# Report from the Expert group
# Benchmarking the Promotion of RTD culture and Public Understanding of Science

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Note: Comments are welcome and can be sent to Gwenda.Jeffreys-Jones@cec.eu.int

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## DISCLAIMER – LEGAL NOTICE

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# SUMMARY

The recently declared project to make Europe the most dynamic and competitive knowledge-based society in the world, as initiated by Heads of State and Government at the March 2000 Lisbon summit, makes much of the need to reach out to European citizens. An essential area for policy makers within this context is the prevailing culture for research and technological development in our societies, both within Member States and Europe wide. Levels of public understanding, awareness of, and involvement in, issues concerning science and technology are key to the full democratic implication of citizens in a knowledge society.

The Expert Group Benchmarking the Promotion of RTD Culture and Public Understanding of Science[1] was therefore set up in September 2001, as an addition to the other four groups already benchmarking other aspects of national RTD policies in Europe[2].

STRUCTURE OF REPORT

The Introduction to this Report describes the mission and objectives given to the group by the European Commission: to establish the current state of RTD culture in Member States, to provide a survey of the ongoing activities, and to recommend measures to be followed to improve the present situation. In order to clarify the meaning behind the vocabulary used in different Member States, our introduction also contains an analysis of the concepts behind "Public Understanding of Science", "Public Understanding of Science and the Humanities (Wissenschaft)" and "Culture Scientifique".

From the expertise of the Members of the Group and known previous national and international literature[3], it was decided to divide the work into six areas of study corresponding to six "actors" engaged in the promotion of public understanding of science:

- Governments and their agencies
- Scientific community
- Education (formal and informal)
- Science museums and science centres
- The media
- Industry and the private sector

The Report is consequently divided into seven chapters, including a chapter analysing the results of Eurobarometer 55.2, which was published during the course of our work (November 2001). There is, of course, some overlap between the actors, which we have taken into consideration and detailed as far as possible.

In the Conclusions, we put forward suggestions for the future round of benchmarking RTD culture in order to take forward the work performed by this group.

[1] RTD = research and technological development. PUS = public understanding of science. These terms are taken from the Council of Research Ministers' conclusions, June 2000.
[2] The other groups dealt with national research policies relating to Human Resources; S&T Productivity; Public and Private Investment; and the impact of S&T on competitiveness and employment.
[3] « Quand la science se fait culture ». La culture scientifique dans le monde. Bernard Schiele editor, Université du Québec à Montréal, 498pp. Editions Multimondes, Sainte-Foy, Québec, 1994. National reports for Europe are divided along the same lines as ours.

## MAIN FINDINGS

This report demonstrates the wide range of activities undertaken to promote RTD culture and public understanding of science, in the different Member States and by the different actors. We hope that this will contribute to mutual learning, by helping policy makers to assess whether further RTD culture activities, or incentives to such activities, would be useful in their Member State.

The analysis undertaken in this report also shows that the collection of specific new data by the European Commission would allow a more accurate and more quantitative estimate of the current state of scientific culture and public understanding of science in Member States. It would also help to benchmark the impact of the activities outlined in this report.

Broadly speaking, the six actors can be divided into two groups, one group is composed of *governments*, the *scientific community* and *industry*, and it tends to undertake initiatives and short term actions in response to demands or problems. The second group of actors, composed of *science museums*, the *media* and *education systems*, are by their very nature engaged in ongoing and long term actions as they are constant components of the cultural scene.

The actors' efficiency in the promotion of public understanding of science depends on specific issues which are outside their range of action, such as the particular history of a Member State, the weight of the entertainment industry within contemporary culture, the range of interest at a given time of the public at large in terms of science and technology. The actors' activities may also suffer from instability of political or economic origin.

### FINDINGS THAT APPLY TO ALL ACTORS:

- The existence of two trends in RTD culture policies: one based on a pedagogical approach which tries to increase the knowledge of the citizens (by a variety of means), the other which focuses on establishing a two-way dialogue between citizens and other actors in order to build a consensus on S&T challenges facing society.

- The occurrence of a scale problem: some "actors" address themselves to large audiences in monumental urban settings, or through mass media channels, others have activities involving small groups on a very local level.

- Due to the need to cover the costs involved in undertaking action, the promotion of scientific culture depends increasingly on profit-making/ business tactics as more visitors, readers, listeners or viewers are needed.

- In each of the sectors investigated, there is a clear need for more social science research on problems linked to the diffusion of RTD culture. Suggestions are made at the end of each chapter.

Below are the findings and recommendations that concern each of the actors examined by this Expert Group. They are presented in greater detail within each chapter of the report. Each of the chapters is complemented by an extended country-by-country analysis, which, due to their size, are provided in annexes.

1) EUROBAROMETER

The publication of the Eurobarometer 55.2[4] "*Europeans, science and technology*" provided a unique opportunity to try to extract from its results indicators useful for our benchmarking exercise. A comparison was made between knowledge levels and interest levels in Member States. The cross-correlation of those two indices provides a new vision of the public climate for science and technology in Member States, which can help policy makers and "actors" in the field. While the climate for promoting RTD culture and PUS is generally favourable, some countries may need to implement urgent measures to prevent a sharp deterioration. Existing surveys can be useful if carefully analysed. New, more sophisticated, surveys will benefit the understanding of the public climate for promoting RTD culture and PUS.

***Recommendations***

1. Careful and sophisticated analyses of existing Eurobarometer data, which look for indicative correlations and associations, should be supported so that the wealth of information contained in the figures can be extracted is such a way as to help policy makers and actors.
Reasoning**:** The findings of Eurobarometer and national surveys concerning RTD culture and PUS are useful as indicators of the public climate for science and technology, if used appropriately. All actors can use these data so as to be aware of the climate for their activities.
Action**:** management teams involved in developing policy in this area.

2. Comparisons between existing survey data sets should be carried out to see if useful and informative trends can be identified.
Reasoning**:** Actors need to know not only the current situation but the way in which the climate they are working in is developing.
Action **:** management teams involved in making policy in this area.

3. In particular, those concerned with the promotion of RTD culture and PUS should monitor knowledge and interest levels in combination, as an aid to judging the public climate for initiatives and activities in this area.
Reasoning**:** Given the criticism of ranking countries on the "knowledge scores", a combination of this index with the levels of interest can provide insight into the development of the climate in the promotion of RTD culture and PUS.
Action **:** management teams involved in making policy in this area.

***Further work***

1. Critiques of the current Eurobarometer questionnaire are that the knowledge questions do not really measure citizens' abilities to deal with scientific and technical issues, and that other indices are also not as secure as they should be. There should be a research programme to develop new questionnaires and other observational instruments that are better grounded theoretically.
2. More use should be made of attitude data (bearing in mind the criticisms of researchers).
3. Eurobarometer indicators should be correlated with economic data.

[4] Eurobarometer 55.2 *Europeans, science and technology.* European Commission DG Research (Brussels, Belgium. 2001)

### *Future indicators*

1. To come out of further research outlined above.

2) GOVERNMENTS AND THEIR AGENCIES

The analysis of EU Governments' actions was based on the determination of their degree of leadership through the statements they issued or regulations they implemented, the policies and activities supported, actions aimed specifically at women, the use of the Internet to provide information and generate public involvement, and the degree of participation and encouragement to dialogue and debate. Several case studies provided evidence for good practices: the evaluation of the science week 2001 in Austria; the design and role of consensus conferences in Denmark; the project "City of Knowledge" in Barcelona; and the evolution of PUS promotion in the UK from the "deficit in knowledge" model to the practice of dialogue. The overall picture of Governments' actions is one of unevenness in development of appropriate action for the promotion of RTD culture and PUS. Most Governments do not have a clear idea of what exactly they are doing, at least when it comes to levels of resourcing. Some Governments appear to be providing little leadership in this area.

### *Recommendations*

1. Governments should take a lead in promoting RTD culture and PUS by assembling a team responsible for ensuring that activities and programmes in this area go ahead.
Reasoning**:** The examples of Austria, Denmark, Portugal and the U.K. show the importance of dynamic leadership in promoting RTD culture and PUS, and in ensuring that programmes are put in place and are supported.
Action**:** Government, (lead ministry, involved ministries) RTD culture/PUS team.

2. Governments should have clearly stated policies in the area of promoting RTD culture and PUS. They should develop techniques for evaluating their activities in this area.
Reasoning**:** Given their role in leadership, Governments need to be clear what they are supporting, why and how. Given that some programmes are now fairly mature, their effectiveness requires investigating; the Austrian Science Week evaluation shows one way this can be done.
Action**:** RTD culture/PUS team, (lead ministry, involved ministries) Government.

3. Governments should draw up an inventory of the activities they support in the area of promoting RTD culture and PUS, and thus obtain a clear idea of the financial contribution they are currently making.
Reasoning**:** Although information on activities was forthcoming, it proved hard to find out how much was being spent in this area and it appears that Governments themselves do not have an overall picture of what they are doing. In the future, it may be that targets, such as the Portuguese 5% solution, are proposed; at which point accurate knowledge of the current situation becomes even more urgent.
Action**:** RTD/PUS team, Treasury/Finance Ministry, Government.

4. Governments should make a particular effort to make information on science and technology available to women.

Reasoning**:** The Helsinki Group has highlighted the importance of women in science[5]. The U.K. survey of public attitudes shows that women are more concerned than men about science and technology. But - outside of schemes to get more young women to follow science careers - little is currently being done specifically to promote RTD culture and PUS among women.
Action**:** RTD culture/PUS team.

5. Governments should promote the use of the Internet to make science and technology accessible to citizens, so that they can play a part in ensuring that discoveries and developments are used for their benefits.
Reasoning**:** At present only just over half of the E.U.'s member states are using the internet for the promotion of RTD culture and PUS. This resource offers real possibilities for citizens to be involved cheaply and effectively in debate and dialogue. Note that the Internet does not replace other measures in this area.
Action**:** RTD culture/PUS team and relevant government departments.

6. Governments should instigate appropriate measures for involving the public in vital discussions, debates and decisions concerning the future uses and directions of science and technology.
Reasoning**:** The old "Deficit Model" of simply giving information to a public presumed to be ignorant has been shown to be inadequate (particularly by the U.K. experience). There are now several models and techniques to deal with the current mood for dialogue, as examples from Denmark, Holland and Germany show.
Action**:** RTD culture/PUS team.

***Further work***

1. The role of regional and local government needs to be investigated, particularly for those Member States for which this level of government is traditionally important.

2. Research is also needed on the work done addressing particular sectors of the population - e.g. farmers, medical practitioners and patients' groups, fishing fleets, *etc*. - since in these areas specific requirements are often set down by the information recipients.

3. Schemes supported by Government, particularly in areas of dialogue and debate, those at aimed at women in particular, and those making use of the Internet, should be investigated.

***Future indicators***

1. The amount spent on the promotion of RTD culture and PUS as a percentage of the overall national research budget.

3) SCIENTIFIC COMMUNITY

The scientific community was defined as leading research bodies which are members of the European Science Foundation[6] plus the Academies which are members of ALLEA[7], the European federation of national academies of sciences and humanities. During this exercise, it

[5] www.cordis.lu/improving/women/helsinki.htm
[6] http://www.esf.org the European association of national organisations responsible for the support of scientific research"
[7] http://www.allea.org/

was not possible to deal with the activities of individual scientists, research institutions, universities or colleges.

The activities of the scientific community can be seen – like Janus - as facing two ways: towards the external world, and towards their staff/ membership. Although many agencies are doing much to communicate about their work by organising events, web sites or press services, others appear to be doing almost nothing. Some work must be done to convince scientists to invest more in PUS, especially by training young scientists in communication skills. Specific actions for women are being developed in a few countries, mainly aimed at encouraging young women to take up scientific careers[8]. Partnerships between research organisations and the education system should be encouraged both by direct contact with teachers and students, and also by producing resources. Special attention should be given to research problems, or scientific achievements, with social implications and impact on public opinion.

***Recommendations***

1. The leadership of the scientific community should promote a culture of transparency and communication of their work and results to the public. This should be done by financing programmes, competitions, public calls for proposals, awards and other initiatives aimed at promoting RTD culture and PUS.
Reasoning**:** Activity in this area is increasingly demanded by society (as evidenced by the EC's *Science and Society Action Plan).* Where schemes exist to enable scientists to carry out such tasks (e.g. Portugal, U.K.), the level of activity is highest.
Action**:** leading scientific academies and learned societies

2. Scientists should be given training in communication skills, taking into account the need for public dialogue, debate and inclusion in decision making.
Reasoning**:** The training offered to most European scientists does not equip them to carry out such tasks. Countries (such as the U.K.) that do have training schemes have a highly active community for the promotion of RTD culture and PUS, and scientists who receive training report the experience to be useful.
Action**:** scientific academies and learned societies, in partnership with professional science communicators.

3. Activities aimed at promoting RTD culture and PUS should be evaluated, looking at the aims and objectives of organisers, researchers and their audiences.
Reasoning**:** Although activities in this area are widespread, little is known as to how effective they are. After thorough evaluation (as in the case of Science Week Austria), some basic assumptions may be found to require reassessment.
Action**:** outreach events and programmes organisers.

4. Promotion procedures should be able to take account of a scientist's activity in the area of promoting RTD culture and PUS.
Reasoning**:** The goodwill of researchers is required to make the "science and society" movement successful. Many scientists, however, would agree with those evaluated in Science Week Austria and the member of the French promotions committee that there is little recognition of the time and effort that they invest in the promotion of RTD culture and PUS.

[8] For more information please see the report of the expert group benchmarking Human Resources.

Action**:** research and higher education institutions.

5. The scientific community must recognise its responsibility for the improvement of basic science education and lifelong learning of science. This should include:

- Direct contact with teachers and the production of learning resources ;
- Direct and regular partnerships with schools in order to provide temporary placements for students in research laboratories. Whenever possible, these partnerships should be extended to knowledge based companies;
- Involvement in large-scale educational projects concerned with the impact and social implications of science.

Reasoning**:** The scientific community needs to be involved with young people, including those who are not going on to become researchers themselves, for the future of science and society relations. Existing schemes that place school students in research laboratories, such as those in Portugal, show that this works well.
Action**:** the scientific community as a whole.

6. The scientific community should maintain press and information services specialised in dialogue with the media. They should also look at the Internet as providing possibilities for direct contact with the public, without making use of the mass media.
Reasoning**:** The media require information in a digestible form. But there are criticisms of the way in which science is sometimes presented. Internet initiatives such as those in Denmark, Germany, Portugal, Sweden and the U.K. provide an alternative route for reaching the public, as well as for dialogue and debate.
Action**:** leading research laboratories, academies and societies.

***Further work***

1. The activities of individual research institutions and universities should be assessed to obtain a better picture of activity on the ground, on a country by country basis. (In the current exercise we have been able to put together such information for one or two cases.)

2. The steps taken to train researchers for communication and dialogue tasks need to be looked at.

3. Evaluation indicators for regional, national and European science weeks and festivals should be developed.

***Future indicators***

1. Quantitative indicators of science weeks and festivals (numbers of events, audiences, numbers of participating scientists and institutions).

2. Statistics on funding available for science communication activities for/by researchers.

3. Number (or proportion) of researchers undertaking science communication training.

## 4) EDUCATION[9]

Education is the primary provider of *knowledge* in society and plays a key role in shaping public understanding of science. The pedagogical methods in science teaching, and curricula contents, differ from one Member State to another. Our report presents the current situation and various trends are described. Extra-curricular activities and informal learning are also reviewed. The evolution of new research strategies in science education is also examined. The overall mono-disciplinary character of science teaching in the Union is underlined. Science and technology options in schools are social and gender dependent. The question of experimental versus academic oriented curricula is a subject of national differences. Faced with the reluctance of students to choose science and technology subjects, we recommend greater use of out-of-school resources in schools. The question of teachers' training is essential. The creation of Internet networks between schools could help schools to exchange material on science subjects. Science and technology teaching should start at an early age (six) and within the framework of interdisciplinary topics such as "the environment" or "health".

### *Recommendations*

1. Governments should consider the age at which children start to be taught science and technology related subjects (e.g. at the age of six). Of particular importance is the introduction at an early age of subjects like Health Education, Environmental Education, etc.

Reasoning: The familiarisation of students from the early stages in socially oriented areas, such as Environmental studies, will improve citizenship and societal welfare.
Action: ministry of education, agents responsible for curriculum development, agents for teacher training, in service training centers.

2. Interaction between schools and out of school centres should be encouraged and facilitated, by making time and space available in the National Curricula. Additional resources should be made available in schools and training given to teachers in order to facilitate the evaluation and use of out-of-school resources and teaching packages.
Reasoning: There is clear evidence, for example from Germany and Holland, that out-of-school learning is attractive to pupils and pedagogically sound. Thus every effort should be made to develop structures so as to facilitate the assimilation of their characteristics into the school curriculum.
Action: ministry of education, agents responsible for curriculum development, science centres.

3. Governments should provide resources, technical support and incentives to teachers in order to facilitate the development of schools networks, particularly networks relying on use of the Internet. These networks could serve as agents promoting the exchange of good practices and school-developed material for science teaching. Existing networks (e.g. the European school net, networks from the Comenius programme, etc.) can provide the basis for this action.

Reasoning**:** It has become clear for example through the Comenius programme, that ICTs have served as very good communication tools, thus making young people eager to use them. Their successful integration into the teaching of science-related subjects can change the

[9] It should be noted that this expert group has focused on the knowledge and understanding needs of the *general public*, rather than future professionals. The issue of « scientific careers » is dealt with by the expert group benchmarking Human Resources.

pedagogical climate of classes to the benefit of students. Teachers could also benefit because they would be exposed to the multiplicity of teaching materials and good practices developed in other schools. Finally, a pupil's own use of ICTs promotes in itself one dimension of PUST, in the form of hands-on experience.
Action: ministry of education, local authorities, industry, schools

4. A PUST dimension should be included in teachers' initial and in-service training courses.
Reasoning: The purpose of PUST is to educate all students and not only thoses who will follow scientific careers. In the current political climate, citizens are increasingly called to participate in debates about science and society. More students will develop a basic understanding of science methods, reasoning and conceptual framework if teachers place greater emphasis on the societal aspects of the science they are teaching.
Action: Ministry of Education, universities, local authorities, in-service training centres.

5. Teacher training programmes, and in-service training centres, should be given incentives to allow their students to undertake part of their practical training in science centres.
Reasoning**:** Nowadays, youngsters learn quite a lot outside formal education in school, and science centres are important agents for promoting science. It is important to familiarise teachers with the techniques and material developed in these centres.
Action: Universities, teacher training colleges, teachers in-service training centres, science centres.

***Further work***

1. The chapter on education has demonstrated the lack of relevant information available. The outcomes of such research will iron out many crucial aspects involving the previous recommendations. Certain quality criteria should be established for the available teaching resources. Research is needed concerning the quality standards of resources, the use of various resources, the impact of resources on students' knowledge and attitudes and novel educational resources. Attention should also be paid to training of teachers per level of education (the number of teachers per S&T specialty and various socio-demographic factors such as age, gender, academic qualifications) and to the analysis of content which is taught (facts/methods orientation and scientific literacy orientation which prevents the processes of knowledge construction problematic from black-boxing)[10].

2. Science and Technology understanding leads to effective citizenship thus becoming an integral part of every individual's development. Girls are usually less likely than boys to study science at school, which has an impact on their future lives. Thus Governments and universities should initiate and support research programmes concerning factors that contribute to the reluctance of students to choose science and technology subjects and take up scientific careers.

***Future Indicators***

1. The starting age for teaching children S&T related subjects.

2. The percentage of teaching time allocated to S&T related subjects.

[10] This work should take place in cooperation with work already undertaken by the Member States and by DG Education and Culture.

3. The qualifications of S&T secondary teachers.

4. The number of S&T secondary school teachers by specialism.

5. The percentage of time allocated to Science and Didactics of Science during the initial training of primary teachers.

6. The number and description of semi-formal and informal activities.

5) SCIENCE MUSEUMS AND CENTRES

Our chapter on the role of science museums and centres in the promotion of RTD culture and PUS benefited from the help of ECSITE[11], the European network of science museums and centres, which has just carried out a survey involving its 260 member organisations. ECSITE's analysis was conducted in terms of budget, number of visitors, number of full time staff, exhibition space. From it emerged a European picture in which four institutions dominate the others: the "Science Museum" and the "Natural History Museum" in London, the "Deutsches Museum" in Munich and the "Cité des Sciences et de l'Industrie" in Paris - nicknamed "the Big Four" in the report. Point by point comparisons are made between the Big Four and the smaller institutions. Results of visitor surveys performed in individual science centres are also given. The evaluation problem is dealt with: how can we measure the impact of science museums and centres on education, career choices, and of course their economic impact? Three case studies provide insight and the potential for mutual learning: "the UK scene", "France", and, as a concrete example of the new role of science museums in the public sphere, the presentation of a debate on mad cow disease at "la Cité" in Paris. From the data accumulated it should be possible with some research to design useful benchmarking tools to measure the impact of science centres and museums on education, vocation and the local economy. Support should be given to exchanges between institutions on programs as well as on staff.

***Recommendations***

1. National governments should give high priority to partnerships with science centres and museums for any national policy in PUS[12].
Reasoning: Science centres and museums are successful tools for science communication and science learning. The ECSITE survey shows that they attract a great number of motivated and interested visitors. A large proportion visits as part of a school group, representing future European generations. Our report indicates that experiences in a science centre play a key part in youngsters' decision to follow a scientific career. Science centres therefore contribute to the future competitiveness of the EU in R&D as well as to the scientific literacy of the general population.
Actors: National and regional governments.

2. Special programmes should be set up in co-operation with science centres and museums to stimulate scientific vocations, especially targeted at girls.
Reasoning: As above, our report indicates that experiences in a science centre play a key part in youngsters' decision to follow a scientific career.

[11] http://www.ecsite.net
[12] Please see the recommendations in the "Education" chapter which also underline the need for co-operation between the informal and formal education sectors.

Actors: National and regional governments, education ministries, science centres and museums.

3. Special support is required for small and middle sized science centres and museums.
Reasoning: Our report demonstrates that small and middle-sized institutions, which compose a majority of the field, are particularly valuable since they respond to a real local demand and specifically address a young interested public. (46% of visitors to these smaller centres are under-15s.) They are currently obliged to find a large part of their operating resources through partnership or sponsoring since they receive lower average levels of public funding. New initiatives are needed to prevent their closure.
Actors: National and regional governments.

4. Co-operative projects between institutions should be supported (for example, travelling exhibitions and programmes, staff exchanges, training programmes, internet platforms for exchange of materials and expertise).
Reasoning: Mutual learning, optimising exchange of best practice and reduced costs for operations (economies of scale). Specific attention should be paid to co-operation between "traditional" science centres/ museums and the new emerging field in science communication represented by zoos, aquaria and botanical gardens. Specific training should also be provided to staff to help them to deal with their new tasks and responsibilities regarding dialogue with the public.
Actors: European Commission; local, national and European networks of science centres and museums, including ECSITE.

5. Support should be provided to science centre professionals to enable them to train other actors in cutting edge science communication/dialogue skills.
Reasoning: In the context of the recognised need to increase genuine dialogue with the public on science/ scientific issues, first efforts have been undertaken in science centres to bring different actors together, such as the debates at La Cité des Sciences. These have been successful and have demonstrated the need for further contact between the different actors. This is an area in which the skill level demanded is increasing. Action in this area could also make a contribution to capacity building in the candidate countries. This is a new domain for which no funding is currently available.
Actors: European Commission, national governments, science centres.

***Further work***

1. Initiatives have started recently where science centres contribute with their content and communication tools, to create new "learning objects" which should be of help to science teachers to improve teaching techniques – the effectiveness of these "learning objects" should be evaluated. Two web based learning objects are currently being developed, involving "Heureka", "La Cité" and "European School Net"[13].

2. Universities should undertake long term research on science learning through the science centre/museums experience, by initiating joint university-science centre "research-action" surveys, whereby a school based activity is tracked over several years. University involvement would bring methodological support as well as an independent analysis.

[13] Please see the recommendations in the "Education" chapter which also underline the need for co-operation between the informal and formal education sectors.

### *Future indicators*

Effective benchmarking indicators are required to measure the precise impact of this sector in several areas, for example in education, career choices, employment, society, tourism and the local economy. The authors have chosen not to recommend specific indicators at this point, in anticipation of the results of the international study on this subject, taking place under the auspices of "Heureka", the Finnish science centre, which will be available towards the end of 2002. The study aims to build a consensus on appropriate indicators for this field.

## 6) MEDIA

Media, especially television, are the public's main source of *information* (not to be mistaken with "knowledge"!) on science and technology. The public, however, do not appear to trust journalists very much. On scientific matters, journalists themselves often take their cue from the prestige weekly scientific journals such as Science (USA) or Nature (UK), and from their press releases in particular. Journalists cite the Internet as their most important source of information.

This chapter examines scientific news coverage in the "main"/ "quality" newspapers in the EU and the way the news agencies handle science. The main science popularisation magazines are listed and described. Case studies examine "science on the BBC", "science, advertising, and the media", and "biotechnology and the media". The role of the Internet as a media is described. Two interesting initiatives for the training of journalists are presented: one from the European laboratory CERN (Geneva) and the other from a German laboratory (Max Planck), EICOS. We argue that television operators should schedule more debates on science/ scientific topics. Journalists should receive better training in scientific matters, and media/ communication studies should be encouraged in universities and research centres.

On 9 July 2002 a meeting was held in Brussels on « Life sciences and the media »[14] bringing together scientists and media people, the recommendations issued concur with our own, below.

### *Recommendations*

The recommendations that follow consist of actions to be taken in order to improve public perception/awareness of science, a process in which the media play a pivotal role. <u>These suggestions should in no way interfere with the free and democratic action of mass media</u>, may these be public or private. They should, however, be considered – particularly by the public media – whenever decisions are to be taken, especially when dealing with issues of information management and when making things easier for journalists in their daily work. Freedom of expression is unquestionable, but we argue that citizens also have the right to receive such information as enables them to be active and critical participants in the "knowledge society".

1. Promote the presence of science issues and scientists in public television through specific science programs and debates, where possible, with *special emphasis on local scientists and local TV networks* this will show the public that science, like politics or other issues, is something close to their daily lives.

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[14] See DG Research press release July 11 2002, http://europa.eu.int/comm/research/index.html

Reasoning**:** According to various surveys, including the Eurobarometer 55.2, television is the main source of science information for the lay public. Individuals tend to perceive scientific developments as having little to do with their everyday life, and so, do not feel involved. Increasing the presence and visibility of local scientists on public television, particularly in local networks, could help overcome this (e.g. as with the experience of Barcelona public TV). Science is fairly well represented in most television channels, but pressure on schedule space and time leads to information simplification and the transformation of news pieces into a sort of showbiz. A rebalancing of scientific information and its showbiz like treatment is needed.
Action**:** Governments (national, regional and local), national TV councils, media schedulers.

2. Increase the number of science journalists working in public news agencies and information services, and thereby *increase the number of news items on science developments* and news released by those agencies.
Reasoning**:** National information agencies act as a reference for all types of news items and exert a great influence on the media agendas. There is a need for more specialised science journalists in these agencies.
Action**:** National public news agencies

3. *Promote awareness of the value of the Alphagalileo news service* amongst science journalists and information officers of research services, universities and other scientific institutions. This agency should be extended to other Member States and Candidate Countries.
Reasoning**:** Alphagalileo is an up-and-running service that is successfully diffusing scientific knowledge between European researchers and specialised journalists. But its representation is currently limited to 6 Member States: Finland, Germany, France, Greece, Portugal and the UK.
Action**:** Appropriate ministries; European Commission; Alphagalileo.

4. Increase the number of science communication training courses for professional media communicators.
Reasoning**:** In general terms, the Labasse report[15] showed that university journalism degrees lack science communication courses. Additionally, science degrees pay little or no attention to the acquisition of (popular science) communication skills[16]. To increase the amount and quality of science items in the media seems an impossible goal unless journalists' and scientists' interest and skills in science popularization do not improve.
Action **:** Education ministries, Universities, Research Centres.

***Further research***

It is necessary to establish national and EU-wide[17] studies on how the media disseminate scientific knowledge, and make those studies possible through the setting up of networks of university research groups. These studies may include science popularization books, a form of science dissemination not contemplated in Eurobarometer 55.2 but which has relevant impact in the formation of European scientific culture.

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[15] B. Labasse, *The communication of scientific and technical knowledge*. (European Commission DG XII, Brussels. 1999.)
[16] On this point, please see the recommendations of Chapter 3 on the Scientific Community.
[17] Framework 6 clearly has an important role to play here.

## *Future indicators*

There are few indicators relating citizen's *expressions* of interest in scientific culture to their actual *consumption* of scientific culture. In future, indicators that appear in media studies - readerships of popular science magazines and books, hours of science broadcast on television and radio, for example - could be cross-correlated with the data of Eurobarometer surveys to offer a more exact picture of the various public attitudes in the different Member States.

## 7) INDUSTRY AND THE PRIVATE SECTOR

Our report's evidence on industry's activities in the field of public understanding of science is derived from an Internet and databank survey. The question of risk perception by the public is important for the image of industrial operations; communication needs to go beyond academic studies. Historically, industry is at the origin of many national and local museums all over Europe. It still has a strong interest in local facilities some of which, including open-air museums, offer a flavour of industrial or cultural heritage. In large museums, industry has a strategy of sponsoring exhibits or of renting exhibition space for its own productions. Four industrial branches are surveyed in the report: energy, chemistry, biotechnology and communications. We found that energy and utility companies make available large amounts of scientific and technical information about their activities, some of which is designed for use in schools. Chemical and communication companies seem to be most interested in activities targeted at schools. Biotechnology enterprises seem less interested in delivering basic knowledge to the public and rely upon the academic world to do so. But the situation in this field is changing in Europe due to new action[18]. On July 4 2002 DG Research launched the « Science Generation Initiative » (with a financial contribution of € 1.44 million)[19] « to help inform EU citizens on life sciences and foster debates on bio-sciences ». Created in France in 2000, initially as a small scale experiment, by Aventis, the project will now be extended to Italy and Sweden. Some large companies declare a commitment to sustainable development and to a policy of dialogue with the public on controversial issues. Four case studies are presented in the report: the attitudes of the Finns towards various energy forms; the "Fondation Villette Entreprises" in France; "Siemens" and the "Econsense Forum" in Germany; and the "Wellcome Trust" in the UK.

