TECHNOPOLIS

RCN in the Public Understanding of Science

Background report no 9 in the evaluation of the Research Council of Norway

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Synthesis report
Erik Arnold, Stefan Kuhlman and Barend van der Meulen, **A Singular Council? Evaluation of the Research Council of Norway**, Brighton: Technopolis, 2001

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RCN in the Public Understanding of Science

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Summary

This paper presents a discussion of current issues in public understanding of science and compares policies and practices for six selected countries with those of Norway, and RCN in particular. The six countries were chosen because of their reputation for progressive policies on science communication.

We found that in both concept and practice, the term 'public understanding of science' varies from country to country, both within Europe and most noticeably between Europe and the USA. The concept of public understanding of science is very context specific, and is dependent on the policy background and priorities in the country concerned.

In many areas in Europe, there has been a strong swing away from the model of 'educating the public', which had assumed public acceptance of research and technological development would increase with greater understanding of the science and engineering principles involved, towards a democratic model which includes the public in decision-making about science. Indeed this so-called 'deficit model' is now so condemned in some countries that the term public understanding of science is politically incorrect, and practitioners prefer the term 'science communication' or 'science and society'. This is particularly noticeable in the UK and in Denmark.

Norway, has much in common with the UK and Denmark in that its citizens have a high level of scientific literacy, but are relatively unenthusiastic about the potential implications of advances in science and technology. This so-called 'information paradox' has profound implications for public understanding of science practice where the main purpose is to shore up public trust in science if the method used is essentially about providing the public with more information. Research has shown that the general public are really a multitude of publics with different attitudes, and the while the education model may be useful for those largely supportive of science and its aims, it is unlikely to reach out to many others.

For science communicators in the UK and in Denmark, the activity is about dialogue. It is argued that people's knowledge, experience and values can provide valuable insights, both in terms of framing issues and questions, and in assessing and evaluating solutions. Without such public involvement, decision-makers operate with incomplete information. In addition, the process of engagement is said to depolarise a debate, bringing the parties on all sides out of their entrenched positions and creating an opportunity for a more reasoned discussion.

It is possible to identify general goals for public understanding of science activities in the different countries analysed here, but national policy differs markedly. The following points attempt to typify the policy focus of the six countries

- In Norway, a major focus is on dissemination of results of research, seeking to legitimise scientific research and addressing in particular a perceived lack of understanding by the general public of the importance of scientific research to the economy. The need to communicate was enshrined in a White Paper in 1992, and an RCN strategy for science communication exists to co-ordinate activities
- Denmark's science communication emphasises engagement with the public, reflecting a strong voting culture and a highly literate population that demands consensus in decision-making
- In France, the focus is on science as part of general citizenship and a belief that scientific literacy is an integral component of national culture
- The Netherlands has a broad-based policy on science communication, covering citizenship and culture, public debate on social issues and the economy. The Netherlands invests in PUS at a much higher rate than most EU member states
- Science communication in the UK continues to be dominated by the scientific establishment's concern to secure public trust in science, which has been rocked by a succession of food scandals during the 1980s and 1990s. In addition, the last two government science White Papers have encouraged the scientific community to increase outreach activities for wider economic reasons (the new economy) and to experiment with methods to capture public opinion and use it in decision-making
- The US focuses on scientific literacy. This reflects a concern about future competitiveness of the US due to poor scientific competence (on various international benchmarks) amongst the public and school children in particular. The US has also, hitherto, not had to face the same crisis of public trust in science and its regulation which has plagued most countries in Europe in the last decade. The US has a more open system of government and advisory systems than most European countries and much scientific information is made publicly available by virtue of the transparency laws.

It is extremely difficult to get an accurate picture of the total money spent by the various countries on science communication. Figures tend to under-represent PUS activity in that much of the work is hidden in staff costs, training budgets and general communication which is carried out by scientific administrators, PR staff and scientists as part of their jobs. The Netherlands is generally recognised as the world leader in terms of best practice for public understanding of science. Overall responsibility for co-ordinating science communication activities is given to Weten, whose budget is three times more than that of the RCN at Euro 1.5million. The total figure in the Netherlands is likely to be at least Euro 6 - 8million.

RCN work on public understanding and dissemination of science is at the level of good international practice. RCN has made good progress in achieving the goals it set out in its strategy for science communications in 1996 and now runs a number of very successful schemes, including *Nysgjerrigper* and the National Research Week. The commitment and involvement of all Divisions at the RCN in the new national website, *forskning.no* is very encouraging. *Nysgjerrigper* and the National Science week both appear extremely successful. *Nysgjerrigper* has successfully broadened a narrow elite competition to an inclusive club with over 100,000 members. The Norwegian National Science 'week' is longer and more wide-ranging than most in other European countries.

Involvement of the public in priority setting and the direction of future scientific research is, however, lower than would be expected when compared with the UK or Denmark, which have a similar profile in terms of scientific literacy but scepticism of science. Science communication also tends to be rather traditional in form and content in Norway (ie largely lectures, television programmes and press articles) and researchers tend to prefer to meet the public in the safety of their own institutions rather than in public arenas. While the new Norwegian Board of Technology is an office of technology assessment whose primary customer is the parliament, its use of lay and expert consultations on technology may over time contribute to increased understanding and debate about science.

Our recommendations are as follows

- In Norway, where citizens display the classic information paradox, merely providing more information is unlikely to address the issue of public mistrust. Greater involvement of the public in debating science and setting priorities is likely to be helpful in increasing the public's sense of the accountability of science and scientists. Lessons can be learnt by studying examples of consultation methods in Denmark or the UK's research councils
- A central flexible and responsive pot of funding similar to the UK's COPUS grants scheme would facilitate more diverse activities in public understanding of science in Norway and prevent the over-dependence on traditional methods
- Norway is not alone in finding that the lack of reward for individual scientific researchers is a disincentive for them to be involved in science communication. Writing in the requirement for dissemination of results into grant proposals will help to solve this. However, there will also need to be a greater commitment from institutions themselves to release scientists from their day-to-day duties and an incentive to do so

Public understanding of science

Contents

1 Introduction

This paper presents a discussion of current issues in public understanding of science and compares policies and practices for selected countries with those of Norway and RCN in particular.

The analysis is based on a review of literature on the subject and selected interviews with people responsible for science communication in the relevant science ministries and learned societies.

We have used a very broad definition of public understanding of science that encompasses science communication, aspects of education, dissemination of research results (*forskningsformidling*) and dialogue with the public and stakeholders.

1.1 Evolution of policy thinking

In the past two decades, there has been an evolution in both policies and practices associated with the concept of Public Understanding of Science (PUS).

Policy thinking has evolved against the backdrop of a more general trend towards a notion of science as a social activity that should be defined in part at least through public debate. Policy makers talk openly of a loss of public confidence in science and science regulatory systems debased further by a seemingly endless succession of public health crises and food scandals. Many also feel uneasy about the implications of scientific advances in certain areas of biotechnology or information technology. A UK survey in 1996 commissioned by the OST and the Nuffield Foundation found that public interest in science was strong[1]. At the same time, they found that general attitudes towards science and technology had become more ambivalent compared with the last time that similar measures were made in 1988. This picture appears to be mirrored across Europe. Greater awareness – derived from an aggressively free press and global media – combined with unease about change has fuelled the emergence of a more critical perspective amongst the public about science.

The public is also less deferential in general to national authorities and institutions[2]. The political climate in Europe now places transparency and accountability at a much higher premium, and the atmosphere of greater accountability is reflected in science funding and in the use of science advice in policy-making.

The other force for change in this context relates to a changing understanding among policy makers of the relationship between science and the economy. The knowledge economy or the new economy has placed a premium upon technological literacy as both a direct spur to innovation and as a platform for the critical appraisal of know-how and technology sourced from around the world.[3]

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[1] Durant, Evans and Thomas, public understanding of science, *Nature* 340 1989; Durant and Bauer, *Public understanding of science in Britain*, report to the OST, 1997

[2] EC. *Science society and the citizen in Europe*. 2000

[3] The International Institute for Management Development (IMD) in Lausanne, Switzerland publishes its World Competitiveness Yearbook. The competitiveness ranking is based on

1.2 What is public understanding of science?

The concept and practice of the term 'public understanding of science' varies from country to country, both within Europe and between Europe and the USA, with some countries concentrating on science education, and others dialogue. For many funding agencies, in addition to traditional public understanding of science activities, dissemination of the results of research has taken on a greater importance. This activity to some extent overlaps with the concepts of science communication, but is often treated separately. In this report we will include dissemination of research results and consider it within a much broader definition of science communication.

In many areas in Europe, there has been a strong swing away from the model of 'educating the public', which had assumed public acceptance of research and technological development would increase with greater understanding of the science and engineering principles involved[4]. Indeed this so-called 'deficit model' is now so condemned in some countries that the term public understanding of science is politically incorrect, and practitioners prefer the term 'science communication' or 'science and society'. Interestingly, we see that an improvement in scientific literacy is often not associated with an increase in public trust in science, but rather a greater scepticism – the so-called 'information paradox'. This will be discussed later in chapter 2 and in the country reports in the Appendices.

The UK's House of Lords Report, Science and Society, argued that the 'deficit model' should be replaced by a 'democratic engagement model' – engaging the public in a dialogue, and involving them in priority setting and regulation of science itself. This change in tone is particularly apparent in controversial areas of science such as biotechnology. The UK for example, has set up a variety of overarching commissions to advise on implication of genetics, for food, for the environment and for medicine. All these commissions now incorporate consultation within their brief. In Denmark, as will be discussed later, such consultation methods have been commonplace for longer.

In the UK, where there has been a great deal of discussion on the role of science communicators, the definition of 'science communication' preferred by those working within institutions practising it is

> '…working towards finding ways of fostering public outreach from the scientific community by building bridges between science and its stakeholders. Science communication is about dealing with science and issues of social responsibility and citizenship. It is distinct from promoting science, be it through PR, education, infotainment, or encouraging more people to take up science as a career.'[5]

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aggregated performance across a large number of criteria, from economic growth to entrepreneurialism. Those criteria include a number of 'PUS' indicators such as the proportion of scientists in the labour force and the scientific literacy of the general public

4 Royal Society. Bodmer report: *Public understanding of science*. 1985.

5 Natasha Martineu, COPUS Manager, Royal Society; speech to the British Association for the Advancement of Science, November 2001.

For science communicators in the UK and in Denmark, the activity is about dialogue. It is argued that people's knowledge, experience and values can provide valuable insights, both in terms of framing issues and questions, and in assessing and evaluating solutions.[6] Without such public involvement, decision-makers operate with incomplete information. In addition, the process of engagement is said to depolarise a debate, bringing the parties on all sides out of their entrenched positions and creating an opportunity for a more reasoned discussion.

