by the NWO research divisions for the Humanities and Social Sciences and the Netherlands Foundation for the Advancement of Tropical Research (WOTRO). This programme links up with the themes of TNO and the GTIs as well as the strategic agenda of the government departments.

Sustainable Earth

The far-reaching effects of humans on the earth are becoming increasingly more visible and noticeable in virtually every part of this world: hot and cold, dry and wet, rich and poor. This concerns the climate, the environment and ecosystems, but to an increasing extent, indirectly, harmful consequences on safety, economic development, poverty, public health and welfare. Whereas previously most attention was given to describing the processes and preventing harmful effects (*mitigation*), now attention is also increasingly being devoted to the need to adjust to these changes (*adaptation*). Integral scientific research into the (correlated) causes and effects, in relation to the Earth as a natural system are indispensable for supporting an effective approach, as is the translation of results into scenarios and solutions. International, global cooperation is an essential part of this. Dutch science is playing a prominent role in several areas of this research. With the multidisciplinary theme *Sustainable Earth* NWO wants to strengthen this position. The emphasis will be on creating focus and critical mass in the research areas where



the Netherlands has an international position, such as Climate, Geodynamics, Water, Coastal and Marine research, Sustainable Technologies and Energy issues. The focus will be on multidisciplinary research in the subsidiary fields: *Energy and emissions; Changes in the climate system; People and the environment: natural resources, water, rivers, coastal zones*. In the investment policy the emphasis is on an integral, multidisciplinary approach from Earth and Life Sciences, Physical Sciences, Technical and Social Sciences. The results of this research will be of direct importance for the development of policy and innovations. This programme links up with the Innovation Platform's key area *Water*, the foresight studies of COS, the themes of TNO and the GTIs, the strategic agendas of the government departments as well as the EU Framework Programmes.

Dynamics of Life Courses

The thematic programme Dynamics of Life Courses focuses in general on issues related to the life courses of different generations of Dutch people and non-Western ethnic minorities (children, parents and grandparents) in different socialisation contexts and socio-economic circumstances. The research will map changes and transitions in life courses, as well as differences between generations and between ethnic and autochthonous groups in the area of primary relationships, health, education and employment, position in society and cultural integration. The programme could shed further light on wide-ranging and urgent societal issues: social and economic integration, cultural experience, social and employment participation, isolation, the forming of relationships, addiction, ageing, criminality, mobility, as well as the effects of health technology for home care and adapted accommodation. The thematic programme offers excellent possibilities for interdisciplinary research, for the development of new methods aimed at developmental pathways for both individuals and groups, as well as cooperation between top research groups from health care research, the humanities, and Social Sciences.

This programme links up with the themes of TNO and the GTIs, the foresight studies of COS as well as the strategic agenda of government departments.

New Methods of Production, Storage, Transport and Use of Energy

The supply of energy is one of the most urgent societal questions and requires a coherent approach in the short-term. The pathway from concept to market introduction of improved and new technologies for energy supply not only requires many years, but in the long term every energy option will have to be used. Research into substantial improvements of highly-promising concepts and the finding of new methods for energy supply will have to take place in consultation and cooperation with market players. A complete analysis of all energy options is not possible for a country such as the Netherlands. Researchers and market players will therefore have to identify the relevant research subjects within the Dutch context for which sufficient focus and critical mass can be achieved. Various scientific fields can make important contributions to areas such as electricity and heat generation (waste incineration, energy conservation, environment) and materials research (biomaterials, solar cells, hydrogen, fusion). The probability of plans to make a real contribution to the solution of the energy problem will have to be an important criterion for the selection of research areas. This programme links up with the themes of VNO/NCW, the priorities of SenterNovem, the foresight studies of COS, the themes of TNO and the GTIs, the strategic agenda of government departments, and EU priorities.

Knowledge Base for ICT Applications

From health care and the nutritional sector to cultural heritage, the automation of operational processes is growing explosively in all sectors of society and with this the quantity of digital data and communication. An increasing number of 'machines' (computers, processors, 'smart dust',

etc.) interactively support human information processing or even assume responsibility for it. The deployment of ICT makes entirely new concepts of service possible. Optimal use of this potential requires a strong ICT knowledge base, in order to work on, for example, inherent safety and reliable hardware and software, communication by means of (wireless) networks and effective solutions for the analysis, storage and presentation of images, language, speech, and sound. The strongly growing societal demand prompts the search for the underlying principles, which constitute the essential basis for improved applications. Therefore, in the National Research Agenda ICT 2005–2010 (NOAG-ict), the ICT research community opted for integral approach to research (nine ICT research themes) and applications (the twelve ICT application areas of temporary taskforce ICTRegie). In consultation with ICTRegie, NWO has translated this approach into priorities for applications in, for example, health care, the creative industry and the services sector, which are fed by research themes such as digital experience and the invisible computer. Examples are i-care for chronically ill patients, the *ambient museum*, computer games and simulation, and 'software as service'. The NWO ICT thematic programme links up with the priorities of the Ministry of Economic Affairs, VNO/NCW, MKB-Nederland (Branch organisation for small and medium-sized Dutch businesses) and the COS foresight studies. The Innovation Platform has also designated ICT as an innovation axis.

Responsible Innovation

Much is expected from new technological developments, from improvements in the quality of life of individual citizens and society to solutions for global problems such as safety and food supplies. Yet technological development alone will not guarantee the success of technological innovation. A study of the ethical and societal aspects of the innovation concerned should be carried out in parallel to technical-scientific research. This will allow problems related to societal consequences, ethical dilemmas and acceptance to be recognised on time so

that the innovation process can be adjusted well in advance. A condition for this is, however, that a thorough exploration is always carried out in interaction and cooperation with the technical scientists.

NWO is therefore working on a new thematic programme: responsible Innovation. The emphasis is on: i) new technologies and ii) technological transition processes, such as in Health Care, Energy supplies, Transport and Agriculture. Research into these questions will be integrated into the technological development process. Therefore the programme will be developed in close cooperation with BSIK* and other research programmes. The aim is to realise a consortium between universities, government departments and the private sector. All NWO divisions can contribute to this new thematic programme concerning the ethical and societal aspects of research and innovation. This programme links up with the foresight studies of COS, the themes of TNO and the GTIs and the strategic agenda of the government departments.

Brain and Cognition

The acquisition, processing and transfer of knowledge is essential for our modern, knowledge-intensive society. Learning and adaptation processes are continuously needed to respond to rapid changes. In addition to this, the expected strong increase in brain disorders as a consequence of general ageing, means there is an urgent need for treatment methods and strategies for the prevention of brain disorders. The Neurosciences and Cognitive Sciences are of vital importance for welfare (brain diseases, aging), education (developmental disorders, learning) and prosperity and commerce (language and communication technology). Recent important scientific breakthroughs have made it possible to unify brain and mental functions under a single denominator, as a result of which it is now at last possible to integrate knowledge about behaviour, psychological functions, and molecular and cellular processes. Throughout the world the challenge of

this research is being acknowledged and recognised. Dutch neuroscientists and cognitive scientists have an outstanding international reputation and a highly extensive network of international partnerships. The thematic programme, which will possibly be realised in the form of a National Research Initiative (NRI), aims for an optimal integration and concentration of basic Neurosciences research, Medical and Health (Care) research, Cognitive and Behavioural Sciences, Linguistics and Information technology. This subject links up with the themes of VNO/NCW, the foresight studies of COS and of the Study Centre for Technology Trends and the strategic agenda of the government departments.

Use of Nanosciences and Nanotechnology

Nanotechnology has potentially huge consequences for many areas in society, for example in such diverse areas as energy and sustainability, health, safety, jurisdiction and communication, with new commerce in many areas. Due to this wide-ranging impact on our future society, the Netherlands must respond in good time to questions about knowledge, knowledge workers and knowledge infrastructure. The Foundation for Fundamental Research on Matter and the Technology Foundation STW in cooperation with the NWO research divisions for Earth and Life Sciences, Chemical Sciences and the Netherlands Organisation for Health Research and Development (ZonMw) have compiled a strategic memorandum as a first step towards a national NWO initiative in the areas of Nanoscience and Nanotechnology. This contains three strategic themes concerning feasible opportunities for researchers and companies in the Netherlands:

- Nanomedicine;
- Beyond 'Moore' (towards microelectronics beyond silicon technology);
- Functional nanoparticles and surfaces with patterns at a nanoscale.

In cooperation with the government, the private sector and public bodies and following on from the anticipated cabinet viewpoint on nanotechnology, it is expected that an initiative

from NWO will be successful. This programme links up with the themes of VNO/NCW, the priorities of SenterNovem, the key areas High-tech Systems and Materials and Chemistry of the Innovation Platform, the themes of TNO and the GTIs, as well as the EU Framework Programmes.

Dynamics of Complex Systems

New complex methods, strategies and approaches are increasingly required for the social, economic and financial analyses of the future. Research into complex systems started within the Physical Sciences, but has extended to, for example, the behavioural sciences and economics. It is now among the fastest growing scientific disciplines. This research focuses on systems of different characters, such as complex processes in energy distribution networks, the distribution of micro-organisms, reaction rates in a chemical reactor, fluctuations in share prices and changes in the climate. Complex systems behave deterministically, but it is still impossible to predict their evolution on the basis of the known starting conditions. Therefore, more insights into the dynamics and concepts of deterministic chaos are needed. Despite the enormous variations, similar behaviour patterns are still sometimes observed. That is why it is expected that a correct measurement of the frequently gigantic quantities of data together with mathematical modelling and analysis will lead to a better understanding of complex processes. The production sector can, for example, benefit from this via an improved process control; the bio sector thanks to the acquired understanding of complex organisms, and the energy sector due to an improved control of dynamic processes. The programme links up with the themes of VNO/NCW, the priorities of SenterNovem and the themes of TNO and the GTIs.

New Instruments for Health Care

Health and welfare are important themes in society. The medical sector is increasingly demanding advanced technology in order to study processes in the body in greater detail and care is being transferred from the hospital to people in their home



situation. Companies such as Philips and FEI Company are directing their research in these fields, and DSM and biotech start-ups have become new players in this field. Much medical technology is based on physical principles and techniques. Considerable scientific challenges lie ahead for physics, for example, in the development of entirely new instrumentation, techniques and methods. The demand for these comes from companies, biologists and medics. Examples of developments in which physicists can play a major role are:

- high-tech imaging systems: PET/SPEC, Magnetic Particle Imaging (MPI) and Optical and Electro-optical Imaging;
- molecular medicine: functional imaging, biosensors;
- high-tech radiotherapy;
- monitoring and treatment: wireless ECG sensors, implantables (insulin pumps, feedback loop drugs, etc.), ultrasound, Nanomedicine;
- applications of ICT: bioinformatics (data mining); image-processing methods.

This programme links up with the themes of VNO/NCW, the priorities of SenterNovem, the key areas High-tech Systems and Materials of the Innovation Platform, the foresight studies of COS and the strategic agenda of the government departments.

Systems Biology

Insights into the functioning of living systems is essential for effectively developing medicines and food, for managing infections, as well as for understanding the development and regeneration process in humans, animals and plants, or the design of efficient, sustainable bioproduction processes. Organisms function on the basis of complex inter-related networks of processes over many aggregation levels. Genes, proteins and metabolic products influence each other in the cell, in a system in which many links and feedback mechanisms take place in and between various compartments. Also, cells within an organ and organs within an organism maintain such complex reciprocal relationships with each other. The same applies in effect for organisms in a population and for interactions between populations. The essence of systems biology is to *quantitatively* determine how molecules, cells,

organelles, organs and organisms cooperate in time and space to allow biological processes to proceed. As a result of (information) technology developments and progress in the 'omics' disciplines increasingly more data are becoming available, which will be integrated into computational and theoretical approaches and predictive models. This approach signifies a methodological breakthrough. Systems Biology therefore requires cooperation between biologists, chemists, physicists, mathematicians, information scientists and medics. The intended national efforts will focus on three application areas: agro/nutrition, pharmaceuticals and bioprocess technology. This programme links up with the themes of VNO/NCW, the priorities of SenterNovem, the key areas Food & Flowers and Chemistry of the Innovation Platform, the interest of a number of companies and the foresight studies of COS.