## *Recommendations*

1/ Industries must take the lead in making the public aware of their work, including work on new technologies. They should be encouraged to act in the public sphere both as providers of formal knowledge and organisers of dialogues. They should participate directly in discussion on their work.
Reasoning: Some industries have not undertaken PUS activities until now, They have let the academic community shoulder the responsability of communicating about their work. Biotechnology is a good example of such an industry (although the situation is changing, see above). The acceptability of biotechnologies and biological sciences at large is now at stake because of the public's unstable opinion. The lack of an informed dialogue on this and other

[18] See for instance the new Internet site sponsored by Aventis : http://www.science-generation.com and the one sponsored by a section of Fedichem : http://www.BelgoBiotech.be
[19] http://europa.eu.int/comm/research/index.html

"hot topics" could damage the EU's competitivity and ultimately result in serious economic difficulties.
Action: industrial associations and lobbies in Brussels (e.g. Biotechnology lobby groups), companies (e.g. European BioTech companies) and the European Commission (DG Research and DG Enterprise).

2/ On the model of the growing involvement of scientists in public communication, engineers and technicians from industry/private sector should communicate directly with the public in cooperation with and using the help of their Press Information Officer (PIO).
Reasoning: Personal contacts with people directly involved in industrial research and development, who may be local actors, are efficient in the transfer of information and the development of informed opinions / attitudes. This has been seen during the open door industrial operations organised at science weeks (in Germany for instance) or during summer tours of industrial facilities.
Action: Engineers and technicians in the private sector, industry associations, European Commission - DG Research and DG Enterprise

3/ The main problem of industry is trust in the information it provides because of the fear of confusion with advertisement or propaganda. On controversial topics, industry in Europe should cooperate to provide access to data and authentic material through credible and independent channels, such as open data bases or public access to comments and reports of independent experts, especially parliamentary bodies.
Reasoning: There exists across the Member States, a large number of reports or inquiries of parliamentary origin, or coming from academic entities or from public services or Ministries about controversial science and society problems connected uses of new technologies, or industrial risks. Some of them could be collected from the Member States or European Union entities into a common data base open to the public and the press. As a matter of fact the data collected by this benchmarking exercise may be the nucleus of such an information system which could also be useful for future benchmarking.
Action: Industry associations, individual companies, European Commission staff responsible for developing information systems.

4/ Public support is necessary for the provision of information on risks and for the dissemination of expertise on various subjects, for example through lectures, meetings and broadcasts.
Reasoning: Publicly supported information campaigns are necessary not only for a balanced and active dialogue on "hot" topics but for continued discussion of less controversial topics which are also of relevance to citizens' lives. An example of a "hot topic" may be "mad cow" disease (see chapter on the media), a less acute example might be "food additives", both are a human health concern, one of the main interests of citizens.
Action: Governments, European Commission DG Research and DG Enterprise.

5/ Local industries should be encouraged to use public facilities (e.g. museums or town halls) to exhibit information about their activities and to be more active actors in the public sphere.
Reasoning: The public is interested, as shown by the popularity of local industrial museums, to know how local factories and industries work. Open doors limit the black box effect which may generate fear.
Action: Local industries; local, regional and national authorities.

6/ Industry should support the development of educational projects involving industrial partners in primary and secondary schools on the model, for instance, of what the chemical industry is doing in many Member States (for details see the Annex to the report).
Reasoning: Industry can bring an exciting, “real life” aspect to school projects. It is also an essential component of the economic activity and wealth of a nation.
Action: Industry associations in partnership with local education authorities, Ministries for Education, DG Research and DG Enterprise to support existing schemes and new ones in the making, for instance in biotechnology.

7/ The involvement of industry in science centres and museums should be recognised and welcomed.

### *Further Research*

1. How much industry declares it is spending on PUS related activities, as a proportion of their turnover/profits? Statistical units of the European Union may draft a questionnaire to know that.
Action: Eurostat – see below potential indicator.

2. Ways and means of the diffusion and use of science and technology in specialised communities such as agricultural ones or impoverished suburban areas (this is important in relation to educational problems in less favoured populations where technical knowledge may be an asset).
Reasoning: In this report we were only able to examine information targeted at the general population. In the future it would be useful to look at information available to, or targeted at, specific communities. There is significant scientific knowledge in the practice of agriculture today. In impoverished suburban areas, experiments in education[20] show the importance of technical knowledge and skills (i.e.mechanics, or computers or electronics) as a way of building a social status.

3. More social studies are needed on public perception of risk; management of risk by industry and the communication of information on risks to the public.

### *Future Indicators*

1. Precise data on the number of visitors to local industry sponsored or heritage museums.
Action: these data could be collected from National or Regional Statistical Offices in Member States
2. Percentage of turnover dedicated to PUS activities by key companies in the EU (both large companies and SMEs).

[20] *Pour* “Eduquer, Ruptures et enjeux”, n°142, 1994, pp 37-56

# INTRODUCTION

## MISSION AND OBJECTIVES

There appears to be a general consensus that public awareness of science and technology is necessary to equip European citizens with the tools they need to interpret and challenge scientific output from an informed standpoint. These tools are necessary not only for rigorous examination of that output, but to ensure democratic control over the increasing role that science and technology play in our lives. This concept – that aware citizens are empowered citizens – fits in with the move towards good governance at EU level. Aware citizens are also crucial for the development of Europe as the most competitive and dynamic knowledge based economy. “Scientifically literate” employees and consumers are also necessary for Europe to compete against other economic blocks, some of which invest proportionately more in research and development efforts.

The Expert Group was charged with benchmarking the promotion of RTD culture and public understanding of science (PUS) in September 2001. Thus it became a fifth group in the area of benchmarking, in addition to four other expert groups, which began, in October 2000, to benchmark several aspects of RTD policies in Europe. This is the first time that such an enterprise has been undertaken. It is closely connected to the implementation of a European Research Area; the extent to which European research and development activity can go forward clearly depends on the degree of knowledge and awareness in science and technology amongst European citizens and on public opinion.

The objectives of the Group were:
- To establish the current state of RTD culture and PUS in Member States;
- To survey existing activities and measures undertaken to promote RTD culture and PUS;
- To recommend measures for improvement, and to suggest good practices to be followed, or activities to be undertaken at national and European level.

The Expert Group was able to draw on several documents, such as national reports, either embracing a large part of the area or focussed in a particular area such as the media. As experts, the members of the Group were also well acquainted with the extended literature available on topics connected with their mission and the extent of research going on in the field. Additionally, the results of *Eurobarometer Survey 55.2* became available in November 2001, and there have been several recent national public opinion surveys of the attitudes about science (Austria, Denmark, France, the Netherlands) [21]. From those documents and from expert knowledge, it was clear that the matter under examination was a mushrooming affair involving many components.

## INFORMATION GATHERING

To answer our specific terms of reference, the Expert Group decided to use a methodology that would produce a classification of the different activities and promotion efforts undertaken in Member States, would provide a basis to identify good practices, and might lead to

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[21] in Finland, the association *Tieteen tiedotus ry* has published a science barometer 2001 survey called *Tiedebarometri 2001* at the end of October 2001. The results of this survey have not been utilized in the present report.

suggestions for action and mutual learning. To do this, the efforts of six basic "actors" were examined:

- Governments and their Agencies;
- The Scientific Community;
- Education formal and informal;
- Museums and Science Centres;
- The Media;
- Industry and Private Sector.

In addition to the focus on the six actors, the Expert Group tried also to assess three horizontal trends across the whole area:

- Issues concerning gender;
- The use of the internet;
- The extent to which policies and activities went beyond the "Deficit Model" (explained in the case study on the U.K. under "Governments and their agencies").

Although the Expert Group was given no official indicators to work with, the Eurobarometer does allow for some comparison between Member States. Discussion between the Group and Commission Officials resulted in the working premise that Eurobarometer knowledge levels should be taken as indicative rather than absolute, and that the Group would concentrate more on what the interest questions revealed. An analysis of the Eurobarometer was conducted and the results are given in this Report, and compared with the previous 1992 Eurobarometer survey.

The Group was also aware of other useful survey studies, such as various international and national questionnaires concerning public knowledge of and attitudes to the key area of biotechnology, recognised as, potentially, a vital one for development and economic growth, especially *Eurobarometer 52.1* and the work of the team of the project *Educating the European Public for Biotechnology*, whose final report will be available early June 2002.[22] A key source of information was answers provided to questions put to the High Level Group (HLG).

Since available information was usually specific to each of the actors identified above, the mode of collection had to be different in each case:

- For Government, the Group made use of official resources such as ministerial web sites, or of previous reports and studies. The HLG also provided vital information for most Member States.
- For the scientific community, connections and links provided by the European Science Foundation (ESF) in Strasbourg, the Association of European Academies (ALLEA), and personal contacts were used.
- For education, previous studies undertaken by the European Union or the Organisation for Economic Cooperation and Development (OECD) provided access to the different pedagogical strategies in science teaching and curriculum contents in Member States. Personal contacts were also used.
- For museums and science centres, the European Association of Museums and Science Centres (ECSITE) provided valuable help, offering in-depth analysis and quantitative data going beyond the European situation.

[22] *Educating the European Public for Biotechnology*, http://www.boku.ac.at/iam/ebe/

- For the media section, the Group commissioned quantitative data on the circulation and audience of science related publications in Member States, as well as making use of existing (although limited, from a country-by-country viewpoint) media studies.
- For industry and private sector, information was basically obtained through an Internet survey of key industries concerned with PUS and search of data banks recording patrimonial assets and industrial heritage in Europe.

To help understand some specific points the Group listened to other experts, including Commission staff responsible for *Eurobarometer 55.2* and the *Science and Society Action Plan*. Ulrike Felt of the O.P.U.S. network (Optimising Public Understanding of Science and Technology) kindly made a presentation on that research program underlying the cultural diversity of national settings, the communicational contexts problems (contradictory discourses shape the public perception of science) and the weight of history[23]. Graham Farmelo from the Science Museum London made a presentation on the new style of science communication inaugurated by the new Wellcome Wing at the Museum, concentrating on the need to set a stage for dialogue with the public about contemporary science and technology in Science Museums because of a demand from the citizens. On the occasion of a working session in Lisbon, the group had also the pleasure of listening to Minister José Mariano Gago, speaking about the principles of benchmarking, and to his co-workers Professora Ana Noronha and Professora Teresa Ambrosio about new trends in education in Portugal.

This work provided answers to the two first objectives of the group: establish the current state of RTD culture and PUS in Member States and make a survey of activities and measures undertaken to promote RTD culture and PUS.

### BENCHMARKING AND "GOOD PRACTICES"

Our third objective – to make recommendations - was also handled within the framework of the six actors; recommendations are to be found at the end of each chapter. The analysis undertaken generated several "case studies", both short-term and long-term, which may be considered as examples of "good practices" because they provide a basis for mutual learning, one of the main objective of a benchmarking exercise. The great diversity of the "case studies" recorded is testimony to the very different approaches to the RTD culture in Europe. It is clear that there exist nationally specific historical and cultural backgrounds, leading to a variety of practices.

Case studies are at one extreme of benchmarking, as described by Rémi Barré[24] as "the impossibility of benchmarking". This occurs when

> "… no simplification is possible and no comparison legitimate. The best we can do is to provide case studies (*ad hoc* stories illustrated by examples), which can only be put side by side. The advantage of this view is that the case studies may be meaningful to the actors and may provide valid insights. Also it may lead to the development of a conceptual framework, which would be based on a real understanding of how things work."

In this situation, the "impossibility of benchmarking" arises because there is no real comparability between experiences. At the other extreme, Barré defines "oversimplified

[23] Mission Report : OPUS project meeting London 30 September 2001
[24] Rémi Barré « Sense and nonsense of S&T productivity indicators » in *Science and Public Policy*, 28, (4) August 2001, p.263-264.

nonsense". The temptation, he warns, is to reduce the problem to a flow of numbers, and to compute ratios to derive a ranking system. It is then possible to build easy-to-read indicators, but at the risk of producing flawed recommendations based on a superficial system with a low cognitive content. Barré suggests maintaining a balance between the extremes of qualitative and quantitative benchmarking, using numbers as entry points for more in-depth comparisons - "an exercise of learning-by-comparing":

> "To be relevant to public policy, benchmarking must be considered as a process involving some aspects of both extremes… From the first, we should keep the idea of analysis with sufficient depth and due consideration of the socio-political and institutional context and from the second we should keep the idea of indicators useful for comparisons."

We have more or less tried to follow this middle path, mixing qualitative analysis with statistics when available. For instance, we use the Eurobarometer to give some numbers and ratios and - where the numbers have been available from previous surveys - to indicate trends. But we stress that these must be used in conjunction with other factors and local knowledge, not in isolation, and only insofar as they are helpful. The activity of some of our actors can also be related to numbers: visitors in science centres, number of issues sold for scientific magazines, number of hours of teaching science in classroom. Caution is always required, however: visitor numbers, for example, depend on demographic factors - Greater London has a population larger than Belgium.

For magazines, sales depend on the attractiveness of the cover and the style of the contents. It is much more difficult to decide on criteria to estimate the *quality* of the contents. Readership of the serious weekly scientific pages of prominent European newspapers cannot be separated from the day-to-day circulation data. Science on television cannot be benchmarked from the number of minutes broadcast since the impact on audience depends on scheduling - prime time or not - and on the quality of the content[25]. We have given those statistics we were able to collect, as materials to be build upon by future benchmarking exercises since their evolution in the future may provide as yet not so obvious indicators.

The impact of the diverse actions undertaken is still more difficult to benchmark: education, for instance, is a very long-term process whose results may only be seen across generations. New concepts enter culture slowly. If indicators are used to benchmark culture or knowledge, without in-depth analysis, they can at most produce a snapshot of the degree of understanding or interest; they cannot provide policy guidance.

It would have been interesting to have financial statistics showing the expenses of our different actors in the PUS field. Those were however difficult to obtain within the time allocated. But this may be an objective of the next benchmarking round. If they can be obtained, such figures can provide for numerical comparison of the policies within Member States. Any figures that were obtained are mentioned in the country by country section of the report, or embedded in the discussion of key issues (science centres for instance).

### WORK NOT UNDERTAKEN

There is at least one additional "actor" that has not really been considered - independent associations and lobby groups whose goals are very diverse, and of whom some, at least, are

[25] At least there is some consensus in Europe as who produces the best television shows in term of science - the BBC. This is another example of the weight of history in the current state of RTD culture and PUS.

established national and international NGOs. The trades unions also come under this heading. The somewhat heterogeneous nature of lobby groups makes them difficult to circumscribe and analyse. At a local level as well, there is a dense web of independent associations, some of whom play an active part in informal science education. In France, for instance, these associations recently expressed a willingness to take a more active part in the decision making process about PUS and "culture scientifique", criticising implicitly the action of Government, research institutions and museums[26].

There are many sub-actors whose specific roles could not be addressed in this exercise. In particular, these included:

- Local and regional governments;
- Universities;
- Books and libraries;
- The technical press and magazines;
- Radio broadcasts;
- Many branches of industry and the role of their trades unions.

The Expert Group would have benefitted from at least one national expert correspondent in every Member State, although the HLG did partially compensate for this. Nonetheless some national delegations failed to respond to our specific questions, leading – inevitably - to incompleteness. Finally, there was insufficient time to compare the European Union with United States and Japan – clearly an important goal for future benchmarking exercises.

SPECIFIC ISSUES

The Group faced a long list of specific issues to take into consideration. Some of them (such as formal/informal education or science museums/centres) were important points duly treated in the report, others (such as the language/jargon issue, or lifelong learning) warrants a special study beyond the scope of this report. Below are some specific issues, which emerged as important problems to be considered in future benchmarking exercises.

***The role of history***

Science as we know it appeared in the beginning of the $17^{th}$ century and was accompanied from Day 1 by science popularisation and science fiction. While science has always be an international affair, science popularisation and science fiction followed national tracks. One of the first science popularisation books was Galileo's "Dialogue", published in Italian in February 1632. Athanasius Kircher (the most famous scientist of his time, the prototype of the media scientist) used then-recent optical scientific discoveries to design spectacular public shows in Rome around 1640 and created one of the first science museums. One of the first science fiction novels is "Les Etats et Empires de la Lune et du Soleil" of Savinien Cyrano de Bergerac, a physicist, published 1648. Part of the mission of the Royal Society of London, founded in 1660, was public demonstrations of new science, as part of its validation process.

Different strategies in education and religious background have both contributed to national divergences. The historical crisis of science-society relationships, such as the one which occurred in the Romantic era (illustrated by the Goethe-Newton debate about colour), has set

[26] « Assises Nationales de la Culture Scientifique et Technique », Paris, Unesco, 11-13 January 2002, organised by a collective of Federations of Associations mostly working in popular education

the stage for attitudes up to the present day (the status of "Nature" in our society as described by the German Natürphilosophie at the beginning of the $19^{th}$ century, which influenced deeply the north of Europe). The action of the national "actors" in the promotion of RTD culture and PUS consequently depends on the national history or tradition.

The history of science provides many stories used in promoting RTD culture. But the history of the ways and means of promoting RTD culture also shows some recurrent situations, which may be connected to economical cycles. For example it is easy to recognise in the figures of contemporary scientists the basic schemes - and even the words - underlying the campaigns of Faraday and Arago in the first half of the $19^{th}$ century in favour of scientific education. History shows that industry is more active in promoting RTD culture when technological changes are occurring and when a market is to be opened by creating a taste for the use of new machines or products, a situation that happens at times of destruction of old technologies and creation of new ones (as it is the case today and was the case in 1851 when the first universal exhibition opened in London).

The past may have consequences for some of the problems under scrutiny today. For example, one of the reasons that there are only about 40% of girls in the university student population in science in France (see note 29) may be the traditional exclusion of women from the scientific world through the pre-eminence of male only "Grandes Ecoles" such as Polytechnique (established 1804 as a military school), which accepted women only some twenty years ago [27].

### *Science and entertainment*

Of course new technologies and the modern media era have altered strategies for promoting science, traditionally carried out through lectures, books, images or objects. But the old techniques are still very much alive. At the same time, the atmosphere of "show society" has impregnated some of the contemporary actions, particularly in the mass media (TV and tabloids for instance) but also for museums, exhibitions and entertainment parks. The science promoted, then, is not the academic variety, but a kind of science that can provide attractive and spectacular stories, such as space adventures or dinosaur hunts[28]. Many Hollywood movies are based on "scientific" plots and feature scientific characters[29]. All of this colours the atmosphere for science communication.

### *Range of interests in RTD culture*

People are interested firstly in things concerning the body, food or medicine or sports, then in the environment, and thirdly in new technologies[30]. Emotions generated by the possible existence of a hidden dangers or health risks from food or environmental conditions are a major political concern (mad cow disease, Chernobyl fall-out, dioxin). The same studies show

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[27] Catherine Marry co-director of the CNRS MAGE laboratory (Market, Work and Gender) in « Le Monde », April 24 2002, p.22

[28] Paul Caro : « Science in the Media between Knowledge and Folklore » in The Communication of Science to the Public, Science and the Media,. Fondazione Carlo Erba, Milano 1996, pp 111-132.

[29] There are the famous examples of « Jurassic Park » and « Deep Impact ». For a general comment on science in the movies and examples see Donald J. Wink *Journal of Chemical Education* 78 (4), April 2001, pp.481-483

[30] Aymard de Mengin, Surveys of the « Département Evaluation et Prospective » since 1989, Cité des Sciences et de l'Industrie Paris, see also Paul Caro and Jean-Louis Funck-Brentano : L'appareil d'information sur la science et la technique, Tec et Doc Lavoisier, Paris, 1996 pp 46-47. Those findings are also supported by TV inquiries on public interests.

that people no longer perceive science through traditional disciplinary classifications - mathematics, physics, chemistry etc. It may be that the poor image of these basic disciplinary fields is one of the causes of the decreasing interest of young people for science studies at university level[31]. The Barcelona Summit has highlighted this problem in March 2002 as a priority for action in education.

### *Instability in action*

One characteristic of this area is the temporal variability in the decisions, actions, and commitments, of our actors. Governments are short lived and have political agendas. Support for science may be mentioned in a political program and be discarded in the next one. Institutions that have a historical commitment to the diffusion of scientific culture such as national museums may be protected from variable political behaviour because they are rooted in national budgets. But small short-term promotion operations such as science weeks, subventions to associations or yearly projects, may fluctuate, live or die. Financial support for research agencies may diminish; in that case there is a good chance that communication services and science popularisation policies will be hit first. Changes in policies due to sudden political decisions can modify, for good or bad, a particular landscape of RTD culture (such as the recent British decision to make entrance to national museums free).

If world and European economic conditions provide a common background for Members States, politics is state specific. Even education is not protected from political scramble: for instance the French Ministry of Education ordered, in January 2002, a complete change in the pedagogy of teaching science in primary and secondary schools. Some trades unions opposed this, and now the Minister is going to change in the wake of new elections. The Portuguese policy of devoting 5% of its research budget to the promotion of RTD culture and PUS (see case study in “Governments” chapter) may - similarly - also change, following the March 2002 elections. Recent financial difficulties and subsequent restructuring have also hit support from industry to outreach activities. Even apparently stable actors can suddenly walk offstage, as, for instance, when a science magazine, although successful, disappears by a decision of its parent company to leave publishing and go into another field of economic activity. Museum authorities may decide to shift their presentations more to entertainment than to science in an effort to attract visitors and make money. Web pages are notoriously unstable; information abruptly disappears or is not updated. Instability in actors’ policies and activities is one of the hurdles to promoting RTD culture and PUS, but it is difficult to overcome.

### GENERAL FINDINGS

The diverse actions undertaken to promote RTD culture do not fit into a simple scheme. <u>But one can consider that there are, broadly, two groups of actions</u>:

- Short-term actions undertaken mostly at the initiatives of Governments, the scientific community or industry. These depend on conjectural parameters, political and social moods or pressures, cultural, economical, connected to the employment situation or even administrative requirements. Although they are not the main line of business of these actors, such short-term initiatives may end up producing a long-term framework.

[31] A new report was made available in April 2002 to the French Ministry of Education analysing the reasons behind the lost of interest of young people for science, by Professor Maurice Porchet. See « *Le Monde* » April 24 2002 page 22 . The report itself is available on http://www.education.gouv.fr/

- Long-term activities, carried out (almost) continuously, albeit subject to changes, are promoted by education, museums and media. Across Europe, schools, museums and the media, such as newspapers and magazines, have had an interest in the diffusion of scientific knowledge and scientific culture for nearly two centuries.

But there are many overlaps. And on specific objectives, actors work together - for instance in the framework of a science week, or in the organisation of schools' visits to museums, or scientists visiting the classroom. These co-operations have been duly mentioned.

Full specific findings are outlined in each of the six sections of the report. Approximately half of the Member States have stated policies on the promotion of RTD culture and PUS. Looking at members of the European Science Foundation (ESF), it appears that less than half of the European Union's academies, research councils and scientific societies listed there have such policies as well. A few countries have recently introduced legislation regarding S&T curricula in schools. Visitors to museums and science centres appear to want to see more on the social implications of science, whereas for the press the most newsworthy items are controversial issues. Industry generally follows two rather distinct tracks: either they offer information in an attempt to increase knowledge; or they gamble on the development of dialogue with the public.

Some general findings that cover several actors will now be considered:

***PUS, PUSH and Culture Scientifique – discussion of the concepts***

One of the issues in this benchmarking exercise is that the promotion of RTD culture and public understanding of science contains terms that do not quite translate from one language to another. And this, in turn, reflects different historical and cultural nuances. This exercise has not drawn a distinction between the three terms above, although some of the differences in practice from country to country may be attributable to them[32].

"Public Understanding of Science" (PUS) is the term used in the UK, and owes much to the American notion of "scientific literacy". This latter term has been defined include knowledge of scientific facts, understanding of scientific methodology, and an appreciation of the impact science makes on society[33]. It is a way of problematising this area that makes it very amenable to opinion poll/survey measurement, such as those carried out regularly by the American National Science Foundation and less frequently by the Eurobarometer. It makes country-to-country comparison easy to carry out, if difficult to interpret.

"Public Understanding of Science and Humanities" (PUSH) is a deliberate anglicisation of the promotion of what is termed in Germany "Wissenschaft", and has no translation into English, where social sciences, history, economics etc. are seen as something separate from the natural sciences. However, in the German understanding of the humane disciplines, knowledge is being systematically acquired, making use of rules and laws, in a way that makes them epistemologically indistinguishable from the natural sciences. Thus the English separation is artificial.

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[32] Information for this section is taken from the European Network of Science Communication Teachers (ENSCOT: http://www.enscot.co.eu/) and OPUS (http://www.univie.ac.at/Wissenschaftstheorie/opus/)
[33] J.D. Miller. "Scientific literacy in the United States" in *Communicating Science to the Public* (eds. D. Evered and M. O'Connor). (Wiley, Chichester. 1987). Pp. 14-19.

The Gallic notion of "Culture Scientifique" (CS) sees the issue rather differently from PUS and PUSH. In a recent study, three essential characteristics were identified in this approach:

- Science should be seen as part of the general culture, in which democracy leads of necessity to a common sharing of scientific knowledge;
- Science and art are equivalent - or even science *is* an art;
- Science occupies its particular place in culture as a result of its utility.

In CS, therefore, the issue is much more the overall development of a cultured public than it is the enhancement of a particular aspect of culture. But it is essential that science's place and standing in culture be maintained. This approach may be further modified, especially in Italy, with an emphasis on science and the history of science - perhaps Culture Scientifique et Historique.

***Two trends in science–society relationship***

Social scientists have recognised two key trends in contemporary science-and-society relationships[34]. There is a classical viewpoint, in which the public representation of science is considered neutral and objective, as progress benefits everyone. The public should be informed, its curiosity should be aroused, and it is expected to marvel at the beauties of science and the inventions of technology. In the process it should learn. This usually goes along with a stern criticism of the media for "deforming" scientific information. Implicitly or explicitly supporting this view, one can find government ministers, members of the scientific community, many educators, and a large part of industry. A fair amount of coverage of science in newspapers or television, and the more traditional science museums also adopt this approach. This has given rise to what has come to be known as the "Deficit Model" (see Case Study on U.K. in "Governments" chapter).

But another view has emerged. In this, science is considered as a component of society that may become dangerous as a result of being insufficiently controlled[35], or even corrupted by malign intent. In this view, science is not wholly beneficial: it can lead to disaster[36] and exploitation[37]. As a consequence it has to be controlled and its actions and programs have to be criticised and submitted to a democratic appraisal [38]. The media have a very important part to play in conducting inquiries, raising questions and providing a forum for debate in the public sphere. Formal, scientific-like, knowledge is not a pre-requisite to participate in debates, other types of knowledge (e.g. intuition) may be considered as valuable. Science is not something to be watched, enchanted, but a serious social problem that has to be debated by responsible citizens to make the right choices. In order to do so, proper information should be made available to everybody, and in ways that *they* find useful and acceptable.

This latter view of science has now begun to influence the action of our actors. Governments and research organisations are more and more concerned with public debates: they not only participate but organise. In schools, project-oriented pedagogy often tackles controversial scientific issues (cloning or pollution for instance). The media willingly play the "white

[34] P. Chavot in Mission Report : OPUS project meeting London 30th September 2001.
[35] H. Collins and T. Pinch, *The Golem: what everyone should know about science* (Cambridge University Press, Canto Edition, 1993) provide a useful discussion of this.
[36] The classical reference here is to R. Carson, *Silent Spring*. (Penguin Books, London. 1965.)
[37] E.g. S. Aronowitz, *Science as power: discourse and ideology in modern society*. (Macmillan, London. 1988)
[38] Bernadette Bensaude-Vincent, *L'opinion publique et la science, à chacun son ignorance* (Institut d'édition Sanofi-Synthélabo, Paris 2000

knight" in scientific or industrial controversies. And industry itself is taking action to deal with the social, ethical, economical and moral issues. Following this dynamic equilibrium between these two tendencies is certainly an objective for future benchmarking. For instance,conscious of the gap between research life sciences and public opinion, DG Research has launched the "Science Generation initiative"[39] on July 4 2002, backed by € 1.44 million, "to help inform EU citizens on life sciences and foster debate on bio-sciences, with the active participation of students, parents, teachers, researchers and journalists". This is in fact a project of the multinational Aventis already experimented in France, which will be extended to Italy and Sweden with the help of Euro-CASE (the European Academies of Technology association).

***The scale problem***

There are large difference in scale among our actors, their actions, and their audiences. Some actors are huge, such as research organisations, the "Big Four" science museums[40] or the national education system, and reach huge audiences. And although these actors attract large numbers of people, they do not compare to the pulling power of the mass media, which may carry some scientific content, such as TV series, movies or some entertainment parks. Other actors are small, with relatively small audiences; but one notes the huge impact of small science centres on local communities and the importance of local spirit in the crowds gathered in small towns for a science week event. And if they form a dense enough web, the quality of these small audiences may generate powerful public opinion trends.

Big actors also carry out small-scale activities, such as experiments in science education: "La Main à la Pâte" was trialled in just 5% of French classes, for instance. Our different actors address themselves to audiences of very different size, too. Many activities organised by Governments, the scientific community or industry reach very small but key audiences; a typical example are conferences in which medical professionals hear about new clinical developments, or visits to industrial visitor centres. On the other hand big museums and science centres, the mass media and the education system reach crowds.

There are demographic factors to consider: very large cities and heavily populated areas have much more in terms of museums, newspapers, school visits, access to public debate, libraries, fast Internet connections and so on. This creates an urban dimension to the science/society relationship: public monuments dedicated to science are integrated into urban public spaces as cultural references. In turn, this generates migration from the countryside or smaller towns, producing scientific tourism throughout Europe. Science is a component of the attractiveness of a few powerful urban centres. Should this be a cause for celebration - as it clearly is in the case of a city like Barcelona, recreating itself as the "City of Knowledge" - or should we worry that such imbalance and concentration might one day make, say, London the EuroDisney of science communication?