In any discussion about public dialogue, however, two immediate questions arise. The first is 'who is the public?' and the second is 'what is the purpose of dialogue?'[7] There is no one homogenous public holding a set of consistent and coherent opinions, attitude and values, but rather multiple 'publics' holding a wide variety of divergent views that are highly dependent on individual, community and societal contexts.[8]

There is a recognition now, that in order to communicate with the public, we must define our audience more closely. A recent UK report assessed public attitudes to science and found a number of discrete groups within 'the public'.[9] It found that while the old model of 'providing people with information' may be appropriate for communicating with those generally supportive of the aims and objectives of science, it is unlikely to draw a wider range of people into debates about current science policy issues.

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6 For example, see Global Environmental Change Programme (1999). *The politics of GM food: risk, science and public trust*. Special briefing no 5. SPRU, University of Sussex.

7 Parliamentary Office of Science and Technology (POST). *Open Channels. Public dialogue in science and technology*. 2001

8 See for example, Irwin and Wynne (1996). *Misunderstanding science? The public reconstruction of science and technology*. Cambridge University Press; Smith and Wales (2000). Citizen's juries and deliberative democracy. *Political Studies* 48 1(2000) 51–65.

9 Wellcome/OST. Science and the public. *A review of science communication and public attitutes to science in Britain*. 2000

2 International comparison of PUS

2.1 National policies on science communication

Most OECD governments promote and financially support Public Understanding of Science activities for one or more of the following three broad reasons

- The flight from science – concerns about the difficulty of filling science courses at university for example, too few people continuing in science professionally
- Science as part of citizenship – the notion that it is important for the public to be able to participate in democratic debate about science and that they are unable to do so without a basic level of scientific literacy and awareness about science and its processes
- Acceptability of science – raising public awareness of science so that funding of scientific research is politically more desirable, and also so that certain types of scientific research (e.g., biotechnology) are acceptable.

Such concerns are also apparent at the European Commission, [10] where coordination of 'science weeks' across member states is being advocated as a means of raising awareness of science amongst young people in order to encourage more to continue science into higher education and beyond.

The drive for funders to communicate the results of research stems partly from the mission of the public sector research system, which policy-makers and scientific administrators have a responsibility to ensure the knowledge it generates, and its archives, are available to the public. This is also partly about valorisation, that is taxpayers sponsor research in order to derive social and economic benefits that would not accrue in the same degree were science and research left to the market. The public sector research system is engaged in the pursuit of socially desirable and beneficial activities.

Given the social goal of public science, it is desirable to involve society in debates about which science and what resources. Historically, this has been addressed through proxies – government and science funders – but with the revolution in information and the individuation of the democratic and political process, it is becoming both possible and desirable to engage the public directly, whilst avoiding direct democratisation of science, or grant funding by referendum[11].

In addition, some organisations see science communication in part as a vehicle for public relations (PR) about the organisation itself, for example, medical charities seeking funding will publicise the relevance of their research; research councils that may seek to raise public awareness of the relevance of their activities in order to

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[10] Busquin. *Towards a European research Area*. European Commission, 2000

[11] House of Lords. Science and Technology Select Committee. *Science and society.* 2000

safeguard public funding; companies may part fund public understanding of science exhibitions and lectures in order to legitimise their own work (e.g., a number of oil companies have been high profile investors of public understanding of science schemes in the UK).

2.2 Differing social contexts

The approach and motivation for undertaking science communication in the countries we looked at varied substantially according to the individual social context.

Surveys of public attitudes to science[12] suggest that people in some European countries – most notably Denmark, Norway and the UK – have a better understanding of scientific method than those in others; and that people in those countries display less unmitigated enthusiasm for science. In comparison, the National Science Foundation's Scientific Indicator reports[13] suggest that the public in the USA are relatively supportive of science, but relatively ignorant of scientific methods. This information paradox has profound implications for methods of public understanding of science. Clearly, simply providing the public with more information and better education will not necessarily improve levels of mistrust.

The different social contexts are reflected in national policies on science communication. In the USA, where institutional openness is enshrined in law and the public on the whole is more enthusiastic about new technologies, education is the prime focus. In Denmark, however, where the public is highly sceptical about science, public consultation is a highly developed art.

So, while it is possible to identify general goals for public understanding of science activities, national policy does differ markedly and as with most policy fields, it tends to be context specific. The following points attempt to typify the policy focus of the five countries considered here

- In Norway, a major focus is on dissemination of results of research, seeking to legitimise scientific research and addressing in particular a perceived lack of understanding by the general public of the importance of scientific research to the economy. The need to communicate was enshrined in a White Paper in 1992, and a national strategy for science communication exists to co-ordinate activities.
- Denmark's science communication emphasises engagement with the public, reflecting a strong voting culture and a highly literate population that demands consensus in decision-making
- In France, the focus is on science as part of general citizenship and a belief that scientific literacy is an integral component of national culture
- The Netherlands has a broad-based policy on science communication, covering citizenship and culture, public debate on social issues and the economy. The Netherlands invests in PUS at a much higher rate than most EU member states

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12 1992 Eurobarometer Survey; 1996 Eurobarometer Survey; OSB Omnibus March 1999.

13 NSF. *Scientific Indicators*. This report is published each year. The most recent report in 2000 is available from their website www.nsf.org

- Science communication in the UK continues to be dominated by the scientific establishment's concern to secure public trust in science, which has been rocked by a succession of food scandals during the 1980s and 1990s. In addition, the last two government science White Papers have encouraged the scientific community to increase outreach activities for wider economic reasons (the new economy) and to experiment with methods to capture public opinion and use it in decision-making
- The US focuses on scientific literacy. This reflects a concern about future competitiveness of the US due to poor scientific competence (on various international benchmarks) amongst the public and school children in particular. The US has also, hitherto, not had to face the same crisis of public trust in science and its regulation which has plagued most countries in Europe in the last decade. The US has a more open system of government and advisory systems than most European countries and much scientific information is made publicly available by virtue of the transparency laws.

2.3 Organisation of public understanding of science

Science communication encompasses organisations which actively communicate science, as well as those whose primary role in this area is to facilitate others to communicate science, with many organisations straddling both classifications. Actors include science funders, researchers themselves, institutions representing science and the interests of science as well as specialised centres or exhibitions set-up to solely to communicate science. The audience for the different activities is also manifold and often dissimilar. It includes children (and teachers and parents), the general (interested) public, the media, policy-makers.

Large numbers of scientific organisations and scientists are engaged in science communication, pursuing a broad agenda through hundreds of discrete initiatives. This is positive in that a distributed approach complements the diverse requirements of the audiences involved and their varied situations (basic scientific knowledge, motivation for engagement, location, etc). But some commentators argue that variety is not the result of a conscious effort to segment demand and match it, but is rather accidental and confused[14]. Certainly, both the Dutch and the UK governments have made it a national priority to consolidate and coordinate the many disparate activities to increase the quality, consistency and relevance.

Of the six countries considered here, the Netherlands is alone in having a national public agency dedicated to science communication. Denmark, France and the UK have central governmental bodies with responsibility for cross-departmental promotion and coordination of PUS activities. In Norway, this function is performed by the RCN. However, in these four countries primary responsibility for the implementation of PUS remains with the scientific community itself.

The UK and the US both have member-based organisations (facilitators) the sole purpose of which is to promote public understanding of science (the BA and the AAAS respectively).

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[14] Wellcome/OST. Science and the public. *A review of science communication and public attitudes to science in Britain*. 2000

France, The Netherlands, Norway and the UK have each published government White Papers, in the recent past, on science communication. In the Netherlands, the White Paper dealt solely with PUS, in the UK, Norway and France, the official documents covered PUS within a more general science policy document.

The majority of research councils and research organisations have dedicated science communication functions, which are increasing in scope and sophistication.

2.4 Budget

Science communication budgets are small by comparison with research expenditure generally and as such they are rarely separated out in the financial reports of the various funding organisations and institutes. The partial data that are available confirms that programme budgets will tend to be measured in tens of thousands of Euro rather than millions, with most national budgets amounting to perhaps a few million Euro in total.

It is extremely difficult to get an accurate picture of the total money spent by the various countries on science communication. Figures tend to under-represent PUS activity in that much of the work is required to be carried out by scientific administrators, PR staff and scientists as part of their jobs. In that sense, it is hidden in staff costs, training budgets and general communication.

The Netherlands is generally regarded as the world leader in terms of best practice for public understanding of science. Overall responsibility for coordinating science communication activities is given to Weten, whose budget is three times more than that of the RCN at ¤1.5million. However, other organisations also play active roles. These include the Rathenau Institute, specifically in contributing to debate about science, and its annual budget is around Euro 2million; and around 5% of KNAW's annual budget (Euro 35million) is devoted to public understanding of science (Euro1.75million). Hence the total figure in the Netherlands is likely to be over Euro 6 - 8million.

The example of the Netherlands, and the UK to a lesser extent would suggest that in the future we shall see an increase in dedicated organisations – with larger budgets – to facilitate the improved engagement of the public and scientific communities. Notwithstanding this tendency, there are other indications to suggest that there will be a parallel effort to increase the number of scientists that have a direct engagement with the public and other lay audiences. For example, it is now a condition of every research grant in the UK's Biology Research Council. Similarly the requirement to disseminate research results is written into the programme description for all new programmes at the RCN as of this year.

2.5 Public understanding of science activities

Given the nature of the PUS mission – and the size and diversity of the audience – it is not surprising to find that most countries can enumerate large numbers of PUS activities, albeit individually small actions.

The spread of activities across countries is quite diverse, but there are some strong patterns. All have a variety of science museums and exhibits. In the UK however, there has been considerable investment in new centres, with interactive science exhibitions now all over the country.

2.5.1 General science communication

The Denmark, France, Norway, the UK and the USA all run a national science week every year, incorporating exhibitions, TV programmes, special events etc. The UK government has sought to give a major, one-off boost to this promotional activity by calling 2001 a science year, involving such varied actors as schools, universities, government and the Royal Mail. Norway's Research Week is probably the most visible however, with banners in all towns across the country where activities take place.

There are numerous examples of PUS experiments in each of the case studies presented in the appendix, which may have resonance with Norway. These include

- Denmark's Experimentarium
- Denmark's Science Shop
- The Netherlands Science Centres
- The Netherlands' Technika 10
- The UK's COPUS programme
- The UK's AlphaGalileo science centre on the Internet

It is notable that despite the high visibility of Norway's science week and the extraordinary success of *Nysgjerrigper*, that the RCN lacks a central pot of funding to respond to specific projects in the science community to undertake projects in science communication. For example, the UK's COPUS grants support a many varied activities including theatre, exhibitions, videos, promoting diversity and originality.

Interactive science centres are an important feature of science communication in the UK, Denmark, the USA in particular, but although such centres do exist in Norway they are on a much smaller scale.

2.5.2 Science and public debate

All countries in Europe are struggling with the notion of involving the public in decision-making about science. In Europe this has lead to selective consultation. In the US on the other hand, which has a more open governmental structure and a greater level of public trust, transparency takes a higher priority. Denmark has a highly advanced and specialised system of consultation and involving the public in debate about science. The UK is rather further behind, but attempting to open up many of its committees to public scrutiny. Although Norway is similar to both the UK and Denmark, in terms of having a highly scientifically literate population, which is nevertheless sceptical about some aspects of science, activity to promote public debate about science appears less advanced.

