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Promoting Multidisciplinary Research

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Adviesraad voor het
*W*etenschaps- en **T**echnologiebeleid

AWT

Inhoudsopgave

Summary

1. Advice question and focus

The Minister of Education, Culture and Science and the Minister of Economic Affairs asked the Advisory Council for Science and Technology Policy to issue recommendations on how to foster multidisciplinary research.

There is a growing need for multidisciplinary research. Scientific, social and technological issues have become so complex that it is increasingly necessary to involve different disciplines in order to answer questions. Moreover, the greatest opportunities for breakthroughs are present precisely at the point where disciplines interface. That is why the various parties involved are facing the challenge of bringing different disciplines together.

The Council decided to focus primarily on ways of creating opportunities for multidisciplinary research and then bringing them to their full fruition. It places less emphasis on extensive analysis of the obstacles, which are complex, intertwined and deeply embedded in the national and international research establishment. They cannot simply be ´organised away´.

The Council looked at macrofactors that affect the success of multidisciplinary research. These are issues that transcend individual projects or programmes. The government is the obvious party to influence macro-factors and therein lies the added value of the Council's advice.

The Council consulted with a range of expert practitioners at home and abroad, holding interviews in the Netherlands, Finland, Switzerland and England. The situation in the United States was the topic of a separate literature study.

2. Summary answers to the advice questions

a) What precisely are the underlying reasons for the lag in multidisciplinary research?

Multidisciplinary research in the Netherlands is not actually lagging behind other countries. In addition to the development of several multidisciplinary academic fields (e.g. bio-informatics), for some time now there have been various successful multidisciplinary projects and initiatives. Nevertheless, the Council believes that more should be done to promote multidisciplinary research, not only because initiatives to that end are being taken in other countries, but also due to the tremendous importance of such research. The bottlenecks that hinder the growth of multidisciplinary research appear to be remarkably similar in every country:

- The standard university structure, in which disciplines are separated;
- Cultural differences and differences of approach between disciplines;
- The peer review system and the related assessment systems; and
- Fragmented articulation of research questions.

b) What can the research community do to promote multidisciplinary research? What is the specific role of the universities in this respect?

The Council finds that all research institutes, including the universities, have a role to play in fostering multidisciplinary research. The research community itself needs to introduce incentives to promote multidisciplinary research. Because obstacles manifest themselves much more strongly within universities, the Council has focused its recommendations on fostering multidisciplinary research at universities. There are several reasons why universities, in particular, have an active role to play. For example, students and research assistants (AIOs) are not trained merely to do research at the university, but are given the skills necessary to work within institutes and companies that have a multidisciplinary population. University researchers often participate in multidisciplinary projects and programmes on a temporary basis. This should not have a negative effect on their career. Finally, the university environment is characterised by breakthroughs and exciting developments, and it is at the boundaries between disciplines where those are most likely to occur.

c) Does the government have a duty to promote multidisciplinary research and if so, how should it go about fulfilling that duty?

The Council believes it is up to the knowledge institutions themselves, in principle, to promote multidisciplinary research and develop incentives for that purpose.

However, because multidisciplinary research serves considerable public and private interests, the government should play a part in promoting it. First, the government, in the person of the Minister of Education, Culture and Science, bears final responsibility for the research system at large. Second, the government, and more particularly the Minister of Economic Affairs, is responsible for stimulating innovation in the business community. Innovation is inherently a multidisciplinary process. Third, the government is a 'knowledge consumer', and as such poses countless questions to the research establishment. This responsibility rests with all the ministries, under the coordination of the Ministry of Education, Culture and Science. The Council observes that while the government already fulfils these responsibilities in many ways, the promotion of multidisciplinary research requires extra effort. The Council has a number of general recommendations in this regard.

3. Recommendations

The Council distinguishes three important issues in the effective promotion of multidisciplinary research. First, there must be a sufficient number of researchers who are motivated and capable of conducting multidisciplinary research. Second, those motivated researchers must be given the opportunity to meet each other. In order to bring disciplines together, people need to be brought together. It is not about a single person practising several disciplines, but about assembling individuals with different backgrounds. Third, these researchers need to feel connected by interesting, challenging goals. The Council formulates its recommendations along these three lines.

Enough motivated researchers

The Council makes the following recommendations for generating the right stimuli to encourage researchers to participate in multidisciplinary research.

- Broaden the concept of scientific quality. Boards of governors play an important role in ensuring that the scope provided in the new visitation system is actually used in practice. That should also be an important point of attention during the meta-evaluation of the system by the KNAW (Royal Netherlands Academy of Arts and Sciences).
- Pursue a targeted policy of broadening the careers of scientific researchers at every stage. This is the joint responsibility of the universities, the NWO

(Netherlands Organisation for Scientific Research) and the KNAW. The Council provides a range of options for applying this recommendation, inspired by examples from abroad.
- Improve the image of multidisciplinary research. This is primarily the task of the research institutes.