6 Line of action 3: Science for society

Social issues and the call for strengthening technological and social innovation are creating an increasing need for high-quality, applicable knowledge. This requires current, social issues to be more attuned to the available scientific potential and vice versa. As an intermediary organisation, NWO aims to bring knowledge users and scientists together under the heading *Science for society*.

6.1 Socially-inspired programming

In selecting thematic research programmes, NWO allows itself to be inspired by social issues. This means that the priorities of social parties and the business world influence the selection of research themes.

Action:

- Developing socially inspired programmes by translating social issues in terms of research together with departments, the business world and other social agents.
- In setting up thematic research programmes, paying greater attention to research which is directed at translating scientific insights – fundamental or not – into applications in practice (in the clinical sciences this is referred to as translational research).
- Investigating the way in which NWO can better attune the results of scientific research to the social issues of small and medium-sized businesses. Concrete

options for doing this are the further development and broader implementation of the *Small Business Innovation Research* (SBIR) system based on the United States and the *Valorisation Grants*. The expertise gained within the STW will be more widely implemented.

- Institutions for higher vocational education (the HBO) can be linked to STW projects and programmes for the purpose of the valorisation of knowledge. In this way, NWO wishes to provide an impulse to regional networks for innovation in which the HBO plays an important role.

6.2 Stimulating cooperation between scientists and professionals

Science and society interaction is strengthened through short connections between organisations. Cooperation between scientists and other professionals can lead

to a more effective use of knowledge. In addition to the instruments for pioneering research as described above, there is a need for innovative research in which the sciences and society (including the business world) bear mutual responsibility for formulating new research subjects and in which the application of excellent research is guaranteed as much as possible in advance.

Action:

- Carrying out the Smart Mix, to select public-private consortia from knowledge institutions and social parties (see insert).
- Continuing the Casimir programme (see insert) and, in consultation with the Ministry for Economic Affairs and the Platform Bèta Technique*, investigating the possibility of expanding the Casimir programme. Subsidising cooperation projects between science and governmental organisations, as well as between the sciences and education, for example with regard to a PhD project, may be considered.
- Developing academic practice workshops, where scientists and professionals can interact. The objective is, on the one hand, to pass on recent scientific knowledge to professionals from the field and as such promote innovation; on the other



Casimir programme

The Casimir programme stimulates the public-private exchange between researchers in scientific and technical disciplines with a view to promoting mobility amongst researchers and expanding the quality of frontier research. The objective of the programme is to allow researchers from public knowledge institutes to temporarily work at companies and vice versa. Mobility and the possibility of temporarily continuing a career as researcher at a different location do indeed render the researcher's work more attractive and varied. This increases the appeal of research and improves the opportunities on the labour market for researchers. In the meantime, 23 exchange projects have already come into existence via the Casimir programme.

Smart Mix

The Smart Mix is a new instrument,¹⁶ aimed at removing two obstacles in the knowledge infrastructure in the Netherlands; too little focus and critical mass in excellent scientific research and the fact that scientific results and social needs are still insufficiently in tune with each other. The former will be dealt with by a focused strengthening of excellent research groups. A solution for the latter will involve vitalising the cooperation between the business world and knowledge institutions in areas that are crucial for the Netherlands.

The Smart Mix distinguishes itself from existing instruments by combining the focus and critical mass in excellent research with concerted action between players in a broad part of the knowledge chain. As such questions deriving from the business world and social organisations lead to dynamic networks of excellent research.

The Dutch Ministries of Economic Affairs and Education, Culture and Science have each made a sum of 50 million available as of 2007. A collective bureau from NWO and SenterNovem undertakes the implementation of the Smart Mix.

¹⁶ Regulation published in the *Staatscourant* (the Dutch Government Gazette), 27 March 2006.

hand it is to enable scientific research to become better attuned to the knowledge issues in the field.

6.3 Shared partnerships for utilising knowledge

In the coming strategic period, NWO will pursue cooperation with partners who have supplementary expertise in the area of knowledge utilisation. NWO is not equipped to organise the whole project from the development to the utilisation of knowledge. Possible partners for NWO are naturally the final users of knowledge, such as companies and governmental bodies, but primarily intermediary organisations such as SenterNovem¹⁷ and TNO. The guiding principle in entering into collaborations will still be that expertise and competencies from the organisations involved complement each other to the optimum. In this context, NWO talks about *shared partnership*.

Action:

- Intensifying cooperation with TNO and SenterNovem, amongst other things, by ensuring that the policies of the organisations are better in tune with

each other, and where possible, by working together on the factory floor, as it were. By way of trial for structural cooperation, a joint research programme will be started with the TNO. Together with SenterNovem and on the basis of the experiences which have already been gained with, amongst others, Smart Mix and the programme for large scale research facilities; it will be further investigated how the expertise of both organisations can best be used together. This manner of working together is in keeping with the idea of transforming SenterNovem into a full programme organisation, for example according to the Finnish model.¹⁸

6.4 Continuing research authorities and selecting social world class institutions

NWO has three temporary taskforces: NGI, ACTS and ICTRegie (see Chapter 2). With a directorial and substantial financial impulse, they have the task of stimulating new scientific research in specific strategic areas which are of great future importance and of bringing together scientists and knowledge

¹⁷ Here NWO is following recommendation 14 in the final report of the *Commissie Dynamisering* (Committee for Dynamism) and will also take into consideration their advice in the further realisation of this cooperation. NWO will even take a step further by, in addition to SenterNovem, also intensifying the cooperation with TNO and wherever possible, realising the potential harmonisation between the three partners.

¹⁸ For this, see *Genomics 2008-2012*; building up and utilising NGI and *Het veld aan zet* (The field's turn), strategic plan by ICTRegie for the period 2005-2010 and the action taken by ACTS in the context of the key area of chemistry.



What will Science for society provide?

- At least 13 sizeable thematic programmes inspired and guided by social issues. For this it is estimated that an average amount of 7 million euros will be needed annually in the interests of the desired focus and critical mass.
- 120 research projects aimed at the public-private exchange between researchers.
- 3 temporary taskforces of a substantial size.
- 6 World Class Social Institutes.

users from society. Furthermore, in 2005, the instrument of 'World Class Social Institute' (MTI) was set up by the Ministry of Education, Culture and Science. NWO regards it as its task to partially facilitate excellent research programmes from these institutes, according to regular procedures. At the same time, NWO wishes to play a role in selecting these institutes. It is via temporary taskforces and MTIs that NWO wishes to contribute to *science for society*.

Action:

- Continuing the temporary taskforces in the areas of Genomics, Chemical Technology for Sustainability, and Information and Communication Technology.¹⁹ These initiatives have appeared to be successful, both from the point of view of added value for society as well as regarding the building up of a sustainable infrastructure of knowledge. Continuing these initiatives is necessary to ensure that the results maintain a lasting impression. After all, the structural results of these investments in these domains will only be visible after a period of five to ten years. In order to continue, cooperation with the relevant departments is required.
- Selecting new MTIs (World Class Social Institutes). At the request of the Ministry of Education, Culture and Science, NWO conducts the entrance selection, appoints boards and carries out evaluations. As

long as it is in keeping with the normal NWO procedures, programme financing is also provided for. For the time being, the MTIs have a term of four to six years.

6.5 Facilitating researchers in activities relating to the utilisation of knowledge and communication

NWO will develop an active policy for supporting researchers in carrying out activities that enable professionals to utilise knowledge and for communicating to a broad audience.

Action:

- Integrating communication and knowledge transfer in programme development, so that communication is planned and budgeted for from the beginning of a project.
- Continually requesting that explicit attention is paid to the utilisation of knowledge in formulating research proposals. In monitoring the progress of the project, it will be more emphatically assessed how the utilisation of knowledge and communication is realised.
- Organising workshops and courses in which the utilisation of knowledge stands central. Subjects such as the eligibility of the research for patents and IPR regulations can be considered. The

first contact point for this within NWO is Technology Foundation STW.

- Setting up a consultation structure for utilising scientific knowledge, in which universities and other knowledge institutes can exchange experiences, and build up networks, etc. In this, STW will take the lead.

¹⁹ For this, see *Genomics 2008-2012*; building up and utilising the NCI and Het veld aan zet (The field's turn), strategic plan by the ICTRegie for the period 2005-2010 and the action taken by ACTS in the context of the key area of Chemistry.

7 Required: In-depth investments in the knowledge society

A structural investment of 433 million euros is required to realise the ambitious strategy of NWO for the period of 2007-2010. The successful implementation of this indirect funding strategy depends, moreover, on a strong and secure financial position of the universities so that high standards can be maintained. NWO further argues for improving the coordination and attuning of various new forms of financial arrangements, constructed in the recent past to meet the objectives of frontier research.

7.1 Increasing indirect government funding by 433 million euros per annum

Investing in the knowledge society

Dutch investment in knowledge is not on a par with the objectives of the Lisbon strategy. The government believes that these objectives should not be lowered. It also believes that it is largely the responsibility of the member states to meet these objectives. It follows that a substantial investment on a national level is required to further develop our knowledge society. Recently, the REA (Advisory Council for Economic Affairs) has advocated an annual investment of 15 billion euros. The Innovation Platform is preparing an Agenda for Knowledge, a guideline for (additional) investments in the Dutch knowledge society. A large proportion of these investments should be allocated to

the sciences as this area constitutes the obvious foundation for the knowledge society. The Committee for Dynamism has recently advocated a boost in investments in science of about 1 billion euros. The financing of excellent research according to the three lines of action presented in this strategy paper will yield an important boost in the quality of scientific research, and will contribute significantly to the liaison between science and society. Both are needed if the Dutch knowledge economy is to achieve the desired position amongst the top in Europe.

NWO long-range perspectives

With the current budget expectations however, it will be impossible to realise these ambitions. The current basic budget of little more than 300 million annually is by all means insufficient, if only because there is no room for flexibility in this budget. In the

recent period, investments were speeded up by NWO in order to help out universities in their penurious situation and on behalf of enhancing the knowledge society. This implies that expenses in the coming years will surpass revenues (see Figure 7.1). A critical ceiling has now been reached, however. For the coming period an additional injection is needed to bring balance to the regular revenues and expenses.

The substantial overspending of the budget was financed by liquid assets in NWO's reserve funds. However, these sources will soon be exhausted (See Figure 7.2), which means that the limits of this aggressive overspending policy have been reached.

What is more, the available resources for excellent research will decline drastically without additional financial input. In that case, the annual expenditure of NWO will drop with 150 million euros during the period 2005-2010. With no policy adjustments, NWO will have to spend about 300 million euros less on science for the total period of this plan – a dark and unacceptable scenario indeed. A substantial financial injection is absolutely necessary for the Netherlands.