2.5.3 Science in education

US educational programmes are promoting a new approach to science teaching, which revolves around scientific processes and methods, with less emphasis on scientific facts.[15] Other countries have also sought to move away from teaching about facts and figures, but have rather sought to place scientific knowledge in school teaching within a context of science as part of culture. This is particularly apparent in the UK, where science will be taught in the new citizenship lessons, as part of a general course on democracy. The UK also now insists on children studying a core component of science up until they are 16 in an effort to increase general literacy levels.

The Norwegian scheme, *Nysgjerrigper* is of relevance here. This successful scheme is aimed at school children up to 14. What began as a rather exclusive competition to find the smartest/most inventive child has been broadened by the RCN to become a club which includes teaching materials and publications. They have seen the scheme grow from fewer than 20,000 members in 1997 to over 100,000 members by May 2000.

2.6 The specific role of Research Councils

Research Councils in the UK are taking an active role in science communication. Their focus is mainly on opening dialogue. For example, BBSRC are investing in research into a new tool for engaging the public and capturing views so that stakeholders can help to shape further research. Consultation on direction of research is now more commonplace – the work primarily about ensuring that scientists have 'a licence to operate'. BBSRC also routinely ask grant holders to undertake some form of science communication about their work. The request is for two days only, and most spend it in schools. The requirement appears to be largely tokenist thus far and is not monitored for impact.

The UK's MRC is also working on projects to involve communities around its research institutes in discussion about science on a very local level – involving local councillors, local people, businesses and schools in debating issues such as animal experimentation.

Dissemination of research results in UK research councils is relatively diverse, mostly centring on exhibitions at science fairs, as well as annual reports and the Council's own website.

In the US, the closest counterpart to the UK research councils or to the RCN is the NSF. Along with other American activities in this area, the focus is very much on education, and education of young people in particular. One interesting project is a competition called the *Innovation generation*, where young people are encouraged to invent and think about ways in which science can be used to help the community

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[15] As with any exercise in communication, there are tensions about what, why and how to communicate with the public. A desire to communicate 'facts' about science can conflict with the need to communicate how the scientific process works. The former aims to provide concise and unequivocal information, while the latter will tend to reveal the uncertainty and complexity that characterises scientific method. Greater understanding of the limits to science and the scientific process are necessary for us to grasp how accepted theories can be overturned by human endeavour or empirical evidence.

around them. It fosters both an innovation culture and a sense of community, as well as ensuring that science is firmly grounded in relevance.

In the Netherlands, although the NWO funds exhibitions and public lectures, the main activity of its communication department is in dissemination of its own research results. This is primarily via the media, and in particular via specialist media. However, it also published posters of NWO-funded work for use in schools.

France has no direct counterpart to the RCN. The closest relative is CNRS. Its work in this area comprises, exhibitions, work specifically with young people media relations, and the web. In terms of dissemination, the CNRS publishes a scientific magazine "CNRS Info" to inform science journalists. The CNRS also has an Ethical Committee for Sciences.

The prime focus of the RCN is in dissemination of research results. In this regard its activities are highly advanced – the requirement to disseminate is written into all programmes, there is considerable buy in from all the various divisions of RCN that communication is a good thing and it operates a number of exciting and high profile projects. However, involvement of the public in debate about the implications of science is weaker, in comparison with countries with similar attitudes and levels of scientific literacy.

2.7 Statistics

There are few internationally comparable data that provide a ready made measure of national differences (and rates of progress) with regard to the public understanding of science. Most governments content themselves with monitoring trends in human resource indicators relating to science and technology, such as the proportion of scientists and engineers in the labour force or the proportion of scientists within the total population of graduates and post-graduates.

2.8 The effectiveness of PUS

Government's growing interest in science communication is not supported in any direct sense by evident trends in scientific literacy nor indeed is it driven by the demonstrated success of past schemes. At present, it is largely based in faith, faith in the relationship between strong science and the new economy. A recent survey of science communication attitudes in the UK[16] found that while science communicators rated the importance of evaluation very highly, in practice, few science communication activities in the UK are evaluated in depth, owing to scarce resources. COPUS (see the UK country report) itself encourages science communicators to evaluate their activities[17]. Any evaluation of effectiveness tends to be measured by the organisations themselves on the basis of, for example, numbers involved (e.g., popularity in terms of attendance at a meeting or exhibition), the extent of any media coverage, or solicited feedback in the form of questionnaires from participants.

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16 Wellcome/OST. Science and the public. *A review of science communication and public attitudes to science in Britain*. 2000

17 COPUS: *So did it work?* London: Royal Society, 1998.

A number of surveys have been conducted on public attitudes to science[18]. One such study mentioned earlier reported that the public were becoming more sceptical of science over a ten year period from the late 80s. Another more recent survey compared levels of trust in scientists over a five year period and found attitudes to be relatively static, with a rise of just 2% from 63 to 65% of respondents in a questionnaire stating that they would trust scientists to tell the truth. It will be interesting to note any trends in attitudes over the longer-term as practice by science communicators changes towards a more inclusive dialogue based model.

[18] E.g., MORI, on behalf of the BAAS. *Trust in scientists*. August 2001

3 Public understanding of science in Norway

3.1 National policy

Norway, along with Denmark and the UK appear to exemplify the so-called knowledge paradox: levels of knowledge about science are high in Norway but the public is sceptical about the benefits and safety of advances in science. [19]

The problem of 'flight from science' is comparatively recent and is caused by the small cadre size: a falling birth rate compounded by an expansion in the 'soft' subjects in the higher education sector has lead to increased competition between higher education courses for a smaller number of students.

Norway's commodity-based economy needs to become more knowledge-intensive. Consequently there is awareness that there needs to be a policy which encourages more people to pursue scientific research as a career.

The 1992 White Paper, which set out the need to merge the research councils, also called for a national strategy to be developed on research communication. RCN developed such a strategy, as an extension of its overall 'Research for the Future' (*Forskning for Framtiden*) strategy of 1996.

3.2 Major actors

The initiatives to promote PUS are large in number, but weakly coordinated. Apart from the national strategy, the initiatives are in a large part dependent upon the separate institutions own initiative and resources. Most universities and research institutes engage in science communication and dissemination of research results via many different kinds of publications, websites, events, and press coverage. There also museums and a number of small science centres engaged in the communication of science. There are no reliable statistics on the total of science communication activities on a national level.

Institutional strategies for dissemination of research results to the general public have been adopted at a number of institutions (for example, Oslo, NTNU, University of Bergen and a few state-funded colleges).[20] The dissemination of research results in the Institute-sector is primarily directed towards the users of the applied research, rather than to the general public. However, the institutes also generally employ information officers who also engage in dissemination activities directed towards the general public.

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19 PUS-studies conducted in Norway in the 1990s (NSD Rapport 118) show that the Norwegian public in general harbours a more concerned attitude on S&T and gene technology in particular compared with most other EU-countries. The Norwegian public is however in general better informed on S&T matters according to NIFU report 2/2000 measured with a battery of 21 knowledge items in the 1999 survey).

20 NIFU found in their publication *skriftserie nr* 15/2001, that the most scientifically reputable researchers are the ones who are most actively engaged in disseminating their knowledge to the general public.

The RCN developed a strategy in 1996, in response to the 1992 Government White Paper, which set out the following main goals for the public to have

- Access to, and interest in, the results of research, the opportunities they provide, knowledge of their limitations and the working methods involved
- A positive appreciation of the importance of research for democracy, the economy, welfare and culture.

Subsidiary goals were to generate

- Relevant common actions for disseminating research to the general public
- Understanding and interest in the value of research for its own sake
- Recognition of research-based knowledge and technology as important socio-economic drivers
- Acceptance of the contribution of research to the understanding of culture and identity
- A good, research-based foundation for a critical understanding of social relations

To achieve these goals, the RCN planned to

- Increase its overall effort in the dissemination of research to the general public
- Ensure that its own projects and programmes include an element of dissemination and public understanding
- Encourage all institutions receiving base funding to develop a dissemination strategy and to report this to RCN
- Monitor existing activities
- Take the initiative to launch a nationally co-ordinated electronic information system for research projects
- Establish arenas for researchers, the media, public research brokers and the general public to consider dissemination techniques

The council considered that research performers constitute the foundation of dissemination and public understanding of science and that they should develop appropriate strategies and ensure that project applications adequately take dissemination into account.

The Public Relations and Information Division has special responsibility for both the co-ordination and setting of priorities within the RCN and for national projects in public understanding of science activity at the RCN.

3.3 Activities

The RCN has initiated three activities on the national level

- *Nysgjerrigper*
- The National Research Week *Forskningsdagene*
- A new website aimed at the general public, *forskning.no* devoted to popular research and the transfer of science-based knowledge. This aims to present ongoing research and research results to the general public.

The three activities are organised as projects with their own staff.

Nysgjerrigper is a very popular club and competition for children in primary school which aims at increasing their understanding of science and technology, thus improving the recruitment to research Teachers use *Nysgjerrigper*-related material extensively in their work. The club has now 100,000 members and the annual budget is NOK 4 million (EUR 0.5 million).

Research Week is an annual festival involving many of the country's universities, colleges, institutes and companies. The objective of the Research Week is to promote interest in research, and help people appreciate its content, purpose and importance for Norway. Research week events may target special groups, but more often a general public. Lectures, debates, demonstrations, exhibitions, cultural events, even shows and fairs, comprise the program as the research institutions open their doors to the public. The annual budget for 2001 is NOK 2.5 million (EUR 0.3 million), and the money is allocated to various measures targeting schools and pupils, science centres, and the development of Web pages, TV programmes, videos and books. The programme started in year 2000 and will end in 2003. In general there are about 150 local organisers involved in some 850 individual events.

The Research Council is also involved in *Stiftelsen ungdom og forskning* (The Foundation for Youth and Science). Through this foundation – and in co-operation with *Forbundet Unge Forskere* (an independent youth-organisation for science-related activities) – it arranges the annual competition *Unge Forskere* (Young Scientists).

The Council's Science and Technology Division has implemented a programme (RENATE) aimed at increasing the interest for mathematics and natural science in all levels of the educational system.

The Council is also financing studies of public understanding of science and technology done by the Norwegian Institute for Studies in Research and Higher Education (NIFU).

Many of the other Divisions also have their own communication plans, which include the dissemination of research results. These activities are primarily aimed at potential users of research. The Science and Technology Division however, has a special programme for dissemination of research results and recruitment, which supports different activities with 2–3million NOK a year from 1996–2003.

Around 6–10 million NOK is contributed annually for the various projects in public understanding of science from the Public Relations and Information Division itself, with 1.5millionNOK additionally contributed annually by the other Divisions towards the running of the website *forskning.no*. These figures do not include the expenditure for dissemination of research activities, which are an integral part of the daily work of the Division.