Promote interaction and meetings

Meetings and interaction are essential if multidisciplinary research is to flourish. While it is important for scientists to interact with one another and form ties, it is equally important for them to interact with people from outside the academic community, such as policy-makers, representatives of social groups and people from the business community. The Council makes the following recommendations in this respect:

- Organise the establishment of meeting places (horizontal ties). Boards of governors can play a pioneering role together with the deans and directors of university research centres.
- Set up leading institutes for research into societal issues such as education, health, safety, ageing and mobility (MTIs).
- Strengthen the reciprocity between non-university thematic institutes and universities. Knowledge developed at universities is often the seedbed of research conducted by thematic institutes. It is essential to promote the flow of knowledge between universities and those institutes. Networks and interaction between universities and the outside world should be promoted by employing parttime professors and introducing secondment schemes.
- Encourage meetings and interaction with other disciplines within education.

Set challenging goals

Multidisciplinary research can be successful only if the goal, question or ambition is attractive and shared. The Council makes the following recommendations in this respect:

- Direct the articulation of research questions, in order to ensure that they are truly integral. Different parties should seek each other out at an early stage in order to formulate the key questions. For social issues, in particular, external direction is nearly always essential. It is important not to take the step towards ´solutions´ too quickly. This will only block perspectives and in practice too little attention will be paid to humanities and social science aspects. The Council

puts forward a number of options for setting challenging goals and formulating the related integral questions.

- Put more money into interdisciplinary themes and increase the share of thematic research. Funding distributors such as the NWO, and university boards of governors have a potent tool for promoting multidisciplinary research, since they determine which initiatives are to be funded. By increasing the share of thematic funding, it will be more attractive for scientists to participate.

Conclusion

Inspired by examples from abroad the Council has drawn up a long list of recommendations and suggestions for stimulating multidisciplinary research. Each of those measures can help to promote multidisciplinary research. As we know, there are many roads that lead to Rome. The Council hopes that this report will inspire scientists and policy-makers to develop initiatives that will help multidisciplinary research to continue to flourish.

1 Advice

1. Advice questions

The Minister of Education, Culture and Science and the Minister of Economic Affairs asked the Advisory Council for Science and Technology Policy to issue recommendations on how to foster multidisciplinary research. They posed the following questions.

- What precisely are the underlying reasons for the lag in multidisciplinary rese arch?
- How can the research community itself promote this type of research? What is the specific role of the universities in this respect?
- Does the government have a duty to promote multidisciplinary research and if so, how should it go about fulfilling that duty?

1.1 Background

Scientific and societal developments require input from a wide range of disciplines

There is a growing need for multidisciplinary research. Scientific, social and technological issues have become so complex that most cannot be answered from a single perspective. Questions at the forefront of science increasingly require input from several disciplines. Genomics, proteomics, speech technology and nanotechnology are just a few of the fields that are developing like wildfire because they bring insights from different disciplines together.

Societal issues, too, increasingly require input from a range of disciplines. The problems in the health care system cannot be dealt with exclusively by producing more medical technology. Sociological, demographical, psychological, ethnological and administrative research, to name but a few areas, are equally important. Only by drawing such diverse perspectives together do the contours of societal issues in their complexity emerge.

This is also essential for innovation

Companies are also facing the challenge of bringing disciplines together. Like no other, they know how important multidisciplinary research is for innovation. The CD player, for example, would never have been invented had it not been for the multidisciplinary research of several different disciplines.

The box below gives an interesting example of where multidisciplinary research can lead.

Alan MacDiarmid received the Nobel Prize for Chemistry in 200 for the discovery and development of conducting polymers. This breakthrough will eventually lead to the development of roll-up TFT screens and other flexible computer components. He has no doubts about the importance of multidisciplinary research in science:[1]

'Research used to be primarily restricted to one's own discipline. If you were a chemist, you did chemistry research. If you were a physicist, you did physics research. This award is s wonderful recognition of the importance of interdisciplinary research. Here we have chemists, physicists, electrochemists and now electronic engineers all working together on the same problem. If you have a physicist and a chemist having different concepts, different abilities, different techniques all working the same problems, we have "one plus one often make more than two." The development of this whole synthetic metal field worldwide is probably one of the best examples in the last two or three decades of interdisciplinary research.

Science in the future is going to utilise the concept of interdisciplinary research much more, where people get together to solve a given scientific problem - people with completely different backgrounds. Alan Heeger and I found, however, you have to learn a different language - a different lingo - for a physicist to talk to a chemist and a chemist to talk to a physicist. It's not easy; it's much easier just to do research in your own discipline. It's tougher to do interdisciplinary research. But I have no doubt that we will see interdisciplinary research receiving more and more attention in the future.'

In other words, multidisciplinary research is necessary. But that's not all. Multidisciplinary research is not only necessary, it is exciting. The chance of a

1 Quotes from the press conference held when Mr MacDiarmid was awarded the 2000 Nobel Prize for Chemistry, on 10 October 200. For the complete transcript see http://www.upenn.edu/almanac /v47/n08/nobel2000.html.

The chance of a breakthrough is greater where disciplines meet

breakthrough is greater where disciplines meet. However, all too often the boundaries of our knowledge run parallel with the boundaries between disciplines. Nobody knows what lies beyond those boundaries, but that only stimulates our imagination more. Science remains an endless frontier.

The observation that it is desirable to stimulate multidisciplinary research is not new. This has been said time and again, and not only by the AWT. Various agencies have recently taken the initiative to promote multidisciplinary research (see box). The opportunities inherent in multidisciplinary research are being recognized abroad, too. The AWT wishes to make a contribution by way of these recommendations, in order to ensure that such initiatives succeed.