***PUS as business***

The chapters on "Science Museums and Science Centres" and "Media" show clearly the importance of economical factors contributing to the diffusion of scientific information. The contribution to tourism of science and technology oriented Museums, Science Centres,

[39] http://www.science-generation.com and http://europa.eu.int/comm/research/index.html
[40] These are La Cité des Sciences, the Deutschesmuseum, the London Science Museum and the Natural History Museum.

patrimonial industrial assets, open-air museums, and the like is important especially on the local scale besides the few huge Institutions which are part of the attractiveness of large urban settings. In front of classical art museums or monuments, they offer a contrasted image of European culture and its history. In addition to their educational flavour, they promote the diversity in taste of the public. Many are very successful but there are problems of profitability, continuity of resources and maintenance spending. The costs are very high and public-dependent outlets need to attract visitors, readers, or watchers. They must have a policy to do so. The paying public may not discriminate between, say, entertainment parks or sensational literature, on the one hand, and "serious" museums or science magazines, on the other. So there is a tendency – noted earlier - to use components of "show society". This makes some science topics much easier to popularise than others. It can also introduce tension between the scientific community and, say, a science museum or public t.v. channel[41]. Here is a source of potential conflict between our actors that warrants following carefully.

### *Further research*

In general, information in the area of promoting RTD culture and PUS is highly dispersed. There is little in-depth synthesis; just data that are hard to compare together with a few older studies that are difficult to use in a fast changing landscape. So more research is needed at the European and national levels. This needs to provide an analysis of the past and present trends, and offer perspectives that go beyond raw facts. Future benchmarking requires a unified European methodology. The 1994 study on science education in Europe,[42] which was based on a collection of comparable national reports, could provide a model for doing this.

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[41] See for instance the criticism of the French Minister of Science addressed to public television channels, April 2001

[42] Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994

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# CHAPTER 1: ANALYSIS OF EUROBAROMETER 55.2 DATA

## 1.1 INTRODUCTION

Surveys and questionnaires are well-established techniques for measuring public attitudes to a range of subjects and issues, and their use in the area of RTD culture and PUS can be dated from that undertaken in 1957 by the American Science Writers' Association[43]. This survey was carried out in the wake of the successful launch of the Sputnik satellite by the Soviet Union and was used to support political initiatives to improve science education in the United States. In doing this, science educators were tapping into the concepts of the American educationalist John Dewey, for whom it was important to acquaint the citizens of the USA with "scientific thinking", giving rise to the notion of Scientific Literacy[44]. The National Science Foundation has carried out surveys since 1973, biennially since 1979[45]. According to Jon D. Miller, the scientific literacy that can be probed by survey techniques consists of knowledge of facts and concepts, understanding of the scientific process and awareness of the impact of science on society. Under Miller's direction, NSF surveys have consisted (and consist) of self-reported levels of interest and awareness of various areas of science and technology (including medicine), knowledge of scientific facts, and ability to state or recognise scientific methods. The American science indicator survey model has been adopted - sometimes with some changes - across the world.

At various times, individual Member States have carried out their own surveys. The European Union has also carried out such surveys periodically. The first (by the Commission of the European Communities) was in 1977 and showed that Europeans considered science as "one of the most important factors in daily life"[46]. Attitudes showed a general consensus in support of science. Eurobarometer surveys were carried out in 1988[47] and 1992[48]. This forms the basis of a comparison with the latest Eurobarometer Survey 55.2 (carried out in 2001)[49], reported below, which attempts to draw conclusions about the development of the climate in Europe and individual members states for the promotion of RTD culture and PUS. In the following section, we also allude to criticisms of surveys - or at least the way they have been interpreted. One interesting critique of the Miller model of scientific literacy has been put forward by Durant[50]. In this, he points out that much of the science citizens need to understand current scientific and technological issues is not certain; instead it is "science in the making", precisely the sort of knowledge that surveys are least well suited to measuring.

The drawbacks to reducing a field as complicated as the promotion of RTD culture and PUS merely to a comparison of numbers and ratios have already been pointed out in the Introduction. However, the Eurobarometer figures exist as a general backdrop in front of which all our actors perform, and may provide a helpful reference for all of them.

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[43] S.B. Withey. "Public opinion about science and the scientist." *Public Opinion Quarterly* **23**, pp. 382-388 (1959).
[44] John Dewey. "The supreme intellectual obligation". *Science Education* **18**, pp. 1-4 (1934).
[45] Jon D. Miller PUS launch issue reference.
[46] Commission of the European Communities, *Science and European public opinion.* (Brussels. 1977.)
[47] *Basic statistics of the Community*. (Eurostats, Brussels. 1989.)
[48] *Basic statistics of the Community*. (Eurostats, Brussels. 1992.)
[49] Eurobarometer 55.2 *Europeans, science and technology.* (European Commission, Brussels. 2001)
[50] John Durant. "What is Scientific Literacy" in *Science and Culture in Europe*. (The Science Museum, London. 1993). p. 129.

## 1.2 THE CURRENT SITUATION

### *Data selected*

This report makes use of Eurobarometer 55.2 data from the Spring 2001 questionnaire[51]. This is not in order to rank countries according to knowledge scores or some other criterion, but to provide an indication of the public climate for science and technology throughout the European Union, so that policy makers may better orientate their activities. We have chosen the percentage of respondents able to give the correct answer to the true/false knowledge questions, averaged over the 12 questions, and an indication of the range across the questions, as well as the numbers understanding scientific methods and concepts as investigated in the surveys. We report the percentage of interviewees saying that they were fairly interested in science and technology, and make this the determinant of our interest level. Alongside this, we give self-reported levels of interest for medical developments, because they are highly relevant to daily life, and – by way of contrast – interest in astronomy and space matters, since this may be a good probe of general cultural/intellectual interest in science. As a measure of citizen's willingness to act on their reported interest, we report percentages that have visited a science museum or centre in the last year – though this is, of course, far from being the only way that interest can be satisfied. Finally we give the level of esteem in which doctors and scientists are held, together (for comparison) with politicians. Our findings are summarised in Table 1 below. Results are given in multiples of the E.U. average figures.

Across the European Union, the average correct response to the knowledge questions was 57.8%. 43.5% were at least fairly interested in science and technology. Just over 60% of E.U. citizens find medical developments interesting and the corresponding figure is 17.3% for astronomy and space science. 11.3% of the E.U. public visited a science and technology museum/centre in 2000. Doctors are held in esteem by 71.1% and 44.9% esteem scientists, compared with 6.6% for politicians. (Esteem is averaged over scientists and doctors in Table 1, below.)

### *A new indicator – combining knowledge and interest*

A full analysis of this (and the other) Eurobarometer data is beyond the scope of this report. But it is possible to pick up some trends. Traditionally, proponents of increasing activity to promote RTD culture and PUS have argued that high knowledge levels are inextricably linked to greater interest in, and positive appreciation of, science and technology[52]. An analysis of the 1992 Eurobarometer data indicated that the relationship was more complex than this, however, especially for countries with higher than average knowledge levels[53]. We postulate that an indication of the climate for the promotion of RTD culture and PUS may be obtained by looking at knowledge and interest levels in combination, and that future knowledge levels may depend more on current interest, than the other way around - a sort of "demand-led" RTP/PUS economy. So we have included the ratio of knowledge/interest (K/I), since this may

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[51] Eurobarometer 55.2 *Europeans, science and technology.* (European Commission, Brussels. 2001)

[52] For a discussion of this see G. Thomas and J. Durant. "Why we should promote the public understanding of science". *Scientific Literacy Papers* **1**, pp. 1-14 (1987).

[53] J. Durant, M. Bauer, G. Gaskell, C. Midden, M. Liakopoulos and L. Scholten. "Two cultures of public understanding of science and technology in Europe", in *Between understanding and trust: the public science and technology*. (Eds. M. Dierkes and C. von Grote. Harwood Academic Publishers, Amsterdam. 2000.) pp 131-156.

indicate where current activities are fulfilling the general public's own perceived needs, or where there may be a need to generate either more interest or more resources. We propose:

- a level of K/I significantly above 1.00 - 1.10 or greater - may be a sign of citizens saying they already have enough public science, or that there is a climate of disenchantment;
- a level of K/I significantly below 1.00 – 0.90 or less – may indicate unmet requirements, with opportunities for initiatives in this area to bear fruit.

*Table 1: Indicative levels as a multiple of E.U. average*

| **Country** | **Knowledge** [a] | **Interest** [b] | **K/I** | **Activity** [c] | **Esteem** [d] |
|---|---|---|---|---|---|
| Belgium | 0.92 | 0.93 | 0.99 | 0.86 | 1.07 |
| Denmark | 1.11 | 1.34 | 0.83 | 1.50 | 0.97 |
| Germany | 0.98 | 0.66 | 1.48 | 1.09 | 0.93 |
| Greece | 0.85 | 1.34 | 0.64 | 0.45 | 1.07 |
| Spain | 0.91 | 0.94 | 0.97 | 1.00 | 1.01 |
| France | 1.02 | 1.20 | 0.84 | 0.71 | 1.10 |
| Ireland | 0.84 | 0.70 | 1.20 | 0.36 | 0.75 |
| Italy | 1.05 | 1.13 | 0.93 | 0.77 | 0.99 |
| Luxembourg | 1.01 | 1.15 | 0.88 | 1.23 | 1.11 |
| Netherlands | 1.16 | 1.30 | 0.89 | 1.21 | 1.07 |
| Austria | 1.00 | 0.83 | 1.20 | 1.04 | 0.86 |
| Portugal | 0.81 | 0.84 | 0.96 | 0.79 | 0.93 |
| Finland | 1.12 | 1.17 | 0.95 | 0.91 | 1.02 |
| Sweden | 1.25 | 1.42 | 0.88 | 1.72 | 1.13 |
| U.K. | 1.01 | 1.04 | 0.97 | 1.40 | 1.01 |

[a] Average over 12 knowledge questions of percentages giving right answer
[b] Percentage saying they were (at least) fairly interested in science and technology
[c] Activity as measured by attendance at science museum or centre
[d] Average of percentages expressing esteem for doctors and esteem for scientists

### *Analysis*

On the knowledge scores, the lowest are to be found at the north-west, south-west and south-east extremities of the European Union – Ireland, Portugal and Greece – and the highest clustered in northern Europe – Denmark, Finland, the Netherlands and Sweden. The more central countries score around the E.U. average. Interest levels do not correlate well with knowledge for the lower and middle placed countries on the knowledge scale: for instance, Germany - almost average on the knowledge score - has the lowest self-reported interest level, but citizens of Greece, third lowest on knowledge report high interest levels. It is noteworthy, however, that all four of the highest scorers on the knowledge scale - those more than 10% above the E.U. average - report high interest levels.

Looking at the K/I indicator, only six member states (40%) are within +/-7% of 1.00 (Belgium, Finland, Italy, Portugal, Spain, and the U.K.). These range from high knowledge scoring Finland, to Portugal which is lowest on the knowledge scale. That leaves nine Member States that deviate fairly significantly. At the high end of the scale are Germany and Ireland. In the case of Ireland, although the knowledge score is low, interest is so low that K/I is 1.20. But Germany, with average knowledge levels, has even lower interest levels such that

K/I is 1.48, the highest in the E.U. This makes it likely that current policies and activities in the promotion of RTD culture and PUS have, in those two countries, yet to reach out meaningfully to the general public and to awaken their interest.

At the lower end of K/I, even though Greece scores low on the knowledge scale, its citizens report themselves to be so interested in science and technology that K/I is just 0.64. This could be seen as a hopeful sign, since a more informed public may follow greater interest in time. France and Denmark also have low K/I, which might indicate unsatisfied public demand in the area of RTD culture and PUS. Looking at the activity indicator for Greece and France, encouraging greater attendances at science museums might be one way of meeting this demand.

There is an enormous range in activity levels, expressed as visits to science museums and centres, with values varying from 36% of the E.U. average in Ireland to 172% in Sweden. It is not clear to what extent this is a function of the availability and accessibility of such centres. The breakdown of membership of ECSITE (the European science centre organisation) for these two countries shows that Ireland has four museums or centres and Sweden nine, relatively less compared with the 91 centres in the U.K.[54] If accessibility is a factor, then it is not simply a function of the *number* of museums and science centres available. In all countries, the public generally holds doctors and scientists in fairly high esteem, valuing them well above comparable professions, such as judges. Few countries deviate far from the E.U. average, but in Austria and – particularly - in Ireland the scientific and medical professions should be mindful of their public image.

[54] See chapter on *Science Museums and Science Centres*.

## 1.3 COMPARISON WITH 1992 EUROBAROMETER

### *Methodology*

One of the reasons for conducting surveys at regular intervals is to investigate to what extent activities may have an impact on the relevant area. For the promotion of RTD culture and PUS, it therefore makes sense to see if anything can be learned from a comparison with Eurobarometer 55.2 and the survey carried out almost a decade earlier[55]. Although we have not had access to the raw data for the 1992 survey, we have been able to make use of that presented by Durant and coworkers[56], since they also made use of the 12-question knowledge scale and reported interest in science and technology. This work also produced an insightful conceptual framework, to which we refer briefly:

- Durant and coworkers identified trends in which knowledge correlated positively with the level of industrialisation;
- In looking at interest levels they identified a positive correlation with industrialisation for the less to averagely industrialised E.U. member states. This gave way to a tendency for interest levels to decline, particularly in countries they characterised as post-industrial (Denmark and Germany).[57]
- Thus they characterised "disinterest out of ignorance" for the less industrialised countries and "disinterest out of familiarity" for Denmark and Germany (and to a lesser extent, Belgium and the U.K.). Implicit in their analysis was the idea that the characteristics they found would be dynamic rather than stable, if left to their own devices.

The analysis of the 1992 data covers only 11 member states - Belgium, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain and the U.K. In addition, Germany is given in terms of East Germany and West Germany. To compare with the 2001 Eurobarometer 55.2 data used here, three steps have been performed:

- The 1992 Germany data have been numerically averaged over East and West;
- The 1992 data have been expressed as multiples of the E.U. average, in the same way as that has been carried out to produce Table 1;
- The 2001 data given in Table 1 have been renormalised to remove Austria, Finland, Luxembourg and Sweden.

In Table 2 we present changes relative to the average pertaining in 1992 and 2001. There appears to have been little change in knowledge scores over the past decade. The current average answering correctly is 57.8% (stated above). In 1992, it was 56.7%. This means that it *is* possible from what is presented here to say if a particular country's average knowledge level has changed over the last ten years, since a change relative to the E.U. average is almost identical to the absolute change. Changes in real, rather than relative, interest levels are more difficult to judge, since the method of asking about these changed between the two surveys. But normalised to the E.U. average, the interest level changes between 1992 and 2001 should be a good indication of what is happening.

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[55] *Basic statistics of the Community*. (Eurostats, Brussels. 1992.)

[56] J. Durant, M. Bauer, G. Gaskell, C. Midden, M. Liakopoulos and L. Scholten. "Two cultures of public understanding of science and technology in Europe", in *Between understanding and trust: the public science and technology*. (Eds. M. Dierkes and C. von Grote. Harwood Academic Publishers, Amsterdam. 2000.) pp. 131-156.

[57] N.B. These authors drew a distinction between Denmark, which they characterised as optimistic towards science and technology, and Germany, which they described as pessimistic - see later.

*Table 2: Percentage changes in indicative levels, as a multiple of contemporary E.U. average, between 1992 and 2001*

| Country | Knowledge 2001-1992 | Interest 2001-1992 | K/I 2001-1992 |
|---|---|---|---|
| | | | |
| Belgium | -5% | -2% | -4% |
| Denmark | -1% | +32% | -28% |
| Germany | -12% | -29% | +23% |
| Greece | -3% | +25% | -16% |
| Spain | -6% | -6% | no change |
| France | -7% | +14% | -19% |
| Ireland | -9% | -21% | +18% |
| Italy | +4% | +9% | -4% |
| Netherlands | +9% | +25% | -13% |
| Portugal | +2% | -5% | +7% |
| U.K. | -5% | no change | -5% |

***Analysis***

The entries in this table fall into three groups on the K/I indicator: those with only relatively small changes (Belgium, Italy, Portugal, Spain and the U.K.); those with large (>10%) negative changes in K/I (Denmark, France, Greece and the Netherlands); and those with positive K/I changes greater than 10% over the last decade. The group with little change in K/I could be characterised as showing a fairly stable climate for the promotion of RTD culture and PUS and are generally around or below average on the knowledge scale. These countries do not have current K/I levels that differ appreciably from 1.0, and one could conclude that there is not an unmet public demand for greater scientific knowledge or awareness, although it may be necessary to generate more interest if knowledge levels are to be improved. One country in this group that is worth some further comment is Portugal. Although it appears interest levels declined, it should be noted that Portugal went from being lowest in 1992 to fourth from lowest in 2001 on this indicator. And there was a slight improvement in knowledge relative to other E.U. countries.

In the cases of Denmark, France and Greece, the large decreases in K/I result mainly from a large increase in interest, although slight decrease in knowledge is recorded. In the case of the Netherlands, the other country with steeply decreasing K/I, increasing knowledge is accompanied by even more dramatic increases in interest. These are all countries with K/I levels below 0.90, indicating possible unmet public demand in this area. Given the decline in K/I stems mainly from increased interest levels, the climate in these four countries could be characterised as favorable to the promotion of RTD culture and PUS at the present moment, and policies and activities in this area could be extremely productive. In the case of Greece, which has a rather low knowledge score, now could really be the moment to *carpe diem*. It also possible to observe that Denmark shows the largest decrease in K/I (-28%), despite maintaining (almost) static knowledge levels. This effect was, implicitly, predicted by Durant and coworkers. It is worth noting that Denmark is the country that, traditionally, has done most to involve its citizens in decisions about the future of science and technology[58].

[58] See chapter on *Governments and their agencies* for more details of this.

Germany and Ireland have rather large increases in K/I. In these countries, a dramatic fall-off in interest is occurring simultaneously with significant falling relative knowledge levels. These are danger signals. Germany has dropped from leading the E.U. in the knowledge scales, to being merely average. In Durant and coworkers' analysis, the Germany of 1992 was already suffering from a post-industrial *triste* as far as science and technology were concerned. Ten years on, this appears to have taken a toll on knowledge and interest of science and technology that may have serious repercussions. For Ireland, there is a danger that the "disinterest through ignorance" features noted in 1992 may be leading to a downward spiral into a "don't-know, don't care" situation as far as RTD culture and PUS is concerned.

## 1.4 DISCUSSION AND SUMMARY

This is a very limited first-pass look at the latest Eurobarometer data and their relationship to that of 1992. It is clear that there is important information contained in the detailed figures that can illuminate the climate for promoting RTD culture and PUS. A full comparison of Eurobarometer 55.2 with levels of industrialisation, as performed by Durant and coworkers for 1992, could be useful. It is also useful to look further at possible correlations between knowledge and interest levels concerning science and technology, on the one hand, and other areas of daily life and culture - economics and politics, for example - on the other.

Survey data of the Eurobarometer kind need to be treated a certain scepticism, however, particularly when it comes to knowledge questions. Surveys have been used in the past to paint a picture of an ignorant public[59], showing a "deficit of knowledge"[60] – an approach which has given its name to the "Deficit Model", a line of reasoning that says the promotion of RTD culture and PUS is "simply" a matter of stuffing the empty public's collective head with scientific facts in the hope that they will be more interested in science and value it more[61]. It is arguable that the real indicator measured by knowledge surveys of the "12-questions about science kind" is to what extent citizens have the *same* store of knowledge of scientists, and to what extent they *think* like scientists[62]. And how scientists think and why, and what their thinking has to do with common sense has been much debated[63]. It certainly seems to be the case that knowledge survey questions do not really probe the toolkit of knowledge and strategies that members of the general public bring to bear when dealing with problems that have a scientific and technical aspect to them[64]. More recently, methodological concerns have been expressed over the way data on public attitudes has been collected and analysed[65].

It is important, however, to qualify scepticism towards science awareness surveys, in order not to devalue them unjustly.

- While it is true that the original "deficit modellers" made much of the results of surveys, which showed low levels of public knowledge of science (low scientific literacy), to bolster their particular agenda, that does not mean that surveys are inextricably linked to the Deficit Model and can therefore serve no other purpose;
- It is certainly true that "broad brush" surveys do not really tap into the full array of knowledge resources available to people to deal with science in issues that really matter to them (e.g. family health, local pollution, ethical issues concerning research etc. For that reason "rankings" on the basis of knowledge scores alone is misleading;

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[59] E.g. J.D. Miller. "Scientific knowledge in the United States", in *Communicating science to the public*. (Eds. D. Evered and M. O'Connor. Wiley, Chichester. 1987). Pp. 14-19.
[60] A.G. Gross. "The roles of rhetoric in the public understanding of science". *Public Understanding of Science* **3**, 3-23 (1994).
[61] J. Gregory and S. Miller. *Science in Public*. (Plenum, New York. 1998.) pp. 89-90. See also U.K. case study in chapter on *Governments and their agencies*.
[62] M. Bauer and I. Schoon. "Mapping variety in public understanding of science." *Public Understanding of Science* **3**, 141-156 (1994).
[63] E.g A. Chalmers. *What is this thing called science?* (Open University Press, Milton Keynes. 1978.); L. Wolpert. *The unnatural nature of science*. (Faber, London. 1992).
[64] J. Gregory and S. Miller. "Caught in the crossfire: the public's role in the science wars" in *The one culture? A conversation about science*. (Eds. J.A. Labinger and H. Collins. University of Chicago Press. 2001.) pp. 61-72.
[65] R.Pardo and F. Calvo, "Attitudes toward science among the European public: a methodological analysis." *Public Understanding of Science* **11**, 155-195 (2002).

- However, it is also possible to use even existing survey data more sophisticatedly to draw conclusions about how the general climate for science (acceptability, image etc) varies according to knowledge level of science, as measured imperfectly by surveys;
- It is possible to cross-correlate survey data with science along with indicators on other issues, e.g. political awareness etc;
- It is possible to design more sophisticated surveys that are less judgmental in their underlying concepts.

Assuming one considers the area of RTD culture and PUS to be important, and that surveys can be useful if used as outlined above, then no country can be complacent. At the higher end of the scale, E.U. member states could look to Sweden, Denmark and the Netherlands for advice and examples of how to generate and maintain buoyant knowledge and interest levels. There is some indication that Portugal, at the lower end of the scale, is making progress, and that Greece could capitalise on high interest levels to improve knowledge. But it is also clear that some countries have more to worry about than others in this area. In particular, countries with low or falling knowledge levels and with static or increasing K/I could be in danger of going into a downward spiral of disinterest out of ignorance or general disenchantment.

## 1.5 RECOMMENDATIONS

1. Careful and sophisticated analyses of existing Eurobarometer data, which look for indicative correlations and associations, should be supported so that the wealth of information contained in the figures can be extracted is such a way as to help policy makers and actors.
Reasoning**:** The findings of Eurobarometer and national surveys concerning RTD culture and PUS are useful as indicators of the public climate for science and technology, if used appropriately. All actors can use these data so as to be aware of the climate for their activities.
Action**:** management teams involved in developing policy in this area.

2. Comparisons between existing survey data sets should be carried out to see if useful and informative trends can be identified.
Reasoning**:** Actors need to know not only the current situation but the way in which the climate they are working in is developing.
Action **:** management teams involved in making policy in this area.

3. In particular, those concerned with the promotion of RTD culture and PUS should monitor knowledge and interest levels in combination, as an aid to judging the public climate for initiatives and activities in this area.
Reasoning**:** Given the criticism of ranking countries on the "knowledge scores", a combination of this index with the levels of interest can provide insight into the development of the climate in the promotion of RTD culture and PUS.
Action **:** management teams involved in making policy in this area.

***Further work***

1. Critiques of the current Eurobarometer questionnaire are that the knowledge questions do not really measure citizens' abilities to deal with scientific and technical issues, and that other indices are also not as secure as they should be. There should be a research programme to develop new questionnaires and other observational instruments that are better grounded theoretically.
2. More use should be made of attitude data (bearing in mind the criticisms of researchers).
3. Eurobarometer indicators should be correlated with economic data.

***Future indicators***

1. To come out of further research outlined above.

## CHAPTER 2: GOVERNMENTS AND THEIR AGENTS

### 2.1 INTRODUCTION - GOVERNMENT AS A KEY ACTOR

Governments and their agencies are vital players in the promotion of RTD culture and public understanding of science (PUS) for a number of key reasons:

- Decisions on whether, and to what extent, the general public needs to know about science and to be involved in discussions and decisions about the future direction of scientific and technological research and development are essentially political. As the prime political player in any country, this is clearly an issue for Government;
- Government has large-scale resources at its disposal, which it can either use directly or through agencies. These agencies may be directly accountable to Government or work at "arm's length" from it;
- Government plays a more general leadership role in any country, setting a tone that others may follow, be they individuals or organisations. Thus Government's attitude to the diffusion of scientific knowledge and information, and its overall appreciation of the import of science and technology, can set the "cultural scene".

This input therefore examines three strands of activity:

- Identifiable leadership in the area of promoting RTD culture and PUS;
- Specific policy statements and policies in the area;
- What resourcing is given to this activity.

It also highlights any specific policies aimed at involving women, and at the extent to which the Internet is being used as a means of dissemination and involvement. There has been an increasing realisation – in some countries, at least – that information dissemination is insufficient on its own. So this input also looks at the extent to which Governments are opening up science and technology policy to public participation, dialogue and debate. It also points up a number of individual national experiences that we feel may be interesting to a number of countries in the European Union, as examples from which lessons can be learned and on which future policies and activities may be based.

### 2.2 SCOPE OF STUDY

For the purposes of this exercise, Government activity aimed at the public at large is the focus, rather than specific sub-groups, such as farmers or patient groups. This input also focusses on central, rather than regional and local government, although some instances of regional approaches are included. The information that has been obtained is broken down over the 15 Member States of the European Union, and the European Commission is also addressed.

The sources of information for this chapter are the responses to questions put to the High Level Group; the input of the Expert Group and several speakers who addressed it; the *Europta Report;*[66] specific material made available by two European networks funded under

[66] L. Klüver, M. Nentwich, W. Peissl, H. Torgersen, F. Gloede, L. Hennen, J. van Eijndhoven, R. van Est, S. Joss, S. Bellucci and D. Bütschi. *European Participatory Technology Assessment (EUROPTA) Report*. (Danish Board of Technology, Copenhagen. 2000.)

the RPAST programme (ENSCOT[67] and OPUS[68]); and publicly available general literature - books, reports, research papers etc.

## 2.3 SUMMARY OF FINDINGS

Details of the information it has been possible to gather is given in the country-by-country summaries. In some cases – notably Italy and Luxembourg – we have been singularly unsuccessful either in getting responses to High Level Group questions or in accessing local knowledge via contacts and web pages. This makes the analysis of these countries very incomplete. The table below indicates where we have been able to obtain information for the areas set out in the introduction.

| Country | Leadership | Policies & Activities | Resourcing | Women | Internet | Participation & dialogue |
|---|---|---|---|---|---|---|
| | | | | | | |
| Belgium | ü | ü | ü | | ü | |
| Denmark | ü | ü | ü | ü | ü | ü |
| Germany | ü | ü | ü | | | ü |
| Greece | ü | ü | ü | (ü) | | ü |
| Spain | ü | ü | | | | (ü) |
| France | ü | ü | | | ü | ü |
| Ireland | ü | ü | ü | | | ü |
| Italy | ü | ü | (ü) | | | |
| Luxembourg | | | | | | |
| Netherlands | ü | ü | ü | | | ü |
| Austria | ü | ü | ü | ü | ü | ü |
| Portugal | ü | ü | ü | (ü) | ü | |
| Finland | ü | ü | | | ü | ü |
| Sweden | ü | ü | | | ü | ü |
| U.K. | ü | ü | ü | ü | ü | ü |

N.B. **(ü)** indicates information of only limited or local relevance was obtained.

***Leadership***

It has been possible to identify leadership actors within the sphere of Government in approximately half of the European Union's 15 member states (Austria, France, Germany, Greece, Ireland, Portugal, Spain and the U.K.) These consist of a lead ministry, often with an identifiable team responsible for the promotion of RTD culture and PUS either present (France, Ireland, Portugal and the U.K.) or being formed (Austria). In a further four countries (Belgium, Denmark, Italy and the Netherlands), there is clear evidence of government leadership (at least historically), although this may be distributed over two (Italy) or three (the Netherlands) ministries, or indeed devolved to regions (Belgium). Specific bodies (the Danish Council of Ethics and the Danish Board of Technology) may also take the lead role in some

[67] European Network of Science Communication Teachers (ENSCOT). http://www.ucl.ac.uk/sts/enscot/
[68] Optimising Public Understanding of Science (OPUS). http://www.univie.ac.at/Wissenschaftstheorie/opus/

activities. An issue that is difficult to address is the role of regional governments, *vis-à-vis* central government. In Germany, for example, regional initiatives are sometimes taken up at federal level. But investigating this process in detail is outside of the scope of this report.

From a benchmarking point of view, there is some correlation between the identifiability of leadership responsibilities within Government, and the ability of countries to respond fully to questions posed to the High Level Group (HLG). This was particularly clear in the case of Austria, Denmark, Portugal and the U.K., countries that gave very full responses It would be going too far to equate the level of HLG responses to activity on the ground. A reasonable conclusion, however, is that having clearly identifiable leadership teams in this area does help keep Government informed of what is happening. It may also help provide continuity, against changes in individual ministers with responsibility for science, technology and research, who may be more or less interested in the public, social and ethical aspects of their brief.

Among the countries that were able to give the most complete responses to the HLG questions, Denmark is generally held up as a paradigm of citizen involvement, Portugal is portrayed as an example of how to “kick start” activity to promote RTD culture, and the U.K. is known to have an active PUS scene. These countries all have clearly defined and established teams/bodies in the area of promoting RTD culture and PUS, and Austria, which has just formed its PUSH team, has led the way in evaluating science week activities (see Case Study in Scientific Communities chapter, following). These examples, and others available in the Annex to this chapter, point to the coincidence of (at least), and link to (probably), an RTD promotion/PUS team and well developed activity in this area.

One question that the information gathered does not answer unambiguously is whether, given such a team, a single lead ministry (e.g. Portugal, UK) or a combination of ministries (e.g. France, Italy) provides a better setting. The arguments for the single lead ministry centre on simple lines of communication and management, clear location of responsibility, and consolidation of budgets. The arguments for an interministerial team include “inclusivity”, ensuring that, say, research, education and culture ministries all play their part. (Note that this latter option could still be made to work if one of those concerned was designated the lead ministry, and that the former option need not be *ex*clusive.)