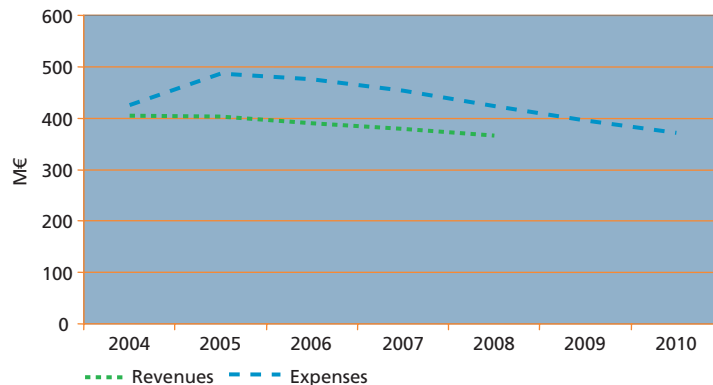


Figure 7.1 Revenues and expenses NWO 2004–2010 (in M€).
 Source: Long-term budget NWO

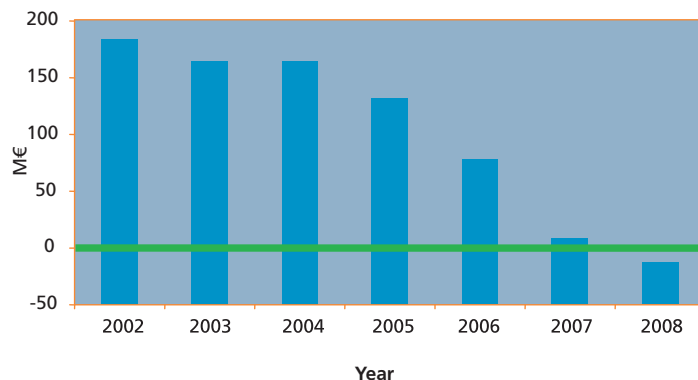


Figure 7.2 Survey of the NWO liquid assets position (in M€)
 Source: Long-term budget NWO

Increase of 433 million euros

An aggressive investment in science by the national research council is in order. NWO is asking the government for a structural addition of 433 million euros per annum.²⁰ This amount has two components. In order to continue with a number of successful initiatives such as the Innovative Research Incentives Scheme and the temporary taskforces, a structural 150 million euros are needed to replace the current, incidental financing. The other 283 million is needed for the intended great leap forward. Apart from enhancing response mode funding and career support programmes, these additional resources shall be mainly used for new modalities such as National Research Initiatives and a large scale research infrastructure. An additional 100 million euros for socially engaged world class science has been allocated by Smart Mix, to match the target NWO has set itself of acquiring an additional 100 million euros.

The board of NWO is fully aware of the fact that it is claiming a substantial proportion of public resources. It is convinced, however, that the stakes our country has in scientific knowledge, now and in the future, legitimate and necessitate this claim. This claim is further justified by the expenditures on the sciences in other economically and scientifically successful countries. Countries like Sweden or Finland spend a great deal more than the Netherlands on science and research. Recently, the United Kingdom and the United

States of America have significantly raised their budget for science. The lesson for the Netherlands is clear: the increase claimed by NWO is a 'must.'

Table 7.1 describes the financial means for the strategic plans for 2007–2010. These means are needed for the three lines of action *Opportunities for researchers*, *Consolidating strengths* and *Science for society*. Table 7.2 illustrates how these means will be distributed amongst the different instruments of these lines of action.

²⁰ This request is in line with the recommendations (nt. 9, 15, and 16) in the final report of the Committee for Dynamism, which advocates a structural rise of the NWO budget of 500 million euros annually.



Table 7.1 Financing of strategic plan

Financing NWO strategic plan per annum		
Current structural NWO budget (including Smart Mix)		423
Increase		
Structural increase from public means	433	
Acquisition by NWO of external means	100	
Total per annum		533
Total annual NWO budget		956

Table 7.2 Financing of policy intentions of the strategic plan

Financing policy intentions NWO strategy	Current level structural basic budget	Required annual increase		Total annual budget
		For permanently establishing current temporary initiatives	For developing new initiatives	
Line of action 1: Opportunities for researchers				
Career support programmes and response mode funding	140	10	60	210
Recruitment of world class scientists from abroad	0		10	10
Doubling of investment programmes for NWO Large and NWO Medium	28		28	56
Subtotal	168	10	98	276
Line of action 2: Consolidating strengths				
National Research Initiatives	0		50	50
Large scale research facilities	0		125	125
Transnational programmes within and outside the EU	10	10	10	30
Thematic science-driven programme	40	25		65
Fortifying and enlarging the role of institutes	80		30	110
Subtotal	130	35	215	380
Line of action 3: Science for society				
Multidisciplinary, socially inspired thematic programmes such as Casimir, workshops for academic practice, etcetera	20	45	45	110
Temporary taskforces	5	60	25	90
Subtotal	25	105	70	200
Smart Mix (NWO together with SenterNovem)	100			100
Total	423	150	383	956

7.2 Preconditions for successful implementation

If the NWO strategy is to be successful, a number of preconditions will have to be met.

Strong direct government funding

The NWO strategy relies on the solid foundation of good education and strong direct government funding. An overall good education system will procure the necessary supply of talented researchers. Strong government funding is required to ensure that universities can fully participate in the possibilities for indirect government funding. NWO should concentrate its resources on world class science, instead of repairing the gaps in the system of direct government funding. It follows logically that the requested accrual should not be effectuated by simply moving parts of the budget for direct funding to indirect funding. Moreover, NWO believes that the problem of 'matching'* should be tackled – a reason why NWO has decided on the policy to finance new instruments for subsidy and 'BIG facilities' investment programmes without increasing the pressure on matching. With current programmes such as the Innovative Research Incentive and NWO Large and NWO Medium, the requirement of a matching contribution on the part of universities will be abolished.²¹

Greater coherence and streamlining of financial arrangements

The emphasis of recent years on surplus investments in scientific research has been enormously important but has given rise to a range of diverse arrangements for funding. Adding these diverse arrangements to other long-established funding channels, for instance foundations collecting private donations, it becomes evident that such a host of different financial arrangements sacrifices transparency. The sheer administrative burden involved in applying for funding becomes rather taxing indeed. Apart from this, it has become more desirable to address economic and social themes in greater coherence. Again, therefore, *consolidation of strengths* is the byword. NWO targets collaboration as the prerequisite for success. An example is the shared partnership of NWO, TNO and SenterNovem.

Enlarging the target group

As soon as increase has been secured, the funding policy will be expanded to include new target groups. Universities and other established research institutes have traditionally constituted the most important target group for NWO funding. There are, however, other institutes involved in scientific education and research in the Netherlands, often licensed to administer doctorates. There is

no reason to deny these institutes access to NWO funding, as long as the rigid criteria for quality are met. TTIs (Technological Top Institute) and MTIs (Societal Top Institute) may similarly put a claim on these channels for funding, on the condition that the criteria remain invariably high and taking notice of the preference for academic collaboration. In line with the mission for innovation and applied science, there should also be room for institutes of Higher Vocational Education (the HBO) collaborating with universities. Obviously, NWO's intention to widen the funding policy to include new target groups can only be realised when the requested increase is granted.

²¹ See also Recommendation nr. 7 in the final report of the Committee for Dynamism. In contrast to what is maintained by this commission, NWO believes that the abolishment of matching in the case of the Innovative Research Incentives Scheme should be linked to a rise in the NWO budget.

8 NWO: Ready to meet the challenge

NWO is introducing some important changes in its own organisation. To improve the connection between science and society, NWO will add an advisory council to its board. Cooperation across the NWO research divisions will be enhanced by a greater flexibility in the basic budgets. NWO institutes and research authorities – important instruments in implementing the strategy – will acquire a more solid footing in the organisation.

8.1 Involving external partners in NWO policy priorities

To improve the interaction of NWO and its social context, an advisory council will be established at the level of the Governing Board, as a prelude to possible changes in governance. This council will consist of prominent, authoritative figures from society.²²

Similar councils may be established at the level of NWO research divisions. Alternatively, the current practice of including experts in these research division boards with no ties to a university but with a background and expressed interest in science may become more formally established.

8.2 Enhancing cooperation across NWO research divisions

The boards of NWO research divisions coordinate and survey relevant scientific developments in the domains they are concerned with. In the years to come, this expertise will remain invaluable for granting indirect government funding to university based researchers. With a growing emphasis on multidisciplinary and interdisciplinary research, the domains of the NWO research divisions will necessarily become more fluid. Although there has been some considerable breaking down of barriers in the recent past, NWO will emphatically encourage collaboration across the research divisions, mainly by establishing clustered consultative councils. These will be designed as meeting places for the research division boards, temporary taskforces and NWO institutes to attune and

decide on research programmes and related collective activities.

To give impetus to the implantation of the new strategy, the basic research division budgets will partly be made more dynamic. Part of the research division budgets will be made dependent on the successful implementation of the new strategy. A set of parameters inferred from the new policy intentions will help to decide on possible adjustments to these budgets. The different positions of the NWO research divisions will be acknowledged in this policy of enhanced flexibility.

8.3 Solid grounding of NWO institutes and temporary taskforces

The specific tasks assigned to the NWO institutes can be carried out profitably if two conditions are met. The first consists of excellence in scientific performance, to be monitored and audited periodically. Secondly, these institutes need to be well embedded in the Dutch scientific world. This will be achieved by grounding them more solidly in the organisation of NWO. NWO expects these

²² This policy decision is in line with the 10th recommendation in the final report of the Committee for Dynamism.



institutes to take the lead in effectuating the aspirations for 2007–2010, and to intensify cooperation with the NWO research divisions and with the universities.

The temporary taskforces too are to be more solidly grounded in the organisation of NWO. This will be effected by accommodating the procedures of these bodies to the general NWO procedures. The temporary taskforces have a temporary status – of considerable duration – and the research themes they are concerned with will in due course be incorporated into the existing NWO organisation.

**Incentives for
multidisciplinary and
interdisciplinary programmes and for
socially-inspired programming**

As an incentive for the development of multidisciplinary and interdisciplinary research, the Governing Board of NWO has decided to grant a bonus of 25%, derived from the general means of NWO, to the budget of thematic programmes collaboratively conducted by three or more research division boards. Programmes designed in collaboration with social partners will receive a bonus from the Governing Board. This bonus will consist of an additional 50% on top of the sum total invested by social partners. The size of the budget for this policy will be decided upon annually.



9 Closing remarks

NWO experiences a deep-rooted bond to science and to society. Scientific research is about thousands of exciting things we would so much like to understand better, not just because we are curious but also because society asks us to. It is justifiable, therefore, to spend the money from public means on a gamut of different scientific projects, including for example polar research, the birth of stars, the effects of the rise in sea-level, the world-wide dispersion of viruses, rural and urban society, how language comes into being. Knowledge satisfies our innate curiosity about the essence of things, and knowledge provides the key to the future of our country.

If the Netherlands is to acquire a strong position in European and global terms, it will need to commit itself to a drastic rise in investments in frontier research, and so in researchers, in accordance with the Lisbon strategy. Our research strengths will have to be exploited and the searchlight will have to be kept on promising scientific applications.

With this strategy plan, NWO presents its ambitious intention to return the Netherlands, in a unified effort of all knowledge partners, to the position of front-runner in Europe. An effective collaboration with all scientific institutions, private and public knowledge partners and ministries is a prerequisite.

The ministry of Education, Culture and Science will need to continue playing its central part in financing the additional investment requirements of NWO. A new structural investment of 433 million euros is needed in the next four years to effectuate the strategy of *Science Valued!*. All parties with an important stake in further developing our knowledge society have constructively participated in bringing this plan about. As their interest indicates, the proposed strategy, including the required investment, provides to all concerned the key to effectively achieve a leading position for the Netherlands in Europe.





Implementation of strategy by NWO research divisions, foundations and NWO institutes

All NWO research divisions and foundations and NWO institutes will contribute, according to their distinctive missions, to implementing the NWO strategy. This appendix concisely renders their views on scientific developments in their specific area and describes their plan of action for the coming period.