There is a generally positive attitude from the different Divisions of the RCN towards PUS. All programmes as of this year must include a dissemination strategy. Within the Public Relations and Information Division, 14 person years are contributed to PUS in total. The time and staff allocation for the various activities breakdown as follows

- The National Science Week requires about 2 man-labour years (finances from the project's own budget). Total budget 3million NOK (activities and staff). Not counted here, of course, is the massive effort contributed by the participating institutions
- *Nysgjerrigper* calls upon approximately 1.6 man-labour years (again financed from the project's own budget) with a total budget of 4million NOK.
- *Forskning.no* is a national activity with its own staff of approximately 4 man-labour years and an annual budget of 4–5million NOK at the outset.

Exhibit 1shows the kinds of methods used by RCN to disseminate results of research.

Exhibit 1 Communication methods used by RCN in disseminating research results

Channels	RCN products
Web	forskningsradet.no Ekko (intranet) RCN contribution to the national website forskning,no
Media	Around 2500–3000 press clippings a year 10–20 comments/articles from the Council's management
Public events and meetings	National Research week
Publications	Foskning (monthly) *Nysgjerrigper* Tell Us (monthly in English) Annual report to policy-makers

There are scarce scientific documentation of the status for and impact of dissemination of research directed towards the public. In 1999, NIFU conducted a full-scale PUS-survey on contract from RCN[21]. Daily newspapers were found to be the most important sources of information for the public (newspapers are widely read

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21 First documented in the National Indicator Report of 1999, issued by the RCN

by the general public in Norway), however, the internet is expected to become a major information source on research in the future.

In addition to the main channels outlined in Exhibit 2, the Council also makes use of variety of more original methods in its work to disseminate results of research, such as

- Stand-up researchers in cafés and streets
- Ambulating buses, trains and boats
- Grants for journalists to stay (work/secondment) in a research institution
- Grants for researchers to work with a newspaper
- Prizes for excellent research dissemination

The RCN report making limited use of involvement of the public in priority setting and decision-making on funding.

One concern is that although many scientific researchers are willing to participate in dissemination of research results to the public (primarily out of good citizenship) they are not given any formal credit for their engagement in such activities. Science communication also tends to be rather traditional in form and content (e.g., largely lectures and press articles) and researchers tend to prefer to meet the public in the safety of their own institutions rather than in public arenas.

The Norwegian Board of Technology (*Teknologirådet*) was set up as an independent office for technology assessment by the Norwegian government in 1999. It has 12 members, appointed for 4 years, a 3 MNOK budget and a small secretariat, initially funded through RCN. It works at the interface of science and technology and aims to "further a human- and environmentally friendly technological development. The Board shall address technological challenges and the possibilities of new technology in all areas of society. It aims to stimulate public debate and to support the political opinion and decision-making processes." The Board reports to parliament. It started work in a significant sense during 2000, and has been involved in a number of lay and expert panel investigations in issues such as energy use and genetically modified foods.

Exhibit 2 and **Exhibit 3** list the activities used to communicate science: **Exhibit 2** lists the activities in Norway in general against the broad aims for PUS identified above. **Exhibit 3** lists the activities undertaken by the RCN against their own goals.

Exhibit 2 Kinds of activities used to communicate science

Purpose / Target	Inform, educate, entertain	Opinion forming, attitude change	Recruitment	Informing policy-making
Children, teachers. Parents etc	*Nysgjerrigper* *Unge Forskere*	National Research Week	*Nysgjerrigper* RENATE Recuitment programme (S&TD)	
General public	National Research Week *Forskning.no*	National Research Week *Forskning.no* Grants for scientists and journalists Stand up researchers Lectures Events Ambulating buses and trains etc		*Forskning.no*
Policy-makers		The Norwegian Board of Technology (*Teknologirådet*)		Annual report

From **Exhibit 3**, it would seem that the RCN has made good progress in achieving the goals it set out in the strategy in 1996.

Exhibit 3 List of action points from plan against activity carried out

Plan	Activities
Increase its overall effort in the dissemination of research to the general public	Secured new funding for dissemination/PUS from other RCN Divisions
Ensure that its own projects and programmes include an element of dissemination and public understanding	All new projects will include dissemination in project plan as of this year (2001)
Encourage all institutions receiving base funding to develop a dissemination strategy and to report this to RCN	Institutional strategies for dissemination of research directed towards the public has been adopted at a number of institutions (i.e. University of Oslo, NTNU, and University of Bergen and at a few state funded colleges
Monitor existing activities	Evaluations undertaken on Research Week activities annually, and *Nysgjerrigper* from time-to-time.
Take the initiative to launch a nationally co-ordinated electronic information system for research projects	A new national website *Forksning.no* aims to present ongoing research and research results to the general public
Establish arenas for researchers, the media, public research brokers and the general public to consider dissemination techniques	

4 Conclusions and Recommendations

The practice and policy of public understanding of science varies from one country to another, according to the social context in which it operates.

It is possible to identify general goals for public understanding of science activities in the different countries analysed here, but national policy differs markedly. The following points attempt to typify the policy focus of the six countries

- In Norway, a major focus is on dissemination of results of research, seeking to legitimise scientific research and addressing in particular a perceived lack of understanding by the general public of the importance of scientific research to the economy. The need to communicate was enshrined in a White Paper in 1992, and a national strategy for science communication exists to co-ordinate activities
- Denmark's science communication emphasises engagement with the public, reflecting a strong voting culture and a highly literate population that demands consensus in decision-making
- In France, the focus is on science as part of general citizenship and a belief that scientific literacy is an integral component of national culture
- The Netherlands has a broad-based policy on science communication, covering citizenship and culture, public debate on social issues and the economy. The Netherlands invests in PUS at a much higher rate than most EU member states
- Science communication in the UK continues to be dominated by the scientific establishment's concern to secure public trust in science, which has been rocked by a succession of food scandals during the 1980s and 1990s. In addition, the last two government science White Papers have encouraged the scientific community to increase outreach activities for wider economic reasons (the new economy) and to experiment with methods to capture public opinion and use it in decision-making
- The US focuses on scientific literacy. This reflects a concern about future competitiveness of the US due to poor scientific competence (on various international benchmarks) amongst the public and school children in particular. The US has also, hitherto, not had to face the same crisis of public trust in science and its regulation which has plagued most countries in Europe in the last decade. The US has a more open system of government and advisory systems than most European countries and much scientific information is made publicly available by virtue of the transparency laws.

Norway has a very proactive attitude towards the need to disseminate research results. Along with France, the UK and the Netherlands, it has published a White Paper, which included recommendations on public understanding of science.

The RCN has made good progress in achieving the goals it set out in the strategy in 1996 and now runs a number of very successful schemes, including *Nysgjerrigper* and the National Research Week , and the commitment and involvement of all Divisions at the RCN in the new national website, *forskning.no* is very encouraging.

Nysgjerrigper and the National Science week are both extremely successful. *Nysgjerrigper* has successfully in broadened a narrow elite competition to an inclusive club with over 10,000 members, and the Norwegian National Science weeks is longer than most others conducted in other European countries, and undoubtedly more visible.

It is extremely difficult to get an accurate picture of the total money spent by the various countries on science communication, as figures tend to under-represent PUS activity in that much of the work is hidden in staff costs, training budgets and general communication. The Netherlands who are the world leaders in this area appear to allocate at least Euro 6 - 8million annually to science communication.

Science communication in Norway tends to be rather traditional in form and content (eg largely lectures and press articles) and researchers tend to prefer to meet the public in the safety of their own institutions rather than in public arenas. However, the schemes they run compare well with those in other countries. For example, the National Science weeks are now conducted in most European countries, but Norway's national research week is longer than most, and is highly visible. *Nysgjerrigper* also deserves special mention.

Norway, has much in common with the UK and Denmark in that its citizens have a high level of scientific literacy, but are relatively unenthusiastic about the potential implications of advances in science and technology. This so-called 'information paradox' has profound implications for public understanding of science practice where the main purpose is to shore up public trust in science if the method used is essentially about providing the public with more information. Research has shown that the general public are really a multitude of publics with different attitudes, and the while the education model may be useful for those largely supportive of science and its aims, it is unlikely to reach out to many others.

For science communicators in the UK and in Denmark, the activity is about dialogue. It is argued that people's knowledge, experience and values can provide valuable insights, both in terms of framing issues and questions, and in assessing and evaluating solutions, as well as creating an opportunity for a more reasoned discussion. Involvement of the public in priority setting and funding of science is more advanced in the UK and Denmark, than in Norway. Greater involvement of the public in debating science and setting priorities, on the other hand, is likely to be helpful in increasing the public's sense of the accountability of science and scientists. The Norwegian Board of Technology may make a contribution here – it is too early to tell – but its activities are essentially critical, rather than contributing to research policy in an active sense. Lessons can be learnt by studying examples of consultation methods in Denmark or the UK's research councils.

Examples of good practice include The Danish Board of Technology whose stated objectives are to 'further the technology debate, assess technological impacts and options, and advise the Danish Parliament and Government'. The UK's research councils are also using a variety of innovative methods to involve the public and other stakeholders in debate. The MRC's use of local meetings involving local councillors, schools, businesses, universities and its own institutes is of particular note.

We recommend that there should be

- Greater involvement of the public in debating science and setting priorities is likely to be helpful in increasing the public's sense of the accountability of science and scientists. Lessons can be learnt by studying examples of consultation methods in Denmark or the UK's research councils
- A central flexible and responsive pot of funding would facilitate more diverse activities in public understanding of science in Norway and prevent the over-dependence on traditional methods
- Norway is not alone in finding that the lack of reward for individual scientific researchers is a disincentive for them to be involved in science communication. Writing in the requirement for dissemination of results into grant proposals will help to solve this, however, there will also need to be a greater commitment from institutions themselves to release scientists from their day-to-day duties and a reward for doing so.

Appendix A Public Understanding of Science in The Netherlands[22]

A.1 Policy on PUS

The Netherlands Government regards public communication on science as an integral part of its science and technology policy. It promotes and financially supports activities in this area for three reasons:

- The citizen's right to be informed about developments that may influence their everyday lives, or that may have implications of ethical concern.
- The need for a good infrastructure for education, scientific research and technological development as a basic requirement for retaining economic strength.
- The importance of science and technology as a vital aspect of national culture.

The Netherlands does not have a member-organisation such as the BA or the AAAS. The Weten Foundation for Public Communication on Science and Technology, however, operates similar functions, though different in origin and smaller in scale.

Universities, public scientific institutes, and private research based companies all have their own responsibilities in informing the public at large, and taking notice of public opinion. Most of these institutes provide public information (through the media) and organise public activities on a regular, though limited base.

In addition, there is a large number of private and public initiatives undertaken by intermediate organisations and individuals. These are of diverse nature. Some directed at promoting public support for science or technology, others at strengthening public influence. Some try to steer public opinion and behaviour, while others at provide information and entertainment in a leisure environment. A total of 1600 institutes and 3000 individuals are present in the field. A few hundred of these institutes are dedicated solely to public communication initiatives, others provide information as a side activity, or provide services of which aspects are of interest to the public. Financing of activities of most of these initiatives is of a mixed nature, comprising both public and private funds.