***Policies and activities***

If activity in a certain policy area is felt to be important, it is generally accepted that those involved should have clear aims and objectives to inform their activity. In terms of Governments, this is usually to be found in terms of policy statements and – as necessary – accompanying measures (legislation, provision of resources, etc.)[69]. With the exception of Luxembourg, we have been able to identify government policies and activities in the area of promoting RTD culture and PUS in all of the E.U.’s member states. This would appear indicate a healthy situation. However, those policy statements ranged widely from clear political appreciation of the importance of this area, in many countries, to the formulation of a legal framework for the promotion of RTD culture and PUS, in the case of Italy. Activities also vary from countries that have taken particular initiatives - alone or as partners with research organisations and the scientific community’s societies - to benign support for science days and weeks (with or without financial support). Because the policies and activities are so

[69] Deliberate inactivity, of course, cannot be ruled out as a legitimate policy.

varied, it is important to look at the country-by-country analysis to get a full picture of what is happening (see Annex).

One issue to be addressed is that of evaluation - does any approach or activity in this area have any measurable effect on the public, either in increasing knowledge levels, or awareness or appreciation of science and scientists? Several countries have carried out their own public knowledge and opinion questionnaires, although the ability of broad-brush surveys to answer questions on impact is probably limited. In conjunction with the Wellcome Trust, the U.K. Government has recently carried out a survey that characterises the British public under six headings that range from “confident believers” to “not for us”[70]. This shows that “one size fits all” general approaches to promoting RTD culture and PUS may not be appropriate. Austria has carried out a detailed evaluation of its 2001 Science Week, which is currently being evaluated (see case study in Scientific Community chapter)[71].

### *Resourcing*

Although it is often difficult for Governments to identify exactly how much of general budgets for scientific and technical research go into activities aimed at promoting RTD culture and PUS, it is disappointing that it was possible to get reasonably current figures for (at least some of) this activity from only sixty percent of the E.U.’s member states (Austria, Belgium, Denmark, Germany, Greece, Ireland, the Netherlands, Portugal and the U.K.). The figures obtained range from Euro 13 million for Portugal’s all-embracing Ciença Viva programme to Euro 250,000 for Germany’s specific “PUSH-Dialogue Science and Society” project. In addition, a figure of Lire 10 billion was obtained for Italy’s activities in 1991, although a new grant scheme is now in place. This lack of information may well reflect a situation in which Governments themselves are unsure of their full activities in this area - to what extent they are resourcing whom to do what. Knowing what they are doing is surely, however, a *sine qua non* of determining what more, if anything, needs to be done and how it needs doing.

### *Women*

Despite the work of the Helsinki Group in emphasising the importance of science and technology for women, and ministerial statements at European Union level, it would appear that only two Governments (Denmark and the U.K.) have existing policies directly orientated towards women for the promotion of RTD culture and PUS, outside of any emphasis that occurs within the formal education system. Denmark promotes the visibility of young women researchers through FREJA (Female Researchers in Joint Action). The U.K. has a specific “Promoting SET for Women” team that undertakes several measures aimed at young and older women. The U.K.’s analysis of public attitudes found that women made up a large majority of those who said that they were “concerned” about scientific and technical innovation and progress[72]. It may be that some Governments consider women and science not to be of particular concern, or at least of no more concern than the general public as a whole. Certainly there are country-by-country differences that may have a bearing on this; Portugal,

[70] U.K. Office of Science and Technology and the Wellcome Trust. *Science and the public: a review of science communication and public attitudes to science in Britain*. (Wellcome Trust, London. 2000.)
[71] U. Felt, A. Müller and S. Schober. *Evalueirung der Science Week Austria 2001*. (Bon-desministerium für Bildung, Wissenschaft und Kultur, Vienna. 2001.)
[72] U.K. Office of Science and Technology and the Wellcome Trust. *Science and the public: a review of science communication and public attitudes to science in Britain*. (Wellcome Trust, London. 2000.)

for example, points out that it has the highest proportion of women researchers of any country in the E.U. It may also be, however, that issues of women and RTD culture have yet to be specifically addressed in government thinking and activities. A third country, Austria, has just started a programme to promote women in science and technology (FFORTE), although there is currently little in this programme for women outside of the scientific professions.

### *Internet*

Much has been written and said about the new “information society”, or even the “knowledge society” in which we live, and the role of the Internet in both spurring it on and providing the infrastructure for it to work. The evidence for its use in the promotion of RTD culture and PUS is not clear, however. A recent UK survey showed that only 13% of British citizens currently use the Internet to get information on science and technology, and only 17% wanted Internet information[73]. The most recent figures from the U.S. National Science Foundation[74] show an even lower figure for getting information – just 9% as against 44% for t.v. But when American citizens are asked to state where they go to for information on *specific* topics on science and technology, 44% state the Internet, as against only 6% making use of t.v. However the media section of this report shows that many journalists now use Internet as a primary source of information. So, indirectly, Internet is one of the main source of information of the public. This is why special care should be given to the production of scientific information on the Internet.

Governments do seem to have general policies in favour of the use of the Internet and development of web resources. The European Commission’s *Science and Society Action Plan*[75] certainly envisages many actions making use of the Internet. So one might imagine that the Internet would be seen as a natural outlet for efforts to promote RTD culture and PUS, although only just over half of E.U. member state Governments currently appear to be using it specifically for this purpose (Austria, Belgium, Denmark, Finland, France, Portugal, Sweden and the U.K.). That is not to say that relevant information - for example, science week programmes, government reports *etc.* - is not available on the web. But it is to say that many Governments and their agencies do not seem to be actively promoting the Internet as a way of reaching out to their citizens where science and technology are concerned. Denmark uses the Internet to make local initiatives to promote RTD culture and PUS known nationally, and to put young researchers in touch with school children. Finland and Sweden have established Internet information services, “Research.fi” and “SAFARI”, respectively. The French CNRS is using the Internet to “open science up to society”, as is the U.K.’s Royal Institution.

### *Participation, dialogue and debate*

In recent years, there has been a growing realisation that citizens do want to be involved in deciding how new technologies are developed, so that they can assure themselves that scientific discoveries are being used in way that are felt publicly to be useful and appropriate. Two thirds of E.U. Member State Governments now either have or are developing mechanisms of involving the general public in issues concerning scientific and technological

[73] *Ibid.*, pp. 88-89.
[74] National Science Foundation, *Science and Engineering Indicators 2002*. http://www.nsf.gov/sbe/srs/seind02/
[75] European Commission. *Science and Society Action Plan*. (Brussels, 2001). Out of 38 listed “actions”, numbers 4, 15, 20, 21, 23, 30 and 37 specifically mention the Internet, and many others call for “networks”, which may well involve the Internet.

developments (Austria, Denmark, Finland, France, Germany, Greece, Ireland, the Netherlands, Sweden and the U.K.).

Denmark currently has the most extensive toolkit of participatory instruments, organised through the Danish Board of Technology. Denmark was also the E.U. country that pioneered Scientific Ethical Committees to approve research procedures such as medical trials. Many countries are now trying to use one of the techniques pioneered in Denmark, consensus conferences of technology assessment (Austria, France, Germany, the Netherlands and the U.K.). Austria has held a referendum on genetically modified organisms. There are also activities such as scenario workshops, policy forums and citizens juries. What is not clear, however, is to what extent there is a culture of Government acting on the findings of such activities. Science shops are another way of empowering citizens, providing them with independent scientific and technological advice as required for local issues, in particular. They seem to be well co-ordinated and active in the Netherlands.

### *PUS, PUSH and Culture Scientifique in government approaches*

Trying to determine the dominant approach of Governments to promoting RTD culture and PUS in the countries of the European Union is difficult because, although one may conceptualise ideal models, reality on the ground is much more complicated. For instance, notions associated with the Culture Scientifique model are clearly discernible in countries that adopt a more Public Understanding of Science/Science and the Humanities approach; attempts to get more science in the British media often cite the “Two Cultures” notions of C.P. Snow[76] and its associated effort to give science the cultural worthiness of the fine arts and literature. Similarly, in France, home of Culture Scientifique, many features of the PUS/PUSH information dissemination/knowledge raising are clearly visible. Additionally, the situation is currently in a particular state of flux, as many countries try to move away from the Deficit Model - filling “empty heads” with scientific “facts” in the hope that this will make them more amenable to science - to a more engaging policy of dialogue and debate[77].

Insofar as a dominant approach is apparent, we would characterise Ireland, Portugal and the UK as mainly PUS, with Austria, Germany and the Netherlands as PUSH-orientated. Belgium (especially Wallonia), France and Italy adopt a mainly Culture Scientifique approach, with Italy perhaps laying more stress on historical aspects than the other two countries. The E.U.’s other member states appear to have less easily identifiable general attitudes to this area of activity.

[76] C.P. Snow. *The Two Cultures.* (Cambridge University Press. 1993.)
[77] S. Miller. “Public understanding of science at the crossroads.” *Public Understanding of Science* **10**, pp. 115-120 (2001).

## 2.4 CASE STUDIES: GOOD PRACTICE AND EXPERIENCES WORTH SHARING

### *Case study 1 - the design and the role of consensus conferences, Denmark*

The Danish Board of Technology has expertise going back over some two decades of Consensus Conferences, a type of meeting that makes it possible to include the public and their experiences in technology assessment. The conference is conducted as a dialogue between experts and lay people (non-professionals) that stretches over three days, which are open to the public. At the end of these three days, a final report is produced and passed on to members of Parliament. Thus Consensus Conferences can be seen as an important mechanism in bridging the gap between the public, experts and legislators. Topics that are suitable for this type of assessment are characterised by:

- Having social relevance;
- Needing expert input;
- Being possible to delimit;
- Containing attitudinal issues as yet unclear.

Transport policy and energy policy have been chosen as topics for such consensus conferences, for example. The lay panel - in Denmark this usually consists of 14 citizens - is comprised of open-minded people of divergent backgrounds selected from some 1,000 invitees so as best to represent the population at large. The citizens receive thorough briefings on the topic under discussion, so that they can question expert witnesses from a position of preparation. The briefings take place over two weekends, which also give the panel members a chance to get to know one another. They also formulate the questions they wish to ask and participate in choosing the experts they wish to examine.

During the first day of the public session, experts expound on the issue and the questions put to them in advance by the lay panel. The second day of the conference enables the lay panel to as questions, getting the experts to elaborate and clarify their positions. There is also a chance for the audience to ask questions. Later in the second day, the panel produces a first draft of their report for discussion amongst themselves with a view to achieving consensus. On the third day, the report is presented to the public and the experts, with a view to clearing up any misunderstandings before the final report is sent out to Parliament. This report carries great weight in subsequent debates.

### *Case study 2 - Barcelona City of Knowledge, Spain*

Barcelona, the regional capital of Cataluna, is currently undertaking an ambitious project to transform itself into a “City of Knowledge”, a home for high-tech, knowledge-based industries making use of its geographic and cultural location and its university and private research base. The project is being lead by the city council, the Ajuntament. Among its intentions is that of ensuring all the inhabitants of Barcelona have ready access to the Internet, and to the information available on the worldwide web. That, in itself, is not a particularly novel aim. What distinguishes this project, however, is that the Ajuntament sees the development of the “City of Knowledge” as being inseparable from efforts to raise the profile of science and technology among its citizens, and to involve them in developing new knowledge.

> The Information Society … considers citizens as recipients, and thus people become passive agents in the prevailing communicative system. In the Society of Knowledge … citizens must be able to differentiate between information and communication,

> encourage a critical spirit and, above all, develop a capacity enabling the public to make its own decisions and selections[78].

The Municipal Activities Program for 2000-2003 has three main strands of its approach to the development of the City of Knowledge:

- To promote the use of information and communication technologies, expand individual and collective access and make them available to everyone in various segments of city life;
- To promote Barcelona as a centre of excellence and world-leading scientific, technological and biomedical centres;
- To promote scientific and technological culture.

It is the third of these strands that is most germane to this report: it involves a programme of research into local public perceptions and attitudes towards science alongside a populatisation campaign; in 2001, for example, there was a series of 35 public lectures entitled “Science on the Streets”. All the lectures were also broadcast in their entirety on the local television channel, and attracted significant audiences. Again, in and of themselves, none of these activities is particularly novel. But the combination, at a city level, of directed economic development combined with efforts to bring the whole population along with the transformation being undertaken, is - we believe - unique. The final feature that is noteworthy is that this is seen as a long-term project:

> Not all members of an urban population are in the same position in trying to adapt to the new forms of living, such as making the most from using, comprehending and managing new technologies, as well as scientific and technical resources, benefitting from the business opportunities arising from telecommunications networks etc. History tells us that in each social revolution that has taken place no less than two generations have elapsed between the first signs having appeared until the change is fully implemented. This explains why public administrations need to pursue an active role during this procedure so as to provide the most balanced opportunities to all, covering all social and generational groups[79].

***Case study 3 - the 5% solution, Portugal***

The decision by the Science Minister in 1995 that 5% of the research budget would be made available to the promotion of RTD culture and public understanding of science came after years that were characterised by scarce activities in this area that lacked continuity. Thus Portugal affords the opportunity to see what may happen when a serious programme is launched where previously very little existed. The new direction was mainly manifested in the Ciência Viva national plan for scientific and technological culture. This has three main strands:

- Scientific education: the programme promotes and supports projects for practical activities in public and private basic and secondary schools, involving the schools themselves, universities and research laboratories. Already more than 3,000 projects in 3,000 schools, involving 7,000 teachers and 600,000 students have been carried out, and a further 718 new projects have been approved for the fifth year. The twinning of schools and scientific institutions, now involving 37 schools and 20 research institutions, is a key feature of this

[78] V. de Semir, Councillor for the City of Knowledge, (2000).
[79] V. de Semir, Councillor for the City of Knowledge, (2000).

programme. There are also “Science in the Holidays” two-week placements for young people in laboratories;
- Scientific and technological awareness for the general public: this includes the vacation activities already noted, a National Day of Scientific Culture (November 24), an annual Science and Technology Week, and scientific film festivals;
- Ciência Viva science centres: The first centre opened in Faro in 1997. The Pavilhão do Conhecimento in the Parque das Nações in Lisbon, which took over one of the Expo ’98 pavilions, has been open since 1999. There are now two more full members of the network, and one associate member. Other projects are underway. The Government has also made available nearly €200,000 to support scholarships for museology course abroad.

According to a recent national study, levels of scientific knowledge, interest in scientific issues, and the importance accorded to science by the general public have all increased since the 1992 Eurobarometer data. This is borne out by only slight increases in Portugal’s scores in the Eurobarometer 55.2 data. There has also been an increase in a more critical attitude towards science, the national study suggests.

***Case study 4 - from deficit to dialogue - PUS at the crossroads, UK***

The UK has a lively public understanding of science scene at both amateur and professional level. The development of “official thinking” about the promotion of RTD culture and public understanding of science has been very well supported by documentation in the UK, perhaps more so than in any other country. Thus it is a good case from which positive and negative lessons can both be drawn.

It is usual to date the recent public understanding of science movement from the publication in 1985 of the Royal Society report *The Public Understanding of Science*[80] This report, came to the conclusion “that scientists must … learn to communicate with the public, be willing to do so and consider it their duty to do so”. As a result of this report, the Committee on the Public Understanding of Science (COPUS) was established. This has three partners:
- The Royal Society: Britain’s premier scientific society was founded in 1660 and granted its royal charter in 1664. It hosts COPUS;
- The Royal Institution: Britain’s first public laboratory, founded in 1799, was home to great science communication pioneers such as Michael Faraday;
- The British Association for the Advancement of Science: this science promotion organisation has held an annual festival of science since 1831.

COPUS provides funds to (mainly) scientists who wish to popularise their work, places young scientists in the media for fellowship periods up to three months, liaises with the Women’s’ Institutes in putting on local lectures, and promotes a science book prize. In 1993, the Government White Paper *Realising Our Potential*[81] introduced public understanding of science in the country’s research councils. As a result, there is now ~0.5% of the research budget available for RTD promotion activities.

[80] W. Bodmer (chair). *The Public Understanding of Science*. (Royal Society, London. 1985).
[81] H.M. Government. *Realising our potential*. (London, 1993).

The COPUS Decade - as the years from 1985-95 have been termed - saw a rather particular type of science communication: top-down, insofar as scientists tended to decide what the public needed to know; one-way, insofar as the public rarely had input into the process; and, as a result, celebratory rather than critical or evaluative. This became known as the Deficit Model, since it assumed scientific *sufficiency* but public *deficiency*[82].

COPUS and other agencies proved extremely successful in making science communication an activity that was felt to be worthwhile and necessary, and in mobilising large numbers of scientists young and old to take part. As a result, thousands of scientists - from PhD students to council members of the Royal Society - took part in popularisation activities enjoyed by thousands of members of the public. U.K. science became more visible in the media.

But in 1996 survey results showed that, despite the expenditure of millions of Euros and the efforts of these thousands of enthusiastic scientists, there was little change in UK levels of scientific literacy over the past decade - as measured in knowledge/attitude surveys - other than a greater recognition of the initials DNA. Some commentators then, mistakenly drew the conclusion that COPUS project had been a waste of time. 1996 was also the year it became officially recognised that BSE could infect humans to give rise to variant CJD; there were widespread concerns about declining public trust in scientists and respect for science[83].

During the COPUS Decade, however, the interest in public understanding of science as an area of research activity had led to more sophisticated appreciations of the public - the heterogeneous nature of this assumed homogenous entity, the fact that people and groups of people possessed “lay expertise”, and thus could make useful inputs into discussions about the use of scientific information and the directions science and technology might follow, and the fact that individuals partook of scientific information in a “situated way”, that enmeshed with other sources of information, and they everyday uses they made of it. This has been characterised as the Contextual Approach[84].

In 2000 the House of Lords published what has become a landmark report, *Science and Society*[85]. This took account of that more sophisticated view of the public, and called for dialogue and debate and - above all - openness in relations between science, experts and the public. Their Lordships also took a great deal of notice of the approach of other counties, particularly those, which made use of participatory technology assessment mechanisms. In their White Paper of that year *Excellence and Opportunity*[86] the Government devoted an entire chapter (and other sections) to the need to create “confident consumers” for science among the public. A recent survey by the Wellcome Trust and the Office of Science and Technology has identified six categories of public attitude to science and technology - from the “Confident Believers” to the “Not-for-me”[87].

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[82] A.G. Gross. “The role of rhetoric in the public understanding of science.” *Public Understanding of Science* **3**, pp. 3-23 (1994).
[83] S. Miller. “Public Understanding of Science at the crossroads”. *Public Understanding of Science* **10**, pp. 115-120 (2001).
[84] D. Layton, E. Jenkins, S. McGill and A. Davey. *Inarticulate science? Perspectives on the public understanding of science and some implications for science education.* (Leeds Media Services. 1993.)
[85] House of Lords Select Committee on Science. *Science and Society*. (The Stationary Office, London. 2000.)
[86] H.M. Government. *Excellence and Opportunity*. (The Stationary Office, London. 2000).
[87] U.K. Office of Science and Technology and the Wellcome Trust. *Science and the public: a review of science communication and public attitudes to science in Britain*. (Wellcome Trust, London. 2000.)

The challenge now in the UK is to act on the greater understanding of what is meant by the public, understanding, and the nature of developing science. That is not to say that there is no knowledge or understanding deficit - there must be, if scientists are doing their job. But it is to say that scientific information has to be communicated appropriately to the situation and the recipients, and in such a way as to empower them to take part in the important debate about present and future directions for research and development.

### 2.5 DISCUSSION

In this first benchmarking exercise, looking at Governments and their agencies as actors in promoting RTD culture and PUS, time constraints have limited what information has been gathered and what analysis it has been possible to make of this information, and of existing survey data. We are well aware, as the case study looking at the U.K. experience makes clear, that Government policies and activity in this area are not set in stone; this is an area of ongoing development in which most of the actors concerned are themselves learning. It has not been possible to do justice to this time dependent nature of the area in all cases. It is also clear that such development that has taken place has not done so in isolation, but as part of other political, social and economic changes – many of these of a profound nature. This whole area is characterised at a Europe-wide level as being part of the development of the European Research Area, with accompanying calls for the creation of a new and explicit social contract between science and the citizens of the EU[88]. On reflection, the fact that following the Lisbon 2001 summit research ministers took the decision to commission benchmarking in this area is testimony to the increasing importance with which Governments view the promotion of RTD culture as part of the initiative to make the EU "the most competitive and dynamic knowledge-based economy in the world".

During the course of the process of benchmarking, the European Commission itself, part of the government of the European Union, published its *Science and Society Action Plan*[89]. This includes – of necessity - many references to issues that are also investigated here, and makes many proposals that this benchmarking exercise can be seen to support. This shows the importance of E.U. leadership alongside that of national Governments. What emerges clearly is that the desire to increase public awareness in this area, and recognition of the need for citizens to be convinced of the benefits of scientific and technological development and involved in making decisions, are well placed on the agenda of many of the E.U. member states. Exchange of national information and experiences is going to be increasingly useful, as different countries try various techniques of accomplishing their aims and objectives.

At this stage, the overall picture is still of unevenness in development – with Governments more or less active in some or all of the field identified here. As countries develop their policies and programmes, Governments will need to be keenly aware of social, cultural and historical factors that mean that experiences made in one country will not translate simply into other countries. A "one size fits all" approach will not work. For example, countries that have more homogenous populations and/or traditionally high levels of citizen involvement may find it easier to reach consensus, and thus to use representative techniques of public involvement. (The same is true on a region by region basis within any particular country.)

Social, cultural and historical factors need to be borne in mind in deciding if the programmatic direction should lean towards PUS, PUSH or CS. Similarly, while there is a

[88] Commisioner P. Busquin. Address to conference on *Science and Governance*. (Brussels. Oct. 16-17, 2000).
[89] European Commission. *Science and Society Action Plan*. (Brussels, 2001).

justifiable move away from the Deficit Model towards recognising the importance of contextual and lay knowledge and towards citizen involvement, that does not mean that there no deficit exists. It is precisely the job of scientific and technical experts to know more than the average citizen and the Government minister (or whoever) they are advising. Respect for citizens' rights and opinions should not obscure this. There is the further complication that different areas of science and technology are not equally amenable to "dialogue and debate" approaches for a variety of reasons: the public may not have a great deal of input into the mass of the Higgs' boson (should it eventually be measured); they certainly do have a great deal to say about issues concerning health and safety and the morality of various applications of reproductive and genetic research.

We have pointed to the relative lack of use of the Internet by Governments in this area, and feel more could be done. However, we also indicated that survey data is by no means clear as to whether or not there is real public demand. And any action that is taken should be set in the context of recent social science research. This has warned against the dangers of "cyberbole" – hyperbole about the potential of cyberspace to affect the society in which we live. Woolgar has drawn up five rules for dealing with "virtuality". The third of these points out that "virtual technologies supplement rather than substitute for real activities"[90]. That is to say that the use of Internet information and involvement technologies does not obviate the need for "traditional" and other additional activities. (But in matters of science, journalists now say that they use Internet rather than their old ways of collecting information[91]) It should also be noted that simply putting something on a website is no guarantee that it will be accessed; nor does it (without accompanying measures) fulfil requirements for informing and consulting.

## 2.6 Recommendations

1. Governments should take a lead in promoting RTD culture and PUS by assembling a team responsible for ensuring that activities and programmes in this area go ahead.
Reasoning**:** The examples of Austria, Denmark, Portugal and the U.K. show the importance of dynamic leadership in promoting RTD culture and PUS, and in ensuring that programmes are put in place and are supported.
Action**:** Government, (lead ministry, involved ministries) RTD culture/PUS team.

2. Governments should have clearly stated policies in the area of promoting RTD culture and PUS. They should develop techniques for evaluating their activities in this area.
Reasoning**:** Given their role in leadership, Governments need to be clear what they are supporting, why and how. Given that some programmes are now fairly mature, their effectiveness requires investigating; the Austrian Science Week evaluation shows one way this can be done.
Action**:** RTD culture/PUS team, (lead ministry, involved ministries) Government.

3. Governments should draw up an inventory of the activities they support in the area of promoting RTD culture and PUS, and thus obtain a clear idea of the financial contribution they are currently making.
Reasoning**:** Although information on activities was forthcoming, it proved hard to find out how much was being spent in this area and it appears that Governments themselves do not have an overall picture of what they are doing. In the future, it may be that targets, such as the

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[90] S. Woolgar, "Five rules of virtuality" in S. Woolgar (ed) *Virtual Society? - technology, cyberbole, reality*. (Oxford University Press, forthcoming September 2002)
[91] see the section « How journalists and the media work » and note 152 in the Media chapter of this report

Portuguese 5% solution, are proposed; at which point accurate knowledge of the current situation becomes even more urgent.
Action: RTD/PUS team, Treasury/Finance Ministry, Government.

4. Governments should make a particular effort to make information on science and technology available to women.
Reasoning: The Helsinki Group has highlighted the importance of women in science[92]. The U.K. survey of public attitudes shows that women are more concerned than men about science and technology. But - outside of schemes to get more young women to follow science careers - little is currently being done specifically to promote RTD culture and PUS among women.
Action: RTD culture/PUS team.

5. Governments should promote the use of the Internet to make science and technology accessible to citizens, so that they can play a part in ensuring that discoveries and developments are used for their benefits.
Reasoning: At present only just over half of the E.U.'s member states are using the internet for the promotion of RTD culture and PUS. This resource offers real possibilities for citizens to be involved cheaply and effectively in debate and dialogue. Note that the Internet does not replace other measures in this area.
Action: RTD culture/PUS team and relevant government departments.

6. Governments should instigate appropriate measures for involving the public in vital discussions, debates and decisions concerning the future uses and directions of science and technology.
Reasoning: The old "Deficit Model" of simply giving information to a public presumed to be ignorant has been shown to be inadequate (particularly by the U.K. experience). There are now several models and techniques to deal with the current mood for dialogue, as examples from Denmark, Holland and Germany show.
Action: RTD culture/PUS team.

### *Further work*

1. The role of regional and local government needs to be investigated, particularly for those Member States for which this level of government is traditionally important.

2. Research is also needed on the work done addressing particular sectors of the population - e.g. farmers, medical practitioners and patients' groups, fishing fleets, *etc*. - since in these areas specific requirements are often set down by the information recipients.

3. Schemes supported by Government, particularly in areas of dialogue and debate, those at aimed at women in particular, and those making use of the Internet, should be investigated.

### *Future indicators*

1. The amount spent on the promotion of RTD culture and PUS as a percentage of the overall national research budget.

[92] www.cordis.lu/improving/women/helsinki.htm

# Chapter 3: Scientific community

## 3.1 INTRODUCTION

### *The role of the scientific community*

This chapter examines the contribution of the scientific community to the promotion of RTD culture and public understanding of science. We understand "scientific community" as the active group of scientific researchers and teachers, plus their institutions and societies. The role of the scientific community in the promotion of scientific and technological information to society was recently recognized in the Action Plan *Science and Society* :

> "Because of their knowledge, researchers, research organizations and industry now have a particular responsibility vis-à-vis society in terms of providing scientific and technological information to Europe's citizens. Communication of scientific and technological progress should be stepped up, in particular the progress flowing from the Research and Technological Development Framework Programme".[93]

The scientific community is a key actor in the promotion of RTD culture and public understanding of science for several reasons:

- The fast pace of advancement at certain frontiers of science, which often correspond to strategic areas for development, requires direct and open communication between those who produce knowledge and the public;
- Scientists acquainted with the public's needs (*civic scientists*) gain "a grassroots understanding of the public's perception of societal problems and its expectations of how science can contribute to solutions"[94];
- Improving the public visibility of scientists and engineers should help to attract more young Europeans to RTD careers, therefore improving the match of education and career choices to labour market requirements.

### *Scientists as independent actors*

In many instances, Governments work hand-in-hand with the scientific community, particularly with the leaderships of national academies and learned societies. The various research councils and national scientific laboratories often act as a "bridge". In one respect, because these bodies are funded from the national budget, they are accountable to Government. At the same time, the scientists who rely on them or work in them make up much of their committee structures. The scientific community therefore feels that they have "ownership" of these organisations and facilities. One might therefore expect that the

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[93] European Commission DG Research, *Science and Society Action Plan.* (Brussels, 2001.) See « Action 9 ». http://www.cordis.lu/rtd2002/science-society/home.html

[94] Dr. Neal Lane, at the time Director of National Science Foundation (USA), addressing the Affiliates Meeting of the American Association for the Advancement of Science, 13 February, 1998

scientific community and Government would act in concord. However, the scientific community has its own interests and rights distinct from Government.

In their professional lives, scientists are used to submitting their findings to the scrutiny of their peers and depend on independent juries for the promotion in their scientific careers. They do not ask for government permission for what they do, say, or publish. One issue is therefore who takes the lead in programmes designed to promote RTD culture and PUS. The previous chapter showed that in the case of Portugal, it was the Government which introduced the "5% solution" and initiated the Ciência Viva programme. But in the case of the U.K., it was the scientific community - in the form of the Royal Society - which took the lead. And one of the key motivations for the Royal Society's action, in the mid-1980s, was a perception that scientific research budgets could not be defended unless public interest in science was raised and public opinion mobilised in defence of science - hence the foundation of "Save British Science"[95] not long after the setting up of COPUS.

For these reasons, therefore, we consider it necessary to deal with the scientific community as an actor separately from Government, even though there will certainly be overlap between the activities of the two players.

### *Resourcing and training*

Scientists are increasingly facing demands for them to play a part in outreach activities and to engage in debates concerning science and society. There have always been scientists only too willing to, and capable of, doing this, but the trend in the 20th century was for intermediaries - journalists, broadcasters, press officers, professional popularisers - to take over this role, compared with the situation of the 19th century, an era of great scientist popularisers[96]. In part, the increasing importance of mediators between science and the public was due to growing complexity and specialisation; in part, science's intellectual independence meant that it fitted less and less well within overall cultural frameworks[97]. Now the drive is to reverse this trend, bringing scientists much more into direct contact with the public.

The professional training of scientists in the E.U. does not usually include how to deal with science in its public dimension, however. The resourcing of the scientific community commonly involves equipping laboratories, providing computer equipment and enabling them to make use of large-scale infrastructure facilities, and other requirements for them to work *as scientists*. If they are to play the *communication* role that the political community - including their own leadership - are asking them to play, they need the wherewithal to do it.

### *Professional recognition*

In recent years, the workloads of professional scientists have increased, particularly in the area of administration and (in the case of university-based researchers) teaching. In some countries these factors now play a part in the career advancement of individual scientists. With the growing emphasis on researchers playing a full part in science and society dialogue,

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[95] www.savebritishscience.org.uk
[96] J. Gregory and S. Miller, *Science in Public: communication, culture and credibility*. (Plenum, New York. 1998.)
[97] R.M. Young, "Victorian periodicals and the fragmentation of a common context" in *Darwin's Metaphor*. (Cambridge University Press. 1985.)

as well as more traditional outreach activities, it is worth raising the issue of to what extent this activity should contribute to the promotion process.