1 Earth and Life Sciences (ALW)

View on scientific developments

The twenty-first century will be the century of earth and life sciences, as was predicted at the recent turn of the century. In order to secure an enduring life on earth regarding safety, health, and prosperity, science and society are facing a number of important challenges. Changes in climate, extinction of species, impact on the atmosphere, natural disasters such as floods and tsunamis, speedy dispersal of life-threatening viruses across the globe, and the wish for sufficient food production for all, manifest with ever greater emphasis the pre-eminence of a coupled system for a healthy and sustainable life environment with the economy. A fundamental knowledge of and insight in the systems, underlying processes, and mechanisms that constitute the foundation for the coupled system, is vital to developing and implementing a social policy geared towards a balanced economic growth. All forms of life, from the most primitive to the most complex of organisms, are integrated in mutual reciprocity with their environment on earth. Life for all these forms is directly dependent on the environment which influences and shapes it in turn. The same life environment marks the natural limits for evolution and growth. There are many uncertain and sometimes absolutely unforeseen interactions within and links to this dynamic balance, taking place in non-linear networks on different scales in time and space. These processes and complex mutual reciprocities range from the molecule to the biological system and the natural system of the earth itself. Earth and Life Sciences is pre-eminently disposed to take up this scientific challenge, doing both fundamental research within the discipline of Earth and Life Sciences and, where necessary, following an integral approach across disciplines. The involvement of NWO in stimulating excellence, active encouragement and coordi-

nation on the basis of regulation and close collaboration with national and international partners will be indispensable. Moreover, the contribution of Earth and Life Sciences to the excellent international position of Dutch research and researchers is notable, but the support of NWO in maintaining that position is essential.

Specification of the NWO strategic plan

Opportunities for researchers

Earth and Life Sciences will both remain dedicated to a programme for independent project-based research in open competition for response mode funding, and intends to participate in the open competition for larger coherent funding. In continuation of earlier policies, career support programmes such as the Innovative Research Incentive will be actively supported and boosted, given the high quality and large number of potential applicants. Encouraging the appointment of female assistant professors will be part of our policy, together with Physical and Chemical Sciences.

Consolidating strengths

Focus and critical mass are created by developing multidisciplinary and trans-disciplinary thematic programmes of sufficient critical mass. Current fundamental topical questions arising from society demand an increased coherence in and boost of research in the areas of Geodynamics, Topography and 'Geohazards,' Climatology, Water Biology, Systems Biology, and the composite approaches of Developmental Biology, the Neurosciences, and Genomics towards questions concerned with ecology, biodiversity and evolution. Earth and Life Sciences will develop these subjects as lines of research,

embedding them in thematic programmes, in collaboration with NGI (Netherlands Genomics Initiative). Additional investments are required for scaling up the research infrastructure. This concerns for example large scale systems for observing and monitoring the earth, Genomics facilities, bio-banks and collections for the newest spectroscopic and microscopic instruments with techniques for image creation. A national plan for instruments will be developed by Earth and Life Sciences for medium- to large scale instruments. Transnational centres and programmes will be developed in cooperation with European partners.

Science for society

In close consultation with all relevant departments, research institutes, universities and social organisations in this field, a project is being designed to effectuate and implement a national research and development plan in the area of coastal and marine research. Socially relevant issues concerning safety, the creation of economic value, the quality of life environment and nature, and of water and health will be addressed and further explored in the context of new thematic programmes such as *Sustainable Earth*, *Systems Biology*, *Brain and Cognition*, and *Nanosciences*. These thematic programmes will be strongly enhanced by the Earth and Life Sciences core research lines including those already established and those to be further developed.

Chemical Sciences and Advanced Chemical Technologies for Sustainability (CW/ACTS)

View on scientific developments

The discipline of chemical sciences has proved throughout to be a powerful, autonomous force, with an excellent performance in terms of international ratings. It has moved on from a science dedicated to the molecule to a science concerned with entire molecular systems. The context of these systems may have a medical/biological nature, or may be derived from the high-tech materials or technology vital to such a system. Molecular thought has made an increasing impact on other areas in science, to the effect that the chemical sciences have the indispensable function of an enabling science, characteristically strong in the analysis and synthesis of molecules and molecular systems. A profitable scientific exchange with the three areas of Medical and Biological Sciences, with Physics and Materials Physics, and with Sustainability and Technology can only be realised with a strong proper discipline.

CW and ACTS intend to embark on the course of the new NWO strategy by creating an environment of excellence for science, technology and its applications. Chemistry in the Netherlands is characterised by good degree courses, an excellent position in scientific research and a powerful chemical industry. The position of the faculties of science and technology is precarious, however, which has resulted in an innovation gap between recently acquired knowledge and its application in industry. It has become the task of universities to enhance innovation, resulting in new activities and large scale public-private cooperation. The Innovation Platform has recognised the key position of the chemical sciences. CW and ACTS argue for fortifying existent strengths in the scientific

and industrial domain, and will involve their partners in this area in designing the future of the chemical sciences in the Netherlands.

Specification of the NWO strategic plan

Opportunities for researchers

World class science is practised by world class scientists, and the high standard of chemical research in the Netherlands is due to a relatively large group of excellent researchers. CW opts for enhancing curiosity-driven, unlimited research with ECHO project funding and TOP-subsidies, and possibly with a form of subsidy in the prior stages to sufficiently warrant the innovation of research. Career support programmes will be continued, with, apart from the Innovative Research Incentive, specific regards for minority groups and a talent chart of Dutch top-class talents. CW intends to encourage clustering excellent researchers in order to create focus and critical mass. The research infrastructure will be improved by means of a cooperative operation to acquire instruments and large advanced research facilities. Clear long-term arrangements between NWO and the universities are needed to effectuate activities with focus and critical mass. These means will help CW/ACTS coordinating this process in a natural manner. CW/ACTS will also fortify the ties between researchers, NWO and industry.

Consolidating strengths

CW/ACTS intends to consolidate its strengths with other disciplines and parties outside NWO in order to perpetuate a

multidisciplinary approach to scientific and social questions. Apart from the existent arrangements for collaboration, two new important multidisciplinary initiatives are concerned with, respectively, *Systems Biology / Life Sciences* (with Earth and Life Sciences, ZonMw and the NGL) and *Nanosciences* (with FOM/N and STW). Subject areas such as catalysis, industrial biotechnology, micro-reactor technology and complex molecular systems are fully in scope and the possibilities for National Research Initiatives are being explored. CW aptly recognises scientific quality and has a full perspective on the field of chemical research. ACTS has built up practical experience in collaborative programmes between the academy and trade and industry. Joining forces, CW and ACTS will bring different research groups together in order to, on the one hand, cluster individual world class scientists, and on the other encourage cooperative research with trade and industry or with the government. Internationally, CW/ACTS will work towards enabling transnational cooperation, using existing forms of subsidy. Chemistry will continue cooperating with European partners such as CERC3, ERA-nets and the Technology Platform Sustainable Chemistry.

Science for society

Chemistry is pre-eminently trimmed for contributing to social questions of health, energy and the environment, and lifestyle. Sustainable production processes, new high-tech materials and devices, new products in food and pharma, and understanding and combating disease, will all profit from a better knowledge of the underlying molecular processes and reactions. This is tackled, on the one hand, through research programmes demanded by industry or the government. On



the other hand, chemistry in the Netherlands has a number of scientific strengths, utilised by entrepreneurial researchers to set up a line of their own or to sell acquired knowledge to business companies. Larger public-private collaboration networks provide the foundations for partnerships between universities and industry in order to tackle social questions (think of materials/polymers, industrial biotechnology, food, catalysis/sustainability, and, in the coming years, pharma, nanotechnology, division technology, analytical techniques and molecular medicine). Decisions related to planning are made top-down, utilising the significant expertise of the universities. ACTS has a few years' experience in this approach, and will focus on innovating the existent programmes bringing scientific and social questions together in the areas of energy, (chemical) processes and industrial biotechnology. CW/ACTS will also advocate Innovation Labs, the location for young researchers to remould their discovery into prototypes or IPRs. Other ways to boost innovation will also be explored. In the key area of Chemistry, CW/ACTS and the VNCI (Association of Chemical Industries in the Netherlands) seek to develop possibilities for enterprising researchers. This is done by creating new regulations for private-public cooperation, for more commercially financed R&D jobs, for boosting the image of chemistry and, ultimately, for more innovations in molecular research.

Physical Sciences (EW)

View on scientific developments

The increasing interest in science and innovation is due to the recognition that if science is – both fundamental and applied – of sufficiently high standards and output, it can form the cornerstone of a powerful infrastructure in the Netherlands, essential for prosperity and quality of life. The view of NWO that cooperation on a European scale is vital, is crucial in this respect. Informatics/ICT, Mathematics and Astronomy form an essential component of this infrastructure. Acting both together and individually they are indispensable for, on the one hand, acquiring knowledge about the nature, origin and future of mankind and the world, and on the other hand for advancing technological innovations and improving the quality of life. In order to maintain the high level of scientific research in the Netherlands, a number of conditions should be met. Science education and scientific research should be mutually connected, research groups should have sufficient critical mass and size, career support programmes are a necessity, the social status of the researcher should be boosted, good research facilities should be ensured and it should remain attractive to come and stay in the Netherlands. It is the function of NWO to act as an architect of knowledge in order to facilitate these conditions. This implies conducting frontier research of excellent quality, developing a national strategic agenda, enhancing multidisciplinary research, creating focus and critical mass, promoting the dissemination of knowledge and emphasising internationalisation.

Specification of the NWO strategic plan

Opportunities for researchers

The ambition of EW to create opportunities for curiosity-driven research is considerable. The high standard of applications for response mode funding and for the Innovative Research Incentive legitimates the intention to honour 30 % of the proposals. Furthermore, EW intends to initiate or participate in important thematic programmes on a regular basis. In collaboration with the National Computing Facilities Foundation (NCF), the possibility of a National Research Initiative (NRI) for Scientific Computing and E-science is being explored. On the part of Systems Biology, a new multidisciplinary research programme will be brought about: Computational Life Sciences. A thematic programme of *Astroparticle Physics*, possibly funded by Smart Mix, is also being considered. In cooperation with other NWO research divisions it will be attempted to extend the ERA-net Complexity to include a thematic programme, referred to as *Complexity*. Informatics research groups will be stimulated to concentrate on acquiring external funding with the aid of a Leverage-programme, which will strengthen their human resources. To create career possibilities for female post-doctorates, EW intends to continue its More Women Researchers as University Lecturers (Meervoud) programme.

Consolidating strengths

In order to be able to compete globally, the wide-ranging field of Astronomy, Informatics/ICT and Mathematics needs a focussed specialisation within the Netherlands. The input of demands from society is fundamental. For each planning period and for the different research areas, EW devises strategic plans or national research agendas. Recently, the National

Research Agenda for ICT has been established. In cooperation with the ICTRegie, STW and SenterNovem, a number of ICT strengths are being defined. The input for such definitions comes forth from the key areas of the Innovation Platform and the research council 'ICT and sectors' of the ministry of Economic Affairs, to be funded with sources such as the 'Omnibus' budget* or FES*.

The Astronomy world class research centre NOVA and the NWO institutes ASTRON and SRON have developed a strategic plan for the period 2005-2015, which includes developing appropriate instruments. It describes what steps are to be taken to be well qualified for new large infrastructures such as SKA, ELT and XEUS. The future of the telescopes in La Palma and Hawaii is also implicated. There is a need for new *Memoranda of Understanding*. Mathematics is involved in a national chain of actions plan (with the Technology Platform) with a specific focus on international collaboration. A precondition for the creation of a strong, coherent structure for Mathematics in our country is continuous investment in thematic Mathematics clusters.

EW will furthermore monitor the input from Mathematics in Informatics and Life Sciences, which is also important to trade and industry. EW has joined, to this effect, the Platform Systems Biology of ZonMw, the Netherlands Genomics Initiative (NGI) and the NWO research divisions Earth and Life Sciences and Chemical Sciences. Meanwhile, international cooperation will be realised in two ERA-networks – Astronet and Complexity – and in setting up international conventions for Mathematics, Informatics/ICT and Systems Biology.