Multidisciplinary research is an important element of the NWO´s strategy for the coming years. The KNAW has appointed a multidisciplinary research working group, which has recently issued a report. TNO also acknowledges the importance of multidisciplinary research in its strategic plan. Multidisciplinary research also plays a prominent role in the mission statements of many universities. The missions of many non-university research institutes is multidisciplinary by definition. In most cases, their raison d´être is to conduct multidisciplinary research.

1.2 Focus and nature of the advice

The Council focuses primarily on ways of creating such opportunities…

This advice is based on the notion that breakthroughs usually take place when the boundaries between disciplines are crossed. In its advice the Council focuses primarily on ways of creating such opportunities and bringing them to full fruition. The Council seeks its added value in putting forward inventive and effective policy measures that offer opportunities to promote and maintain multidisciplinary research within the existing system. It places less emphasis on extensive analysis of the obstacles, which are complex, intertwined and deeply embedded in the national and international research establishment. They cannot simply be ´organised away´. The council will gear its recommendations towards finding ways to make those obstacles manageable.

… and places less emphasis on removing the obstacles

In this report, the Council devotes particular attention to the macrofactors that influence the success of multidisciplinary research projects and programmes. One of those factors is the faculty divisions within universities and the availability of sufficient funding. These are issues that transcend individual projects and program-

mes. Those directly involved in multidisciplinary research, e.g. researchers and programme leaders, have little influence on these factors. They can only influence microfactors, such as good communication and good management. This has been a topic of intense study. Those studies show, however, that favourable microfactors are not enough. Favourable macrofactors are just as important to the success of multidisciplinary projects and programmes. However, only limited recommendations are given for optimising macrofactors. That is why the Council is focusing on macrofactors in this report. It believes that the government is the obvious party to influence macrofactors and therein lies the added value of the AWT´s advice.

Attention for macrofactors …

… and for multidisciplinary research between unrelated disciplines

The Council has the impression that multidisciplinary research between unrelated disciplines requires more stimulation than cooperation between related disciplines. With increasing frequency, the social sciences are being called upon to make a greater and timely contribution. The Council will therefore devote extra attention to multidisciplinary research between unrelated disciplines and, in particular, between the science disciplines and the social disciplines.

1.3 Premises

Monodisciplinary and multidisciplinary research are not mutually exclusive

The Council wishes to emphasis that monodisciplinary and multidisciplinary research are not mutually exclusive. In general, monodisciplines provide the nutrients which allow multidisciplinary research to flourish. This relationship is not hierarchical. Many of the monodisciplines today originated as combinations of different fields in the past. In other words, the boundaries between monodisciplines and multidisciplines are changeable. This gives all the more cause to promote multidisciplinary initiatives.

Multidisciplinarity is a broad term

The Council uses the term multidisciplinarity in this report to refer to all possible forms of multidisciplinary research between scientists from different disciplines. Terms such as interdisciplinarity and transdisciplinarity have the same meaning, but add extra dimensions. The term interdisciplinarity draws attention to the degree to which working methods and research results are integrated; the term transdisciplinarity focuses on the degree of cooperation between scientists and representatives of other sectors, such as the public authorities, the business community and users. Although the Council is aware of the differences in meaning, it wishes to stay out of any discussion on definition issues, and consequently does not make any use of the distinction between the different terms in this report.

2 Answers to the Questions and Recommendations

Actively bringing knowledge from different disciplines together increases the opportunities for social, technological and scientific innovation. With this report, the Council would like to contribute to the stimulation of multidisciplinary research. Its approach is practical. In this chapter, the Council puts forward recommendations which it believes will prove their worth in practice and which are aimed at creating and making the most of opportunities. The Council has purposely not combined its recommendations with extensive descriptions of the obstacles that hold multidisciplinary research back. Nor do the recommendations offer ´solutions´ to problems, rather they provide methods of making the problems manageable. Of course, the Council acquired information about the main bottlenecks. This is touched on briefly in the answers to the questions and more extensively in the explanatory notes (part B of this report).

The recommendations are aimed at making problems more manageable, not solving them

When preparing this report, the Council consulted with various expert practitioners in the Netherlands and abroad. A round of interviews and a workshop were held in the Netherlands. Appendix 1 contains a list of the discussion partners and workshop participants in the Netherlands. Interviews were also held in three other countries: Finland, Switzerland and England. The situation in the United States was the topic of a literature study. The findings were described in background documents for each country.[2] Appendix 2 contains a list of the discussion partners abroad. The Council used the insights it gained from those consultations to formulate the recommendations in section 2.2 of this chapter.

Before the recommendations are given in section 2.1, the advice questions will be answered in brief.

2.1 Brief Answers to the Advice Questions

What precisely are the underlying reasons for the lag in multidisciplinary research? The advice question presupposes that the Netherlands is lagging behind in

2 The background documents are available at www.awt.nl.

The Netherlands is not lagging behind other countries...

multidisciplinary research. However, the Council finds that this term is too strong for the actual situation. The Netherlands is in fact not lagging behind other countries. A great deal of good work is being done. In addition to the development of many multidisciplinary fields over the past several years (e.g. epidemiology, econometry, cognitive science, language and speech technology, bio-informatics), there have been several successful multidisciplinary projects and initiatives. Nevertheless, the Council believes that more should be done to promote multidisciplinary research, not only because initiatives to that end are being taken in other countries, but also due to the tremendous importance of such research for scientific, social and technological renewal.