### 3.2 METHODOLOGY

This chapter gives an overview of how - and how far - the scientific community involved in the promotion of RTD Culture and PUS(H) in the Member States. Where possible, we account separately for:

- **Leadership:** identifying the leading scientific institutions and the way they operate and/or interact with governmental policies and bodies in the promotion of RTD culture and PUS;
- **Key activities:** type of activities and outreach, and information about their impact (where available);
- **School-based initiatives:** contact with researchers, the provision of teaching materials and programmes;
- **Women:** bringing women into the scientific community;
- **Media:** type of media (Internet, TV, etc.);
- **Participation of the public:** efforts to involve the public in debate, over and above simply supplying information;
- **Resourcing and training:** directed towards individual scientists and research groups to enable them to carry out outreach work.

The information was gathered by direct enquiry to the Academies of Sciences, by searching through web pages of European institutes, in particular those registered at the European Science Foundation (ESF), and by information from contacts (see Annex).

Science week and festivals are also listed, as they represent major opportunities for a direct contact between scientists and the public. We have also included in the Annex seven activities funded by the European Commission for the European Science and Technology Week (November 4-11, 2002).

In the course of this benchmarking exercise, we have not been able to look at more than the surface (with the exception of one or two countries). The policies and activities of leaders in the scientific community do not tell the whole story. For that, one needs to look at the activities of individual universities, and within those, individual research groups, and within those, individual scientists. There are the popularisation "superstars", whose books sell hundreds of thousands (sometimes millions of copies) and who may be known worldwide[98]. These individual scientists do much to raise public awareness of the importance of science, in general, and the subject they espouse, in particular. At the other end of the scale, but no less important, is the army of researchers prepared to discuss their work and enthuse individuals on a one-on-one basis. Many of today's scientists would refer to a life-changing discussion with an otherwise anonymous researcher as being what decided *them* to choose a life of science. But it is impractical to benchmark this detailed level of activity, no matter how personally crucial it may be.

[98] Stephen Hawking's *Brief History of Time* topped the best-sellers lists worldwide, for example.

## 3.3 Summary of findings

### Leadership

The need to promote scientific and technological culture is written into the official policy of many countries. If these activities are to be effective, the support of the scientific community is essential. Their lead organisations - learned societies and academies - set the scene for scientists as a whole. This chapter deals with cases where the scientific community takes the lead by actively promoting key activities or by addressing special target groups and the media.

Starting with the ESF web page, out of 50 institutions located in current Member States, only 23 mentioned any activities related to RTD culture, science and society or PUS. In four Member States (Belgium, Greece, Italy, Spain) none of the listed organisations referred to these areas either in their ESF entry or on their home web page. In other countries (Denmark, Finland, Luxembourg), the reference was only to policy advice rather than communication with the public at large. At the other end of the scale, all four of France’s ESF-listed general research organisations (out of six members) have clear outreach objectives and sections on their websites. In the UK, all seven ESF members have promoting PUS as part of their mission statements, and have material designed for the public on their home web pages.

The ESF web page must not be considered as representative of the European scientific community as a whole, however, as many of those listed there are government agencies, advisory bodies and other funding institutions. This benchmarking exercise has therefore also looked at particularly active research institutions not listed in the ESF web pages.

In some Member States, very active **learned societies** and associations for the promotion of science and technology, take the lead in the promotion of scientific culture. The oldest is the *British Association for the Advancement of Science* (BA, founded 1831), but similar roles are played in Finland by the *Federation of Finnish Learned Societies* and in Germany by the *Stifterverband für die Deutsche Wissenchaft (German Science Founders' Association),* which has created the initiative *Dialogue Science and Society,* in collaboration with other entities. In countries with regional autonomies, small associations exist with a very strong leadership at regional level, like the *Cercle d´Amics de la Ciència* in Cataluña, Spain.

**Scientific academies** take the lead in some countries or share it with one of the above associations. The United Kingdom is a paradigmatic case, where the Royal Society and BA cooperate in this area. In Austria, Finland, Netherlands, and Sweden Academies have a very important role in scientific culture. In France the Academy created a well known and widespread science education programme *(La Main à la Pâte).*

The need to coordinate efforts in the promotion of scientific culture at national level has been felt in many countries. Therefore **National Agencies** or **Foundations** have been created to that effect. Some are totally funded by the government, others count on sponsorships from the industry as well. *Danish Science Communication, Forfás* in Ireland, *Stichting Weten* in the Netherlands, *Ciência Viva* in Portugal and the recently created *Fundación Española para la Ciencia y la Tecnología,* in Spain, are examples of institutions with this specific purpose. The creation of a similar institution was recently recommended to the French government[99]. In

[99] Réal Jantzen, *La Culture Scientifique et Technique en 2001 : Constats pour agir demain*. (Report presented to the French Ministries of Education and of Research, July 2001.), p54.

Germany the similarly recent initiative *Futur – The German Research Dialogue* is a different sort of institution, which includes foresight studies of trends in science and technology, in particular, in science communication and internet development.

Some large **research institutes** assume a leading role in the promotion of scientific culture: *CNRS* in France, the *Max-Planck Gesellschaft, Herman Von Helmholtz- Gemeinschaft* and *Fraunhofer Gesellschaft* in Germany, *Istituto Nazionale per la Fisica della Materia* and *CERISS* in Italy.

**Universities** are more and more involved in the organization of activities and events for the general public and for schools with different purposes: promoting scientific culture, creating links with the local society and recruiting students. In Belgium, in the Wallone region, the lead in PUS(H) is shared by a network of faculties of sciences of the 5 regional universities.

Key Activities

Conferences and debates for the general public or for schools usually exist all year round. There may be specific projects, in addition. In Portugal, for instance, field trips and sessions of astronomical observations are organized during the summer vacations. Geologists, biologists, and astronomers are actively involved in the organization of these activities for the general public during August and September. However, *Science Weeks* and *Festivals* are the largest group of events where the scientific community interacts with the general public.

<u>Science Weeks and Festivals: from regional to nationwide events</u>

S&T Weeks and Science Festivals generally include conferences, debates, interactive exhibits, scientific films, scientific programmes at TV and science theater. There may also be opportunities to visit university and national and regional research laboratories. In some cases there are fairs and events in the streets. In some countries the predominance of a specific type of activity or strategy for raising public awareness of science and technology has a cultural aspect, as in the case of the humanities in Germany, the history of science and technology in Italy, or the arts, as it is the case of Finland and Germany.

Until the end of the nineties, universities, learned societies and laboratories played an active role in promoting S&T weeks, mostly at a local or regional level. This was the case in a small number of countries, like the Scandinavian countries, France and Germany. Public Awareness of Science was in its early days and, to most governments, it was not even an issue. Regional weeks and science festivals with a well-established tradition exist in the United Kingdom, Italy, Germany, Spain and Sweden. Now, the situation is changing: with a few exceptions, most European countries stage a *national* science week or festival. Even France - where research laboratories and societies have a long tradition as promoters of PUS(H) events at a regional level - has organized its first nationwide event in 2001, under the co-ordination of the Ministry of Research.

The following table summarizes the nationwide science festivals in the European Union.

**Table 1 –Nationwide science festivals in the European Union**

| ***Country*** | ***Nationwide Science Week*** | ***Promoter*** | Type of organisation |
|---|---|---|---|
| **Austria** | Austrian Science Week | Pharos | Private agency |
| **Belgium** | Vlaamse Wetenschapsweek | Technologielann | Science and Technology Centre Government supported by Government and industry |
| **Denmark** | Dansk Naturvidenskabs festival | Danish Science Communication | Government supported agency |
| **Finland** | Science Review Culture Tieteen pãivãt | Academy of Finland / FFLS | Academy / learned society |
| **France** | Fete de la Science | Ministry of Research and Culture | Government |
| **Germany** | | | |
| **Greece** | | | |
| **Ireland** | Science Week Ireland | Forfas Science Technology Innovation | Agency supported by Government and industry |
| **Italy** | | | |
| **Luxemburg** | | | |
| **Netherlands** | Wetenschap en Techniek Week | Stichting Weten | Government supported agency |
| **Portugal** | Semana da Ciência e da Tecnologia | Ciência Viva | Government supported agency |
| **Spain** | Semana da Ciência | The Fundación Española para la Ciencia y la Tecnología | Government supported foundation |
| **Sweden** | Populãrvetenskapens Vecka | Vetenskapsradet | Government supported agency |
| **United Kingdom** | National Science Week | British Assoc. for Advancement of Science (BA) | Association |
| **European Union** | European Science and Technology Week | European Commission, Improving Human Potential Programme | Government |

Examples of a co-ordinating role by independent scientific institutions in nationwide science festivals are found only in federations of learned societies (Finland) and associations (UK). More generally, scientific institutions play a partner role, organizing activities at a local level (mainly in their own facilities) within a framework of nationwide events funded by Government and, in most cases, co-ordinated by public agencies.

More and more universities and scientific institutions promote regional large scale events. This is not only the case of countries with an older tradition is this field (France, Germany) but also, more recently, the case of Portugal or Belgium, where universities – structured like the Wallone SCITÉ or individually, like the Universidade de Aveiro – assume the leadership and promote hundreds of RTD and PUS events in their own regional S&T weeks. In countries like Germany, Spain or Italy, large scientific institutions promote particularly successful regional science festivals.

Some indication of the scale of activities involved in these festivals was presented recently to the Raising Public Awareness of Science and Technology programme (RPAST)[100]. Science Week Austria involved 900 separate events and attracted a total audience of 600,000. 700 events in Denmark gained 130,000 participants, while in Sweden the figures were 350 and 80,000 respectively. In the U.K. there were 2,500 events with a total audience of 400,000. These were all national events or major, well-established festivals. In Germany, a local festival still managed 70 events, with an average audience of over 2,000 per event. In other countries, too, tens, if not hundreds, of thousands of members of the general public regularly turn up to science festival activities. Additionally, the Portuguese Science Week involved 200 institutions putting on 500 events in 2001.

National and regional Science Weeks and Festivals will tend to incorporate a European component, as the E.C.-funded events for European Science and Technology Week will bring new resources that can be used at the national events. For 2002, only Ireland and Luxembourg are not involved in any of these E.C.-funded events. On the other hand, Italy and the U.K. are both participants in six out of the seven proposals.

Trends

The model of organization of science festivals in Europe seems to be evolving according to the following main lines:

| | **------------------------ > 1990** | **------------------------ > 2000** |
|---|---|---|
| **Co-ordination** | Scientific community | Government supported bodies |
| **Scope** | Local level | National level |
| **Strong and weak points** | Scientific institutions are the main actors. Few events in a small number of countries. | More events in a larger number of countries. The “bureaucratic” danger: a more passive role of scientific institutions |

The “nationwide model” has the advantage of energising the organization of events, bringing science to a wider public and to a larger number of countries in Europe. In certain cases, particularly in countries with less experience in this field, this model has played a seed role, making scientific institutions more aware of their social responsibility in terms of the improvement of scientific and technological culture.

The active involvement of the scientific institutions in strategic decision-making in this area is by itself an assurance of the quality of the events. It is also a guarantee against what we would call the “bureaucratic danger”: an exclusion of the relevant scientific institutions from the decision-making and the contact with the public. This could lead to a dominance of professional popularisers, distancing the working scientists from the public at large. On the other hand, with the shift of the organizational burden to government or agencies, scientific institutions have more freedom to focus on innovative ways to convey the information to the public, provided that a suitable policy of resourcing and training is put into practice.

[100] European Commission Raising Public Awareness of Science and Technology call for proposals 2002.

According to current evolution, the near future could include the best of both worlds: public bodies should assume their role as stimulators and supporters of the activity developed at a local and regional level by the scientific institutions themselves and should concentrate their efforts on promotion, advertisement and organization of a national agenda of events, preferably with other European contributions.

It is now important to assess the scientific rigour of the events and to evaluate their public impact. According to research in Belgium, Flemish Science Week results in 87% of audiences feeling more positive towards science. However, only in the case of Austria has there been a comprehensive attempt to assess the impact of science week events. This is presented as a case study below.

Schools: The role of the scientific community in education

With a few exceptions, the involvement of the scientific community in basic and pre-university education is a relatively recent phenomenon in Europe. Over the past decade, European scientific institutions became increasingly aware of their role in inspiring greater interest among students in science and research. Bridging the gap between the growing social need for technological development and the decreasing interest of students for a scientific career is one of Europe's most important challenges. Governments, together with universities and scientific institutions have an important social role to play in the search for a solution.

The contribution of scientific institutions has been mainly focused in providing teaching aid materials, scientific information or multimedia for educational purposes. Nevertheless, there have been some serious efforts to interact directly with schools in a regular basis, whether these links are promoted directly by a scientific institution or by a governmental body. Given the available information, we will address these efforts and examine some of the best known existing links between the scientific and educational communities on the basis of clearly identified programmes (see Table).

<u>An early start: Primary School</u>

Being mainly interested in stimulating the option for a scientific career, projects are specially targeted at upper level secondary students. Yet, there are some interesting projects particularly designed for basic science learning in France, Ireland, Portugal and Sweden.

In France, *La Main à la Pâte* is an important example of a large-scale programme for basic schools launched by a Science Academy. In Ireland, *Forfás – a National Policy and Advisory Board for Enterprise, Trade, Science, Technology & Innovation* – is currently supporting IT institutes which are collaborating to create *Primary Science Clubs*, designed to support the new primary science curriculum developing other important initiatives for this age group. Over the past five years, the *University of Aveiro*, as well as two other universities in the north of Portugal, have carried out of science education projects involving large numbers of primary schools, supported by Ciência Viva, to introduce practical work.

In Sweden, the *Royal Swedish Academy of Sciences* promotes *NTA-Project (Natural Science and Technology for All)*: a science education programme for children from kindergarten to grade 6, and the *Royal Academy of Engineering Sciences* organizes several programs for scientific education.

Closer contact with science research

Laboratory facilities and research expertise are an important part of the contribution that scientific institutions have to offer to young pre-university students or undergraduates students. This is why many European universities and research institutes organize science camps, summer science weeks, laboratory placements for students, often with the support of governmental agencies, regional authorities or local industry.

Germany, Portugal, Italy and Denmark are amongst the countries where scientific institutions provide summer placements, on a regular basis, for secondary students or young undergraduates. The initiative is in some countries extended to secondary school teachers, particularly in what concerns handling up-to-date laboratory equipment and follow-up of the most recent developments in scientific and technological research Germany, France, Portugal, Finland).

In Germany, the co-operation between schools, universities and research laboratories is, in most cases, organized and funded by the scientific institutions themselves, taking place mostly at a regional level. Since 1997, a network has been built up between schools, universities and firms, and it now extends to include partners throughout Germany. Projects like the *"XLAB"* (University of Göttingen), the *"Transparent Laboratory"* (Berlin) or the *"NaT-Working"* (The Robert Bosch Foundation's) promote initiatives where school students and teachers carry out their own experiments under the guidance of scientists. *TheoPrax* is another local initiative, including the study of industrial problems and DESY *(Deutsches Elektronen-Synchrotron),* in Hamburg, has developed its own initiative.

In Italy, the *Advanced Biotechnology Centre of Genoa* has carried out, since 1993, a number of initiatives in the area of public understanding of science directed to schools and to the general public. Amongst other activities, this scientific institution provides training short courses for students in research laboratories. The *Instituto Nazionale per la Fisica della Materia (INFM)*, a group of 38 research centers in the area of the Material Sciences, is actively engaged in science education projects.

**Initiatives designed to support science education in basic and secondary schools**

| **Country** | **Primary level** | **Secondary level** | **All levels** | **Special groups** |
|---|---|---|---|---|
| Austria | | Junior Academy | | |
| Belgium | | | | |
| Denmark | | *BioInfo Genious*(46) | | CarlsBerg Laboratory (for teachers) |
| Finland | | LUMA Academy of Science Annual Contest | | |
| France | | *Rencontres Science et Societé* | *Passion Recherche Cahiers* | |

| | | | | |
|---|---|---|---|---|
| | | | *pedagogiques* | |
| Germany | | *Transparent Laboratory*<br>*NaT-Working*<br>*TheoPrax*<br>*Schools Online* | *Science live-Mobil* (74) | |
| Greece | | | | |
| Ireland | FION Science Project 2002 | | | WITS - Women in Technology and Science |
| Italy | | ABC (126) | ORA | |
| Netherlands | | | STICHTING WETEN | Technika 10 |
| Portugal | | Scientific Occupation of Students during Holidays<br>Genoma<br>HealthXXI | CIENCIA VIVA Annual Call for proposals | |
| Spain | | | | |
| Sweden | NTA project | | | Ingvar Lindqvist Prize<br>(for teachers) |
| United Kingdom | | Pupil Researcher Initiative | | |
| EU | | Physics on Stage | Sea&Space | |

In Denmark, the *Carlsberg Laboratory* has established, since 1986, a collaboration with the Minister of Education for the training of secondary teachers. The project resulted in the creation of *EBG (Educational Biotechnology Group)*. A course for biology teachers was organized with the aim of transforming the research manuals into practical teaching aids for use in school laboratories. After the notification of the Ministry of Education, the teachers who passed this course have a specific accreditation and are allowed to carry out the relevant experiments in genetics and biotechnologies.

Other examples exist promoted by research institutions in France, like for example the *Centre National d´Études Spatialles (CNES)*, which organizes summer teacher training courses about the Space Science and its applications. In the Netherlands, the cooperation between schools, universities and research institutes is being actively promoted by *Stichting Weten* , the leading institution developing PUS(H) activities in that country.

<u>The school - scientist dialogue</u>

The dialogue between scientific institutions, universities and schools in Europe is rarely conducted under a regular institutional link or under a specific science education project co-management, which means that scientific institutions play the role of the "provider" (promoting public events and disseminating scientific information) whereas the schools play the role of the passive"consumer".

In the United Kingdom, for example, there is great concern about the decline in public confidence in certain areas of science over the past decade. The main goal of the *Science and Society Programme 2002*, promoted by the *Royal Society*, is to reverse this trend. In order to achieve a more "personal" and direct link with schools, a new project – the *School's Ambassador* - is currently under preparation, based on regular visits by individual scientists to schools. The role of scientists in supporting science education at school is specifically emphasized by the most important scientific and research societies in the U.K., which have been very active in promoting activities for young people. This example has been followed and similar initiatives have been set up by other learned societies and academies, particularly in the north of Europe. But again they are designed as nationwide initiatives, targeting a wider public, with schools students seen as just part of a specific segment of the public.

In Portugal, *Ciência Viva* has been organizing and funding science education projects in basic and secondary schools, since 1997, where scientific institutions, universities and schools form partnerships to co-manage the projects. This is changing the traditional top-down relation between scientific institutions and schools, as close collaborations develop and schools themselves can be the promoters and managers of the project.

The *Academy of Finland* promotes an annual science competition for senior secondary students[101] – *LUMA*. Launched in 1995 by the National Board of Education with the aim of raising the level of mathematical and scientific knowledge in Finland, the programme now involves co-operation among universities from Finland, Hungary and Sweden. In Austria, the *Junior Academy* – a special programme for high school students - has been created in cooperation with the Vienna Board of Education.

Women: specific initiatives

Specific actions for women are being developed, either to attract young women into science and technology, in countries where large differences exist between the number of male and female scientists and engineers, or more related to gender studies[102]. There appears to be very little activity, however, that is aimed at women in the general public, despite studies showing that laywomen have more concerns about the future directions of science and technology than laymen[103].

*Witec (Women in Science, Engineering and Technology)* started as a European Programme and has produced an *European Database of Women Experts in SET*[104]. The database enables users to find a broad range of information about women experts across Europe. This Programme involves Denmark, Estonia, Finland, Germany, Greece, Ireland, Italy, The Netherlands, Norway, Spain and Sweden.

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[101] www.aka.fi/viksu
[102] See report of the Helsinki Group *Women and Science*. (European Commission, Brussels. 2002.)
[103] Wellcome Trust and Office of Science and Technology, *British Attitudes to Science and Technology*. (London. 2001.)
[104] www.shu.ac.uk/witec/

In Ireland, *Women in Technology and Science (WITS)* was launched in November 1990 to actively promote women in science in Ireland. The association has members from a broad range of scientific, engineering and technological backgrounds including teachers, computer experts, technicians and journalists. *WITS* members range in age and experience from third level students to some of the country's most senior scientists and academics[105]. Besides promoting the role of women in science and technology and facilitating contacts and association, one of the aims of this association is "informing public attitudes on the participation of women in science and technology" and "encouraging the participation of young women in science and technology". *WITS* is primarily funded by corporate and individual members subscriptions. Funding has been received from the EU and the Irish Government for specific projects.

*Technika 10* is a special programme to attract young schoolgirls into technical professions through technical clubs and courses co-funded by *Stichting Weten*, in the Netherlands (see case study in Education chapter). The German Federal Ministry for Education and Research supports projects to motivate girls for sciences. The A*ssociation for Women in Science and Engineering* (UK) is an association to promote women in science and engineering, often developing targeted PUST events. COPUS has activities in co-operation with the Women's Institute to discuss issues of concern to women. In Finland, the research programme *"Power, Violence and Gender"* was launched by the Academy of Finland.

Media

The Internet is increasingly being acknowledged as a most effective way to distribute scientific information. In several countries, science lines and web consultancies have been established to enable the public to ask questions to the scientists. *ScienceNet* and *ScienceLine*, in the UK are the paradigmatic example. More recently Denmark *(Ask a Scientist)*, Germany (*Wissenschafts-Hotline),* Portugal *(Consultório Científico)* and Sweden have created similar initiatives.

Television is widely recognized as the most important way through which people get in contact with science (see Media chapter). However, with some exceptions (U.K., Germany, France and Finland), science TV production in Europe is rarely supported by governments and is generally too expensive to be used by scientific institutions as a go-between in their dialogue with the public.

It is still possible to find some examples of the use of TV by the scientific community: in the Netherlands, for example, *The Royal Netherlands Academy of Arts and Sciences* is responsible for the subjects of a series of 30 television programmes about scientific research, starting next September; *Stichting Weten* also stimulates activities in the media, including television and Internet and provides scientists, journalists and other professionals with advice on science communication practice; Finland has a TV channel dedicated exclusively to culture, science and education:"*YLE Teema*". Scientific institutions and universities collaborate closely with this channel in the production of science and nature documentaries. In particular, that channel will televise public lectures such as those in the *University of Helsinki's Studia Generalia* series; *NOW* promotes Science Quizzes for juniors and seniors at television on Christmas, attracting a large audience. A similar quiz is supported by *Ciência*

[105] http://www.witsireland.com/

*Viva* in Portugal. The BBC annual televises live the Christmas Lectures from the Royal Institution[106]. The Vega Trust, run by Nobel Prize winner Sir Harry Kroto, has developed a series of master classes, which are broadcast in the BBC's "Learning Zone".

While not attracting as wide an audience as t.v., science film festivals are an important way of reaching the public. Following the French experience in this area, Ciência Viva started CineCiência – a science film international festival held in Lisbon, since 1997, on a yearly basis. another way. The *University of Trás-os-Montes e Alto Douro* (UTAD), a small regional university, promotes an annual international scientific film festival: *TeleCiência*. This university has established a network with other universities and city hall theatres, and the films can be seen in the main cities during the Science Week. The Festival is sponsored by Ciência Viva.

### Participation of the public

Many of the ESF members that mentioned the promotion of RTD culture and PUS do make some news items available for the press. But only in France and U.K. is there an opportunity presented to the general public, on the web-pages of leading scientific organisations, to be involved in discussion about future directions of science. In France, this is accomplished through the *Science pour tous* link on the home page of the *CNRS*. In the U.K., the *Royal Society* web-pages have a section called *Talk to us* and the *National Environmental Research Council* has a *Science and Society* section on its web-page that invites members of the public to discuss topics such as "Should we implement the Kyoto protocol?". The German *Dialogue Science and Society* programme clearly involves the scientific community in discussion with the public.

In some Member States, special committees of members of the Parliament have been assigned the task to interact with scientists and address issues about science and society: this is the case of Finland *(Committee for the Future)* and Sweden *(Parliamentary scientist club "Science and people")*. A totally different but interesting example is promoted in France by some associations of health patients and researchers in the field, discussing different forms of treatment with patients and their families.

### Resourcing and Training

The equipping of the scientific community to communicate to the general public, to deal with the media, to brief policy makers, and - in general - take part in the debate between science and society is clearly a matter of key importance. It has generally proved difficult, however, to find a great deal of information about the extent to which resourcing and training are available. Little is apparent from the web pages of ESF members, and a detailed investigation of their activities in these respects would be an important task for a future benchmarking exercise. There have been several attempts at international level to bring scientists and the media together. In 1995, for example, the International Federation of Science Editors organised a conference in Barcelona to do this[107]. A more recent attempt involved participants

[106] These lectures for school children were started in the 1840s by Michael Faraday, and are delivered one a day over the Christmas week.
[107] http://www.icsu.org/Membership/SA/ifse.html. IFSE-8 conference, July 1995.

from Europe along with the developing world to discuss the way in which researchers, public information officers and journalists came together in a process of mutual learning[108].

Once more, the U.K. appears to be well organised. The scientific community has access to funding for PUS activity through a number of competitive funding schemes, such as that run by CoPUS, and some of the research councils. There are also expectations that funded researchers will voluntarily put some effort into outreach, one to two days per year, in the case of life scientists, or equivalent to 0.5% of the grant value, in the case of particle physicists and astronomers. As far as training is concerned, the British Association plays an important role. Its Media Fellowship scheme enables young (usually post-doctoral) researchers to spend several weeks working in a media organisation, shadowing journalists and broadcasters, and sometimes writing or producing for public dissemination. This scheme is aimed at making scientists aware of the world of the media, their expectations, requirements and constraints. The Royal Society also encourages its University Research Fellows to take part in such schemes. Less grandiose, but more easily accommodated within a research timetable, are the media training courses offered via the research councils to all their community, from postgraduate level upwards. In the Netherlands, *Stichting Weten* also provides scientists with advice on practical science communication.

It has not been possible to look at the university courses available to science students (postgraduate and undergraduate) to train them in communication skills. This is again an important area for future work. Science communication courses are known to be available in individual universities in at least six member states (France, Germany, Ireland, the Netherlands, Spain, U.K.), and to have existed previously in one other (Italy). But this list is almost certainly not exhaustive, and presents another task for future benchmarking exercises.

[108] "International workshop on science and the media", February 2002. Organised by the Carribean Academy of Sciences and SciDev Net (http://www.scidev.net).

## 3.4 CASE STUDIES: GOOD PRACTICE AND EXPERIENCES WORTH SHARING

### *Case study 1 - Evaluating the Science Week @ Austria 2001*

The first *Austrian Science Week* was organised in 2000 with aim of creating a new form of direct dialogue between scientists and wider publics. Since then it has been an annual event. During this week, scientists become themselves the communicators, and present as well as discuss their work in more or less public places. Universities and governmental research labs are the main institutional actors, science-based industry being so far extremely under-represented. What is specific about the Austrian context is the fact that also school classes acted as science communications forums. In 2001, the Science Week was evaluated for the first time[109].

Basic concept of the evaluation

For the purposes of evaluation, the Science Week was understood as a place where scientists, different publics, policy makers, the media and the organisers meet, coming from different settings, having different interests and expectations in such an event. A symmetric and open approach to the evaluation was adopted, which did not "measure" the event against a set of criteria predefined by one of the above mentioned groups (e.g. the policy makers, who financed the science week). Instead, the evaluators tried to find out what the different actors expected from such an interactive process and why they got involved, while at the same time evaluating up to what degree these expectation had been fulfilled. Such an approach seemed crucial for at least three reasons:

- the evaluation would remain open to unforeseen positive and negative consequences of the communicational setting;
- there is little experience in this domain in the Austrian context;
- Science Week should become an event that is gradually co-shaped by the different actors (thus also the evaluation criteria should be developed together); evaluation is thus part of a development process.

Methodological framework

The wide range of different perspectives was taken into account in choosing methodological tools to meet the evaluation criteria.

1. The overall structure of the Science Week was analysed. (How many events/presentations took place, in what scientific fields, carried out in what contexts and forms? How were they distributed across Austria? etc.)

2. The point of view of the organisers (before and after the evaluation): open interviews with the organisers were carried out to understand their expectations, their communication paradigms, the strategic decisions they took and what were their criteria of success.

3. The funding/policy side: What did the Government, the ministries involved, expect from such an event? Why did they give funding and how would they define success?

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[109] U. Felt, A. Müller and S. Schober. *Evalueirung der Science Week Austria 2001*. (Bon-desministerium für Bildung, Wissenschaft und Kultur, Vienna. 2001.)

4. Scientists' views on the Science Week

- Short e-mail questionnaires were sent to all scientists who made presentations during the Science Week, to find out their motives for contributing, what publics they wanted to reach, what they expected as benefit, what they thought the public would expect from them and if it was fulfilled, in how far their expectations were fulfilled, their evaluation of the organisational side of the Science Week and some overall assessment of the Science Week. They could also add personal comments. The quota of replies was 31%.
- From the returned questionnaires, a small sample was selected to make more in-depth qualitative semi-structured interviews (sampled according to disciplines, the locality and the type of event). Particular interest was paid to their detailed judgements about the need, the sense and the setting of science communication in the framework of the Science Week.

5. The communicational setting

From the 785 events that took place during the ten days, 40 were sampled according the thematic area, the type of event, the spatial setting in which the event took place and the institutional background of the organisers. Accompanying observations were carried out, either during one complete presentation or for approximately 2 hours when there was continuing activity.

6. Visitors' views on the Science Week

- Short semi-standardised questionnaires were filled out together with visitors during the 40 events (5- 10 questionnaires per event, taking care also to interview people who leave an event rather early).
- From these interviews 15 "representatives" of the public were sampled according to their social data, and qualitative semi-structured interviews with them were undertaken.

7. Bringing different actors together

Finally the different actors were brought together in three focus groups. One was exclusively with representatives off the public; the second was a mix of scientists and representatives of the public and one media representative; the third group embraced policy makers, media representatives and the public.