Science for society

Society and the economy have an increasing interest in problem-oriented research of excellent quality. NWO will contribute to this through matching supply and demand, programming research, selection procedures and the permanent trajectory of knowledge dissemination. EW will pursue with application-oriented research programmes such as CATCH (Continuous Access to Cultural Heritage), where researchers spend at least 60 % of their time on research in cultural heritage institutions, and JACQUARD (Software Engineering), where trade and industry decide on the type of problems they would like to see addressed. Together with ICTRegie, plans are made for a follow-up of JACQUARD, and for a programme on ICT in care. EW is preparing to extend the intermediary function of ICT by setting up a phone-in helpdesk for questions from the business line of ICT, to be addressed by experts most apt to deal with these specific problems. The Mathematics clusters will be focussed on the utilisation of knowledge, ranging from interacting with trade and industry to acquiring talented researchers in Mathematics. For the same reason, the programme 'Teacher in research' will be continued. Secondary school students will have the opportunity to sample Physical Sciences in master classes, public events such as the 'Visualisation Day' or Dizzizit (a component of the ICT knowledge conference). Similarly, Astronomy has a long tradition of 'outreaching'. Finally, an award has been created for the clearest and most interesting example of ICT research for a large audience.

4 Humanities (GW)

View on scientific developments

Research in the Humanities is of excellent quality and a number of disciplines have a leading position in the world of science. The Humanities research division acts as a driving force in stimulating the quality of research and in initiating new developments, against a backdrop of limited means in the humanities faculties. Internationally, the humanities in the Netherlands often function as pioneers in the field of research.

Focus and critical mass in the Humanities is created through national and international coordination of scientific projects. The Humanities intend to spend 75% of its financial means on programmes of response mode funding (including the Innovational Research Incentives Scheme), and 25% on thematic research programmes. Such thematic programmes come into being in the cooperation with other NWO research divisions and with external funding partners, and are fed by questions arising both from within the Humanities and from society.

The Humanities have an essential function in society. With a characteristically broad range of approaches and perspectives, they fulfill the human urge to comprehend the events in our world and in our own existence. The outcomes of research in the Humanities are easily filtered down into society, even if direct applications are difficult to identify.

Specification of the NWO strategic plan

A prominent part in the NWO strategy paper 2007-2010 has been reserved for the Humanities. In consultation with the field of research, representative councils of different disciplines, the division of the Humanities, the relevant division of the Royal Netherlands Academy of Arts and Sciences, and in interaction with social agents, the Humanities means to bring about the following policies:

Opportunities for researchers

- The Innovational Research Incentives Scheme and the programmes of response mode funding will be rigorously continued. At least 30% of the proposals will be honoured.
- The two instruments known as Research Symposia and Internationalising Research Schools will be dismantled in 2006, and a new instrument for Internationalising will be created to enhance focus and critical mass and to raise alertness and visibility in the international market place.
- The instrument of NWO Medium investments will be redressed to realise a number of initiatives in 2010 – either organised around themes or dedicated to the infrastructure across a discipline.

Consolidating strengths

- A leading role for the Humanities in effectuating new programmes of considerable size, such as *Cultural Dynamics*, *Responsible Innovation*, or *Creative Industry*.
- An active contribution on the part of the board to realise three thematic programmes, *Conflicts and Security*, *Dynamics of Life Courses*, *Brain and Cognition*.

- Setting up one single National Research Initiative in the Humanities.
- From the ERA network HERA: realising two transnational research programmes in 2008.

Science for society

- Extending and renewing collaboration with departments and social organisations. Attending to social questions in thematic programmes.
- Enhancing the utilisation of knowledge and an awareness of this utilisation in the discipline.
- Maintaining the requirement for each programme to have an apt plan for the utilisation of knowledge.
- An annual activity to involve the public at large.



Social Sciences (MaGW)

View on scientific developments

The NWO research division of Social Sciences is rather large and wide stretching. It contains nearly 20% of the Dutch research capacity, dispersed over a large number of considerably different disciplines. NWO funding is of vital importance, given the limited capacity of direct government funding. With a good output and a growing number of PhD dissertations (viz. KUOZ), Social Sciences has an excellent international performance, corroborated by several audits. Some disciplines are amongst the international front league

Given the potential for research in the Netherlands, the means of MaGW are rather limited. The percentage of applications for indirect government funding is too low, and an even more effective utilisation of means is called for. Clear, focused, and strategic choices will have to be made in developing thematic programmes and seeking international partnerships. The selection procedures for granting funds should be exposed to continuous critical evaluation in order to ensure that transparency and scrupulousness are maintained when fewer people are involved in the selection procedures and applications become ever more sizeable. This concerns the researchers, too. Social Sciences will actively seek an accumulation of means, necessary for funding the rising number of excellent research proposals and the growing need for knowledge.

Specification of the NWO strategic plan

Opportunities for researchers

Independent and curiosity-driven research will in the future still be protected by the means of the Innovational Research Incentives Scheme and response mode funding, as it is a

precondition in stimulating new developments in this area of science. Social Sciences endorses a policy to that effect, stipulating a fixed part of its basic budget for independent research. The NWO policy concerning the research infrastructure will be carried out by means of the Medium-large Investments support plan, through subsidised programmes connected to DANS and set up in cooperation with the Royal Netherlands Academy of Arts and Sciences. A national routing chart and the conjunction with developments on an international scale (ESRI and NORFACE) are required to boost the prominent position of the Social Sciences.

Consolidating strengths

The quality of research proposals and research projects will be enhanced by both competition and collaboration across the world. Social Sciences will implement its focused policy of stimulating developing transnational bilateral and multilateral programmes and projects, preferably funded from a common budget. The first transnational programme to be initiated has collaboratively come about in a partnership involving twelve countries (NORFACE). The financing of international projects will in the future be integrated in the process of national funding. These opportunities will prepare researchers for the launch of a European Research Council.

Science for society

The Social Sciences are pre-eminently apt to tackle the complex issues that arise from both the knowledge society and from the social consequences of globalisation, migration, ageing, urbanisation, or Informatics. Such issues create the need for a multidisciplinary approach; a strategic collaboration, both internationally and nationally; and a focused attention for the utilisation of knowledge. Interdisciplinary collaboration has been supported by Social Sciences and its policy of

breaking down barriers. A multidisciplinary approach, both within the division of this council and across NWO research divisions, is being prepared in new thematic programmes inspired by social issues: *Conflicts and Security, Quality of Life – Dynamics of Life Courses, and Brain and Cognition*. There is, in addition, an active participation in the domains of three other thematic programmes (*Sustainable Earth, Cultural Dynamics, and Responsible Innovation*) and in programmes in the field of Urban Space and Innovation.

Social Sciences intends to conduct the planning of arrangements for tackling complex issues of the contemporary knowledge society, by means of excellent research to be realised and financed in close collaboration with the relevant NWO research divisions and external partners. New instruments and forms of knowledge dissemination – in the shape of knowledge communities and workshops for academic practice – will be developed to enhance the utilisation and entrenchment of knowledge. New forms of strategic research will be facilitated to enable activity in a larger part of the chain of knowledge.

A powerful concept in terms of excellent research and the utilisation of knowledge is deployed in MTIs (Social Top Institutes), where different parties are consolidated who, together, cover a large part of the chain of knowledge. Social Sciences will contribute to the evaluation of these institutes and to further extend this concept through, among others, Smart Mix funding.

The NWO research division of Social Sciences intends, finally, to boost the image of the social Sciences and to raise the interest of young target groups by means of public activities, for example the biennial festival of science.

Physics Division and Foundation for Fundamental Research on Matter (FOM/N)

View on scientific developments

Challenging questions relating to Physics surface everywhere and inspire physicists throughout the world to get involved in groundbreaking creative activities. The internal dynamics of the NWO research divisions may lead to questions about the origin and secrets of the universe, the smallest nuclear particles, or the internal processes of cells. Changes in technology create the challenge for physicists to develop new instruments and make the impossible possible on the way to new types of laser instruments, innovative devices and an improved control of material resources. Social issues concerning the question of energy, for example, call for the involvement of physicists, for instance in fusion research or the search for new possibilities in adapting solar energy. New disciplines are emerging, leading internationally to multiple intricate questions.

In a small country such as the Netherlands, the community of physicist is forced to make choices.

In the strategic plan of FOM/N, the Physics of life processes, fusion, and Nanophysics/technology have acquired priority. Nuclear Physics will be abandoned as of 2007. If our policy targets are to be efficiently effectuated, it is essential that research in Physics is coherently conducted by the FFRM institutes and our university based research groups. The organisation of FOM/N enables a conductive part in bringing focus to a limited number of thematic programmes, as well as creating due critical mass for an internationally successful implementation.

Specification of the NWO strategic plan

Opportunities for researchers

Apart from the Innovational Research Incentives Scheme, FOM/N participates in two other important instruments, Rubicon and Spinoza. To retain the standards of research and the scope for venturing cutting-edge research, a system of response mode funding with an acceptable percentage of honouring proposals is a prior condition. FOM/N will continue its successful career support gender programme, aiming to further elevate the number of women professors.

Consolidating Strengths

FOM/N has, since the late 1990s, stipulated that 85% of its means be allocated for activities in thematic programmes of subdivisions, and will continue to do so with the intention to maintain and enhance the excellent level, in terms of international standards, of physics research in the Netherlands. Its prominent position in the world is evident through regular audits (NOWT). New and highly promising is the multidisciplinary subject of Nanoscience. Together with STW, Chemical Sciences, Earth and Life Sciences and ZonMw a jointly conducted 'national nano-initiative' will be set up. Other new areas across divisions where FOM/N will contribute significantly, include Systems Biology (with Earth and Life Sciences, Chemical Sciences, and the Physical Sciences), Astroparticle Physics (with Physical Sciences, ASTRON, and SRON), and Sustainable Energy (with Chemical Sciences and STW).

The formation of institutes is eminently important in creating mass and focus in a small country such as the Netherlands, and brings visibility and significance to the position of Dutch sci-

ence in international networks. The VOM institute SAF/NIKHEF forms the core of Dutch research in experimental elementary Particle Physics and coordinates the contributions from university departments, with its centre of gravity located in three large CERN experiments. The FOM institute for Plasma Physics acts as the home for Dutch research in nuclear fusion, with ITER as focal point for the coming years. This institute exploits a large international facility for infrared radiation (FELIX/FELICE). The AMOLF FOM-institute is an internationally highly regarded national centre of excellence for the Physics of Bio-molecular systems and for Nanophotonics. To carry out frontier research, large scale facilities are becoming increasingly necessary. Therefore, FOM/N is also involved in the High Magnetic Field facility of the HFML (at Nijmegen), the AGOR cyclotron (KVI) and the BIG GRID initiative (SAF/NIKHEF). In consort with other relevant NWO research divisions, FOM/N is considering the possibility of future NWO participation in European synchrotron facilities (ESRF), neutron sources (ISIS, ILL, ESS) and the new European laser XFEL in Hamburg.

Science for society

If, in light of the knowledge economy, the Netherlands is to remain an attractive place for businesses with R&D activities, then the willingness of academic researchers to cooperate with external partners in trade and industry is just as important as certain tax measures or the availability of graduates of outstanding quality. FOM/N considers it a social duty to contribute actively to this condition and has decided to liberate the means for programmed collaboration in areas where economic innovations as the result of frontier research in Physics can be expected. Businesses partaking in these FFRM Industrial Partnership Programmes fund at least half of the



research costs. A striking move has been the settlement of the first FOM research group in the laboratory of a business company, Multiphotonic Light Sources, with Philips. FOM/N intends to address social issues with its contribution to, primarily, the thematic programmes Energy and New Instruments in Care. In the first, FOM/N will not only enhance research into fusion and into a new generation of solar cells, but is also exploring highly promising new concepts for energy transmission and energy bearers. FOM/N sees many challenges and scientific opportunities – just like Philips or FEI – in the area of medical technology, for example in developing entirely new ranges of instruments, techniques and methods.

FOM/N enhances the interactions between academic researchers and business companies through the FOM Science Days and by actively participating in boards and in advisory committees, and by their presence in events such as the National Innovation Event (December 2005).