The Netherlands' situation is characterised by an abundance of private and public activities in public communication on science and technology, which provide the people in the Netherlands with information in many forms, and by different media. There is a strong push at present to improve the overall effectiveness of these manifold efforts by increasing the transparency and coherence of activities, and by improving professional standards of delivery. The government stimulates activities along three lines

[22] The material presented in this section was provided in large part by Weten, The Netherlands Foundation for Public Communication on Science and Technology.

- Enhancing Public Understanding of Science of citizens, the general public;
- Promoting Debate on socially relevant issues
- Improve the match of education and career choice to Labour Market requirements

In 2000, the Ministry of Education, Culture and Science (OCW), issued a new White Paper, formulated with the Ministry of Economic affairs (EZ) and the Ministry of Agriculture, Nature Management and Fisheries specifically to promote public understanding of, and support for, science and technology. The White Paper focuses on three main ambitions:

- Broaden reach of science communication through stronger media involvement;
- Greater emphasis within all PUS activities on the needs of young people;
- Increased coherence of manifold PUS initiatives.

The Netherlands Foundation for Communication on Science and Technology, Weten, will lead the implementation of this new policy.

A.2 Organisation of PUS

Foundation for Public Communication on Science and Technology (Weten)
The Weten Foundation is an independent organisation, funded by the central government with an annual budget of Euro 4.5 million. It stimulates national and regional activities in public communication on science and technology.

Weten organises the National Science Week, held October each year since 1986, including some 200 participating institutes, 400 activities, and 175.000 visitors. Weten, further provides institutes, science journalists, and others with professionals information and advice on science communication practice, and stimulates media training for scientists. Finally it provides financial support for initiatives with sufficient quality and public reach, that would otherwise not be realised.

In addition to its core activities, Weten has a budget to stimulate mass media programming on science and technology, and to increase regional collaboration between high schools, universities and research institutes to provide for more attractive careers in R&D for high school students.

The Rathenau Institute
Rathenau is a fairly small organisation that contributes to societal debate and political opinion forming on issues connected with technological and scientific developments. It organises public debates and studies, and reports conclusions and recommendations to the Netherlands Parliament. Its annual budget from the government is around Euro 2 million.

Axis
Axis is a temporary organisation for promoting vocational choice of young people for technical professions, by stimulating more attractive higher education in technology to better match young people's interests with market requirements and possibilities. It is a joint effort of government, private companies and educational institutes. Axis

organises a large number of projects and activities directed at, influencing vocational choice, improving attractive technical education schemes, and promoting interesting job opportunities. The 3-year budget for its activities comprises somewhat under Euro 20 million.

Universities and research institutes

Most research institutes nowadays provide the media with general information related to new research developments on a regular basis. A number of universities in addition organise public debates, lectures and courses for the general public on a regular basis. A large number of institutes participate in a national science week, held in the October every year.

Science shops are university initiatives that provide local public groups and organisations with research facilities, mostly being used by students. In addition to the science shops, most universities provide Transfer Points and Liaison Units to stimulate knowledge transfer activities with private companies.

At present, research institute activities in the field of public understanding of science in the Netherlands are focused on the natural sciences (70%), and the social and behavioural sciences (45%), and less on the humanities (34%), and life sciences (30%). The communication goals are: providing information (70%), education (70%), changing attitudes (30%), and behavioural change (20%). Target audiences for these initiatives are mainly the general public (grown-ups), or children, youngsters and students. Some organisations have very specific target groups, e.g. girls in the age of 8–15.

The Netherlands Organisation for Scientific Research, NWO

NWO is the major government sponsor of scientific research at Dutch universities and research institutes and seeks to raise the quality of that research. Innovation is a key element in this endeavour. To help it achieve these aims NWO receives funding of around ¤450 million from the government. Most of this funding comes from the Ministry of Education, Culture and Science (OCW), though other ministries also contribute. NWO targets all fields of research activity, from physics to theology and from information technology to research on ethnic minorities.

NWO has an active communications department whose main priority is to disseminate the results of research it funds. The main method for disseminating results is via the media – primarily via specialist media. They also issue posters of particular work from time-to-time, which are then distributed to schools. The objective is primarily to safeguard public opinion, and indeed that of policy-makers, to ensure continued funding.

NWO also runs other public understanding of science activities in collaboration with other organisations such as Weten, or organisations abroad such as the British Council. The most well-known event is the Christmas science quiz, for young people and adults, which is broadcast on television and attracts around a million viewers. pursues an active information policy aimed both at researchers and at the media, politicians and the public at large.   Other examples include a joint event with the British Council – scientists and the media, inviting well-known British and Dutch journalists as well as scientists to meet.

The Royal Netherlands Academy of Arts and Sciences (KNAW)
The Royal Netherlands Academy of Arts and Sciences advises the government on matters related to scientific research (councils and committees). It also judges the quality of scientific research (peer review, academy fellowship programme, accreditation committee for research schools in the Netherlands), and provides a forum for the scientific community and promoting international scientific co-operation (international contacts, congresses, funds and endowments). Finally it acts as an umbrella organisation for institutes engaged in basic and strategic research, scientific information services and biological collection management. KNAW obtains an annual budget of around Euro 35 million for its activities from the central government, though its science communication activities would amount to something less than 5% of this.

The activities of KNAW in science communication include a variety of events, public lectures and prizes for scientists for popularising science. KNAW has also runs an annual evening for 'science and society', which involves scientists, companies and politicians etc.

The following bullet points list a wide range of other actors and activities:

- *Science Centres* Science centres partly associated in The Netherlands Union of Science Centres (supported by Weten). Among these the larger of which include NeMo (Amsterdam), Naturalis, Ecodrome, Industrion, Museon and six others. The Science Centres provide the general public and schools with fascinating and playful exhibits and activities, which promote their appreciation of science and technology. The Centres together entertain 1.5 million visitors yearly.
- *Technika 10* Technika 10 organises technical clubs and courses especially for girls in the age of 8 – 15 years of age. At the clubs and courses the girls can get to grips with wood, metal, electronics and electricity, and others. The clubs and courses help girls develop their interest in technical matters, and encourage them to incorporate technology in their (future) choice of training and careers. Hundreds of group activities are now organised in all parts of the country, reaching some 10,000 girls each year in these courses and clubs. Technika 10 is a private initiative, partly subsidised by the government, via Weten.
- *Museums and Observatories* In the Netherlands a great number of smaller and larger historic, technical and natural *museums* provide information for the public on aspects of science and technology in an informal, leisure environment. This also holds for (astronomical) *space and weather observatories* open to the general public. Public libraries all over the country are a source of information for many people, especially families with younger children and the elderly. A number of local public libraries also organise additional activities on scientific and technical issues, such as lecture, exhibits, or even debates, e.g. on novel food production.
- *Zoo's, botanical gardens, and visitors centres* These natural and environmental organisations often provide the public with information and activities that enhance public information on science and technology.

- *Consumer Information Organisations and Centres* Special interest groups and citizens' initiatives are active in the Netherlands on a number of specific subjects, e.g. the Netherlands Centre for Food Information, and Organisation for Consumer and Biotechnology.
- *Newspapers and Magazines* Most daily nation wide newspapers provide readers with special pages on science, besides science news issues on regular or economic pages. Also there are a (small) number of special interest popular magazines on science produced by private companies.
- *Radio and Television* Public broadcasting on radio al television provides for some specific programmes on or around science and technology, as do commercial broadcasting companies though on a lesser scale. There is a clear audience in the Netherlands for these kinds of programmes. Weten promotes quality by subsidising science journalists and research personal.

A.3 PUS Activities

In The Netherlands there has been a clear shift towards the greater involvement of scientists themselves in communicating science to the public, reducing the dominant role of intermediate institutions and individuals. This is a fundamental change of perspective. In addition, another development is an upward trend of providing science theatre in schools on hot issues, such as transplantation of animal tissues on humans. Finally, the numerous PUS initiatives have contributed to a gradual increase in the volume and quality of science programming on television, and more recently on the Internet.

Universities and other science institutes combine public activity goals with public relation goals: public esteem, fund raising, and enrolling students and workers.

Debate activities are partly directed at adults, e.g. campaign on biotechnology and food, but also at young people, e.g. science theatre, which dramatises hot topics. These activities are directed at raising awareness of science issues, and engaging the public in decision-making and priority setting about scientific research, and especially in emerging (and therefore often controversial) fields such as biotechnology.

Labour market activities are directed at young people, schools and companies, in order to providing more attractive educational and career paths in science and engineering, that will inspire young people to take up science or technology in their educational and career choices, to produce the next generation of scientific staff and workers in engineering.

Exhibit 4 Kinds of activity used to communicate science

Purpose / **Target**	**Inform, Educate, Entertain**	**Opinion forming, attitude change**	**Recruitment of scientists**	**Informing policy-making**
Children, teachers, parents etc	Exhibit(ion)s at museums, science centres, observatories TV programmes Popular Science magazines and books	Science theatre Clubs and courses Activity centres	Clubs and courses Open university days, school visits Educational paths and career programmes	

			Science contests	
General public	Public lectures Science pages in newspapers Internet pages Exhibitions Popular Science magazines and books Radio and Television programmes Excursions Folders, brochures	Public debates Campaigns Congresses and conferences Prizes	Advertising: - educational paths - career programmes - job opportunities	Debates, Campaigns, Publicly available reports
Policy-makers				Scientific advice Public Debate Commission reports

Appendix B Public Understanding of Science in Denmark

B.1 National policy

Denmark is renowned for operating a rather different engagement model for science communication rather than the public understanding of science/education model, operated in most other European countries. Denmark society tends to have a political philosophy which seeks consensus rather than confrontation – where consensus means the highest level of agreement that can be reached without any party objecting; it implies neither compromise nor unanimous support. Denmark pioneered the use of consensus conferences to assess public opinion on an issue and their methods have been widely copied by other countries. Denmark has a strong voting culture and a high level of scientific literacy. Denmark appears to epitomise the 'information paradox', where more education leads to increase scepticism – greater public understand of science reduced unquestioning trust in scientists.[23]

B.2 Major actors

Danish Board of Technology

The Danish Board of Technology was established in 1985 and given permanent legal foundation in 1995. It has an annual budget of DKK 10 million. Its stated objectives are to 'further the technology debate, assess technological impacts and options, and advise the Danish Parliament and Government'. The DBT uses a variety of methods to engage the public in debate including

- Scenario workshops
- Consensus conferences
- Voting conferences
- Policy exercise – role play
- Hearings for parliament

In consensus conferences, the citizens have the role of a citizen panel, which will set the agenda for the conference. In scenario workshops, a group of citizens interacts with other actors to exchange knowledge and experience, develop common visions and produce a plan of action. The focus of both methods is to create a framework for dialogue among policy-makers, experts and ordinary citizens. Both methods are also characterised by their ability to create new knowledge.

ITS Science Shop

The Department of Technology and Social Sciences organises a Science Shop, which is an organisation that provides research for citizens on request. Individuals, public-interest group, trade unions and local government agencies can all submit questions to be addressed. The projects are carried out by students as part of their training, under the supervision of senior academics.

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23 House of Lords 3rd report, 1999, *Science in society*.