<u>Some results</u>

1. The public widely appreciated the direct contact with scientists. They still had a lot of stereotype representations of science and scientists and such an event could definitely be a place to question them. However, quite a number of presentations played up to these stereotypes rather than questioning them. Using them helped, on the one hand, to make science recognisable to a wider public; however, on the other hand, stereotypes can create expectations/images, which cannot/should not be fulfilled.
2. Meeting science in a more relaxed setting seemed to help overcome reluctance to approach scientists and scientific issues, and to enter scientific institutions. Open-air events were more often visited by people with lower educational level than more closed venues. Some scientists, however, felt that the "science as fun" element was too predominant.
3. Events that had a clear relation to everyday problems seemed most attractive to visitors. Events where visitors could experiment themselves, or were closely involved in an experiment, were generally judged more positively. The interactive element is thus central.

4. The direct contact with "the public" was described as very positive by several of the scientists and as an enlargement of their personal perception of their work. At the same time there was concern that the time they spent on science communication was "wasted", if it was not taken into consideration in academic evaluations.
5. Scientists and the organisers alike were often extremely unclear about what public they were addressing: they spoke about a general public; however, from the presentations it was obvious that they addressed a rather narrow segment. In that sense, it would be important to get more clarity about the publics they want to address and tailor their presentations accordingly.
6. One of the main success criteria used by scientists was their presence in mass-media reports during the Science Week. This suggests that the notion of "public" was not so much equated with a direct contact with people, but with presence in the media. This was definitely seen as a greater value than having direct contact with a small number of people.
7. There was confusion as to what constitutes an interactive presentation or a dialogue with the public. Most presentations were nothing like as interactive as the scientists described them. Implicitly, the classical linear communication model was still strongly represented.
8. The information on the Science Week distributed in public was too unstructured and often did not fully capture the key elements of the events. While there is nothing like "the public's genuine interest in science", this interest has to be maintained. The problem of who is addressing whom became extremely visible in this context.

Conclusion

This case study shows how a detailed evaluation that takes account of the objectives of the public, as well as those of the researchers and organisers, can be carried out. The work is demanding, however, and clear indicators still need to be developed, so that others may use similar techniques without having to go over the same ground as Austria.

***Case study 2 - Training European scientists to communicate***

The SPHERS[110] network is a EU Framework 5 funded project that links high-resolution spectroscopists from five Member States, plus Switzerland. Its membership currently includes nationals from twelve E.U. countries and associated states. ENSCOT is the European Network of Science Communication Teachers[111], also supported by Framework 5, under the RPAST programme. It currently covers five European Member States. In April 2002, these two networks came together for a Science Communication Scenarios weekend residential course, the first time two such E.U.-funded networks have collaborated in such a way. About 20 SPHERS scientists were given training by members of ENSCOT in a number of simulated situations in which researchers might find themselves having to explain their work to lay (non-professional) audiences.

- The first scenario placed researchers in the position of science journalists, having to write a short news article about their work that could go into a quality newspaper.

- The second scenario had the scientists having to explain their work to a committee of Members of the European Parliament.

[110] http://www.chem.uni-wuppertal.de/sphers/index.shtml
[111] http://www.enscot.co.eu/

- The third scenario involved explaining novel aspects of spectroscopy to the management of science-based company with a view to developing new product lines.

- In the fourth scenario, researchers had to come into the studios of local radio station to be interviewed for a science magazine programme.

- Finally, the scientists went on t.v. to make a personal statement, including what made them enthusiastic about science.

For each of these tasks, the SPHERS researchers were given practical lectures and one-on-one tuition by the ENSCOT trainers. Although the course made use of English as its working language, advice and feedback were given - as far as possible - in the scientist’s own tongue. There were also lectures on the climate for science communication, including the European Commission’s *Science and Society Action Plan,* on news values and media constraints, and on “What does it mean to do European Science”.

For most of the SPHERS members, this was the first training they had been given in science communication. Although the young researchers were under some obligation to attend the course, evaluation forms handed in to the SPHERS coordinator were uniformly positive, expressing the view that this was an important and enjoyable activity for the participants. However, a note of caution is required: not every researcher is either keen or suited to public communication; compulsion could be counter-productive, particularly in view of the increasing burdens professional scientist face in terms administration and financial accountability.

***Case study 3 – IPATIMUP: an RTD promotion/PUS-active research institute, Portugal***

It is useful to review in detail the activities of an individual (albeit particularly active) research institution in the area of promoting RTD culture and PUS. *IPATIMUP (Institute of Molecular Pathology and Immunology of the University of Porto)* is a world-leading research institute created by several faculties of the University of Oporto *(Abel Salazar Institute of Biomedical Sciences, Faculty of Food and Nutritional Sciences, Faculty of Medicine and Faculty of Sciences)* with 40 PhD members and about 30 research graduates. *IPATIMUP* is best known for the results on stomach cancer, in particular on the role of infection by *Helicobacter pylori* and on the precocious diagnosis of certain forms of cancer. Several researchers have been awarded international prizes for their research in these areas.

*IPATIMUP* has created a small unit devoted to Science and Society issues and develops activities with schools, museums and local authorities at Oporto. Multidisciplinary collaborations have been developed in this context, with researchers from the field of the social sciences.

<u>Promotion of scientific culture at school</u>

Since 1997, *IPATIMUP* has extensively participated in the Ciência Viva calls for proposals to promote science education projects in schools. Twenty schools have been involved in educative projects coordinated by *IPATIMUP* or where this institution is a partner. Some of the links have developed into long term relationships of cooperation: twining between the schools and *IPATIMUP* were established, under the “patronage” of the Ciência Viva Agency.

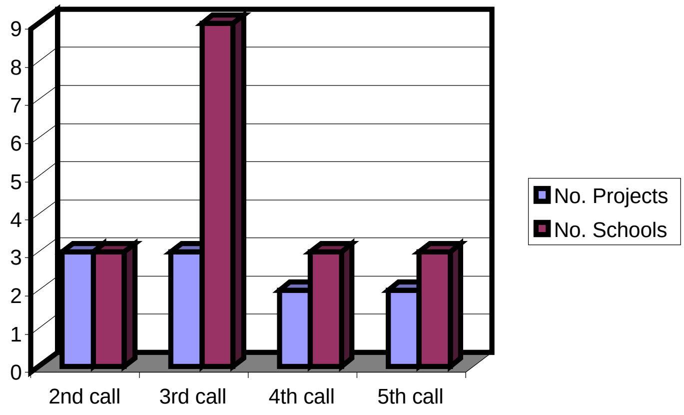


**Figure 1: Projects and school involvement in each call for proposals**

General topics about health and the human body have been developed by the students at school in science clubs. Teachers and researchers working in close collaboration explore ways to introduce the students to themes like the relation of cancer to food, environment and genetics. Data and biological preparations given by the researchers are used, as *IPATIMUP* has a large expertise in this field. The projects are also developed in a perspective of health education and prevention, and are followed by researchers from the social sciences. Many of the schools have been deliberately chosen in the poorest quarters of the city.

A different type of project, *Virtualab* involves collaboration with researchers in the area of engineering and deals with the simulation and remote control of laboratory equipment used to study cells and its DNA content. The science education project is developed in parallel with an interdisciplinary research project.

During the summer holidays, *IPATIMUP* provides short placements for students from secondary schools, generally recruited from those who participated in the science education projects. The students are divided into groups of two or three and are given a small project to develop in the research laboratories during one week, under the supervision of a scientist.

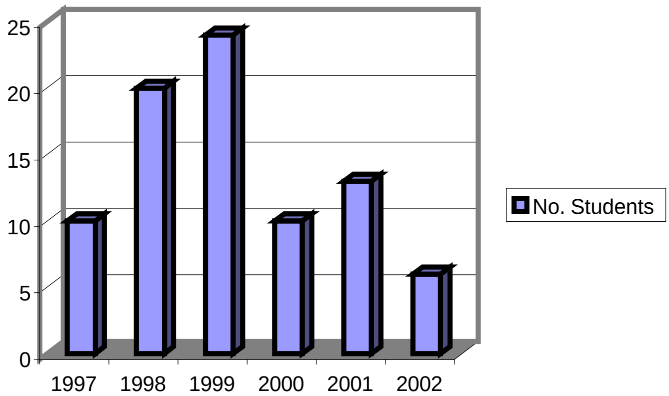


**Figure 2: Number of summer placements for secondary school students since the beginning of this initiative (1997)**

Activities with schools are generally developed in parallel with the leading research activities. In 1999 *IPATIMUP* hosted a large international convention about cancer research at Oporto. In parallel with the scientific sessions, a junior programme was organized where the secondary school students presented the work they had been carrying on at school and at the research laboratories of *IPATIMUP*. This junior programme was a success and was attended by journalists and by many of the scientists as well.

Web based projects for the schools

*IPATIMUP* has participated in two web based projects developed with twinned schools: *Health XXI* (1999-2000) and *The Human Genome* (2000-2002). These projects, where other research institutes in the area of health sciences participated, have been promoted by the *Ciência Viva* Agency, who hosts the project WebPages. In *Health XXI* students visited research institutes, interviewed scientists and wrote about the diseases they were investigating. The interviews and the written materials were developed under the supervision of science journalists and published[112]. *The Human Genome* also promotes the interaction amongst groups of students and teachers in schools and researchers from Health Sciences institutions, around issues related with the research in the human genome. In 2001 the students produced pieces of work about genetic diseases, under the supervision of the researchers and journalists. This year the students were invited to create fiction texts under the topic *Genetics in the year 2020*[113].

Some examples of scientific activities for the general public

*IPATIMUP* has established a long-term collaboration with the *Museum of the Transports and Communications*[114]. This Museum was established in the renewed building of the Oporto Customs, on the right bank of the river Douro, and is sponsored by the local authorities and by several private companies of transportation and telecommunications.

Participation in science weeks

An exhibition about the forms of communication, including an internal TV studio and a newspaper workshop, was held in the *Museum of the Transports and Communications* in 2000. During the Science Week 2000, the entire exhibition was adapted to communicate results about recent results on cancer research and about prevention of this disease. The public could follow real research activities in one of the laboratories of the institute and communicate with the working scientists by videoconference. Performing actors dressed as giant bacteria and viruses interacted with the children to draw attention to the importance of certain bacteria and viruses in lesions that may become malignant. At the same time they would give some health and food counselling to the children.

These activities, developed for the Science Week, evolved into a long term collaboration, where *IPATIMUP* has a permanent laboratory with simple experiments to be performed by the visitors of the Museum. The public can also see the normal activities taking place at the laboratories of *IPATIMUP* by videoconference and communicate with the researchers according to a defined schedule.

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[112] http:// www.cienciaviva.pt/healthXXI
[113] http:// www.cienciaviva.pt/genoma2002
[114] http://www.amtc.pt/museu/

Participation in the events of Porto 2001- European Cultural Capital

*IPATIMUP* has developed a large number of activities during Porto 2001 European Cultural Capital:

- Colloquia, participation in debates, some of them broadcast by the radio, are among the activities included in the *Porto 2001* Agenda.
- A car with a giant DNA replica circulated in the streets; leaflets and a small game were distributed to the public.

Communication with the media

Communicating with journalists is a common practice at *IPATIMUP*. Main research results and prizes have been the object of press releases and subsequent interviews to the involved scientists. Some of the researchers often participate in roundtables and TV debates not only about their research results, but also on current cultural or social issues.

### 3.5 DISCUSSION

The picture that emerges from this survey of the extent to which the scientific community is engaged in the promotion of RTD culture and PUS shows that researchers across the European Union are already active in this field. National and regional science weeks and festivals are present in 13 member states (excluding only Greece and Luxembourg) and the same number is participating in European Science and Technology Week in 2002 (excluding Ireland and Luxembourg). Many other schemes have been catalogued above or in the Annex to this chapter.

Traditionally, scientific researchers have been intimately involved in the development of school curricula. In part, this has been out of a thoroughly understandable self-interest, to ensure the next generation of scientists is well trained and motivated. This exercise has additionally discovered many cases of the scientific community going beyond this, however, organising inspirational camps and events for school students, and acting as exemplars for budding scientists. Many schemes for doing this have been listed above.

As far as leadership is concerned, it is not clear that the principal scientific societies and academies are taking up the challenges facing their members with demands for greater engagement with citizens in general and the debates now current in the public sphere. At least, the area does not appear to be given much prominence in mission statements or on the web pages that have been accessible in this benchmarking exercise. The insistence on leadership is not to try to centralise or in some way “standardise” the efforts of individual scientists or research groups; personal flair and imagination is invaluable. But there is certainly benefit in experiences being shared, so that effort is not wasted in “reinventing the wheel”. So the leadership of the scientific community can also play an important role as a repository of information and advice. Results of such leadership can be clearly identified: the example of Portugal shows that a lively and enthusiastic leadership team can produce an almost immediate “quantum leap” in the efforts of the scientific community to promote RTD culture and PUS; longer term, the UK experience is that there has been a “cultural change in the attitude of scientists to outreach activities”.

Once activities in this area develop, the question arises of to what extent they are achieving whose aims, and why. Studies generally show that scientists themselves get a lot of satisfaction from their efforts. But few people like to admit that what they have done has been ineffective and unenjoyable. So it is imperative to evaluate what is being done in an objective and many-sided fashion, as the Austrian case study shows. Other Member States may well make use of the Austrian experience in doing this.

Perhaps the most worrying feature to emerge from this study is the lack of information about what resourcing is available to scientists to carry out work on the promotion of RTD culture and PUS, and about training to enable them to carry out the tasks that are being increasingly assigned to them by the science-and-society movement. It is hard to see the laudable aims of this movement can be met if the scientific community is not equipped to fulfil its role, in terms of financial support and personal skill development. Even if these resources do exist, for the majority of Member States, the very least one can conclude is that they need to be given greater prominence.

It has not proved possible to investigate whether researchers get any professional recognition for taking part in activities to promote RTD culture and PUS. This is an issue on which the success of the science-and-society movement may well depend, however: this whole enterprise needs scientists to enter into it enthusiastically, feeling that their contribution is really valued. The evaluation of the Austrian science week showed that while scientists did give willingly of their time to make the event successful, they also expressed concern that “it was not taken into consideration in academic evaluations”, and there is much anecdotal evidence that – for the most able and ambitious – talking to lay audiences is seen as wasting time. The experience of at least one member of the Expert Group, who chaired a committee looking at promotion candidates, has been that – despite the fact that researchers fill in an annual log of all their activities, including outreach – this activity counts for little in terms of career advancement.

We would not suggest that public science activities should ever become a *sine qua non* to promotion, and would in no way wish to dilute the quality of senior European researchers. Nonetheless, some reward should surely accrue to those who take on the tasks of dealing with the public face of science on behalf of the community, other than the fact that explaining their work and their field, and arguing about its importance, is a highly enjoyable exercise.

## 3.6 Recommendations

1. The leadership of the scientific community should promote a culture of transparency and communication of their work and results to the public. This should be done by financing programmes, competitions, public calls for proposals, awards and other initiatives aimed at promoting RTD culture and PUS.
Reasoning**:** Activity in this area is increasingly demanded by society (as evidenced by the EC’s *Science and Society Action Plan).* Where schemes exist to enable scientists to carry out such tasks (e.g. Portugal, U.K.), the level of activity is highest.
Action**:** leading scientific academies and learned societies

2. Scientists should be given training in communication skills, taking into account the need for public dialogue, debate and inclusion in decision making.
Reasoning**:** The training offered to most European scientists does not equip them to carry out such tasks. Countries (such as the U.K.) that do have training schemes have a highly active

community for the promotion of RTD culture and PUS, and scientists who receive training report the experience to be useful.
Action**:** scientific academies and learned societies, in partnership with professional science communicators.

3. Activities aimed at promoting RTD culture and PUS should be evaluated, looking at the aims and objectives of organisers, researchers and their audiences.
Reasoning**:** Although activities in this area are widespread, little is known as to how effective they are. After thorough evaluation (as in the case of Science Week Austria), some basic assumptions may be found to require reassessment.
Action**:** outreach events and programmes organisers.

4. Promotion procedures should be able to take account of a scientist's activity in the area of promoting RTD culture and PUS.
Reasoning**:** The goodwill of researchers is required to make the "science and society" movement successful. Many scientists, however, would agree with those evaluated in Science Week Austria and the member of the French promotions committee that there is little recognition of the time and effort that they invest in the promotion of RTD culture and PUS.
Action**:** research and higher education institutions.

5. The scientific community must recognise its responsibility for the improvement of basic science education and lifelong learning of science. This should include:

- Direct contact with teachers and the production of learning resources ;
- Direct and regular partnerships with schools in order to provide temporary placements for students in research laboratories. Whenever possible, these partnerships should be extended to knowledge based companies;
- Involvement in large-scale educational projects concerned with the impact and social implications of science.

Reasoning**:** The scientific community needs to be involved with young people, including those who are not going on to become researchers themselves, for the future of science and society relations. Existing schemes that place school students in research laboratories, such as those in Portugal, show that this works well.
Action**:** the scientific community as a whole.

6. The scientific community should maintain press and information services specialised in dialogue with the media. They should also look at the Internet as providing possibilities for direct contact with the public, without making use of the mass media.
Reasoning**:** The media require information in a digestible form. But there are criticisms of the way in which science is sometimes presented. Internet initiatives such as those in Denmark, Germany, Portugal, Sweden and the U.K. provide an alternative route for reaching the public, as well as for dialogue and debate.
Action**:** leading research laboratories, academies and societies.

***Further work***

1. The activities of individual research institutions and universities should be assessed to obtain a better picture of activity on the ground, on a country by country basis. (In the current exercise we have been able to put together such information for one or two cases.)

2. The steps taken to train researchers for communication and dialogue tasks need to be looked at.

3. Evaluation indicators for regional, national and European science weeks and festivals should be developed.

***Future indicators***

1. Quantitative indicators of science weeks and festivals (numbers of events, audiences, numbers of participating scientists and institutions).

2. Statistics on funding available for science communication activities for/by researchers.

3. Number (or proportion) of researchers undertaking science communication training.

# CHAPTER 4: EDUCATION SYSTEMS (FORMAL AND INFORMAL)

Both the formal educational systems and the informal learning opportunities that students might have as part of the broader school life make a key contribution to the development of public understanding of science and technology (PUST). This chapter focuses on the scientific proficiency of the *general* population, through education. It does not address the needs of future professionals, since this is covered by the expert group benchmarking "Human Resources in RDT". Their report examines the attractiveness and appeal of science including science education issues:

"focusing mostly on the early years of education where exposure to and sustaining interest in science can have a very significant impact on the subsequent pursuit of scientific training and thereafter a career. Less attention shall be paid to factors contributing to the attractiveness of science at later stages of the career"[115].

We therefore focus on the knowledge needs of "ordinary" citizens. As Bruce Alberts, the President of the US Academy of Sciences, said :

"Our role cannot simply be to teach the basic facts and concepts of our discipline, so as to prepare students for the next science course that they may decide to take on their route to medical or graduate school. Our colleges and universities will graduate approximately two million students next year, only about 15% of whom will receive bachelors' degrees in science or engineering. All the rest will become the citizens who determine – by their understanding and appreciation for the nature and values of science - both the vitality of our nation and the future of our scientific enterprise. It would be fine if all Americans knew about plate tectonics or the way the cells divide. But it is much more important that they understand what science is (and what it is not) and how its central values – honesty, generosity, and respect for the ideas of others - have made possible the rationalization of human experience that underlies all human progress".[116]

## 4.1 INTRODUCTION

The following areas for developing indicators and benchmarks when considering the role of formal and informal education in furthering PUST are proposed:

- PUST in the formal curricula, which will include the questions of knowledge organization, modes of teaching S&T related subjects, curricular and teaching resources, training of teachers and students attainment and attitudes.

- PUST in extra-curricular but still school based activities, which could be characterized as semi-formal and include all the activities, which are school organized or based but they are not directly related to the formal curricular requirements. Moreover, non-formal activities, which include families, local communities but also the popularized S&T knowledge available in the public domain but targeted to school-aged population.

The reason for considering the above two dimensions as potential areas for developing indicators and benchmarks is the existence of several empirical studies[117] showing that both

[115] First Milestone Report (April 2001) from the Expert Group Benchmarking Human Resources in RTD

[116] Bruce Alberts in the Foreword of « Science Teaching Reconsidered » Committee on Undergraduate Science Education, National Academic Press, Washington, DC, 1997

[117] See for example: Simpson, R. D., and Oliver, J. S., 1985, Attitude toward science and achievement motivation profiles of male and female science students in grades 6 through 10. *Science Education*, **69**(4), 511–526; Tressel, G., 1994, Preface to *Informal Science Learning: What the Research says about Television, Science Museums, and Community-Based Projects*, edited by V. Crane, H. Nicholson, M. Chen and S. Bitgood

the formal educational systems as well as the informal learning opportunities that students might have as part of the broader school life have a considerable contribution in the formation of:

- A solid knowledge base about techno-scientific facts and corresponding concepts;
- A firm and persistent cluster of attitudes about Science and Technology in general or about more specialized issues (e.g. Biotechnology, Risks, etc); and
- Future career choices.

The aforementioned effects of formal schooling or informal school-based activities can have life-long duration since as other studies[118] have shown, the image of science and technology as perceived in school is for a large segment of the population the most dominant factor affecting its predisposition towards these two areas even in adult life. The close linking of PUST field with the Science and Technology education field is further evidenced by the fact that a number of international educational policy bodies have made the advancement of techno-scientific literacy for all a primary goal for the scientific and technological subjects of school curricula.[119] Thus, we could say that schools are social institutions of primary importance as far as their contribution to the formation of a scientific culture is concerned.

It is for the above reasons (teaching of scientific subjects in schools as means for advancement of techno-scientific literacy for all) that this report focuses on compulsory schooling only.

The sources used in this report include EU sources (e.g. Eurydice[120], Key data in Education) and OECD publications[121] as well as the Solomon/ Gago report "Science in school and the future of scientific culture in Europe"[122]. The latter, although dated, remains the only source of data concerning science education at European level/ in several European countries. It should be noted that it does not contain dedicated chapters on Austria, Finland, France or Luxembourg, which has lead to some gaps in the information presented below. We have filled in these gaps, for example using input from the High Level Group, wherever possible. We have also highlighted areas in which further information is required.

Finally, specific dimension concerning the formal and informal education systems are presented in the annexes. In Annex A, a country by country report is presented featuring the number of S&T curricular subjects taught per year, the level of schooling and type of schools. In Annex B objectives pertaining to information and communication technologies (ICTs) are presented. Annexes C and D describe the number of weekly science periods in the Belgian

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(Pennsylvania: Science Press); Woolnough, B., 1995, School effectiveness for different types of potential scientists and engineers. *Research in Science and Technological Education*, **13**(1), 63.

[118] See for example: Pifer, L.K., 1996, The development of young American adults' attitudes about the risks associated with nuclear power, *Public Understanding of Science*, **5**(2), 135-155; Barton,A.C., Hindin, ? . J., Contento, I.R., Trudeau, M., Yang, K., Hagiwara,S., Koch, P.D., (2001), Underprivileged Urban Mothers' Perspectives on Science, Journal of Research in Science Teaching,, 38(6), 688-711.

[119] AAAS, 1993, *Science for All Americans: Project 2061*, New York: Oxford University Press; Fensham, P., 1997, School Science and its Problems with Scientific Literacy. In R. Leninson and J. Thomas (Eds.), *Science Today* (pp. 119-136), London: Routledge.

[120] www.eurydice.org

[121] For example (a) *OECD PISA*, the three-yearly survey of the knowledge and skills of 15-year-olds in the principal industrialised countries - http://www.pisa.oecd.org/
*(b) Education at a Glance 2001 indicators* - http://www1.oecd.org/els/education/ei/eag/

[122] Solomon, J. and Gago, J-M. (Eds), *Science in School and the Future of Scientific Culture in Europe* (Euroscientia Conferences, December 1994), DG Research , European Commission, Brussels.

curriculum and the compulsory periods per week in Germany respectively. In Annex E certain information about Greece is displayed such as a list of school subjects and the number of lessons. Annex F describes the courses for the different scientific branches taught in Sweden. Annex G presents students' attainment in S&T subjects. Annex H contains information about education in Finland .

## 4.2 AREAS OF POSSIBLE INDICATORS AND BENCHMARKS

The possible areas for developing science education indicators and benchmarks include: identification of S&T related curricular subjects; the starting point for the teaching of Science and Technology oriented subjects; the aims and objectives of S&T curricula; the number of S&T curricular subjects taught per year; the level of schooling and type of schools; the status of S&T subjects in school curricula; factors affecting S&T options; the mode of teaching S&T subjects; curricular resources; methods of recruitment/assessment/ professional development of staff; students' population achievement; methods of assessment and students' attainment in S&T.

## 4.3 PUST IN THE EU MEMBER STATES' FORMAL CURRICULA

***Identification of S&T related curricular subjects (e.g. physics, chemistry etc. but also health education, environmental studies etc).***

From the table below we see that Biology is taught in every Member State except Portugal. Technical/Applied Science is taught in all countries but Italy and the United Kingdom. Only seven countries (Belgium, Denmark, France, Greece, Italy, Portugal and Spain) include Natural Science in their curricula. With the exception of France, all the countries offer Physics and Chemistry as part of their S&T curricula. On the other hand, the subjects IT/Electronics and Integrated Science are offered in a handful of countries (the former is taught in France, Spain and the Netherlands while the latter is taught in Denmark, France, Greece, Portugal and Spain). The subject Earth Science is present in the curricula of Austria, Denmark, France, Greece, Italy, Portugal and Spain. Finally the subject Health/Home Economics is taught only in Austria, the Netherlands and Spain.

*Table 1: S&T related curricular subjects*

| Country | Biology | Techn./ Applied Sci. | Natural Sciences | Physics | Chemis try | IT/ Electro nics | Integrated Science | Earth Science | Health/ Home economics |
|---|---|---|---|---|---|---|---|---|---|
| Austria | ● | ● | | ● | ● | | | ● | ● |
| Belgium | ● | ● | ● | ● | ● | | | | |
| Denmark | ● | ● | ● | ● | ● | | ● | ● | |
| France | ● | ● | ● | | | ● | ● | ● | |
| Germany | ● | ● | | ● | ● | | | | |
| Greece | ● | ● | ● | ● | ● | | ● | ● | |
| Ireland | ● | ● | | ● | ● | | | | |
| Italy | ● | | ● | ● | ● | | | ● | |
| Netherlands | ● | ● | | ● | ● | ● | | | ● |
| Portugal | | ● | ● | ● | ● | | ● | ● | |
| Spain | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Sweden | ● | ● | | ● | ● | | | | |
| United Kingdom | ● | | | ● | ● | | | | |

***Starting point (i.e. year) for the teaching of Science and Technology (S&T) oriented subjects***

In all countries but Italy (for which no information is available), the teaching of S&T oriented subjects starts in primary school. However the exact starting age varies considerably. In Austria, France, Portugal, Spain and the United Kingdom teaching starts at the age of six, in Denmark the teaching starts at age seven, whereas in Germany, Greece and Ireland the teaching process begins at the age of ten. In Sweden the teaching starts in the $7^{th}$ grade (age 12). There is no set starting age in Belgium (see Table 2 below).

**Table 2: Starting point for S&T teaching**

| Country | **Primary school** | **Secondary school** | **Age** |
|---|---|---|---|
| Austria | ● | | 6+ |
| Belgium | ● | | |
| Denmark | ● | | 7+ |
| France | ● | | 6+ |
| Germany | ● | | 10+ |
| Greece | ● | | 10+ |
| Ireland | ● | | 10+ |
| Italy | No data | No data | |
| Netherlands | ● | | |
| Portugal | ● | | 6+ |
| Spain | ● | | 6+ |
| Sweden | ● | | 12+ |
| United Kingdom | ● | | 6+ |

***Aims and Objectives of S&T curricula***

The aims and objectives of science curricula exist in national legislation but it is difficult to access them. We did find objectives pertaining to ICT education, which are presented in Annex B.

***Number of S&T curricular subjects per year, level of schooling (i.e. primary, lower secondary) and type of schools (academic, technical etc.)***

An explicit country-by-country report regarding science teaching is presented in Annex A.

Analysing the curriculum in each country, the following common traits were discerned: S&T subjects at primary level are often introduced as part of broader thematic subjects such as Natural/Technology (Denmark), General Science (Greece), Social and Environmental Studies (Ireland), World Studies (Netherlands), Knowledge of the Environment (Spain) and Study of the Environment (Portugal).

Curriculum differences often occur due to various types of schools (e.g. Catholic and Community Education schools; differences between the different regions in Germany) or due to the strength of central government's guidance (e.g. in the Netherlands, Spain and other countries, the government's timetable is merely a recommendation as opposed to in Greece where the federal grip is tighter). Moreover, science courses often fulfil partial qualifications for academic certificates (e.g. the GCSE in the United Kingdom and the LC in Ireland). As a result of ever-changing educational needs, a few countries have recently introduced legislation regarding S&T curricula (England 1998, Italy 1985, Sweden 1994).

***Status of S&T subjects in school curricula i.e. allocations in timetable, their "presence" in university entrance exam papers, permitted choices of S&T subjects.***

Examining the recommended allocation of annual hours of teaching of compulsory subjects at the age of 7, we observe that Germany allocates slightly over 20% of hours to the subject of Mathematics.[123] This is the highest percentage amongst the EU countries with Denmark, Greece and Luxembourg's rates being the second highest (around 20%). As regards the Human and Natural sciences the percentages of Germany, Greece and Austria vary between 10% and 15%, trailing Scotland which dediacates over 20% of time to these subjects. The pattern changes considerably when we move to age 10.[124] The proportion of hours allocated[125] to Mathematics in France is over 20%, followed by Germany, Belgium, Ireland, Luxembourg, Austria, Denmark and Finland (percentages between 15% and 20%). In Human and Natural Sciences, the highest percentage belongs to Scotland and the second highest to Greece (both over 20%). The next step is to examine the minimum annual timetable allocated to compulsory subjects in general lower secondary education (age 13).[126]. The percentages of France and Austria (around 15%) pave the way, followed by Belgium, Germany, Denmark, Portugal and UK-Scotland (between 10%-15%). The countries of UK-Scotland (more than 20%), Austria (slightly below 20%), Finland, Portugal, France, Denmark and Germany (between 10% and 15%) record the highest higher proportions. For general upper secondary

[123] Key data on education in Europe, 2000, p.72.
[124] Key data on education in Europe, 2000, p.73.
[125] In this report the term « allocated » is intended to describe current practices and does not have legal connotations
[126] Key data on education in Europe, 2000, p.89.

education (age 16),[127] the highest percentage of minimum annual timetable allocated to Mathematics belongs to France (slightly over 20%), followed by Greece (between 15% and 20%). In Natural sciences, the percentage of France is similar to Greece’s (over 20%), trailing Denmark's (30%) and Portugal's (between 25% and 30%).