PhD graduates who apply skills and knowledge in a new job and a new environment probably constitute the most effective contribution of research to society. FOM takes care to prepare graduates for the labour market.

The visibility of FOM/N to a larger audience is achieved by means of outreach projects, such as the Fusion Roadshow, a project for students in secondary education (Hisparc) and its national website, www.natuurkunde.nl.

7 Technology Foundation STW

View on scientific developments

Technology forms the substrate of many products, processes, and systems. Directly or indirectly, it constitutes an influential factor in the capacity to compete in business. Technology is also crucial in meeting the social demands in the Netherlands concerning quality, durability, safety, speed and well-being. A broad technical-scientific substructure, punctuated with in-depth concentrations, is vital in enforcing real breakthroughs in science and its application.

Focus and critical mass is created by programmes and consortia with an impact on domains with an economic, social, or scientific significance. It is essential that opportunities are created both for individual talented researchers and for innovative, groundbreaking and supportive research, to achieve this impact. Likewise, a multidisciplinary approach is required to develop complex processes, products and systems and to effectuate innovation in practice. A large number of technical sciences have a good or excellent scientific performance (notably Electrotechnics, Chemical Technology, Agriculture, and Food Science). A number of disciplines need to be fortified.

The small number of students who opt for a science degree constitute a major problem for the Technical Sciences. In light of what is expected of Technical Sciences in terms of contributing to innovation, and given the sheer bottlenecks in the labour market and the demands for excellent academically formed researchers, it is essential that a much larger number of students be educated in science.

Specification of the NWO strategic plan

Opportunities for researchers

- STW offers opportunities for small-scale, ‘idiosyncratic’ initiatives geared towards unexpected outcomes and aiming for new inspiration. The programme for response mode funding in Technology, the Valorisation Grant and the Simon Stevin Mastership Award support this aim.
- Bottom-up initiatives aimed at fundamental scientific innovations are also stimulated by the STW programme for response mode funding.

Consolidating strengths

- In the programming of research there is a focus on the key areas of the Innovation Platform, the thematic programme Life Sciences and Health, and specific technology-oriented NWO programmes. A close collaboration with NWO research divisions and research authorities occurs within certain programmes: The use of Nanosciences and Nanotechnologies (FOM, ALW, ZonMw, CW), Regenerative Medicine (ZonMw), Life Sciences (CW, ALW, ZonMw, NCI), diverse ICT subjects (ICTRegie and EW), Creative Industry (GW, EW).
- The route towards an STW contribution to the new centres of excellence is explored with the three Technological Universities.
- International activities are aimed at extending the current ERA networks and enhancing STW participation in international companies.
- The contribution of STW to the innovation programmes of the Ministry of Economic Affairs will be attuned to trade and industry – both large scale R&D companies as well as smaller and more specialised companies.

Science for society

- The STW research areas are connected with the strategic agendas of other social parties, such as VNO-NCS, TNO, the three Technological Universities, and industry. An important contribution to dissolving bottlenecks in innovation will be delivered by STW within innovation and germination programmes financed by the Ministry of Economic Affairs.
- Through the autonomous development of instruments for valorising technical scientific knowledge by STW, knowledge can be enhanced collaboratively.
- The (financial) participation of international companies in STW projects will be continued.
- The utilisation of knowledge in society and the business world will be further enhanced by innovation markets, workshops, publications, and with instruments such as the Valorisation grant.



Netherlands Organisation for Health Research and Development (ZonMw)

View on scientific developments

ZonMw represents quality and innovation in health research. For decades, the standard of health research in the Netherlands has been immaculate in terms of an international perspective. The strength of health research stems from a focussed specialisation within disciplines on the one hand, and on the other from an effective transference of knowledge to the practice of care and cure. With the fusion of academic practice, innovation and research into one single organisation, ZonMw is in the front league of international developments. This is paralleled by the related creation of University Medical Centres (UMCS) out of medical faculties and academic hospitals.

To fulfil the expectations of these developments, the triad of opportunities for researchers (response mode funding), consolidation of strengths (collaboration is rewarded) and a social and economic orientation are all indispensable factors. Apart from the programme for response mode funding, therefore, ZonMw has a vast amount of thematic programmes designed to broach multidisciplinary research with partners from other relevant NWO divisions and with other partners in care, health policy and the business world. ZonMw is driven by a focus on integrating knowledge at different levels of aggregation, ranging from the molecule to society, but also by filling the gaps in knowledge that emerge on the way to this goal. An example of the latter is translational research, aimed at creating applications of the enormous amounts of new knowledge in care and prevention.

A systematic approach in health care is implied, related to pregnant and persisting health care issues. The major trends in health care policies are aging (the augmentation of chronic diseases), the decline in health of the young, the genetic and cultural diversification of the population, and ways to check health care (and its costs) with a concern for effectiveness, prevention, quality of life, self-care for (chronic) patients and an efficient organisation.

Specification of the NWO strategic plan

Opportunities for researchers

The necessary budgetary augmentation by NWO will primarily be invested in enhancing the programme for response mode funding, where individual researcher may propose new and challenging research endeavours in subjects ranging from the molecule to society, and where scientific quality is the main criterion in selection. Time and again, the new generations of health researchers testify their awareness of the social context of their own research. Therefore, just like the thematic programmes, the components of the response mode funding programme are concerned with important social issues. These questions require a long-range perspective, as the route to solutions is not always principally evident. The quality and originality of the proposal is the best guide for the future.

As a result of continuous limited means, the response mode funding programme is in a precarious situation. A boost is needed to prevent a belated dealing with important long-term issues, as just mentioned in the trends in health care.

The Innovational Research Incentives Scheme, a component of the open programme, is together with ZonMw aimed at the talented individual researcher and his or her fascination with research. This will be continued, with a focus on the connection between clinical scientific research and the translation of outcomes to the practice of care. The instrument for innovation at the level of a research group is the ZonMw TOP programme. Focus and critical mass will be created by rewarding effective collaboration of prominent research groups at a national level with 'Centre' subsidies for enhancing the research infrastructure. It is to be expected that such collaborations will both improve international competitiveness and increase the attraction of the Netherlands for international partnerships. The budgets required run into many millions of euros, which ZonMw shall have to acquire from increase.

Consolidating strengths

The most important issues for health research in the long run follow from the general health policy. The priorities are defined as improving quality and effectiveness in care, the development and innovation of cure and quality with an ageing population, and the care for vulnerable groups (the young, people with mental health problems or with rare diseases). The tendency to search for an integrated approach of health care questions (ranging from the molecule to society) stems from science. In an attempt to fuse these two tendencies, ZonMw is alert on the subjects of Systems Biology (pharma, food, regenerative medicine), Medication (nanomedicines, priority medicines), Prevention (early diagnosis, infection diseases, obesitas, food and motion), Mental Health (depression, dementia, addiction), and Health Technology (molecular diagnostics, nanotechnology, the image for diagnostics and cure, home care).

Science for society

The position of ZonMw in terms of *science for society* is unique. With the communal assignments of the Ministry of Health, Welfare and Sport and NWO, scientific research is linked up to short-term and long-term targets in health care. With the structural addition of implementation, all stages in the chain of knowledge are covered by ZonMw. Health research is carried out in both the public and the private sector of society. This explains why potential public-private cooperation is always explored by ZonMw when new programmes are prepared. Here, scientific quality and social relevance are the most important touchstones. The merging of consortia qualifying for large national innovation grants is stimulated when high scientific and technological standards are warranted. ZonMw will actively contribute to the acquisition and possible development of resources for NWO thematic programmes, such as *Life Sciences* (see above), *Brain and Cognition*, *Quality of Life*, *Ethical and Social Aspects of Science and Innovation*, *Nanomedicines* and *Health Technology*. ZonMw has been active for years in the areas of international policy (EU, WHO, OECD), information and communication, and will add the objective of implementation to the entire range of its portfolio.



National Computing Facilities Foundation (NCF)

View on scientific developments

The NWO research divisions subsidise scientific research in the Netherlands. The National Computing Facilities Foundation (NCF) subsidises the facilities for scientific research, especially those computer facilities that are beyond the reach of departments or universities. The need for these facilities in science has grown and amplified in recent years. It has grown in the sense that users of conventional high performance computers or supercomputers increasingly wish to extend computation models, aiming both for computation with a higher resolution and for the possibility to establish links with other computation models. It has amplified in the sense that with the enormous rise of technical possibilities (detectors, medical instruments, etc.) an avalanche of data has become available that all need to be stored, managed and analysed. Thus, there is a need for both maintaining and improving the conventional high performance computer facilities and for proper means for the storage, management and analysis of data. Such are, in fact, the requirements in a Grid-infrastructure. With a fast and advanced network and with the help of software, resources become available and transparently accessible for the world of science. This is the Netherlands Science Grid. NCF is concerned with the twofold objective of

- Enabling researchers to really perform frontier science
- Exploiting these facilities with optimal efficiency

Implementation of the NWO strategic plan

Of the three lines of action put forward in the NWO strategic plan, the principle of *Consolidating strengths* is most apt for NCF and has been adopted for a considerable length of time. Not a single university, let alone a department, is able to raise the financial means necessary for the acquisition of large scale ICT machines, such as the material resources at the *grid*. To avoid constraints in research, it is essential that the financing of such equipment be shared. NCF has been following this policy for years in the case of supercomputers. Another striking example of the consolidation of strengths is the intended 100 million euros investment of the Netherlands Science Grid in large scale infrastructures. Foreseen is an infrastructure that surpasses distinctive scientific areas, in the sense that disciplines can join this infrastructure in terms of access and support. Apart from taking care of this infrastructure, NCF needs to have relevant knowledge of various scientific areas in order to promote the utilisation of these resources to their full capacity.

The presence of large national computer facilities in our country implies the participation in collaborative European networks such as e-IRG (infrastructures) and DEISA (supercomputers, through SARA*). We have a strong position for encouraging interaction between and exchange of researchers. This

is also important for an adequate perspective on European developments in the field of large scale computation, because it enables us to make claims on technically state-of-the-art research resources in the Netherlands. Transnational frontier research projects such as LOFAR, LHC (high energy Physics), Bio-Informatics and Climate Research profit considerably from the infrastructure in the Netherlands. NCF aims at opening up this infrastructure to other disciplines.

Foundation for the Advancement of Tropical Research (WOTRO)

View on scientific Developments

The problems of development countries and its global implications have increased considerably in the recent period. However, the funding of research as well as the research potential have declined. A mere 2.5 percent of research means (both direct and indirect government funding) in the Netherlands is spent on problems related to development countries. It should be a structural 5 percent.

As from 2007, WOTRO will abandon the geographic focus on the tropics and support research on problems related to development countries in general. It will also act as a go-between with related (social) organisations inside and outside NWO.

The funding of research is twofold: thematic projects prompted by a number of Millennium Development Goals (75%), and independent, radical and innovative research that may shed a different light on development issues (25%).

Such a thematic approach will facilitate the connection with other NWO research divisions (ALW, Social Sciences, Humanities, CW/ACTS and ZonMw) and will create a noteworthy position in the chain of knowledge for Sustainable Development. The high quality of research eligible for funding, competition and selection will remain a priority.

Implementation of the NWO strategic plan

Opportunities for researchers

A part of the available resources is reserved for response mode funding, creating the opportunity for (continuous) innovation. The new insights acquired may in turn serve as an input for thematic programmes.

Consolidation of strengths

In consultation with prominent researchers, innovative and groundbreaking research questions are being developed by WOTRO, concerning the four Millennium Development Goals of *Poverty and Hunger*, *International Relationships*, *Global Health* and *Sustainable Environment*. With ample global implications and a considerable scope, they are also connected to the NWO thematic programmes *Conflicts and Security*, *Sustainable Earth*, *Cultural Dynamics* and *Systems Biology*. The inherent multidisciplinary approach and organisation of WOTRO is very suitable to these thematic programmes.