... but more should be done to promote multidisciplinary research

The Council wishes to focus on opportunities that facilitate and accelerate the growth of multidisciplinary research. However, it is not blind to the structural obstacles. The bottlenecks that keep multidisciplinary research from developing its full potential are remarkably similar in every country:

The bottlenecks are remarkably similar in every country

- The standard university structure, which separates disciplines
  The facultybased structure tends to keep multidisciplinary research from flourishing in the Netherlands and abroad. Nearly all universities are divided into fairly narrow faculties, even in countries where this structure is not required by law. This gives rise to 'pigeonholing'. On a positive note, there are currently several initiatives in the pipeline in the Netherlands and abroad to promote interfaculty multidisciplinary research by broadening faculties and by implementing thematic horizontal structures.
- Cultural differences and differences of approach between disciplines
  There are major differences in scientific culture and methodology between disciplines, particularly between the social and the science disciplines. This is related in part to the research objectives. Scientific research usually produces results that are universal in time and space. Social scientists are often confronted with results that are highly changeable in time and space (many more uncertainties). It is difficult to bring these different worlds together.
- The peer review system and the related assessment systems
  Worldwide, scientific quality is usually defined in terms of the number of publications in leading journals and the number of citations. Researchers are dependent on the assessment of peer groups for recognition and often indirectly for the funding of their research. Peer groups and the scientific journals tend to have a strong monodisciplinary nature.
- Fragmented articulation of research questions
  Research into societal issues is often driven by shortterm interests and questions

are usually formulated in a fragmented way. Requesting parties, including the government, make insufficient efforts to develop an integral, interministerial approach to research questions in the public sector. This is remarkable considering that societal issues are inherently interministerial in nature and require a broad interdisciplinary approach.

The Council addresses these problems in greater detail in the explanatory notes to this report.

Bottlenecks manifest themselves most strongly at universities

The Council observed that the problems manifest themselves much more strongly at universities than at non-university research institutes.[3] Many of these institutes have a clear, thematic approach and offer an environment in which multidisciplinary research can flourish. Many of them receive substantial input from the social sciences. The situation is very different in the universities, where there are many forces at work that inhibit the development of multidisciplinary research. Non-university research institutes are generally more attractive than universities to researchers interested in multidisciplinary research.

All institutes should promote multidisciplinary research…

What can the research community do to promote multidisciplinary research? What is the specific role of the universities in this respect?
The Council is of the opinion that all research institutes, including the universities, have a role to play in promoting multidisciplinary research. The research community itself needs to introduce incentives that make multidisciplinary research more attractive. The goal is not to exclude monodisciplinary research, but to create a proper balance and enable both forms of research to flourish alongside each other, with mutual respect and the associated mutual benefits. Multidisciplinary research is promoted relatively well at non-university research institutes. However, the Council sees good reasons for promoting multidisciplinary research at universities as well:

the universities, in particular

1. Students and research assistants (AIOs) are not only trained to do university research, but are also given the skills they will need later to do research or other work within institutes or companies. Acquiring multidisciplinary knowledge should be a point of attention in their courses of study. In order to provide this kind of training, university lecturers and researchers need to familiarise themselves with and gain experience in multidisciplinary knowledge development.

3 Examples of non-university research institutes include NIVEL (Netherlands Institute of Health Services Research), NIZW (Netherlands Institute for Care and Welfare), TNO (Netherlands Institute for Applied Scientific Research) and NIDI (Netherlands Interdisciplinary Demographic Institute)

2. University researchers are often involved in multidisciplinary projects and programmes on a temporary basis, after which they return to their university; there they should have the opportunity to continue multidisciplinary lines of research. The period they spend working on a multidisciplinary project or programme should not be regarded as a break in their career, but an enriching part of it.
3. Breakthroughs and exciting developments tend to take place at the boundaries between disciplines. Universities should not deprive themselves of this type of developments. Additionally, when researchers in different disciplines meet new perspectives are born that give more depth to monodisciplinary lines of research.

Attention in policy for multidisciplinary research at non-university institutes remains necessary

Both non-university research institutes and universities have a role to play in the promotion of multidisciplinary research. Because universities face greater obstacles, the Council decided to focus its recommendations primarily on the promotion of multidisciplinary research at universities. That is not to say that the council regards the further development of incentives for and the continuation of multidisciplinary research at institutes as less important. On the contrary, non-university institutes should be supported and facilitated wherever possible. Attention in policy for non-university research institutes should certainly not be permitted to weaken. The Council hopes that some of its recommendations will bear fruit for these institutes as well. The recommendations are given below in section 2.2.

Does the government have a duty to promote multidisciplinary research and if so, how should it go about fulfilling that duty?

Multidisciplinary research is very important to many parties. It is the basis for scientific breakthroughs, it plays a major role in facilitating social change and is an important condition that enables companies to innovate. Multidisciplinary research consequently serves significant public and private interests. Nevertheless, the Council, together with the Ministers of Education, Culture & Science and Economic Affairs, has observed that the spread of multidisciplinary research is not in keeping with its current and potential importance; hence, the desire to promote multidisciplinary research.