***Factors affecting S&T options (social, pedagogical means etc).***

Examining factors affecting S&T options, we observe that in Austria efforts have been undertaken to extend schools’ financial autonomy a fact that can facilitate the procurement of computers and technical equipment for intermediate and upper secondary technical and vocational colleges. This makes occupation-oriented, project-based forms of education easier to put into practice. Since 1997 the Federal Ministry of Education, Science and Culture, department III/E, has participated in the European School Net (EUN).[128] The European School Net provides interactive, Internet-based support designed to improve the quality of education and to promote the use of information and communication technologies at school. In addition, Austria took part in the European Network of Innovative Schools (ENIS)[129, 130].

In Denmark, a long tradition exists in science teaching, involving laboratory work, field studies and various aspects of practical work. It is worth mentioning that practical work has recently been oriented towards activities controlled by pupils instead of exclusively organised by teachers. Experimental projects are compulsory in the upper secondary school. Furthermore, in the 1980s there was a shift in physics courses in secondary school, changing from a strictly discipline-oriented approach into a thematic life-world approach that covered environmental topics as well. There are many teachers unions with their own teacher association and publication for every subject. There is also an ongoing debate regarding curricula, examinations, teaching methods and materials. Danish teachers are independent with no state control over the teaching materials and methods. Topics are derived from environmental issues and the natural life. Denmark has a youth organization in science with a broad range of activities. Attention has been drawn to potentially difficult situations which could arise due to the uneven distribution of pupils who are not native Danish speakers.[131]

The novel pedagogical approaches recently developed in France pertain to S&T options as well as other subjects. A growing number of students do not seem happy with the traditional way of science education that neglects experimental work. It is indicative of the problem that French teachers do not consider interdisciplinary dialogue as a high priority while there is a great emphasis on the programmes' encyclopedism.[132]

The German school system makes extensive use of out-of school resources such as museums and multimedia. There is a longstanding tradition of science clubs and cultural associations that dates back to the 19th century. The results indicate that female students are less interested than boys in science classes. Potential problems include the growing number of non-German pupils, children from asylum-seeking families and students who have already started

[127] Key data on education in Europe, 2000, p.91.
[128] http://www.eun.org
[129] http://www.virtuelleschule.at/ENIS/enis.htm
[130] The Austrian Federal Ministry of Education, Science and Culture: Development of Education in Austria 1997-2000, pp 10-12, 25, 38, 112-113.
[131] Paulsen, A., *Report from Denmark*, (1994: 96-97, 99, 100-103, 109), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.
[132] Caro, P., Tarnero, J., Martinand, J. and Laffitte, M., *Country Report : France*. International Conference *“Science in School and the Future of Scientific Culture in Europe,* Lisbon, 15-16 December 1994.

education in their previous country and then moved to Germany without any language skills.[133]

Unlike Germany, in Greece, the use of out-of school resources is rather limited. The educational system of Greece is very centralized. The Ministry of Education defines the curricula, publishes the textbooks and ensures the adherence of every school to these guidelines. However, schools fail to cover the prescribed material except in the last grade of upper secondary education where the University entrance examinations take place. The major reforms of the educational system did not affect the way science was taught despite changes in the organisation of the content. Of the latter the most prominent are the introduction of subjects related to environmental education and the "integration" of primary science. Moreover, a significant characteristic of modern Greek society is the willingness and ability to absorb new technology in the services sector and at a level which is well above the technical capacity of production of the country. Although there has not been any research in science and mathematics, the results in the University examination indicate that more than 50% of the students in the departments of physics and medicine are female and more than 25% of engineers are female. Science is considered essential for pursuing a career e.g. in medicine and engineering.[134]

In Ireland, remarkable regional differences are demonstrated. In terms of higher "third level" education, there are higher participation rates in the western regions while participation decreases in the eastern areas. Within Dublin, there is a disparity in educational opportunities available in the different areas. In addition, emigration has been a troublesome issue in rural areas, resulting in smaller schools whose viability is questioned.[135]

Science teaching in Italy is not experiment based. The educational system is also very centralized and efforts to change this situation have to overcome considerable inertia. There is scant use of out-of school resources. Significant efforts have taken place to establish the connection between sciences and the outside world like the various initiatives of the Project "Scuola Lavoro" and European Science Week. [136]

In the Netherlands significant regional differences exist. In urban parts of the country the level of education seems to be lower than elsewhere. This is further emphasised due to the growing number of minority or refugee students and the increasing number of people aged 30-40 aiming at being redirected to science teaching.[137]

[133]Riquarts, K., *Report from Germany*, (1994: 140, 145, 150), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[134] Kouladis, V., *Report from Greece*, (1994:186-187, 192, 194-196), in Solomon, J. and Gago, J.M.(eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[135] Childs, P. *Report from Ireland*, (1994: 321-313), in Solomon, J. and Gago, J.M.(eds.) Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[136] Marucci, G. *Report from Italy* (1994: 240, 243, 245, 251,253), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[137] Eijkelhof, H. and Voogtm P. *Report from the Netherlands* (1994:366-367), in Solomon, J. and Gago, J.M.,(eds.) Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

The situation changes dramatically in Portugal where school conditions are very different according to regional status and the status of schools (private/ public). It is not uncommon for the prosperity of private schools in urban areas to be contradicted by the poor conditions of private schools located in smaller urban or rural areas. It is also believed that children of Portuguese emigrants face daunting educational predicaments.[138]

The use of educational technology for the teaching of science began rather early in Spain (project *Mercurio*, 1987, for audio-visual equipment and project *Atenea*, 1985, for computers). The variety of reactions registered amongst educators makes evaluation difficult. At primary level, the curriculum is structured in the areas of knowledge and expertise. Each school must have both integrated and have at least one room as a laboratory. In compulsory secondary education, the schools adapting to this curriculum must have three laboratories (Biology, Chemistry and Physics). In non-compulsory education each of the subjects must have its own laboratory. Certain research centers support environmental education. [139]

In Sweden significant factors are stimulating change in the science education system: [140]

a) The soon-to-be decentralized and deregulated school sector.
b) The trailing performance of school students' in science.
c) The environmental concerns facing society.
d) Awareness of the constructivist view of knowing and learning.[141]

In the UK boys find physics more interesting than girls and are more inclined to take it up. However, the introduction of compulsory science of all types has shown that girls may outperform boys at "Key Stage 4" and although they do tend to prefer biological sciences and environmental studies. [142]

*Some general trends*

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[138]J. Solomon and J.M. Gago, Science in School and the Future of Scientific Culture in Europe, pp.479-480, Euroscientia Conferences, 1994.

[139]. Saez, M., *Report from Spain* (1994: 534, 537, 539-540), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[140] Anderson, B., *Report from Sweden* (1994: 595-596), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[141] "The first way of interest was related to Piaget's stage theory of cognitive development. Two types of investigation were carried out in Sweden as in several other countries. Firstly, textbooks were analysed. Secondly, the pupils using the textbooks were tested with Piagetian tasks. It was found that the majority belonged to the stage of concrete operations. These results pointed to a considerable gap between pupil's level of cognitive development and the conceptual demands of science courses, which was considered an explanation of the often poor results of teaching efforts. The importance of seeing science teaching from the pupil's perspective was also emphasized… Gradually, the stage concept became the subject of increasing criticism. When researchers tried to operationalise it by test problems, it became very fuzzy. However, the Piagetian period opened up, once and for all, the pupil's perspective… A main result is that students, before teaching, have everyday conceptions of natural phenomena… Another major finding is that the science concepts tend to be forgotten, whereas the everyday ones remain some time after teaching…Constructivist wiew of knowing and learning in combination with the many detailed results of investigations and related insights generates many new ideas on teaching science content which are worthy exploring" (Anderson, B. *Report on Sweden*, 1994:595-597, in Solomon and J.M. Gago, Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

[142] Solomon, J, and Hall, S., *Report from United Kingdom* (1994: 633), in Solomon, J. and Gago, J.M. (eds.), Science in School and the Future of Scientific Culture in Europe, Euroscientia Conferences, 1994.

Some common factors affecting S&T options, and useful for policy makers, can be clustered together. For example, immigration in Belgium and emigration in Ireland are significant factors affecting S&T options. Moreover, the significant regional differences in both countries constitute particular challenges: in Wallony, the percentage of non-Belgians in primary and secondary education is three times that in Flanders. Regarding Ireland, the depopulation of rural areas, mainly in eastern regions, reduces school sizes, while the higher participation rates occur in the western regions. A similar case of regional differences takes place in Italy. Although there is a scant use of out-of school resources, some schools in the north and centre of Italy are experimenting with the use of Museums and Cultural Heritage themes. Furthermore, the Project “Scuola Lavoro” and the European Science Week make a contribution to improving the relationship between sciences and the world of work.

Two factors are decisive in Germany. Firstly, the widespread use of out-of school resources providing an alternative mode for the teaching of S&T. Secondly, the increased number of children from families of immigrants and asylum seekers who move to Germany without any language skills constitutes a factor of considerable weight. In the Netherlands the level of education in the urban parts of the country is not even with the level elsewhere because of the increasing number of pupils coming from refugee families. Similar problems occur in Portugal. Taking into account the significant differences not only between private and public schools but also between schools situated in different regions, the theme denotes a great social distinction in education.

In France new pedagogical approaches have recently been adopted. In the past, emphasis was placed on conceptual tasks and not on experiments, leading to rejection from a large number of pupils. Teaching is still characterised by a disciplinary structure rather than by interdisciplinary options. Unlike France, in Denmark physics courses in the lower and upper secondary school changed significantly, in the late 1980s from a very discipline-centred approach towards a thematic life-world approach. Accordingly, the new curricula recommend topics from the life world.

In Spain and Greece technology related subjects are adopted. In the former case, the Ministry of Education has structured the curriculum in the Primary Education in two areas, Knowledge and Expertise. In compulsory Secondary Education the schools have different laboratories for each subject and they also have a technology classroom. Moreover, specific programs have introduced new technologies both in Greece and Spain. The introduction in Greece of subjects related to environmental education and the “integration” of primary sciences are considered essential factors affecting S&T options.

There is also a widespread concern for environmental problems in Swedish society, and a great interest in the constructivist view of knowing and learning. Moreover, the school sector is in a phase of decentralization and re-allocation of responsibilities between national and local authorities.

Finally, concerning Austria, technology is used as a useful educational tool. The European School Net provides interactive, Internet-based support designed to improve the quality of education and to promote the use of information and communication technologies at school.

***Specific features of teaching S&T subjects: practical work and the PUST dimension***

This section deals with a variety of issues such as the use of labs and the explicit appearance of PUST topics in school curricula. The latter is detailed in Table 3, below.

**Table 3: Mode of teaching**

| **Country** | **Practical work** | **Theoretical approach** | **History of Science/ Social aspects** |
|---|---|---|---|
| **Austria** | • | • | Environmental–Traffic–Sexual-Health Education. |
| **Denmark** | Field studies-laboratory works-Experimental Projects | • | Traffic–Sexual-Health Education – Ecology – Environmental studies. |
| **France** | | • | |
| **Germany** | • (25% of the time) | • | |
| **Greece** | • (Demonstrations 20% of the time) | • | |
| **Ireland** | • (26.5% of the time, Field studies) | • | • (30% of the content) |
| **Italy** | • (Field studies) | • | • (Energy+Environmetal problems) |
| **Netherlands** | • | • | • (Science and Industry in Chemistry+ Agriculture and Biotech in Biology) |
| **Portugal** | | • | |
| **Spain** | • (Practical work with an emphasis on statistics) | • | • (STS options to core subjects) |
| **Sweden** | • | • | |
| **United Kingdom** | • (50% of time in ages 5-11, and 25% of the time in ages 12-16) | • | • (Health and sex education+STS options in the GCSE and AS level examination options) |

All the countries except Belgium adopt the “Theoretical approach” in S&T teaching. As far as the “Practical work” mode is concerned, only Portugal and France do not adopt it at all. On the other hand, Austria, Belgium, Denmark, the Netherlands, Spain and Sweden fully adopt this mode of teaching. Especially in Denmark field studies and laboratory works are strongly recommended on all levels and experimental projects are mandatory in the upper secondary school. Spain in particular, puts emphasis on statistics. The other countries only partially utilize this teaching method. In Germany 25% of time is allocated to “Practical work”; in United Kingdom 50% of time for children aged 5-11, and 25% of the time for children aged 12-16; in Ireland 26.5% of the time, plus time is also allocated in Field Studies. In Italy, the time is allocated exclusively in Field Studies, while in Greece the “Practical work” takes the form of “demonstrations” in 20% of the time.

Finally, the “History of Science/Social aspects” mode does not appear in use in Belgium, France, Germany, Greece, Portugal and Sweden while in Ireland a percentage of 30% of the content is allocated in this aspect of teaching. Other countries develop this aspect using various topics. In Austria and Denmark the social measures cover a wide range of themes such as Environmental-Traffic Education and Sexual-Health Awareness. Italy emphasizes Energy and Environmental problems, while the Netherlands concentrates on Science and Industry in Chemistry and Agriculture and Biotech in Biology. Furthermore, Spain focuses on STS options to core subjects and the United Kingdom examines Health and Sex education issues as well as STS options in the GCSE and AS level examination options.

***History, Philosophy and Social dimensions of Science in schools***

In this section we explore the degree of penetration, in the various expressions of the educational systems, of elements from history, philosophy and sociology of Science in the school science curricula. The data presented come from the TIMSS study (as presented in Wang, A.H., and Schmidt, W.H., (2001), History, Philosophy and Sociology of Science in Science Education: Results from the Third International Mathematics and Science Study, *Science & Education*, 10, 51-70) and concern the incorporation of such elements in *official curriculum guides*, *science textbooks* and *teachers’ practices*.

The data presented in Table 4, below, demonstrate that all the countries except Greece include topics related to the History, Philosophy and Sociology of Science in their science curricula. Among all the countries Denmark constitutes an exceptional case since such issues are not only included in the Danish curriculum but are also given particular emphasis. The TIMSS data also reveal that the inclusion of these elements in the school science curricula varies with educational level from country to country. For example Belgium, France, Germany, Greece and the Netherlands include these elements in the curriculum of the upper secondary level (grades 9-12); Portugal, Spain, Norway and Denmark include them throughout the entire secondary level (grades 7-12); while Ireland, Austria and Sweden incorporate them even in the science curricula of the primary level.

**Table 4: Presence of the topics of History, Philosophy and Sociology of Science in official science curricula**

| Country | History of Science | Philosophy of Science[1] | Sociology of Science[2] |
|---|---|---|---|
| Belgium | ■□ | ■□ | ■□ |
| Denmark | ■■ | ■□ | ■■ |
| France | ■□ | ■■ | ■□ |
| Germany | ■□ | ■□ | ■□ |
| Greece | ■□ | | |
| Ireland | ■□ | ■□ | ■□ |
| Italy | ■□ | ■□ | ■□ |
| Netherlands | | ■□ | ■□ |
| Norway | ■□ | ■□ | ■□ |
| Portugal | ■□ | ■□ | ■□ |
| Spain | ■□ | ■□ | ■□ |
| Sweden | ■□ | | ■□ |
| Austria | ■□ | ■□ | ■□ |

1. Under this heading we classify topics related to the *Scientific Enterprise* and the *Nature of Scientific knowledge*.
2. Under this heading we classify topics related to the *Influence of S&T on Society* and the *Influence of Society on S&T*.

■□ Included in the Curriculum ■■ Focused in the Curriculum

Furthermore, as shown in Table 5, below, the topics related to history, philosophy and the social dimensions of S&T are only marginally present in the relevant school textbooks. Given the fact that most of science teaching is textbook-based, the low coverage of these topics in textbooks partially explains their corresponding low status in the teaching procedure as reflected by the percentage of the total teaching time devoted to them across the various European countries (see Table 6, below). As far as the extent of such topics' coverage in the science textbooks is concerned, Portugal, Spain and Italy can be considered as exemplary cases devoting over 8% of their textbooks' content to them.

**Table 5: Percentage of coverage of the topics of History, Philosophy and Sociology of Science in the school science textbooks of the 8th Grade**

| Country | Percentage (%) of topics in textbooks |
|---|---|
| Austria | 1.5 |
| Belgium | No data |
| Denmark | 0 |
| France | 2 |
| Germany | 1 |
| Greece | 0.3 |
| Ireland | 4 |
| Italy | 8.5 |
| Netherlands | 3 |
| Norway | 1.4 |
| Portugal | 13 |
| Spain | 8.7 |
| Sweden | 1.6 |
| **Average** | **3.9** |

**Table 6: Percentage of total teaching time devoted to the topics of History, Philosophy and Sociology of Science in the 8th Grade**

| Country | Percentage (%) of the total teaching time |
|---|---|
| Austria | 1 |
| Belgium | 1.5 |
| Denmark | No data |
| France | 3 |
| Germany | 3 |
| Greece | 1 |
| Ireland | 2 |
| Italy | No data |
| Netherlands | 2 |
| Norway | 2 |
| Portugal | 1 |
| Spain | 2 |
| Sweden | 2 |
| **Average** | **1.9** |

Comparison between Tables 4, 5 and 6 reveals that there is no direct correlation of the curricular emphasis on such topics with the percentage of their coverage in the science textbooks or the percentage of the total teaching time devoted to them. Concerning this point a striking case is that of Denmark which despite the fact that seems to give particular curricular emphasis on such issues, the Danish textbooks and teachers very rarely make any reference to them.

### *Curricular Resources*

As shown in Table 7, below, only Austria, Denmark, the Netherlands and the United Kingdom identify “computers” as a curricular resource. In particular in Denmark there are Educational Centres where schools and teachers can get information about books and teaching materials; teachers can produce their own teaching materials and audiovisual aids in a workshop. “Worksheets/ Collections” constitute a Curricular Resource only in Denmark, Ireland, Spain and the United Kingdom. All the countries except Greece make use of “Labs” as a Curricular Resource. Finally, all countries use “Textbooks” and “Libraries” as Curricular Resources.

**Table 7: Curricular Resources**

| Country | Textbook | Libraries | Labs | Worksheets/ Collections | Computers |
|---|---|---|---|---|---|
| **Austria** | ● | ● | ● | | ● |
| **Belgium** | ● | ● | ● | | |
| **Denmark** | ● | ● | ● | ● | ● |
| **France** | ● | ● | ● | | |
| **Germany** | ● | ● | ● | | |
| **Greece** | ● | ● | | ● | |
| **Ireland** | ● | ● | ● | ● | |
| **Italy** | ● | ● | ● | | |
| **Netherlands** | ● | ● | ● | | ● |
| **Portugal** | ● | ● | ● | | |
| **Spain** | ● | ● | ● | ● | |
| **Sweden** | ● | ● | ● | | |
| **United Kingdom** | ● | ● | ● | ● | ● |

### *Methods of recruitment/assessment/professional development of staff*

As shown in Table 8, below, the training of teachers per level of education varies considerably. In general there are two groups of countries. The countries where the training is entirely university based (France, Germany, Greece, Ireland, Spain, Sweden and the United Kingdom) and the countries where the training is not university based until a certain level (Denmark, Austria Belgium, Italy, the Netherlands and Portugal).

More specifically, in France, science teachers are specialised in one scientific discipline without pedagogical knowledge. In Italy, there is a distinction between Primary and Secondary Teachers: the training of Primary Teachers is not university based, while Secondary Teachers obtain science degrees with no pedagogical knowledge. The training of Primary Teachers is not university based in the Netherlands, Portugal and Belgium while Secondary teachers obtain science degrees from universities. Accordingly, in Denmark the 18 Colleges of Education offer general teacher training of 4 years duration for the primary and lower secondary compulsory school. Very few teachers have any training in science. Teachers for the general upper secondary schools have graduated from one of the five universities, usually with two subjects. Their university training of 5 years does not usually include educational training. To be allowed to teach in the general upper secondary schools they have to be Masters of Science. Both Primary and Secondary teachers in Sweden and Germany are offered university based studies. In Greece and Spain the training for both Primary and Secondary Teachers is university based with some degree of differentiation. In Greece, Primary Teachers acquire pedagogical knowledge, while Secondary Teachers are specialized in one scientific discipline. Spain adopts practicals in schools but only for the Primary Teachers adding one more year to the basic training (Diploma in Didactics of Science) for the Secondary Teachers. The trend (among other possibilities) in the United Kingdom is that Primary Teachers are not specialised in science, holding a general B.ed. The training for Secondary teachers tends to be university based and they also obtain an Educational Diploma (one year).

Regarding methods of recruitment, information is available only for Denmark, Italy, Greece and Portugal (see table 8). Regarding Danish teachers of the general upper secondary schools: during their first year of service half of the time is devoted to practical teaching methodology and a short course of theoretical pedagogy administered by the Ministry of Education. Teachers in science also have to take a course in experimental work administered by the universities. For Italy and Greece written exams with emphasis on didactics is in place, while for Portugal, one school year prior to any tenured position as teacher is required.

Concerning the methods of professional development of staff, information is available for all countries except France and Sweden (table 8, below). There is no clear classification for the other countries. In Belgium, the Netherlands and Portugal teacher training centres are lnked to universities. In Germany, Greece and Ireland in-service training is provided by state institutions. In Denmark the Royal Danish School of Educational Studies runs courses qualifying teaching mainly in the primary and lower secondary schools. In-service training for teachers in the upper secondary schools depends on grants from the Ministry of Education. In-service training of any kind does not contribute to the teacher’s career or salary. In Italy the training is also provided by Provincial Educational Offices and Regional research centers. In Belgium and Germany initiatives of Science Teachers’ Professional Bodies are established. In Spain, teachers take credit for participating in service training activities (increase in salary). Moreover, there is a policy of Sabbatical for postgraduate studies. Finally, in the United Kingdom the training is mostly offered by local education authorities and Primary Teachers attend totally funded in-service training courses.

## Table 8: Training, recruitment and staff development

| Country | Training | Recruitment | Staff development |
|---|---|---|---|
| **Austria** | Primary and special school teachers are trained at a non-university level Teacher Training Center.<br>Teachers at academic secondary schools, intermediate and higher technical and vocational schools are trained at universities | | General secondary and pre-vocational teachers follow post matriculation at Teacher Training Colleges.<br>In service training can be attended either during the holidays or during the school year. |
| **Belgium** | Not university based until the upper secondary level | | Teacher training centers associated with the Universities and Initiatives of Science Teachers' Professional Bodies |
| **Denmark** | Not university based until the lower secondary levels. In upper secondary schools teachers have to be Masters of Science. | | Organized by the Royal Danish School of Educational Studies and by the Ministry of Education. |
| **France** | Science teachers specialized in one scientific discipline without pedagogical knowledge | | |
| **Germany** | University based+ On the job training | | In service training provided by state institutions<br>Science Teachers' Professional Bodies |
| **Greece** | University based with primary teachers acquiring pedagogical knowledge and secondary teachers specialized in one scientific discipline | Written exams | 20 in service training centers (4 months duration, 100 teachers per year) |
| **Ireland** | Primary teachers: Teachers Colleges Degree (3 years)<br>Secondary Teachers: Science Degrees+ Higher Diploma in Education (1 year) | | State in service training organization |
| **Italy** | Primary Teachers: Not University based<br>Secondary Teachers: Science degrees with no pedagogical content | Written exams with emphasis on didactics | Organized by Ministry of Education<br>Provincial Educational Offices<br>Regional research centers<br>5 days/year devoted to in-service training |
| **Netherlands** | Primary Teachers: Teachers' Training Colleges (not university)<br>Secondary Teachers: Science degrees (university) | | University courses for teachers in service training. |
| **Portugal** | Primary Teachers: Teachers training programmes (not university) (3 years)<br>Secondary Teachers: Science Degrees (university) | One school year prior to any tenured position as teacher | In service training courses provided by the Universities |
| **Spain** | Primary Teachers: University based studies (3 years+1 year Practicals in schools)<br>Secondary Teachers: Science University degrees (5 years) + 1 year Diploma in Didactics of Science | | Teachers are credited for participating in service training activities (increase in salary)<br>Sabbatical leaves for postgraduate studies |
| **Sweden** | Both Primary and Secondary teachers are offered University based studies | | |
| **United Kingdom** | Secondary Teachers: University Science Degrees+ 1 year Educational Diploma<br>Primary Teachers: Non specialized in Science holding a general B.ed. | | 4 days per year for in service training<br>In service training is mostly offered by LEAs<br>Primary teachers attend 20 days in service training courses which are totally funded. |

***Students' achievement***

*Methods of assessment*

International comparisons of student achievement scores have become the most prevalent method of assessing the performance of education systems. They also serve the purpose of defining students' performance and attributes towards S&T. The achievement scores presented in Annex G are based on tests administered as part of TIMSS that was undertaken during the school year 1994/95 and on the results of the PISA 2000 program[143].

***Students' attainment and attitudes towards S&T***

Initially, comparisons are drawn among the average mathematics achievement scores of students in 4$^{th}$ and 8$^{th}$ grades.[144]

In 4$^{th}$ grade[145] the average score was found to be 398. Countries with low scores are Portugal (340), Greece (356) and Norway (365). Most of the countries fare better than this group with Japan (457) and the Netherlands (438) leading the way. Other countries with high scores are Austria (421), Ireland (412) and USA (407). Scotland (383) and England (376) represent the middle scores. In 8$^{th}$ grade[146] the average score was found to be 524. Countries with low scores are Portugal (454), Greece (484) and Spain (487). Again Japan has the leading figure (605), followed by Flemish-speaking Belgium (565), the Netherlands (541), Austria (539) and France (538). Many countries are represented in the middle values including Ireland (527), French Belgium (526), Sweden (519), Germany (509), England (506), Norway (503), Denmark (502) and USA (500).

Two main groups are formed in the mean science achievement score for the 4$^{th}$ grade. Countries with score below 400 (Ireland, Norway, Scotland, Greece and Portugal) and the countries with score equal to or exceeding 400 (Japan, the Netherlands, Austria, England and USA). For the mean science achievement score for the 8$^{th}$ grade the cut-off point is 500 with only three countries (Greece, Portugal and the French Belgium) falling below that mark (see Table 18 in Annex G).

In the attitudes towards science we note the following: For the 4$^{th}$ grade students, most of the students feel "Strongly Positive" or "Positive". The cumulative percentage of these categories is around 70%-80% for all countries (see Table 19 in Annex G). For the 8$^{th}$ grade students, the categories "Strongly Positive" and "Strongly Negative" become almost non-existent since their percentages are either 0% or 1%. In this age bracket all but two countries demonstrate a higher "Positive" than "Negative" percentage. The non-conforming country is Japan (see Table 20 in Annex G).

On average, boys have a higher "Strongly Positive" percentage than girls do. This trend is reversed in the "Positive" category. There are few deviations that include Greece (tied at both levels), Iceland and Ireland (higher "Strongly Positive" proportion for girls). For the "Strongly Negative" and "Negative" categories the average proportions are almost identical (see Table 21 in Annex G).

[143] See http://timss.bc.edu/timss1995.html and http://www.oecd.org/pdf/M00030000/M00030434.pdf
[144] OECD-Education at a Glance 2000, p. 299-312.
[145] OECD-Education at a Glance 2000, p. 305.
[146] see. fn. 37.

Tables 22 and 23 in Annex G describe student performance in mathematical and scientific literacy scale. The information is provided with respect to gender and to extreme score values. The average score for males in the mathematical literacy scale is higher than that for females (506 and 495 respectively). Statistically significant differences are indicated in bold. There is no difference in the average scores between males and females in the scientific literacy scale (the common value is 501). As a result, there are fewer statistically significant score differences than before. It is worth noting that in Austria and Denmark males perform statistically better than females in *both* scales.

Regarding the results of the PISA study, performance in scientific ability is demonstrated in terms of countries' mean scores and standard errors (see Table 24 in Annex G). Japan and Korea have the highest score on the scientific literacy scale. Other countries that score statistically significantly higher than the OECD average include Australia, Austria, Canada, the Czech Republic, Finland, Ireland, New Zealand, Sweden and the United Kingdom. Mean scores in Belgium, France, Hungary, Iceland, Norway, Switzerland and USA are not significantly different from the OECD average.[147]

### 4.4 PUST IN EXTRA-CURRICULAR, SCHOOL BASED ACTIVITIES AND NON-FORMAL ACTIVITIES

There is a variety of semi-formal school based activities, such as scientific and/or technology pupils' clubs, scientific/technological competitions/collaboration (e.g. European initiatives, Olympiads, etc). Furthermore, establishing libraries in schools includes identifying the number and types of scientific books, popularised science books and popularised S&T journals. School organized visits (to S&T museums, labs, industries, etc) should be examined in terms of their frequency, their aims and objectives, the types of learning activities and the impact on knowledge and attitudes of students. Likewise, the frequency and types of cooperation (common projects, open days, science fairs and invitations of local experts) should be investigated in participation of schools and groups of students in PUST projects.

Non-formal school based activities pertain to family based activities, initiatives from museums, industry, labs etc.; from local communities, authorities, groups (e.g. pressure groups) and libraries (number of S&T books and journals borrowed by school aged children per year as well as the area of curricular specialization).

Other relevant activities include NGO's school oriented initiatives (i.e. types, frequencies, outcomes etc.); Internet/media coverage/use by pupils (i.e. monitoring the existing/new developments of appropriate material) and publication of popularized S&T books and journals aimed at the school-aged population (number of book titles published per year, area of curricular specialization, age of students target group, rates of readership). Similar activities relate to the use by pupils of books; journals; software on popularized S&T issues; TV/radio S&T programmes aimed at the school-aged population (number of S&T programmes, area of curricular specialization, age of students target group and the rates of viewership/time allocation of the specific programmes/genre); use of the Internet (number of students with home access to internet, time spent on surfing, most frequently visited sites); and the eventual status of S&T related careers.

Table 9 below details semi-formal and non-formal methods of education in each country.

[147] OECD-Knowledge and Skills for Life, First results from PISA 2000, p. 87.