Experimentarium

The Experimentarium is Denmark's only science centre. It was opened in 1991 and its stated aims are to promote interest in natural science and technology in the community as widely as possible and to create a social and cultural meeting place between community, industry, commerce and scientists.' It is very popular, 1 million of the 1.7 million people in greater Copenhagen have been to the Experimentarium since it opened and 60% of Danish schools send parties to visit.

Appendix C Public Understanding of Science in the UK

C.1 National policy

In 1993, the Science, Engineering and Technology White Paper, Realising our Potential, committed the Government to support a campaign aimed at attracting more people into SET studies and careers, and raising public awareness of the contribution of science, engineering and technology. This led to the establishment of OST's Public Understanding of SET Team (PUSET). In recent years there has been a growing recognition in government and the scientific community of the need to move away from the old model of the 'public understanding of science' to one which involves public engagement in science and proper dialogue between scientists and the public. This was set out clearly in the House of Lords Select Committee on Science and Technology report, Science and Society, and the Government's response to this report. The need to develop new channels of communication between the scientific community and the public is also highlighted in the Government White Paper, Excellence and Opportunity – a science and innovation policy for the 21st century.

C.2 Major actors

Exhibit 5 lists the major players in science communication by category. For each of these organisations the purpose of science communication will be slightly different. Exhibit 6 lists typical objectives for each of the different kinds of organisations.

Exhibit 5 Organisations involved in science communication

Science communication facilitators	Research funders	Institutions representing science	Scientists	Specialist science centres and museums	Media
COPUS OST	Research Councils Government Ministries & Agencies Royal Society Medical Charities	Royal Society British Academy Learned Societies	Universities and research institutes Individual scientists	Science Museum Natural History Museum Many others	Specialist such as New Scientist Daily Newspapers

Exhibit 6 Typical objectives of the various organisations involved in communicating science

Objectives	Science communication facilitators	Research funders	Institutions representing science	Scientists	Specialist science centres and museums	Media
Raise profile of science as a career	X	X	X	X	X	
Raise literacy of economically active	X	X	X	X	X	
Secure public support for research		X	X			
Inform policy-making		X	X	X		X
Ensure science is debated & accountable	X	X		X	X	X
Enrich culture	X				X	X

The facilitators

COPUS

In 1985, the Royal Society (RS) set up a working party to look at the nature and extent of public understanding of science (PUS) in the UK; and PUS delivery mechanisms. One of the outcomes of the resulting 'Bodmer Report' was the establishment, by the RS, RI and BA, of the Committee on the Public Understanding of Science (COPUS).

The Committee on Public Understanding of Science is the national umbrella body for organisations and individuals involved in communicating science, and is committed to supporting ways of increasing public engagement with the issues and processes of science. COPUS is not as such as science communicator, but rather a facilitator and enabler. COPUS aims to provide a strategic focus for science communication by promoting it as a key skill for scientists.

COPUS was founded by the Royal Society, Royal Institution, British Association for Advancement of Science (BAAS), in 1986 in response to the 1985 Royal Society report, ‘The Public Understanding of Science’. COPUS has recently undergone an extensive review, such that it will be remodelled more as an inclusive partnership between the many sectors involved in communicating science. COPUS’ objectives have changed since its formation and are now more complex than merely raising levels of understanding of science and are aimed at:

- Improving public confidence in science
- Raising the profile of science as a career
- Improving public support for research

Nevertheless, one can argue that COPUS’ goals remain heavily biased towards science in that the are still all about ‘correcting’ the public’s mispercpetions of science. COPUS is aiming to become the one-stop shop for all science communication in the UK, ie a clearing-house and point of reference for all science communication activity, in effort to prevent duplication of efforts. It will not undertake public engagement activities itself. It will therefore work by:

- Identifying gaps in current programmes and working in partnership with others to find ways to fill them
- Recognising and disseminating best practice in ways of communicating science

OST

Within Government, responsibility for cross-departmental promotion and coordination of PUS activities lies with a small team based in the Office of Science and Technology (OST), which is delivered through the Public Understanding of Science, Engineering and Technology (PUSET) programme. However, a large part of the onus is on the SET community itself to take the lead in communicating the importance of their work and the career opportunities offered. Equally OST considers that industry, with its requirements for a skilled workforce, has a strong interest in fostering a technically literate population. The objectives of the PUSET Team are to

- Demonstrate the **relevance** of SET to people's daily lives and its importance to the economy
- **Generate interest in SET amongst young people** in order to develop and encourage lifelong interest in these subjects and the consideration of science based careers
- Create as many opportunities as possible for people to learn about recent scientific developments and **debate** their value
- Ensure that there is **dialogue** between the scientific community and the public, particularly on issues which raise profound ethical and social issues
- Raise the general level of **technical literacy** so that the public are in a better position to play a more informed role in this dialogue. Equally important is to enhance the **scientific community's understanding of the public**'s interest in and legitimate concerns about SET.

The PUSET team has a budget of £1.25million a year from which it provides grants to a number of organisations to facilitate science communication. Activities undertaken by PUSET include

- Administering of a grants scheme
- Provision of publications such as best practice guides and resource directories
- Encouraging activities that engage a wider audience such as consensus conferences (e.g. the Public Consultation on the Biosciences)
- Monitoring science communication and gauging public attitudes to science.

Projects currently supported by OST include

- British Association for the Advancement of Science (BAAS) core funding.
- COPUS grants
- Scottish Science Trust
- National Respect Campaign
- Y-Touring
- Vega Scientific Trust
- Public dialogue

- Forthcoming national network for science centres.

Department for Education and Skills
Science teaching science in schools must meet a number of needs:

- There is a need for specialist scientists and engineers, as well as generally scientifically literate people to work in an innovative and competitive economy
- To produce scientifically literate individuals who can contribute to and partake in democratic debate as part of a broader notion of citizenship
- There is a recognition that science is part of our culture and is part of producing well-rounded individuals.

The science teaching must therefore meet the needs of both those who will go on to be professional scientists and engineers, and others, for whom a general level of scientific literacy is also important.

The DfES takes responsibility for teaching of science in schools. Science is now mandatory up to the age of 16, including at primary school age, and the National Curriculum now includes teaching on ideas and evidence, *i.e.*, how science works and processes of science rather than just content and facts. This change grew from recognition that traditional science teaching methods were turning young people away from science and equipping them poorly to engage with issues of risk, or where there is a large uncertainty in decision-making.

Teaching about the democratic implications and role of science is also expected to play a major role in the new citizenship programme. Controversially the Government is pioneering specialist Technology Colleges. This aims to provide a centre of excellence for science teaching, but there are concerns that other schools may be denied resources for teaching in this area.

The DfES launched Science Year in September 2001. Science Year involves a whole year of exhibitions, websites, adverts, discussions, material for schools and teachers, to promote interest in and awareness of science among school children, teachers and their parents. It was launched with a giant one-minute jump, which aimed to set up vibrations up and down the country, which could be measured by schools with earthquake equipment. The initiative includes such disparate bodies as the Royal Mail, who have launched special ‘science’ stamps: holograms, scratch and sniff, heat sensitive stamp.

DTI
Science Year also saw the launch of the Science and Engineering Ambassadors Scheme, run by the DTI. The idea behind the scheme is that eventually every student should have contact with a practising scientist or engineer – to raise achievement and aspirations in science and engineering and to break down stereotypes about scientists and engineers.

The research funders

Where research funders actively participate in science communication activities their objectives also have another focus, that of PR for their organisation. This is particularly the case with medical charities, whose science communication activities influence charitable donations.

Government Departments

All government departments who have a remit for funding research now are actively engaged in explaining the purpose and findings of that research. This has particularly been the case since the BSE crisis in the 1980s, but OST plays a similar role to COPUS in that it facilitates and funds other science communication activities. Government Departments which have policies in this area include the Department of Health and the Department of the Environment, Food and Rural Affairs (DEFRA).

In addition, departments are increasingly aiming to open up their policy-making process to public scrutiny. There have been many new non-departmental public bodies and agencies formed to oversee developments in controversial areas of science and to act as a portal for public opinion into the policy-making process. For example, there are three relatively new committees to deal with concerns about genetics biotechnology and food: the Human Genetics Commission, the Agriculture, Environment and Biotechnology Commission (AEBC) and the Food Standards Agency. These bodies conduct most of their meetings in public, conduct consultations and publish minutes and reports of scientific advice and the policy decisions depending on them.

Research Councils

As funders of science, the Research Councils' involvement in Science Communication primarily has the following objectives

- To encourage public awareness of the nature of the research process
- To emphasise the benefits to society of the trained people, knowledge and expertise which result from the research it supports
- To encourage young people to take up science as a career.

All UK Research Councils, except the economic and social science research council, are members of the European Science Communication Information Network (ESCIN), and operate active marketing and communication programmes through the web, dedicated newsletters and, increasingly, semi-public conferences. Science Communication is more than a dedicated button on a Research Council's home page; increasingly, Research Councils are making science communication activities an obligation for grant holders. For example, all BBSRC grants holders are expected to make a minimum of 1–2 days per year available for public understanding activities. This requirement appears so far to be largely tokenist, owing to the small amount of time allocated and the lack of monitoring for impact. Most grant holders choose to spend their time in schools, some others give talks to community groups. It may be an important precedent, however, for funders to recognise the importance of the activity in this way and not to penalise scientists for spending time on something other than research.

UK research councils are concentrating mainly on opening dialogue , looking at issues such as where research is relevant to people's lives, because this area is most important for public trust and interest. The objective is primarily to gain a licence to operate from the public.

Some research councils offer specific grants to promote public understanding, for example, the Engineering and Physical Sciences Research Council has initiatives that include:

- The Public Awareness Awards Scheme, which included a project by the University of Cambridge to launch a series of posters on maths for display throughout the London Underground. The project was also featured in the Guardian newspaper and other journals.
- A travelling road show with poetry inspired by physics research (University of Strathclyde).

A number of research councils have begun initiatives to communicate with local councils, to explain the function of the research councils and their policies. All provide resources for teachers as part of educational outreach programmes.

Medical charities
Charities such as the Imperial Cancer Research Fund and the British Heart Foundation are active in publicising the results of their research. Other charitable organisations, such as the Nuffield Foundation and the Wellcome Trust also have facilitative schemes for science communication. For example, the Wellcome Trust is a major funder of various initiatives such as SciArt, Book prizes, science on stage and screen, and essay competitions in collaboration with others such as the New Scientist.

The institutions representing science and scientists

British Association for the Advancement of Science
The BA was founded in 1831 and exists to promote understanding and development of science, engineering and technology and their contribution to cultural, economic and social life. The BA receives funding from OST, the Wellcome Trust and the Royal Society. Its activities include:

- Collaboration on Science Year
- National Science Week
- Creating SPARKS Festival
- Discussion meetings and exhibitions, including SciBar and Science and Public Affairs Forums
- Alphagalileo – Internet media site for journalists

The Royal Society
The Royal Society straddles a number of categories within science communication: it is a funder of science and communicates science itself, it represents scientists, it funds/facilitates others in science communication activities, and it runs educational activities in science. The flagship output of the Royal Society in this area is the Summer Exhibition, which brings together exhibitors from all over the country with interactive stalls. It is attended widely by media, by schoolchildren and their teachers and also by policy-makers and politicians in an annual reception.