It is primarily up to the knowledge institutes to promote multidisciplinary research…

The Council believes that it is primarily a task of the knowledge institutes themselves to promote multidisciplinary research and to develop incentives to that end. The Council applauds the knowledge institutes that have incorporated the promotion of multidisciplinary research in their strategic plans and calls upon them to translate (or continue translating) those strategic ambitions into action. This report offers assistance in this regard (see recommendations in section 2.2).

... but the government has a duty too

In the Council´s opinion the government also has a duty to promote multidisciplinary research. Specifically because of the major public and private interests involved, the Council urges the government to devote more attention and increase its involvement. The government´s responsibility for research, multidisciplinary and otherwise, has several dimensions.

the Ministry of Education, Culture and Science in view of its responsibility for the research system as such...

First, the government, in particular the Minister of Education, Culture and Science, is responsible for the quality, scope and innovative capacity of the research establishment. The government needs to devote special attention to promoting multidisciplinary research in the knowledge institutes it is responsible for. The Council makes two general recommendations in this respect:

- Knowledge institutes should be called to account with respect to their responsibility for developing and implementing challenging incentives;
- Special attention should be devoted to the promotion of multidisciplinary research during the initiation, design and evaluation of special research promotion programmes, such as the NWO's Innovational Research Incentive Scheme.

...the Ministry of Economic Affairs from the perspective of innovation...

Second, the government, in particular the Minister of Economic Affairs, is responsible for promoting innovation in companies. The Council believes the government should pay special attention to the promotion of multidisciplinary research in this area, too, and makes the following recommendation:

- Special attention should be devoted to the promotion of multidisciplinary research during the initiation, design and evaluation of special research promotion programmes that clearly incorporate knowledge development.

... all ministries as knowledge consumers

Third, the government is a 'knowledge consumer', and as such poses countless questions to the research establishment. All the ministries share this responsibility, but the Ministry of Education, Culture and Science has a coordinating role. A multidisciplinary approach is often needed to achieve good knowledge input and a solid basis for tackling societal issues. In this respect, the Council makes the following recommendation:

- The government should ensure that research questions are broad and incorporate all the relevant perspectives and that projects are actually executed in a multidisciplinary fashion.

The Council welcomes the fact that the government already fulfils these responsibilities in many ways, but observes that the promotion of multidisciplinary rese-

arch requires an extra effort. For that purpose, the Council will discuss the general recommendations above in more detail on the following pages.

2.2 Recommendations

2.2.1 Premises

There are three important issues involved in promoting multidisciplinary research:

Based in part on the practical experiences of a broad spectrum of discussion partners, the Council distinguishes three issues that are of great import to the effective promotion of multidisciplinary research. In the first place, there must be a sufficient number of researchers who are motivated and capable of performing multidisciplinary research. Without the availability of a critical volume of 'human capital', multidisciplinary research has no chance of success. Second, motivated and competent researchers must be given the opportunity to meet each other. Bringing disciplines together is about bringing people together. Third, motivated and competent researchers who have found each other need to feel bound by interesting, challenging objectives. Nothing unites people better than a common goal. These three issues are explained in further detail below.

motivated researchers…

1. Enough motivated researchers

In order for multidisciplinary research to succeed, people are needed who are prepared to work together and who, in addition to a thorough knowledge of their own discipline, have sufficient affinity with other disciplines. They should be extrinsically as well as intrinsically motivated to participate in multidisciplinary research: it is not just a question of willingness, but also of opportunity and ability. This carries consequences for higher education, for scientific career paths, for quality criteria and for research funding.

2. Interaction among researchers

…meetings and interaction…

Many stimuli within science aim to encourage researchers to operate within the boundaries of their own specific disciplines. For that reason, opportunities need to be actively generated for scientists to meet and work together: 1+1>2. The Council notes that it is not about a single person practising several disciplines, but about assembling individuals with different backgrounds. Meetings of this nature are crucial in different stages of the scientific process. In informal and educational contexts they can help generate mutual understanding and respect and teach

researchers to recognise each other's potential contribution. Interaction and multidisciplinary research are essential to determining research themes and/or societal issues, as they are to formulating concrete programmes and projects and identifying research questions. In many, if not all, cases it will become clear that it is necessary to cross the traditional boundaries that exist between disciplines, and between science and practice.

3. Common, challenging goals

… and a shared ambition

Researchers will be able to come together and cooperate successfully only if they have a common goal or shared ambition. Even in the case of curiositydriven research, multidisciplinary research will only succeed if the participants have a common objective. The Council is of the opinion that formulating challenging objectives and interesting themes, and providing longterm funding, would give multidisciplinary research a significant impulse.

In the rest of this chapter, the Council presents its recommendations for promoting the growth of multidisciplinary research in the Netherlands. The selected line of approach is to establish how we can create optimal conditions for fostering, stimulating and allowing multidisciplinary research to flourish. These recommendations are formulated along the aforementioned lines.

The Council is working on several fronts, but is not aiming for completeness

Note, however, the following. Given the complexity of the material, the Council considers it wise and desirable to act on many fronts and therefore presents a large number of possibilities. Nevertheless, its proposals for the promotion of multidisciplinary research within the three main categories of necessary action are not the only options. The measures and examples in this report represent a contribution, but may also serve as an inspiration for other initiatives.

2.2.2 Enough motivated researchers

The recommendations in this section are about creating the right stimuli to encourage researchers to participate in multidisciplinary research.