Thematic programmes will also serve to create focus and critical mass in the financial input. In principle, individual projects shall no longer be funded and the focus will be on interdisciplinary and multidisciplinary programmes. Career support programmes are carried out in the relevant NWO research divisions or in relevant WOTRO programmes. These research programmes take shape in consultation with stakeholders, research partners abroad, relevant NWO research divisions and similar partners in Europe. WOTRO takes the initiative to act as a go-between.

Science for society

WOTRO will, more than ever, stimulate active participation in the chain of knowledge, knowledge transfer, the translation of outcomes in policy and the utilisation of knowledge. A more effective utilisation of the knowledge to combat poverty and enhance sustained development, in line with the aim of the Ministry of Development Cooperation, will be one of the results of this policy. Another consequence will be the improved insight in how specific local issues can benefit from innovation systems. Talks have been initiated with DGIS to prepare a 'national counter' for all scientific research in Development as from 2007.



Netherlands Foundation for Research in Astronomy (ASTRON)

Mission

It is ASTRON's mission to enable astronomical discoveries by means of the management of world class research facilities, technological research, and the development of innovative instruments. ASTRON collaborates actively with astronomical researchers at universities in the Netherlands and abroad.

It is ASTRON's ambition to have a leading part in realising large research facilities with international partners. ASTRON will also be developing the necessary facilities to exploit the new telescopes of the future with greater efficiency. Furthermore, ASTRON has an active policy the domain of technology transfer and in cooperative ventures with the business and industry.

Programmes

ASTRON's radio observatory division carries out the operation of the Westerbork radio telescope to great efficiency, according to international standards. The Westerbork telescope is the world's most sensitive radio telescope, employed for frontier astronomical research. As a recent citation analysis testifies, scientific publications resulting from research with the Westerbork telescope are very highly valued. The radio observatory is currently developing tools for implementing the technical exploitation of the LOFAR facility. With such tools, ASTRON will have the capacity to be involved in the future exploitation of large international observatories such as Square Kilometre Array (SKA). In this respect, ASTRON means to put an effort, through LOFAR, in acquiring new strategic NWO instruments, including the support of risk-taking

research and the development of a *grid* infrastructure and ICT applications for data-intensive research.

The R&D division at ASTRON has two programme lines, optical/infrared and radiotechnology. New instruments and observation facilities are developed along these lines. In the optical/infrared area, ASTRON is a partner in international consortia with an expertise in cooled optics. Instrument development for telescopes in Chile (ESO), La Palma, and future space observatories takes place in close cooperation with researchers at universities and NOVA. ASTRON means to develop a distinctive R&D programme in optics/infrared to prepare for the next generation of large optical telescopes and to take a leading part in instrument development. The collaboration with the NWO research division EW and SRON, with TNO and with the world of business and industry is important.

The second programme line concerns radio-technology. ASTRON has positioned itself as an early adapter of new technological developments, to the effect that it has a leading part in the international cooperative efforts for the large technical developments in the field of radio astronomy. The long-term radio development programme of ASTRON is concerned with building the SKA. Within SKA, ASTRON is one of the leading technology partners, due to its R&D activities in the field of phased-array technology. The strategic ambition of ASTRON to have the European head quarters for SKA situated in the Netherlands will be fortified by this position. Cooperation with a wide range of knowledge institutions and companies is necessary to realise this ambition. ASTRON is ready to fully take part in the NWO programme for large scale research facilities. Moreover, collaboration with institutes abroad, including those in China and South-Africa, will be intensified.

On a short term basis, ASTRON is building the LOFAR sensor network, to be the world's largest facility for radio telescopes but also to be utilised in other disciplines such as Geophysics, research in Agriculture, Meteorology, and so on. This development has been nationally recognised as one of the 'Peaks in the Delta.' It demonstrates that technology designed for astronomy has a range of possible applications in science and society. ASTRON is contributing already, in this manner, to meet the NWO strategic targets, by collaborating with other knowledge institutions in conducting multidisciplinary and interdisciplinary research, and through structural alliances with commercial partners, including smaller regional business companies.

National Research Institute for Mathematics and Computer Science (CWI)

Mission

With Mathematics and Computer Science, CWI houses two fundamental disciplines with a wide and rapidly increasing range of possible applications in all branches of science and technology. It is the pivot in an international network of academic and industrial partners, and is uniquely qualified to deal with practical questions from a fundamental perspective. Thus, it contributes to finding solutions to problems faced by society in the long run. It is both a breeding-ground and meeting-place for researchers and performs a central role in directing the flow of highly qualified talented researchers and new knowledge to universities and the business world.

Main Themes

Fundamental research at CWI in the coming period will be inspired by four main themes.

Geo Sciences and Bio Sciences

Guarding the quality of the threatened system of earth involves a number of complex problems that cannot merely be tackled with either a purely theoretical or an experimental approach, but become feasible with an approach based on modelling and simulation, a combination of methods from Mathematics and computer science. The same holds for the many issues of Bio Sciences. Given the strategic interests, CWI will focus its activities in computational science sharply on Climatology, Oceanography and Systems Biology. In the field of discrete algorithms it will focus on Bio-Informatics.

The information explosion

The amount of digital information is doubled each year. Never before have so many data been assembled by researchers. Never before, has the need for instruments to manage, search and use these gigantic piles of information been so acute. CWI is, therefore, designing a toolkit with new techniques for modelling and analysis, designed to improve the finding and the organising of the correct information. This is done with the help of the new *grid* infrastructure for working at a distance, though by all appearances at local base, with these data.

Social logistics

In the world of transport, in industrial production, in health care and in many other domains of social activity, logistics are of crucial importance. An efficient and easily distributable management of logistic problems, which are notoriously complex, is increasingly important. Also in light of the NWO Spinoza award to Alexander Schrijver of CWI, we will seek to enhance research in logistics, with an emphasis on questions concerning health care and traffic.

Service-Oriented Computing

Software systems are becoming ever more sizeable and more intertwined with their surroundings. Can we rely on these systems? Is software working well and safely? What about our privacy? The practice of offering software as a service rather than as a product means that we are losing our grip on it. If such a software service does not meet those requirements, how are we to know? How can this be amended? Such are the

questions for CWI, applied in financial service centres, embedded systems and the creative industry.

CWI seeks to collaborate with the Physical Sciences division and ICTRegie, acting from a research agenda inscribed by its specific expertise. It is expected that the relation with NCF will become strategically more important, given the increased input in service-oriented computing and the GRID.



Institute for National History (ING)

The institute National History (ING) has opted for the following strategic lines for the coming research period:

1. Enhancing infrastructural function
2. New research programmes in intensive partnerships
3. Digitalisation
4. Internationalisation
5. Knowledge transfer

ING has an infrastructural function for historical-scholarly research in putting together reference books, databases, research guides, text editions and so on. The increasing demand for information clustered in a digital structure is met by ING by means of the possibilities it has for disclosing information digitally. Portals are being developed for historical biographical information. ING is concerned, therefore, with enhancing the infrastructural substrate of History.

Three new programmes will be initiated, Representation and Governance in the Netherlands, The Dutch and Culture Abroad, and Club Life in the Netherlands. These themes have been identified in consultation with the scientific community. They offer the possibility of a shared execution with research groups at universities and research institutes, to be extended, possibly, to collaborative research with other disciplines such as the Social Sciences. The procedures for shared research projects with a number of institutes have been started, and more is in store in the future. The participation in NWO thematic programmes, such as Cultural Dynamics, is an option too.

Digitalisation will remain the spearhead of ING, with innovation in aspects of technology and content as the target.

Technological innovations – prepared by prior explorations and experiments – may bear on text-oriented data, the optical recognition of ancient writing, and the automatic attribution of headwords. Innovations in content will emerge as the publication of new research, and in digitalising source material that has previously appeared in print. Thus, the demand is met for an extensive and varied electronic database of historical sources which can serve to inspire new research and novel research questions. Both an interdisciplinary collaboration and NWO funding for large digitalisation proposals are of major importance.

Internationalisation is an important policy objective, not only because of the growth of supranational research programmes and forms of subsidy, but also because a coordinated effort to disclose sources and make them available to research into supranational (European) history may lead to a change in the historical perspective. ING has two objectives in this respect. One or more disclosure projects will be set up in bilateral or multilateral cooperation. Following this, a European platform or network of experts will be established with related institutes. This may also form the point of departure for shared projects and for setting up a communal digital platform of historical information.

The *transfer* of expertise to those other than the specific users group of historical researchers, and the possible utilisation of expertise elsewhere, are subordinate objectives of ING. We will continue to attempt reaching out to a larger audience. Incidental assignments by external parties, concerning issues that are central to the social and public debate, will be accepted when suitable.

Netherlands Institute for the Study of Crime and Law Enforcement (NSCR)

The national and international position of NSCR in the field of criminality and law enforcement will be further enhanced in the years to come. This will be effectuated by means of widening and deepening its research programme with a number of important themes. NSCR intends to extend its participation in international networks, to organise the dissemination of knowledge more effectively, and to disclose its archives more efficiently to the world of researchers at large. The major part played by NSCR in the training of young researchers will be continued, in light also of future structural amendments of the knowledge infrastructure in our country.

The *research programme* of NSCR is both innovative and socially relevant. The three themes of *Mobility and the distribution of crime*, *The citizen and the criminal justice system*, and *Life course, crime and interventions* that were energetically taken up a number of years ago, will be further extended and deepened. The first two themes are connected to the NWO theme of *Conflicts and Security*, whereas the third is at the core of the NWO theme Quality of Life. The actual implementation of these themes is threefold. The first is executed by means of international or comparative research relating to the effects of detention, instigated by the notable lack of theoretical or empirical research in the Netherlands in this respect, despite the considerable rise in the number of detainees. The second consists of research into situational aspects of crime and randomised control-experiments within the field of criminal justice. The latter is a complex and time-consuming type of research that for this reason is rarely executed in the

Netherlands. Finally, issues relating crime to migration or the position of ethnic minorities will acquire a more prominent position within the existing research programme.

It is the ambition of NSCR to intensify its excellent *international* position and to extend the rapidly established networks with partners in the USA and the UK to include other prominent institutes in Europe, such as those in Tübingen, Erlangen/Nürnberg, Stockholm, Lausanne, Rome and Genoa. NSCR will invest in human resources with arrangements for excellent international researchers to be affiliated to our institute on a part-time but structural basis. In addition, NSCR will invest in developing transnational research networks.

NSCR has an active policy for *knowledge dissemination*. To this effect relations outside the field of science are systematically maintained, knowledge is on our own accord transmitted in the media and on our website, lectures and workshops are organised for a broad audience but also for specific target groups, and social developments are signalled pro-actively. The knowledge and the insights assembled and produced by NSCR will be disseminated more systematically to include, apart from press and public, the local and national authorities, the police, the Public Prosecution Service, and the judiciary.

In collaboration with DANS, NSCR will *document* its unique data and store them in *archives*. The accessible nature of NSCR warrants an unobstructed exploitation of databases by national and international researchers, with the evident

restriction that anonymity and privacy should be observed. This service of NSCR enables the perpetuation of structural cooperative networks. Finally, NSCR will continue training and educating young researchers in the years to come.



Royal Netherlands Institute for Sea Research (NIOZ)

View on scientific developments

Internationally, NIOZ belongs to the most prominent oceanographic research centres in the world (audit of May 2005). Research at the institute is both disciplinary and interdisciplinary and is fed by Physical Oceanography, Marine Biochemistry and Toxicology, Biology and Geology. The main lines of research are constituted by the cause and effect analyses of Global Change. Climate studies and research on ecosystems form an important component of the entire range of research in our institute, with attention for global and regional changes and their effects and interactions. A prior condition for understanding the complexities of the ocean, the climate, and ecosystems is a powerful collaboration, both nationally and internationally, with universities and other research institutes on the basis of multidisciplinary projects and programmes. NIOZ participates actively and prominently in these domains, as is testified for example by the function NIOZ is to have in the national research programme of *Sea and Coast*, initiated by Earth and Life Sciences. Here various research institutes and universities will address relevant issues concerning the North Sea and the Wadden Sea in cooperation with task-oriented or commercial institutes.