The Royal Institution
The Royal Institution is best known for its Christmas Lecture series, which is broadcast each year and widely attended by young people. It also runs other discussion events around the science and society theme.

Learned Societies
Most learned societies have PUS initiatives of some sort, with programmes of grants and awards for science communication, or public lectures and exhibitions. The Institute of Physics has been active in the area and has published widely on the topic.

Science museums and centres

The UK has a long history of science museums, from internationally renowned museums such as The Science Museum and the The Natural History Museum, with newer interactive science centres in Bristol, Cardiff and Glasgow, as well as history of science museums in many cities and small towns up and down the country.

The Media
The media have been both praised and maligned in the science communication debate in the UK. The House of Lords Science in Society report noted that many scientists blame the media for poor reporting of science and contributing to a general level of mistrust and misunderstanding by the public. The House of Lords also notes however that the science journalism in the UK appears to be flourishing, and that when compared with other countries, such as the USA, the standard of specialised journalism is very high. Indeed the number of scientists employed by the BBC has doubled in recent years, reflecting the high state of interest in science by the public. This pattern of high quality journalism appears to correlate with a relatively high scientific literacy in the UK in comparison with the USA, despite poor faith in the regulatory system and a general mistrust of certain aspects of science by the public at large[24].

The problems with communication between scientists and the media generally arise when scientists need to communicate with non-specialist journalists on the news-desk, who have very different priorities for the story.

In response to an increased awareness by scientists of the need and opportunities presented by communicating with the media, funding organisations have launched media communication courses and networks aiming to help journalists identify experts in particular fields, such as the Alphagalileo (http://www.alphagalileo.org) Internet press centre.

C.3 Mapping science communication activities

Exhibit 3 details the kinds of activities in the UK against their purpose and target audience.

[24] Durant, Evans and Thomas. Public understanding of science. *Nature* 340 1989.

Exhibit 7 Kinds of science communication activities in the UK, their target audience and broad objectives.

Target audience	Recruitment/ promotion of science as career	PR for organisation	Informing policy-making	Citizenship democracy and accountability	Culture and general education
Children, teachers and parents	Science teaching in schools Science clubs Science Year Science and Engineering Ambassadors Scheme Science Museums Advertisements			Science as part of citizenship lessons Science and theatre projects Exhibitions Media/TV programmes	Science and theatre/art projects Science Museums and interactive centres TV, media, educational resources
General public		Charities – pamphlets, websites	Public consultation through advertising, seminars and polls Publicity and debate in media	Websites and pamphlets from funders and government departments	Science and theatre/art projects Science Museums and interactive centres TV, media, educational resources
Policy-makers	Institutions representing scientists produce briefings on importance of science for policy-makers	Annual reports and other publications from RCs	Scientific advice Position papers and briefings Select committees Research Council Initiatives for Local Councils Publicity/debate in media	RCs required to report to policy-makers on their activities	Discussion meetings

Appendix D Public Understanding of Science in the USA

D.1 National policy

The prime objective for public understanding of science and science communication activity in the US is educational outreach for most organisations involved. Most of the effort is aimed at high school children and the general public at a large.

For some government departments and administrations, (e.g., NASA), outreach programmes serve to maintain public enthusiasm for the very high levels of research expenditure committed to space (that is, compared with levels of space R&D investment around the world and with other socio-economic objectives).

Consultation on research priorities is via openness policies enshrined in FACA regulation. Openness in general is greater in the USA than in other countries in Europe owing to the Federal Advisory Committees Act (FACA) and right-to-know laws, which require agencies to put information in the public domain. Those organisations and committees covered by the Act must hold meetings in public and publish minutes and reports. Information is more readily available generally and communication with the public is written into the mission of most organisations.

Policy-advice in the US is served by a narrower spectrum of organisations than in the UK, for example. The NAS is essentially contracted (via the National Research Council) to produce scientific advice on a particular area of need by the Congress itself or by one of the departments or Agencies. The broader role of informing policy-making taken by various sectors in the UK (research Councils, university science groups etc) is therefore less prominent.

A recent report by the National Science Foundation (NSF) looking at science and engineering indicators[25] found that most Americans have highly positive attitudes toward science and technology. There is strong support for government investment in basic research, and Americans also appreciate technological advancements, especially rapidly expanding communication capabilities such as the Internet. America has not suffered the same degree of crisis of public confidence in its scientific advisory and regulatory system, which has afflicted most countries in Europe. Science literacy is low, however. The NSF report found that Americans do not seem to know much about science, especially the scientific process. Concern by the government about lack of scientific literacy in high school children, and the consequent affect on competitiveness, prompted an investment into raising the general level of achievement in these children. The prime focus of initiatives in America in public understanding of science therefore appears to be in educational outreach for school-age children, primarily to raise scientific literacy levels.

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25 NSF. *Science and engineering indicators* 2000.

D.2 Major actors in science communication

Public understanding of science is pursued by all governmental organisations to some degree, as part of their mandate. There is no single agency with responsibility for coordinating PUS activities across government.

Exhibit 8 Organisations involved in science communication

Facilitators	Funders	Institutions representing science	Scientists	Specialist science centres and museums	Media
AAAS NAS	Federal Government Departments NSF	Scientific societies	Universities	Boston Science Museum and many others	Specialist science media Television & radio

American Association for the Advancement of Science (AAAS)
The AAAS is the main body in America responsible for promoting public understanding of science. The AAAS is probably best known as the publisher of *Science* magazine, which is an important source of income. Other activities of the AAAS include:

(a) Science Education programme
This wide-ranging programme aims to raise the level of scientific literacy of all age groups

- Science, Mathematics, and Technology Education Programmes
- Human Resources Programmes including
  - studies of conditions causing talent pool losses of women, minorities, and people with disabilities
  - in-school and out-of-school programmes
  - programmes/strategies for career participation, career development/advancement, and workforce issues
  - materials connecting science and technology to under-participating communities
  - community networks to advance SMT education and literacy
- Public Understanding of Science and Technology Programmes
  - science/technology programming for print, radio, television, electronic media
  - non-traditional mechanisms that communicate science to the public
  - lifelong learning in science and technology through formal and informal education
  - assistance to public science and technology sites such as museums and zoos
  - programmes that help scientists and engineers communicate with the public

(b) Science and Society Programme
The AAAS supports a number of programmes focused on areas where science, society and government intersect, including organising a number of public forums on sensitive scientific issues. Activities include, advice to Congress on R&D in the budget, Science and Human Rights Programme, as well as encouraging dialogue on science, ethics and religion.

(c) Careers initiatives
Including:

- Fellowships placing PhD scientists or Masters engineers with three years professional experience into Congress for a year, to learn about the policy-making process. Programmes are designed to provide each individual with a unique public-policy learning experience and to bring technical backgrounds and external perspectives to decision-making in the US government.
- A Media fellowships programme placing final year students in to news rooms
- A science careers web-site

AAAS also organises EurekAlert! an Internet resource of science stories for journalists, similar to the AlphaGalileo site in the UK.

National Academy of Sciences (NAS)
The NAS incorporates the National Research Council, the National Academy of Engineering, and the Institute of Medicine (all known as the National Academies). The National Academies provide science advice to Congress and the White House, but operate outside the framework of Government, assembling committees of experts to produces reports.

The NAS has an Office of Public Understanding of Science (OPUS). Its flagship project is ‘Beyond Discovery’, a series of publications that trace the development of well-known inventions to demonstrate the value of curiosity-driven research. OPUS concentrates on explaining the processes and methods of science and not just facts.

Federal Departments
Most funding of science in the US is dealt with via the Federal Agencies. The largest share of funding for science is biomedical and is dealt with by the National Institute of Health. The other main funder of science is the National Science Foundation. Other important governmental research funders include NASA, the Department of Energy and the Department of Agriculture. It is a prerequisite of receiving Federal funding that the organisation concerned must have an outreach programme. NASA in particular has a very large outreach programme, including educational activities.

National Science Foundation (NSF)
The National Science Foundation (NSF) is an independent US government agency responsible for promoting science and engineering through programmes that invest over $3.3 billion per year in almost 20,000 scientific research and education projects in science and engineering. The NSF also funds research in to the public understanding of science and public outreach. It sponsors the largest and longest ongoing survey of public understanding, publishing annually a science and engineering indicators report, referred to earlier, demonstrating the level of scientific literacy in the public at large.

National Institutes of Health

The NIH is one of eight health agencies in the Public Health Service, which in turn, is part of the US Department of Health and Human Sciences. The NIH is a research organisation: its budget for 1999 was over $15.6 billion.

The NIH set-up the Council of Public Representatives (COPR) in response to a report by the Institute of Medicine in 1998 which recommended that the NIH have greater public participation in setting its research priorities. The main function of the COPR is to bring public views to the debate on NIH funding priorities. The COPR is a fully chartered Federal Advisory Committee, and under FACA regulations, all its meetings are held in public.

Scientific societies
Most of the scientific societies have active public outreach programmes. The most active of these is probably the American Chemical Association (ACA). ACA has a world reputation for its educational resources in particular for its school textbooks.

Museums and science centres
America has a rich tradition of science museums and centres. Amongst two of the better-known examples include the Boston Museum of Science and Franklin Institute Science Museum. Museums are popular in America, for example, the Boston Museum receives over 1.7 million visitors each year, making it the most well-attended cultural attraction in Boston.

D.3 PUS activities

Most public understanding of science schemes are directed at children of high school age. The kinds of activities employed are given in the next table.

Exhibit 9 Typical science communication activities in the US, their purpose and their target audience

Purpose / Target	Education	Recruitment of scientists	PR for organisation	Informing policy-making
Children, teachers, parents etc	– School clubs – youth clubs – science–community linkages – Websites – Museums – Exhibitions	– Careers advice and websites – In-school/out of school clubs		
General public	– Museums – Life-long earning initiatives – Exhibitions	– Careers advice and careers programmes including fellowships for Congress and media	– Websites	– Consultations routine by organisations such as NAS – All minutes and reports publicly available
Policy-makers		– Studies on loss of women and minorities from science	– Promotional material	– NAS/NRC work under contract to government departments, agencies and Congress to produce advice on issue of interest

Appendix E France

E.1 National policy

Reinforcing the diffusion of scientific culture and techniques has gained special interest in France since the early 1980s[26]. Three levels of activities can be identified: specific actions promoted by the ministry in charge, the popularisation and diffusion of results by research institutes and universities, and the pedagogical work of scientific museums.

In 1982, the law on the orientation and the programming of research explicitly included 'information and scientific and technical culture' in the list of missions of the public research organisations, two years later the law on higher education introduced the same for universities.

In parallel to the request towards the producers of scientific research to communicate their results, a more customer-based approach led to the creation or the renovation of several museums or science parks.