It is essential to broaden the concept of scientific quality

Broaden the concept of quality

As a rule, the national and international standards for assessing the quality of scientific research and the standing of researchers do not encourage researchers to get involved in multidisciplinary research. What counts is the number of publi-

cations and citations in leading international (usually monodisciplinary) journals. These standards are clearly recognisable in the evaluation criteria that are used to assess the quality of research groups. The new Standard Evaluation Protocol 2003-2009 for Public Research Organisations, recently published by the VSNU, the KNAW and the NWO, offers scope for broadening the concept of quality. Research groups are expected to formulate a mission statement and to identify other groups that have similar mission statements with whom they wish to be compared by the evaluation committees. The Council believes this type of development to be highly desirable as it will fill the need for broadening of the concept of scientific quality. The university boards of governors have an important role in ensuring that the scope added to the existing evaluation systems is actually used. In its metaevaluation the KNAW will need to include an assessment of whether multidisciplinary research can be evaluated better in the new system than before.

Pursue targeted policy enabling researchers to broaden their career paths

The Council is of the opinion that more opportunities should be created for scientific researchers to broaden their careers. It finds that currently young professors, in particular, have but few options for acquiring expertise in a new direction.

Generous, longterm financial incentives give talented young researchers and professors the opportunity to move in new directions and to continue along that path by establishing research groups. The NWO´s Innovational Research Incentive Scheme (the VENI-VIDI-VICI grants) is a good example. Young researchers are given the chance to set out their own lines of research and to continue the research programmes by taking on other researchers and setting up research groups. The extent to which scope is created for multidisciplinary research should be a point of attention in the evaluation of the incentive scheme.

Options are needed at every stage …

The Council wishes to emphasise that researchers should be encouraged to broaden their careers at every stage. This is the joint responsibility of the universities, the NWO and the KNAW.

… for increasing the multidisciplinary nature of scientific careers

Below are a number of concrete options for career broadening, some of which were inspired by examples outside the Netherlands (for more details, see the explanatory notes to this report):

- Grants for cooperation between researchers from different disciplines with the aim of developing new ideas or new avenues of research (for example, the discipline-hopping awards in the UK).
- Research grants for a limited period (e.g. one year) to facilitate knowledge transfer from one discipline to the other (for example, postdoctoral mobility in the UK).
- Promoting career movements between organisations (for example, scientists to policy development or the business community, and vice versa). At the European level, opportunities to that effect are offered in the Sixth Framework Programme within the context of the Marie Curie actions on mobility, training, knowledge transfer and excellence recognition. Programmes of this kind have so far only involved exchanges between countries, but they can also be set up at the national level.
- Establishing funds for 'adventurous multidisciplinary research'. The UK has set up an 'adventurous fund' which challenges individual researchers and research groups to break new ground by applying existing techniques to entirely new disciplines, by defying research conventions, etc. An important element is that a negative outcome is not regarded as a 'failure', as research of this kind is more susceptible by nature to negative results.

Improve the image of multidisciplinary research

The image of multidisciplinary research needs to be improved

Many researchers consider multidisciplinary research to be secondrate. The Council believes the low status of this type of research is unjustified. Steps need to be taken to improve the image of multidisciplinary research. The Council makes the following suggestions, primarily for the benefit of the research institutes themselves:

- Give leading researchers the scope to develop multidisciplinary initiatives. Talent attracts talent: their commitment will have a magnetic effect.
- Involve leading scientists in the execution of multidisciplinary research. This can be accomplished by setting up scientific advisory boards and appointing leading scientists as members. Their high standing will reflect on the project or programme.
- Get highlevel commitment for thematic research. In Switzerland, a multidisciplinary project in the area of global sustainability was able to attract leading researchers only after the governors of MIT, ETH/Zurich and Tokyo University committed themselves to the project (see explanatory notes on Switzerland).

2.2.3. Promote interaction and meetings

Meetings and interaction are crucial

Interaction and meetings are crucial if multidisciplinary research is to flourish. It is important for scientists to develop ties amongst themselves, but it is equally important to facilitate interaction between scientists and policymakers, representatives of social groups and members of the business community.

Meetings can be organised in several ways, during education, in the research programming phase, or in the execution phase. New perspectives may also emerge from informal meetings, which could result in the broadening of a project or in new lines of research.

The Council makes the following recommendations:

Organise the establishment of horizontal associations (meeting places)

Establish meeting places within universities…

In order to promote multidisciplinary research, universities need to actively establish meeting places. This is not a new idea. The Interfaculty Research Centres of Delft University (DIOCs),[4] the spearhead institutes and interfaculty research institutes of Twente University[5], and the matrixlike thematic structures at various other universities, including, for example, the Institute for Logic, Language and Computation (ILLC) at the University of Amsterdam[6] are ongoing initiatives to promote interaction among researchers from different disciplines. Initiatives to that end must be actively promoted. The boards of governors can play a pioneering role together with the deans and directors of university research centres and institutes.

… and, as needed, temporary independent organisations

A furtherreaching method of organising horizontal associations is to establish temporary organisations around broad, (permanent) multidisciplinary themes, such as the model of the Leading Institutes of Technology (Dutch acronym: TTIs, Technologische Topinstituten) or that of the Regional Genomics Association (Regie-orgaan Genomic). The Council recommends setting up more independent, temporary organisations of this nature for other 'permanent' themes. A point of attention in this respect is that disciplines should be involved across the entire breadth of the themes (i.e. the sciences, the humanities and the social sciences, if necessary). Once researchers from the different disciplines have found

4 For more information, see www.tudelft.nl
5 For more information, see www.utwente.nl
6 For more information, see www.illc.uva.nl

each other and cooperation ties are firmly rooted, the temporary organisation can be terminated.