Implementing the NWO strategic plan

Opportunities for Researchers

The programme for excellent post-doctorates, a career support programme for talented young researchers, was abandoned after 2003 due to a lack of means. Given the unfavourable distribution of age groups in the permanent staff at NIOZ, a new attempt is made to attract young researchers with a tenure track system.

Consolidating strengths

The concept for the Science Plan 2005–2010 envisions four multidisciplinary research programmes, each explicitly embedded in collaborative partnerships with several universities and national and international institutes. As regards the NIOO, NIOZ intends to consolidate forces with complimentary research programmes and by tightening the organisational ties with the institute in Yerseke. In respect of a future MTI, a structural collaboration with task-oriented and commercial institutes will result in covenants such as 'Wageningen Marine'. Internationally, research at NIOZ is embedded in numerous research programmes (in ESF and EU) or international collaborative networks, including shipping agreements. A national key position is reserved for NIOZ in procuring research infrastructures with regard to MRF (Marine Research Facilities). An international leading position in a number of areas is kept up at NIOZ by designing and building instruments for marine research, partly with international partners.

Science for society

The implementation of the national research programme *Sea and Coast* has an eminent surplus value for society. NIOZ is also involved in other respects with social issues, as its function within the future Wadden Academy may testify. NIOZ is also increasingly involved in informing the public, partly realised in national initiatives such as the Naturalis or Ecomare museums, and also in organising lectures, group tours and public events. Knowledge utilisation is starting to become one of NIOZ's targets in collaborative industry-sponsored projects.

SRON Netherlands Institute for Space Research

View on scientific developments

The mission of SRON encompasses two important elements:

- Development and exploitation of innovative instruments for frontier Space research
- Promotion, coordination and support of national activities in the field of Space research

Satellite supported Space research is by definition a multi-disciplinary scientific activity involving, among others, Astrophysics, Astrobiology, Atmosphere Physics, Geophysics, Oceanography and Planet Physics. Scientific progress in these fields is highly dependent on observations from space. The technology (especially of sensors and integrated systems) involved is becoming more generally applicable. As a result, there is a great deal of cross-fertilisation between the scientific disciplines concerned (for example Atmosphere Physics and Planet Research, Geophysics and Astrophysics). The prominent contribution to increasingly complex space missions (as in the Principal Investigator, PI) demand augmented efforts, with an increasingly manifested presence of international (space) industry.

Implementation of the NWO strategic plan

Opportunities for Researchers

The challenges of Space research and the mutual interaction of scientific questions and technical possibilities continue to inspire researchers. This inherent characteristic of Space research is concerned with the following missions in the coming period:

- Another PI project (first priority is an X-ray mission)
- Planet research (within and outside our solar system)
- Sensor Technology, Interferometric Technology, Miniaturisation

A long established joined cooperative with the departments of Astrophysics and Earth Sciences at the universities of Utrecht and Groningen (the two locations of SRON), involves other knowledge institutes as well, such as the KNMI. This shows for example in a number of university posts for SRON employees. SRON also has an energetic PhD programme, and has collaborated intensively as of long with the Technical University of Delft. There is no shortage of opportunities for multidisciplinary scientific and technological research programmes. Space Research also provides the gateway to prominent international networks and large scale state of the art research facilities.

Consolidating strengths

At a national level SRON takes the initiative for the implementation of the Plan of Action for Space missions. A strategic collaborative venture with TNO and Dutch Space can be counted among the first results. The above-mentioned collaboration with universities forms an important point of departure in this respect.

SRON has acquired a position in Europe that enables partaking in ESA by creating new programmes and missions. It is evident that the EU will in the future be more involved in establishing space programmes.

At a global level, consortia are welded for developing and building large space instruments (the example of Herschel

HIFI). This will not be different with a new PI project. We shall seek to join consortia around scientific themes and/or technological developments, especially in the field of Climate and Environment, Planet Research, and new emerging technologies (such as Nanotechnologies, Sensors and High-tech Systems). Programmes for funding the establishing of such consortia are essential.

Science for society

Many scientific breakthroughs in astronomy and increasingly in Earth Oriented Science follow directly from observations from space. Space research has made an essential contribution to the highly esteemed position of these scientific disciplines in our country. A great many of these results draw the interest of the public at large and subscribe to the large intrinsic cultural value of science for our society. Space research is especially relevant to these social themes:

- *Climate and Environment.* Earth-oriented research examines the dynamic processes of the systems of earth, the atmosphere and of oceans, including the effects of antropogeneous influences.
- *Exploitation / Valorisation of Knowledge.* Miniature instruments and ultra sensitive sensors have a broad array of applications. Universities, other knowledge institutes and industry may wish to use satellite data. An intensive relation with STW is being developed by SRON. SRON also participates in the Dutch Technology Transfer Programme (DTTP) coordinated by TNO.
- *Directing.* SRON has been asked by the government to be involved, in association with the NIVR, with programming and prioritising the Dutch Space Effort (Plan of Action for Space missions, ESA), which will consider scientific, social and industrial interests.



Acronyms

ACTS	Advanced Chemical Technologies for Sustainability	FELIX	Free Electron Laser for Infrared eXperiments
AGOR	Accelerator Groningen-Orsay	FES	Foundation for Enhancing Economical Structure
ALW	Earth and Life Sciences	FOM	Foundation for Physics Research
AMOLF	FOM-institute for Atomic and Molecular Physics	GW	Humanities
ASTRON	Institute for Astronomical Research in the Netherlands	HBO	Higher Vocational Education
AWT	Advisory Council for Science and Technology Policies	HERA	Humanities in the European Research Area
CATCH	Continuous Access to Cultural Heritage	HFML	High Field Magnet Laboratory
CERC	Chairmen of the European Research Councils' Chemistry Committees	HIFI	Heterodyne Instrument for the Infrared
CERN	European Organisation for Nuclear Research	ICT	Information and Communication Technology
COS	Committee of Sector Councils	ICTRegie	National ICT Research and Innovation Authority
CW	Chemical Sciences	ILL	Institut Laue-Langevin
CWI	National Research Institute for Mathematics and Computer Science	ING	Institute for National History
DANS	Data Archiving and Networked Services	IPR	Intellectual Property Rights
DEISA	Distributed European Infrastructure for Supercomputing Applications	ISIS	Innovative Solutions in Space
DGIS	Ministerial Director International Cooperation	ITER	International Thermal Nuclear Reactor
DJA	Young Academy	KIQ	Knowledge Investment Quotation
DTTO	Dutch Technology Transfer Programme	KNAW	Royal Netherlands Academy for Arts and Sciences
ECHO	Excellent Chemical Research	KNMI	Royal Netherlands Meteorological Institute
e-IRG	e-Infrastructure Reflection Group	KVI	Institute for Accelerator Nuclear Physics
ERA	European Research Area	LHC	Large Hadron Collider
ERA-NET	European Research Area Network	LOFAR	LOW Frequency ARay
ERC	European Research Council	Meervoud	More Women Researchers as University Lecturers
ESA	European Space Agency	MKB	Royal Association for Medium and Small sized Business Companies
ESF	European Science Foundation	MRF	Marine Research Facilities
ESFRI	European Strategy Forum on Research Infrastructures	MTI	Societal Top Institute
ESO	European Southern Observatory	NCF	National Computer Facilities
ESRF	European Synchrotron Radiation Facility	NGI	Netherlands Genomics Initiative
ESS	European Spallation Source	NGO	Non-Governmental Organisations
EU	European Union	NIOO	Netherlands Institute for Ecology
EUROCORES	European Science Foundation Collaborative Research Programmes Scheme	NKI	Netherlands Cancer Institute
EUROHORCS	European Heads of Research Councils	NORFACE	New Opportunities for Research Funding Co-operation in Europe
EURYI	European Young Investigators	NOVA	Netherlands Research School for Astronomy
EW	Physical Sciences	NOWT	Netherlands Observatory of Science and Technology
FELICE	Free Electron Laser for Intra-Cavity Experiments	NRI	National Research Initiative

NSCR	Netherlands Institute for the Study of Crime and Law Enforcement
NWO	Netherlands Organisation for Scientific Research
OECD	Organisation for Economic Cooperation and Development
PI	Principal Investigator
R&D	Research and Development
REA	Council of Economic Advisors
RPB	Centre for Spatial Planning
SAF/NIKHEF	Institute for Subatomic Physics/National Institute for Nuclear Physics and High Energy Physics
SARA	Computing and Networking Services
SBIR	Small Business Innovation Research
SER	Social Economic Council
SKA	Square Kilometre Array
SRON	Netherlands Institute for Space Research
STW	Technology Foundation
TNO	Netherlands Association for Applied Research in the Natural Sciences
TTI	Technological Top Institute
UMC	University Medical Centre
VNCI	Association of Chemical Industries in the Netherlands
VNO-NCW	Confederation of Netherlands Industry and Employers
VSNU	Association of Universities in the Netherlands
WHO	World Health Organisation
WOTRO	Foundation for the Advancement of Tropical Research
WRR	Scientific Council for Government Policy
XEUS	X-ray Evolving Universe Spectroscopy
XPEL	European X-Ray Laser Project
ZonMw	Netherlands Organisation for Health Research and Development



Terminology

Some typically Dutch notions and names in the text may need extra paraphrasing to convey their full meaning to foreign readers. The phrases below have been marked with a blue asterisk where they first occur in the text.

- Page 5: **second flow of funds**, the secondary, competitive funding in addition to the core funding of Dutch science at universities (first flow of funds). In general, scientific research generated by the industry and businesses is referred to as the third flow of funds.
- Page 7: **national Innovation Platform**, a high-level platform, chaired by the Prime Minister, consisting of senior representatives from government, science, society and industry, which acts as a thinktank on the Dutch knowledge and information system.
- Page 9: **SenterNovem**, promoting agency of the Ministry of Economic Affairs for sustainable development and innovation.
- Page 9: **Smart Mix**, subsidy programme which supports cooperation of innovators, specifically between knowledge institutes like universities on the one hand and companies and civil society organisations on the other, on a broad range of subjects.
- Page 9: **MTI**, first-class societal institutes, which combine excellent scientific research with the demand for knowledge from e.g. ministries and representatives of governmental policy.
- Page 9: **Big Facilities**, as recommended by the Innovation Platform, in 2006 a budget of 100 million euros has been allocated for investment in large-scale research facilities at 5 top-class institutions. Also known as BIG Programme.
- Page 15: **Committee for Dynamism**, also known as the Committee Chang after its chairman Mr K.H. Chang, advised the Dutch government on efficiency in financing scientific research.
- Page 27: **investment agenda**, a ten year budget plan for financing scientific research in the Netherlands.
- Page 33: **VNO/NCW**, Confederation of Netherlands Industry and Employers, the largest employers' organisation in the Netherlands, representing more than 90.000 enterprises.
- Page 36: **BSIK**, (pronounced: basic) subsidy scheme for investments in the knowledge infrastructure, with funds from FES (see page 56 below).
- Page 39: **Platform Bèta Technique**, commissioned by the government, education and business sectors to ensure sufficient availability of people who have a background in scientific or technical education.
- Page 46: **matching**, in this case, the contribution by the university or research institute in financing the research project or investment.
- Page 56: **Omnibus budget**, the ministry of Economic Affairs has collected various specific subsidies aimed at innovation in one so-called Omnibus budget, by which it can use its funds with more flexibility and accessibility.
- Page 56: **FES**, Fund for Re-inforcing Economic Structure, in which 40 percent of the profits from natural gas resources flow.
- Page 65: **SARA**, SARA Computing and Networking Services facilitates high performance computing & visualisation, high performance networking and infrastructure services, for the business community and scientific, educational, and government institutions.