Within the yearly public budget for research and development (BCRD), a certain amount is devoted to "scientific and technical culture" (see Exhibit 10).

Exhibit 10 Public budget for scientific and technical culture, 2000-2001, (KEuro)

Year	Public budget for scientific and technical culture
2000	6,327
2001	8,613
2002	8,918

Source: Speech de M. Schwarztenberg, Ministère de la Recherche

E.2 Organisation of PUS

The Ministry of Research, the Ministry of Education and regional partners

The Ministry of Research is the first the core-administration concerning the issue of science communication. In subjects like the opening up of research institutions for visits of school-classes or more general manifestations like the yearly fair of sciences it collaborates mainly with the Ministry of Education. Another partner-administration is the Ministry of Cultural Affairs, who is in charge of many museums with a scientific mission.

For the last 10 years, the Ministry of Research in collaboration with the Ministry of Education has organised an annual science fair[27], which takes place in all regions of France. The aim of this event is to increase the awareness of and interest in scientific studies and professional research in young people, and to multiply activities within the educational world, as well as to inform a the public at large about scientific

[26] See the speech of M. Roger-Gérard Schwartzenberg, Minister of Research, at the CNRS, on November 12, 2001.

[27] La fête de la science, see htt://www.recherche.gouv.fr

discoveries. So far, the fair has involved more than 2500 activities in about 700 municipalities with the participation of 3500 scientific partners, 15000 researchers and 250000 education professionals and has attracted 1.4 million visitors.

The Ministry of Research launched a series of conferences under the heading "Assises de la culture scientifique et technique" in November 2001 (General meeting on scientific and technical culture) aimed at the different actors in the field of science communication. The subjects included "Woman in scientific and technical professions", and "Towards sciences, citizen!" The meetings take place in different locations, at the Ministry, at the Cité des Sciences et de l'Industrie (CSI-La Vilette Park), and also at the UNESCO, in collaboration with the UNESCO's Meeting of the Science Technology Society (ASTS).

The CCTI

In the regions, 29 "Centres of scientific, technical and industrial culture" work as regional relays for the dissemination activities of research organisations. In 2001, the CCTI and the Minister of Research signed a convention, in order to redefine their role and missions. In the same year, the public funding of the CCTI increased by 50 % up to ¤5 million, using more then half of the funds reserved for scientific and technical culture (see Exhibit 10). The main missions of the CCTI are

- to provide information centres, libraries and media libraries for the general public
- to establish partnerships on and between the regional, sub-regional, national and even international level, in organising common activities and presentations
- to assure the communication around scientific questions via conferences, debates, forums, exhibitions, competitions, and "science-coffee-houses"
- to obtain the involvement of regional press
- to organise the annual "fair of science".

Public Research Organisations

France does not have a research council analogous to the RCN. Public Research Organisations (PROs) are the major players in research in France, and since 1982, the diffusion of scientific knowledge has been one of their explicit tasks. The PROs have installed specified offices for information and scientific communication. A complete discussion of the dissemination efforts of the PROs would go beyond the framework of this study, therefore, the CNRS is selected as an example of an organisation that has been engaged in science communication for two decades.

The CNRS

The CNRS is the biggest research organisation in France. It has a department for scientific and technical information, initially created in 1994 as the "Mission for scientific and technical information", transformed in 1999 into a "Delegation for scientific and technical information" (DIST) and it is directly attached to the General Direction of the CNRS. The DIST is in charge of the coordination of external and internal communication. It comprises an office for demonstrations, exhibitions and the relationship with young people, the office for writing and media relations, the web-office, and the mission for national archives.

Dissemination
In 1981, the CNRS launched its scientific magazine "CNRS Info" to inform science journalists. The magazine aims to "translate, without betrayal"[28], some of the important findings and progresses produced within the 1200 laboratories of the CNRS.

The CNRS has also created an Ethical Committee for Sciences within its organisation (COMETS)[29] in 1994. This independent body was initiated to give its opinion about ethical problems raised by scientific research, where these problems are not yet treated by the National Ethical Committee for Consultation on life-sciences and health (CCNE). Any recommendation of COMETS is given to the director of the CNRS. The members of COMETS do not necessarily form part of the CNRS and they are drawn from diverse scientific disciplines.

Museums and Science Parks
During the last 15 years, the Ministries for Education and Research have undertaken a big effort to renovate several scientific museums and collections.

Four national museums are under the responsibility of the Ministry for Education:

- The National Museum of Natural History (MNHN)[30] has 4 main parts: First, the Grate Gallery of Evolution (Grande galérie de l'évolution) was re-opened in 1994 after the complete renovation of the former Galerie de Zoologie closed for over 30 years. The history of life, the mechanisms of evolution and the relationship between man and nature. Second, the "Galerie d'entomologie" shows the world of insects: 1,500 specimens selected from the most beautiful or most surprising in the world. Third, the Galerie d'Anatomie comparée gives a world-wide panorama of vertebrates. Finally the Galerie de Paléobotanique et de Minéralogie proposes an overview of the history of the plant world since its appearance on earth.
- The Musée des Arts et Métiers was reopened in 2000 after 10 years of closure for renovation. It was founded in 1794 as a "depot of new and useful inventions" and became a museum for all types of trades and crafts. The collection is unique in the world: 80,000 objects, 15,000 drawings testify to the ingenuity of humankind and the spirit of adventure of the pioneers of the industrial revolution.
- The Palais de la Découverte is a dynamic showcase for basic and contemporary science in the shape of interactive experiments with commentaries by lecturers. Astronomy (with the planetarium), biology, chemistry, mathematics, physics. Earth sciences are illustrated.
- Le Musée National de l'Education in Rouen is currently under renovation.

The Cité des Sciences et de l'Industrie (CSI)[31] also depends on the Ministry of Education and Research, but on a profit-based structure[32]. Located in the La Villette Park, the Cité offers a complete panorama of sciences and technology: communication, environment, health, astronomy, computers, etc. through exhibitions, shows, models, conferences and interactive games. It hosts a planetarium and a mediterranean aquarium, the Louis-Lumière cinema (3D films), and a media library. In the park a real submarine can be visited (the Argonaute). Two sections are

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28 See CNRS Info spécial 20 ans, N°394, Juin 2001.
29 Comité d'éthique pour les sciences du CNRS.
30 Musée National de l'Histoire Naturelle
31 City of Science and Industry, Parc de la Vilette in Paris
32 EPIC, établissement public à caractère industriel et commercial.

established for children and adolescent: the “Cité des Enfants” is for children aged 3 to 12, and as of April 1995 the "Techno cité" for 12-15 years old.

The CSI focuses in part on actual and ethical questions. Together with the CNRS, it opened in 2000 a new way of combining exhibitions and debates with the title “dare to know it”. The subjects[33] chosen were themes of an exhibition of animations, ethical debates, conferences, and on-line documentation and discussions.

In the regions, municipalities and regional governments have been encouraged to promote their scientific heritage. Some of the regional museums have been transformed, as, for example, the Museum of Grenoble, which opened a new building in 1988 with room for conferences, a pedagogical laboratory and a library.
Over 100 other scientific museums in France also depend partly on the same ministry[34]: 62 museums of natural history (mainly municipal), 11 university museums, and planetariums, aquariums, zoos and botanical gardens with educational vocation, as well as regional nature reserves. 94 other museums are “mixed” in the sense that they depend both on the Ministry of Culture and on the Ministry of Education and Research, explained by the type of collection they present.

Parliament

In the early 1980s, during debates concerning nuclear, spatial or “cable” research programmes, the French Parliament came to the conclusion that it was unable to evaluate Government’s decisions on the major directions of scientific and technological policy. It decided therefore to endow itself with its own assessment organisation: the Parliamentary Office for Evaluation of Scientific and Technological Options (OPECST)[35]

OPECST, set up in 1983, aims to “inform Parliament of scientific and technological options in order, specifically, to make its decisions clear.” It has a particular structure within Parliament. Its 16 members, who are nominated in order to guarantee a proportional representation of political groups, belong both to the National Assembly and to the Senate. Only members of Parliament may refer matters to OPECST. OPECST acts as an intermediary between the political world and the world of research, it is assisted by a Scientific Committee reflecting the diversity of scientific and technological disciplines in its very composition, it is made up of fifteen leading figures selected for their competence. The reports produced by the “rapporteurs” of OPECST are presented in such a way that they may be used directly for legislative work or budgetary discussion. Members of OPECST must decide whether they publish these works and all or part of the minutes of the hearings and the contributions by the experts. Since 1983, OPECST has published 40 reports.

Media and Information Technologies

The media play a double role in scientific communication: first, they directly publish articles on scientific subjects for a large public, or secondly they inform about

[33] For instance “act on the brain”, “new technologies and private life”, “climate under control”, “sports and society”, “growing old soon living better”, “food production”, “rdearch in the universe”, …

[34] See Jeannin Geyssant: Les institutions muséales scientifiques, partenaires du système éducatif. In: Bulletin de l’Inspction générale de l’Education nationale, n°31, avril 2001, p. 49-63.

[35] See http://www.senat.fr/opecst/english.html

activities of specialised institutions like the CCTI. According to the French Minister of Research[36], there is a deficit in information of the general public by media, illustrated by the results of a survey realised in November 2000. The question “Would you say that there is sufficient or insufficient scientific information?” responses are nearly balanced for written press (44% “sufficient”, 42% “insufficient”). The score is less positive concerning broadcasting media, where the response “insufficient” is dominating largely with 62% for TV and 58% for radio. It seems that scientific programs that have played an important role in TV during the 1970s find less entrance into programmes nowadays.

Whereas journals, newspapers, and broadcasting can today be regarded as traditional media, information technologies have opened new opportunities for the diffusion of scientific knowledge. Scientific museums become rich sources of documentation in several areas like natural sciences, physics, history, geography, technology, and the arts. At the same time, the Internet works as a platform for the diffusion of the periodicals of the big research centres.

E.3 Mapping PUS activities

Exhibit 11 tabulates the examples discussed above, organising them along the target audience of either the institutions involved or specific actions.

[36] See the Speech of M. Roger-Gérard Schartzenberg, at the CNRS, Paris November 12, 2001, http://www.recherche.ouv.fr/discours/2001/dass.htm

Exhibit 11 Actors and actions of science communication activities in France, their target audience and broad objectives.

Target audience	Recruitment/ promotion of science as career	PR for organisation	Informing policy-making	Citizenship democracy and accountability	Culture and general education
Children, teachers and parents	Fair of science CCTI	Science communication of PROs "Dare to know" (CNRS&CSI)	PROs Assises	Fair of science Museums, science parks Assises Media CCTI	Museums & Science parks Fair of science CCTI Media
General public	PROs Fair of science CCTI	Science communication of PROs Media Assises "Dare to know" (CNRS & CSI)	Museums & Science parks Media OPRs	Fair of science Museums, science-parks Assises Media CCTI "Dare to know"	Museums & Science parks Fair of science CCTI Media
Policy-makers	PROs CCTI	Science communication of PROs Media Assises "Dare to know"	OPECTS PROs	OPECTS PROs Assises	Museums & Science Parks Assises