Plea for Leading Institutes for the Social Sciences in addition to Leading Institutes for Technology

Establish leading institutes for social issues

TTIs currently focus on cooperative relationships between research institutes and the business community, and their objective is innovation. The 'leading institutions' model is also potentially very suitable for research into social issues.

In line with the foregoing recommendation, the Council advocates the establishment of Leading Institutes for the Social Sciences (Dutch acronym: MTIs, Maatschappelijke Topinstituten). Suitable subjects of study for MTIs include education, health, safety, ageing and mobility. These are topics which cover the spectrum of government priorities and require support from a broad knowledge base. The Minister of Education, Culture and Science has a coordinating role in this respect. MTIs bring the lines of 'major inspirational goals' and 'meeting places' together. It is important to organise an institute of this kind around a question or theme rather than around an area of technology, as is usually the case with the TTIs. An added positive effect is that, due to the consortium approach, MTIs are in keeping with the European Research Area.

Facilitate encounters in education

In an earlier advice report[7], the Council stated that researchers should be sensitive to contributions from other disciplines and should be capable of communicating with people from other fields in order to combine and integrate knowledge from different fields. Members of the academic community can at the very least be expected to 'learn to speak their neighbours' language'. This applies not only to students who attend university with the intention of seeking a career in society later, but also to future researchers. In short, it is very important to organise encounters and interaction with other disciplines for students.

Introducing students to other disciplines…

The Council finds that the new Bachelor-Master structure offers good opportunities for effecting the necessary broadening of study programmes. It calls upon the university boards of governors to ensure that programmes are given sufficient breadth. Now is the time for renewal.

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7 See AWT advice report 29: *Wisselwerking tussen 'zachte' en 'harde'kennis; benutting van alfa en gamma-kennis in van oudsher beta-dominante sectoren* (Interaction between 'soft' and 'hard' knowledge; use of humanities and social sciences in traditionally science-dominated sectors).

... does not mean sacrificing academic depth

The Council also believes that broadening university education is not necessarily detrimental to academic depth. There should be scope for both monodisciplinary and multidisciplinary programmes. Not all study programmes fit the same mould.

Increase interaction between non-university thematic research institutes and universities

The flows of knowledge between universities and non-university research institutes is essential

Knowledge developed at universities often feeds research carried out in thematic non-university institutes, where multidisciplinary research appears to flourish more readily. It is essential to facilitate the flow of knowledge between universities to these institutes. Research and education will benefit in terms of quality if these parties maintain good relations. Below are several examples of measures that could be taken to achieve just that:

- More part-time appointments for researchers and professors who work at both an institute and a university. This is not at all unusual in the United States, where as a result the multidisciplinary approach has an obvious impact on the organisation of research at the universities.
- Incentives for nonuniversity research institutes and universities that wish to set up joint research programmes (e.g. the UK institutional bridging awards described in the explanatory notes to this report). This would enable research institutes to strengthen their relationships with universities, in part by appointing doctoral students and trainees.

Strengthen networking and interaction between universities and the outside world[8]

Build up human and social capital in personal networks

Personal contact strengthens interaction and networking between universities and the outside world. Both human capital (content broadening) and social capital (collaborative ties) are built up through personal interaction. This involves interaction with the government and civil society as well as with businesses. There are various ways of shaping interaction, for example:

- part-time professors: the number of professors working part-time for governmental agencies and social organisations should be increased significantly.
- secondment (full or part-time) of researchers to companies, public authorities and institutes, and of their staff to universities.

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8 This recommendation touches on a much broader issue of interaction and knowledge flows between universities, research institutes, businesses and civil society organisations. In this report, the Council restricts itself to a single recommendation that is directly relevant to multid-isciplinary research. In subsequent reports the Council intends to address the theme of interac-tion in a broader context.

- forums on specific themes that have both an internal and an external scientific focus (e.g. ProClim in Switzerland; for more details see the explanatory notes to this report).

2.2.4 Set challenging goals

Cooperation can be successful only if the participants have a shared, challenging goal, question or ambition. This section contains recommendations that will aid in the effective development of inspiring goals, questions and ambitions.

Direct the articulation of research questions to ensure they are truly comprehensive

Many of the current social and scientific issues are highly complex. Multiple perspectives and disciplines are needed to deal with all the elements of these issues. Such a broad approach starts with an accurate, comprehensive and integrated formulation of the research question, whereby problems are not chopped up and dealt with in fragments. Although several attempts have been made to find a comprehensive approach, difficulties arise time and again (see the box for an example).

Example: lack of a comprehensive research question regarding nutrition

Start with an accurate, comprehensive and integrated formulation of the question

The societal parties that require information on nutrition, such as public authorities (e.g. Ministries of Agriculture, Nature & Food Quality; Health, Welfare and Sport; and Economic Affairs) and the business community (e.g. the food and agriculture industries) operate in separate compartments. Consequently, they pose diverse, and frequently shortterm, research questions instead of comprehensive questions that require more indepth knowledge and insight from various disciplines. For example, the recent food crises were interpreted differently by different parties: i.e. as agricultural or health and hygiene problems, as international trade policy issues, as technological challenges or as legal issues. Likewise food-related health problems are variously categorised as issues of socio-economics, public information, nutritional technology or genetics. As a result research groups are sent in diverse directions due to the array of 'problem owners'.

Provide external management

(Source: AWT advisory letter *Onderzoek naar Voeding - voeding aan onderzoek* (Research on Food - Food for Research), May 2003)

The Council therefore advocates an approach that facilitates the development of integrated questions. The parties involved should seek each other out at an early stage and formulate the key question together. Especially in the case of social issues, such interaction between the parties will almost inevitably need to be managed externally. Knowledge consumers, such as government ministries and companies can take the initiative to bring parties together. Of course, scientists can initiate meetings themselves. The objective is for all the relevant parties to get round the table. Selfinterest and subinterests should be subordinate to the accurate definition of the broad, central issue. Which parties should be involved depends on the subject. The key is to keep the question as broad as possible from the start and not to seek 'solutions' too soon, as this will only block perspectives and in practice draw attention away from humanities and social science aspects.

... and don't seek solutions to soon

Several alternatives for developing more comprehensive research questions

The Council suggests the following alternatives for developing comprehensive research questions:

- Broad, important subjects can be handled by organising sandpit meetings: a brainstorming session of several days in which various parties get together to deepen new research questions and to invent new initiatives and research proposals (see also explanatory notes UK). Ideally, the participants should represent the entire research cycle: monodisciplinary and multidisciplinary researchers, representatives of social organisations and the business community, et cetera. Obviously, funding and time need to be earmarked for this, and the willingness to actually carry out sound initiatives and usable research proposals should be expressed in advance. A large sum of money should be available for that purpose.
- Work towards a structural dialogue in a range of areas. Scientists and those in the field can give each other insight into the major themes that engage them. Personal interaction (e.g. double appointments or mobility) can be an important stimulus.
- Get a wide range of parties involved, but ensure that each subject is clearly directed and managed under the responsibility of a single actor. This calls for a thematic approach under the guidance of a strong facilitator.
- Make a separate budget available for the phase for developing the comprehensive research question and programming. A good start is of such importance that this activity cannot be done 'between times'. It is a good idea to keep the programming budget separate from the programme funding that may be allocated later (perhaps even to other researchers) for actually carrying out the research.

- Incorporate compulsory mechanisms into the funding conditions that will ensure that comprehensive research questions are actually formulated and maintained.
- Train policy workers to develop comprehensive research questions. Too little use is made of expertise in this area; this activity is often delegated to juniors.
- Delegate the 'scouting function' to specific parties, depending on the sector or issue. The point of the matter is to organise early detection of issues. ProClim in Switzerland is an example of this (see explanatory notes on Switzerland).
- Promote initiatives for establishing 'user committees' for research projects. Extensive interaction between practice and science makes it easier to formulate questions broadly, establish themes and involve practical expertise in research. An example at the programming level is the establishment of a committee of interested parties and/or social advisory councils. These groups need to have a strong and independent position in relation to the research programming.

Increase the share of thematic support to attract scientists

Put more money into multiarea research themes and increase the share of thematic research

Funding intermediaries such as the NWO, as well as the boards of governors of universities, have a powerful tool at their disposal: funding. If they increase the share of thematic funding, the Council believes that multidisciplinary research will become more attractive to scientists. As stated above, it is desirable for universities to generate more horizontal, thematic associations. The Council makes the following recommendations, specifically to the NWO:

- The Council believes it is desirable for the NWO to accentuate the horizontal, thematic lines across the (disciplinebased) area boards. The Council finds that the current division of broad area boards is an improvement on the earlier structure developed in the midnineties. It greatly appreciates the multiarea theme approach in the NWO's current strategic plan. The council encourages the NWO to continue along this path in the future.
- Create a clear front-office function for societal issues. Government ministries and other requesting parties are not interested in and do not need to be confronted with the internal organisation of the NWO back office (in this case, the areabased structure). The NWO could profile it-self as an organisation that wants to and can work in a problembased, demand-oriented way and is capable of involving the right research groups.
- In the execution phase, the NWO needs to monitor this socially oriented research in order to ensure that the work being done meets the broad, multidisciplinary

objectives that were formulated.

- The knowledge and networks produced by a research programme must take root after the programme is finished. Embedment needs to be included in policy.
- For all of this to have the desired effect, the NWO policy will need to undergo thorough periodic evaluations, and interim adjustments will be made as necessary. This is, after all, a work in progress.

2.3 Conclusion

The Council has focused this report on creating opportunities to further the growth of multidisciplinary research. The Council consciously chose not to make a thorough analysis of the bottlenecks, but did not ignore the fact of their existence either. Inspired by examples from other countries, it has drawn up a long list of recommendations and suggestions. The Council is convinced that each of the measures can help multidisciplinary research to flourish. However, this report is not intended to be exhaustive. Within the three main lines of action, other measures than those mentioned could make an equally valuable contribution to the growth of multidisciplinary research: many roads lead to Rome. The Council hopes, therefore, that this report will inspire scientists and policymakers to develop their own initiatives to promote multidisciplinary research.

The Council hopes to inspire scientists and policymakers to develop their own initiatives

The Hague, 11 September 2003

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