## Table 9: semi-formal and non-formal systems

| Country | Museum/Industrial Visits | Institutions' Open Days | Mass media | Science clubs |
|---|---|---|---|---|
| **Austria** | MUSEUM ON LINE is a project initiative of the Ministry of Education where students study museums using new technologies. | | Virtual School Austria and EUN-Austria. The journal MEDIA-IMPULSES is published four times a year. The project "Pupils' Radio 476" was initiated in 1998. Cooperation agreement with the Austrian TV. | |
| **Belgium** | Museum of Natural History in Brussels<br>Telecommunications Center in Lessive<br>Aerospace center in Transine | Universities open days | Flemish Community provides school-TV<br>Companies like Solvay and Electrabel provide teaching material to schools | Astronomy and computer clubs |
| **Denmark** | Hands-on science centers, and plaletareous Visits to science museums with special services for schools. Field work and visits to nature reserves. | | Educational Centres where teachers can produce their own teaching materials and audiovisual aids. | A youth organization in science (Ungdommens Naturvidenskabelige Forening) and a youth organization (Natur og Ungdom) of the Danish Association for the Conservation of Nature |
| **France** | Hands on experiments in science museums in Paris<br>Centres Culturels Scientifiques et Techniques in provincial cities | | | |
| **Germany** | Network of 120 science museums and natural reserves | Two open days per school year<br>One week for open-ended projects based on STS approaches. | Institute for film and Picture in Science and Teaching provides teaching material (5000 media entries) | |
| **Greece** | Science Museums Visits | Universities open days | Educational TV | |
| **Ireland** | Industrial visits are very popular | | | |
| **Italy** | | | | |
| **Netherlands** | Science Museums Visits (NINT-Amsterdam, MUSEON-Hague)<br>National Center for S&T (Amsterdam)<br>Technology discovery centers | 1 week in October is the School Science Week | School TV (NOT)<br>Magazines with exercises related to Dutch newspapers (Exaktueel) | National Olympiads in Biology, Chemistry, Physics and Informatics<br>Young Researchers' Club<br>Technika (100 clubs for girls) |
| **Portugal** | Links schools with the science museums centers<br>CIENCIA VIVA PROGRAM | | | School science clubs |
| **Spain** | Two natural museums (Madrid and Barcelona) | Informal projects for Environmental education | Production of audio-visual material for classroom needs | |
| **Sweden** | Science museums | | Regular TV | |

| | | | | |
|---|---|---|---|---|
| | | | programmes watched by 5-10% of the population | |
| **United Kingdom** | Science Museum (200.000 visits from school science British children, and 38000 visits of school children from overseas), National History Museum, Exploratory (Bristol), Planetarium, etc. | | | Science clubs in-schools<br>National Awards like CREST (creativity in S&T), BAYS (British Association of Young Scientists) |

The table shows that all countries but Italy have developed semi-formal or non-formal systems in education. Irish schools tend to rely more on "Museum/Industrial Visits". Belgium, Germany, Greece, the Netherlands and Spain have established "Research Institutions' Open Days", while there is no information about this in Austria, Denmark, France, Portugal, Sweden and the United Kingdom. France, Portugal and United Kingdom appear not to use mass media based materials in their schools, as opposed to Austria, Belgium, Denmark, Germany, Greece, the Netherlands, Spain and Sweden. Finally, only schools in Belgium, Denmark, the Netherlands, Portugal and the United Kingdom support "science clubs". This is the case particularly for Denmark, the Netherlands and the United Kingdom.

## 4.5 CASE STUDIES : GOOD PRACTICE AND EXPERIENCES WORTH SHARING

### *Case study 1 - New insights for science education, Denmark*

There is a "Centre for Studies in Science Education" [148] at the University of Aarhus. "The purpose of the centre is to compile and increase existing expertise in science education studies in order to improve both science teaching at all levels and the general scientific literacy/public understanding of science". To improve primary school science teaching and science teacher training, "a project has been running for several years, initially focusing on introduction of metacognitive strategies in physics and chemistry teacher education along the lines of a UK project ('Thinking Science'[149]) which has shown good results in the cognitive acceleration through science education (CASE) of 11-12 year olds (development of thinking tools)". The scientists are interested in the "development of a deeper understanding of the particular nature of science ('the unnatural nature of science') vs. spontaneous thinking on scientific subjects, and the implications for the understanding of science. Analysis of structural differences between scientific and everyday language, what these differences reveal about conceptual differences, and the consequent barriers for understanding".

### *Case study 2 - The Technika 10 experience, Netherlands*

#### Introduction

**Technika 10** was founded in the Netherlands in 1986[150]. Its aim was to stimulate young girls' interest in technology and to broaden their future professional horizons. The motivation for

[148] http://www.nat.au.dk/CND/
[149] http://www.kcl.ac.uk/depsta/education/teaching/CASE.html This project is industry supported, see the report on the UK in the Chapter 7 on Industry and the Private Sector.
[150] http://www.technika10.nl/

this initiative lies in the fact that technology classes are not always designed for young girls resulting in a much larger number of boys who opt for technology training.

**Description**

Technika 10 activities are spread throughout the Netherlands. It is the responsibility of the individual Technika 10 organisations and welfare institutions to implement these activities. Technika 10 Nederland provides further information and expertise on Technika 10 activities. Moreover, the National Centre has build up knowledge on women, girls and technology. In the year 2000, more than 200 girls-only technology clubs were in place in over 100 cities attracting approximately 10,000 girls.

Girls become acquainted with the areas of wood, metal, electronics chemistry, information technology, mechanics, drawing and electricity. Activities might involve visiting a company or surfing the Internet. All activities are exclusively for girls and are geared towards improving their positive attitude towards technology in a stress free environment. It is imperative that a woman be in charge of all clubs or courses so that the girls can have a potential role model. The teaching tools used are more familiar to a young girl's world.

Girls between the ages of 10 to 12 years are eligible to participate in Technika 10 activities. Moreover, girls belonging to the age groups of 8-9 years or 13-14 years may participate in the programs of Technika 10 Junior and Technika 10 Plus respectively. The activities are held in either a community centre or a school building in the local area. Technika 10 is also frequently encountered within the educational system since many primary schools request that Technika 10 activities be carried out during lessons or as an extra-curricular activity.

**Advantages of the programme**

The programme's specific advantages can be summarised as follows.

- It utilises the full potential of the female students, who will subsequently become active and productive individuals.
- It bridges the technology gap between the two genders.
- It provides equal learning opportunities
- It develops the much-needed collaboration among students, industry and the local society.
- It generates more posts for female instructors and more revenues from the project's activities.

## *Case Study 3 - "School Science Centres", Greece*

History

In 1993 the constitution and framework of School Science Centers of Secondary Education was decided. The first 16 Centers were created under the guidance of the Pedagogical Institute. In 1996 the network of the School Science Centers was further developed (one Center is scheduled for each Department of Secondary Education in every Prefecture) and supervision of the Centers was transferred to the Department of Secondary Education of the Ministry of Education. Since then constant guidance gradually turns School Science Centers into instruments through which the Ministry of Education implements the educational policy concerning experimental teaching of Science.

Aims

The aim of School Science Centers is to research and provide technical and pedagogical support for the experimental teaching of science courses. They also act as advisory boards for the organising of school laboratories at prefecture level.

Functions

Each School Science Center is situated at the seat of every Secondary Education Department at prefecture level. Up to now, 77 School Science Centers operate in Greece and the project will be completed with the creation of one more Center. Each School Science Center supports 15 to 80 school units, on average 35. Respectively, the number of teachers supported ranges between 30 and 300, on average 110 (with small annual differences).

The Centers' supportive tasks are achieved because they:

- Have a permanent exhibition of lab instruments, experimental devices and audiovisual material.
- Provide and distribute lab instruments and related audiovisual material to all lower and upper Secondary Schools of the prefecture.
- Maintain schools' lab instruments and audiovisual devices.
- Offer experimental practice workshop activities to students when the schools laboratory substructure does not allow it.
- Take care of all the necessary improvement, testing and application of new experiments and experimental devices by teachers.
- Conduct training seminars for the teaching of science courses (every center organizes approximately two to five such one-day seminars per school year, while 20% of the Centers organize longer seminars, 40 hour weekly seminars).
- Organise visits of the teachers responsible for the Centers to schools in order to solve technical problems.

Description

**I**. Each Center has its own premises, where possible, which include the necessary areas for its activities, namely:

- Physics laboratory,
- Chemistry and Biology laboratory,
- Capacity for storing, distributing and repairing instruments.

The Center can be housed within a secondary school of the prefecture, when the necessary premises are available.

**II.** The Center employs full laboratory equipment for conducting:

- Demonstrations of experiments for science subjects for all grades of lower and upper secondary schools,
- Circular or frontal student workshops.

It also has:

- Collections of video-tapes, slides, overhead projector slides which present science subjects,
- Tools for small repairs of instruments and audiovisual devices,
- Library containing educational, science and science education books, manuals for teachers and books on teaching methods.

**III.** A science teacher is appointed in charge of each Center by the local Department of Education, for a year at a time. Out of the 77 teachers responsible for Centers 64 are Physics teachers, 11 are Chemistry teachers, 1 is a Biology teacher and 1 is a Natural Science teacher. Almost 200 teachers, the majority of who are Physics teachers comprise the personnel of the Centers.

**IV.** Science school advisors of the prefecture or area have overall supervision of the Centers, and submit an annual report at the end of every school year to the Department of Secondary Education of the Ministry of National Education and Religious Affairs.

The Department of Secondary Education of the Ministry of Education is responsible for the administration and running costs of the Centers.

### 4.6 Research in Science Education

Science Education is a rather new academic field and relevant research can be distinguished in two phases:

The first phase spanned the 1980s when the main focus of research was the mapping of the children's intuitive ideas. The underlying assumption for this kind of research is that children interacting with their natural environment construct in an active way specific mental representations about the concepts later to be taught during their formal schooling. The outcome of this research programme was the accumulation of a wealth of data on children's intuitive ideas (referred in the relevant literature as children's ideas, misconceptions, naïve theories, etc) about practically all sorts of concepts concerning the science subjects in school. The corresponding research was extended to students: (a) of all ages (from pre-school to tertiary education) (b) coming from a variety of countries and cultures. Referring to the pioneers of the field only, relevant research was conducted for example by Driver, Ogborn and Solomon in UK, Martinand, Viennot and Tiberghien in France, Giordan in Switzerland, McDermott in US, Anderson in Sweden, Osborne in New Zealand.

Despite this huge accumulation of data revealing the universality of the mental representations of children about natural phenomena, unfortunately little research has been devoted to exploiting the corresponding data for devising suitable educational material and teaching practices. As a result, the conditions of science education in schools have been only marginally affected by the research findings of this phase.

The situation of research in science education took a considerable turn around the beginnings of the 1990s when we could say that the second phase started. This phase unlike the first one was characterised by a diversification and fragmentation of the research foci in the field. While it is quite difficult to identify dominant research issues, a literature review of this period reveals the following three trends.

- Research on children's ideas has been drastically reduced and only a sporadic recurrence of interest in this issue exists.

- There has been an increase in the volume of the research in issues that have already been included in the research agenda of Science Education during the phase of eighties. Such issues are: a) the teaching strategies in science, b) epistemological analysis of school science, c) methods of assessment, d) gender gaps in science education and e) the principles for organising science curricula.

- Finally, there has been a broadening in the scope of science education research so as to include issues concerning out of school activities related to science learning (*informal science education*), as well as issues related to the way in which school science knowledge can contribute to a responsible citizenship (*promotion of science literacy*). The inclusion of these two kinds of issues in the research agenda of science education has led to a partial overlap with the research concerns of the area of Public Understanding of Science and Technology (PUST).

The science education research during this second phase seems to have influenced to a much greater extent both official policies and school practices. An example of this is the growing number of official initiatives about the promotion of science literacy through schooling (e.g. *Benchmarks for Science Literacy-Project 2061+* by the American Association for the Advancement of Science, 1993).

This trend can be possibly explained by two conditions. Firstly, the research community of science education is much more established now in comparison to ten years ago and so it is in a position to influence the decision making process in educational matters much more decisively. Secondly, the corresponding research seems to be inspired by the practical and pressing needs of the pedagogic discourse.

## 4.7 Conclusions

### *Overview of findings*

The most extensively taught science subjects in the countries of the European Union are Biology, Physics, Chemistry and Technology, which are all offered as mono-disciplinary subjects. On the contrary, subjects characterised by an interdisciplinary approach like Natural Sciences, Earth Sciences or Health Education-Hygiene are only offered in a low number of countries.

With regard to the starting point for the teaching of S&T oriented subjects the countries of the Europe Union can be clustered into two groups. In the first group of countries the S&T teaching starts at the age of six whereas in the countries of the second group starts at about the age of ten.

The curricular subjects are characterized by great variation in the secondary level of most countries. This variation is mainly due to variations in the curricular choices of the different types of schools and the different degrees of the central governments' guidance. The S&T curricula of the primary level though are far more homogeneous since the corresponding subjects are very often introduced as parts of the broader integrated science subjects. An interesting feature of the S&T curricula across Europe is their particular emphasis on topics related to history, philosophy and sociology of science. Despite though this curricular emphasis, the references to such issues either in the relevant textbooks or during the science lessons remain only marginal.

The status of S&T subjects in school curricula is very high. This conclusion is substantiated by the following facts. Firstly, these subjects are allocated around 10-20% of the total teaching time in all educational systems examined. Additionally, S&T subjects constitute major subjects in university entrance exam papers of all the countries of the European Union.

Among the most pertinent factors that seem to influence the S&T options in various European educational systems are gender and family conditions. Specifically, a higher percentage of boys seem to opt for S&T subjects, while the offspring of emigrant or immigrant families are faced with considerable learning challenges. This latter problem exists in many European countries (e.g. German, Denmark, Portugal, Ireland and Belgium). Additional factors that play some role in the opting for S&T subjects are the interdisciplinary approach followed in some of these subjects as well as the availability of out of school opportunities for science learning.

Curricular resources and the quality  of teaching staff also play a significant role in the way that science and technology are taught in the European schools.

As far as the curricular resources used in the S&T based subjects it can be noted that the most widely used resources are textbooks (either officially prescribed or commercially offered),; libraries' resources and school laboratories. It is worrying however, that Information Technologies are rather rarely used as teaching resources for science subjects.

As far as the training of science teachers is concerned, countries across Europe can be divided into two groups. In the first group training is entirely University based (France, Germany, Greece, Ireland, Spain, Sweden and UK) while in the second group it is not University based until a certain level (Denmark, Austria, Belgium, Italy, the Netherlands and Portugal). Furthermore, from the collected data on the issue of teachers' recruitment it can be concluded that a mixture of relevant practices exists. Such practices can be: a) written exams with an emphasis on both the specialized content of each disciplinary area and the respective pedagogical theories, b) the attendance of a pre-service training course or c) a one year working in school prior to any tenured position as teacher.

During the last decade some attempts have been made to evaluate the impact of efforts and investments made in Science and Technology Education worldwide (and of course in many European countries), for example the two large scale studies (TIMSS, 1994 and PISA, 2000). Among other things these two studies have explored the achievement and the attitudes towards S&T of the students' population in many countries of the world. The main findings of these studies are that:

(a) The average achievement of the students' population is relatively low in most of the southern European countries (Spain, Greece and Portugal).

(b) While the vast majority of students hold positive attitudes towards S&T at the early schooling stages (70-80% of the 4th graders in all countries), this situation is considerably moderated at the later stages (8th Grade) with the positions "Strongly positive" or "Strongly negative" almost non-existent in the students' answers.

(c) There seems to exist a gender gap as far as the attitudes towards S&T are concerned, with the boys to hold somehow more favorable attitudes than the girls.

(d) On the contrary, it seems that there is no statistically significant score differences in the levels of achievement in science between the two sexes.

Finally, especially during the last two decades, apart from the efforts to raise the level of techno-scientific awareness within the formal educational systems, a wide network of extra-curricular activities has been developed in parallel, in most EU Member States. Among these activities the most popular (but not necessarily the most effective) are the visits to Science Museums and Industrial sites with particular techno-scientific interest; school-based activities like Open Science Days; Science Fairs or Clubs and the distribution of mass media products (in printed or electronic format) aimed at the school-aged population.

***An educational dilemma: experimental vs. academic oriented curricula***

From the above analysis, two patterns of curriculum formation seem to emerge. The first pattern emphasises the experimental perspective of the S&T subjects featuring practical work and significant use of the laboratory. Mostly, northern European countries adopt this approach. For example, in Austria schools are relatively free to address the vocational needs of the students and the demands of the particular region. Moreover, the existence of innovative projects such as ENIS stimulate the independent nature of learning. In Germany the method of teaching science in primary schools is based on "teaching about real things". Similarly, in Denmark in April 1994 the new Act on the Danish *Folkeskole* was adopted aiming to "prepare pupils for active participation". Moreover, science curriculum tends towards both a life-world thematic and an integrated approach. Additionally, in Belgium the determination of the science teaching material lies heavily on the individual teacher. In Sweden, technology is compulsory with goals to attain both at the end of grade five and nine. Pupils are encouraged to experience the joy of discovery and experimentation. Schools in this country move from the academic school tradition towards the individual's need to understand the world. There is a growing awareness of the "constructivist" view of knowing and learning. Emphasis is given on the importance of seeing science teaching from the pupils' perspective. Other similar examples can be identified in Netherlands, the United Kingdom and Ireland.

The second pattern of S&T teaching focuses on the academic aspect of curriculum development. It is generally followed in the Mediterranean countries. Nonetheless, many countries have interchangeable traits in their S&T curricula. The characteristics of the latter method include proportional distribution of teaching hours devoid of subject specialization. This is demonstrated in Greece where the federal government mandates the number of subjects and hours to be included in the curriculum for the whole country. Exceptions occur in Spain and Portugal where demographic and ethnic differences necessitate diversion within S&T curricula. It is worth noting that in France the formal structure of science education with emphasis on theory and encyclopedism while neglecting the experimental side generates rejection from a large part of the student population. More specifically, they emphasize plain assimilation of the content rather on the training for a method of learning.

While no clear evidence is provided, all EU countries seem to aspire towards the experimental mode of S&T curriculum. At this point a note of caution is needed. It is very difficult for one to make a recommendation in relation to the issue of which mode of teaching is more effective. This difficulty stem from two facts:

- Firstly, it is unlikely that the direct transfer of educational practices that have been proved to work effectively within a particular national context are going to work equally effectively in national contexts with different conditions (e.g. teachers' training, resources, etc).

- Secondly international comparisons based on the results of large-scale surveys of the students' population (PISA, TIMSS) in various countries do not favour either the experimental or the academic mode. For instance the results for Greece (a country adopting the academic mode) show on the one hand a great failure in rote learning while on the other a considerable success in critical thinking. It is left to the individual Member States to decide which mode of S&T teaching is most suitable to their specific needs blending the advantages of both to produce the optimal paradigm.

## 4.8 RECOMMENDATIONS

1. Governments should consider the age at which children start to be taught science and technology related subjects (e.g. at the age of six). Of particular importance is the introduction at an early age of subjects like Health Education, Environmental Education, etc.
Reasoning: The familiarisation of students from the early stages in socially oriented areas, such as Environmental studies, will improve citizenship and societal welfare.
Action: ministry of education, agents responsible for curriculum development, agents for teacher training, in service training centers.

2. Interaction between schools and out of school centres should be encouraged and facilitated, by making time and space available in the National Curricula. Additional resources should be made available in schools and training given to teachers in order to facilitate the evaluation and use of out-of-school resources and teaching packages.
Reasoning: There is clear evidence, for example from Germany and Holland, that out-of-school learning is attractive to pupils and pedagogically sound. Thus every effort should be made to develop structures so as to facilitate the assimilation of their characteristics into the school curriculum.
Action: ministry of education, agents responsible for curriculum development, science centres.

3. Governments should provide resources, technical support and incentives to teachers in order to facilitate the development of schools networks, particularly networks relying on use of the Internet. These networks could serve as agents promoting the exchange of good practices and school-developed material for science teaching. Existing networks (e.g. the European school net, networks from the Comenius programme, etc.) can provide the basis for this action.
Reasoning**:** It has become clear for example through the Comenius programme, that ICTs have served as very good communication tools, thus making young people eager to use them. Their successful integration into the teaching of science-related subjects can change the pedagogical climate of classes to the benefit of students. Teachers could also benefit because they would be exposed to the multiplicity of teaching materials and good practices developed in other schools. Finally, a pupil's own use of ICTs promotes in itself one dimension of PUST[151], in the form of hands-on experience.
Action: ministry of education, local authorities, industry, schools

4. A PUST dimension should be included in teachers' initial and in-service training courses.
Reasoning: The purpose of PUST is to educate all students and not only thoses who will follow scientific careers. In the current political climate, citizens are increasingly called to participate in debates about science and society. More students will develop a basic understanding of science methods, reasoning and conceptual framework if teachers place greater emphasis on the societal aspects of the science they are teaching.
Action: Ministry of Education, universities, local authorities, in-service training centres.

5. Teacher training programmes, and in-service training centres, should be given incentives to allow their students to undertake part of their practical training in science centres.

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[151] NB : the introduction to this report discusses the different vocabulary used in this policy area (e.g. PUS, PUSH, PUST, scientific literacy etc)

Reasoning**:** Nowadays, youngsters learn quite a lot outside formal education in school, and science centres are important agents for promoting science. It is important to familiarise teachers with the techniques and material developed in these centres.
Action: Universities, teacher training colleges, teachers in-service training centres, science centres.

***Further work***

1. The chapter on education has demonstrated the lack of relevant information available. The outcomes of such research will iron out many crucial aspects involving the previous recommendations. Certain quality criteria should be established for the available teaching resources. Research is needed concerning the quality standards of resources, the use of various resources, the impact of resources on students' knowledge and attitudes and novel educational resources. Attention should also be paid to training of teachers per level of education (the number of teachers per S&T specialty and various socio-demographic factors such as age, gender, academic qualifications) and to the analysis of content which is taught (facts/methods orientation and scientific literacy orientation which prevents the processes of knowledge construction problematic from black-boxing)[152].

2. Science and Technology understanding leads to effective citizenship thus becoming an integral part of every individual's development. Girls are usually less likely than boys to study science at school, which has an impact on their future lives. Thus Governments and universities should initiate and support research programmes concerning factors that contribute to the reluctance of students to choose science and technology subjects and take up scientific careers.

***Future Indicators***

1. The starting age for teaching children S&T related subjects.

2. The percentage of teaching time allocated to S&T related subjects.

3. The qualifications of S&T secondary teachers.

4. The number of S&T secondary school teachers by specialism.

5. The percentage of time allocated to Science and Didactics of Science during the initial training of primary teachers.

6. The number and description of semi-formal and informal activities.

[152] This work should take place in cooperation with work already undertaken by the Member States and by DG Education and Culture.

# CHAPTER 5: SCIENCE CENTRES AND MUSEUMS

## 5.1 OVERVIEW[153]

This chapter examines two issues: what contribution do science centres and museums make to public understanding of science in the EU, and what can Member States do to enhance that contribution?

Regarding the first issue, we can note the following: 35 million citizens choose to visit science centres and science museums (SC&M) in the EU every year. 37% of these interested and active visitors are youngsters in school groups – benefiting from the opportunity to learn about science and technology in an informal setting. The learning methods which are offered in SC&M are arguably closer to the world of youngsters and the way in which they want to learn. They have much to offer both young people and the formal education systems, with which they are increasing their cooperation. Not only do SC&M offer validated scientific content, presented in a way which relates to citizen's every day lives, but they have developed specific communication techniques which are appropriate for increasing public understanding of science – sometimes although not always using new technologies. SC&M offer their visitors access to experimentation, through up-to-date labs and hands-on science which they may not have (had) access to at school. In an exciting development, SC&M are increasingly acting as platforms bringing together different actors to debate hot "science and society" topics (e.g. BSE, GMOs etc). In this regard they are respected by citizens as having greater integrity/ neutrality in the debates than other actors which may have vested interests. They bring together representatives of industry, teachers, pupils and other members of the public to debate topics, which are usually either ringfenced in policy circles or dominated by baffling technical detail. In this way, they make a contribution to the policy debate as well as the development of responsible, informed citizens.

There are therefore many good reasons to examine the contribution of this sector to the promotion of RTD culture, and try to evaluate the impact of the sector on European citizens' scientific literacy. We have constructed our analysis and report on the basis of data contributed from the European Collaborative for Science, Industry and Technology Exhibitions (ECSITE) which groups most of the science centres in the EU, plus large parts of the science museums sector[154].

## 5.2 HISTORY

The development of modern science centres started in the US in 1969 with the creation of the Exploratorium in San Francisco (by Frank Oppenheimer) and the Ontario Science Centre in Toronto the same year. It was the start of the fast growing field of interactive science-technology centres in the US. They shared a commitment to visitor's participation, with specially constructed exhibits that encourage interaction. Very soon, the great number of new institutions initiated the creation in 1973 of ASTC (Association of Science and Technology Centres) in the USA.

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[153] Please note that references for the publications cited in this chapter are provided in the bibliography provided at the end of the report.

[154] Details of ECSITE membership are provided in the annexes to this report. For more information, see http://www.ecsite.net/

It was during an ASTC meeting in 1998 that Joël de Rosnay from la Cité des Sciences in Paris decided to invite the European participants to a meeting to discuss the possibility of creating a European network. Things accelerated and in 1989, 23 European museums voted to found ECSITE during a meeting at "La Cité". It was admitted that a critical mass of institutions was reached and that a strong desire was expressed to set up a Collaborative to meet the specific needs and interests of European Museums and science centres.

The networking evolution thus took place slightly in Europe than in the US, and with fewer centres, although the Europeans prided themselves on what they offered their visitors. The minutes of one of ECSITE's first Directors meetings in July 1989 note that: "the European centres equal, and in many cases surpass, American centres in popularity and innovative exhibit design". A little further in the same text it is admitted however that ASTC was initially an invaluable source of information and contacts for European interactive exhibitions. The reality is that ASTC was the inspiration not only for exhibit design but also for the creation of the European network ECSITE.

### 5.3 Latest Evolutions in the Field

As we will see later, the field is fast moving. From the point of view of the activity inside the institutions, very soon traditional museums noticed the wide appeal of "hands-on" activities and developed specific galleries devoted to this kind of presentation. On the other hand science centres, have recently re-discovered the emotion created by visitor contact with "real objects" and so have created galleries and temporary exhibitions with more traditional presentations. In both cases, specific demands coming from the formal education system increase the need for improved educational products. The gap between formal and informal education is narrowing mainly because of activity in the non-formal education system.

Another field contributing to informal education is the sector representing zoos, aquaria and botanical gardens which are now seek closer links with the science centre and museums field. This is noticeable in the increased number of requests for membership to the ECSITE network. The CEO of Monterey Bay aquarium recently stated that "aquaria are concerned with explaining the importance of sustainable development but people are currently more receptive to exhibitions on this subject in science centres, which is why it is important for the two sectors to cooperate"[155].

Finally a slow but noticeable evolution is taking place in the leisure/ recreational market. There is competition between leisure/ theme parks and science centres, for the same public. Leisure time is growing for several reasons and all attractions fight for audience share. Up to now it was considered that leisure attractions could easily benefit from this situation, and science centres/ museums were afraid of losing visitors. Some recent events however show that leisure parks and theme parks are looking to narrow the gap and provide more educational content in their activities. In one case (Europapark in Strasbourg) there is even a plan to add a science centre to existing leisure facilities.

### 5.4 Methodology used in this Chapter

There is no systematic comparable statistical data available for the science centre and museum sector in the EU. At international level, different criteria for data collection are used (for

[155] Ms. Packard, CEO of Monterey Bay Aquarium, USA, 2001.

example, due to difficulties in defining what a science centre/museum is; how to count visitors for outreach programmes and/or temporary exhibitions; how to handle free entrance in some institutions. Country by country statistics are not always useful because so much data is missing, however from the existing information we have identified the following type of data:

- Statistical data about visitor numbers, their origins and profile.
- Available exhibition space, employees and services.
- Performance indicators: e.g. budget/visitor.
- Motivation studies (why do visitors come, what do they expect, what is their representation about scientific issues).

We have made reference to gender issues wherever possible, however few data provide information on gender issues, whether for employees in the profession or for visitors.

The core data for this report have been collected through a survey distributed to all ECSITE members. The ECSITE network has 314 members world wide of which 260 are based in the EU. Even though not all SC&M in the EU are members of the network, ECSITE is accepted as being representative of the field. Results from the survey may then be considered as representative for the whole field.

This chapter makes an important distinction between three types of institution in the EU:

– traditional science centre/museum institutions which have been active in the field for several years (referred to as the “Trads”);
– the “Big 4”[156] institutions in the EU which have their own specific characteristics (see below); and
– the zoos, aquaria and botanical gardens which have appeared in the picture since the late 1990s.

Clearly the zoos, aquaria and botanical gardens sector (hereafter referred to as “zoos etc”) is much larger than that represented in this report. However, the survey results indicated that there are distinct patterns in attendance and exploitation of their resources, so we felt it was useful to include indicative data about this – in a separate section referred to as “zoos etc”. The more traditional museums that have a long tradition of “hands-on” activity and are members of the network since the beginning have been kept inside the general results. The third distinction has been made between the science centre field as a whole and the 4 big institutions based in the UK, France and Germany (the “Natural History Museum” (NHM), the “National Museum of Science and Industry” (NMSI), “la Cité des Sciences” and the “Deutches Museum”. These institutions represent such an significant part of the total number of visitors and budget that including them in the averages calculated from the survey data would not have been representative.

Finally we have isolated the figures coming from the Science Centre in Valencia, Spain. This institution had 3.5 million visitors last year but the centre is located in a large commercial area that does not allow for clear identification of visitor numbers. We have thus only taken into account “paying” visitors. (Note: from 1/12/2001, the NMSI and the NHM in London also

[156] The “Natural History Museum” (NHM) and the “National Museum of Science and Industry” (NMSI) – both in London, plus “la Cité des Sciences” (Paris) and the “Deutches Museum » (Munich).

benefited from a government policy to make entrance to major cultural museums free. This will affect future visitor numbers).

Clearly the rich diversity of institutions in this field makes it quite a challenge to perform benchmarking in the strict sense. Considering the mission of this report, we have focused on the institutions that meet a certain number of criteria, namely those:

- having a public (exhibition) space;
- open all year;
- presenting objects or interactive exhibits with basic scientific explanation.

This means that we do not consider associations that have "only" education programmes for schools, but we do take into account associations which have permanent scientific dissemination programmes even though they have no permanent (exhibition) space.

## 5.5 Results of the Survey of ECSITE Membership

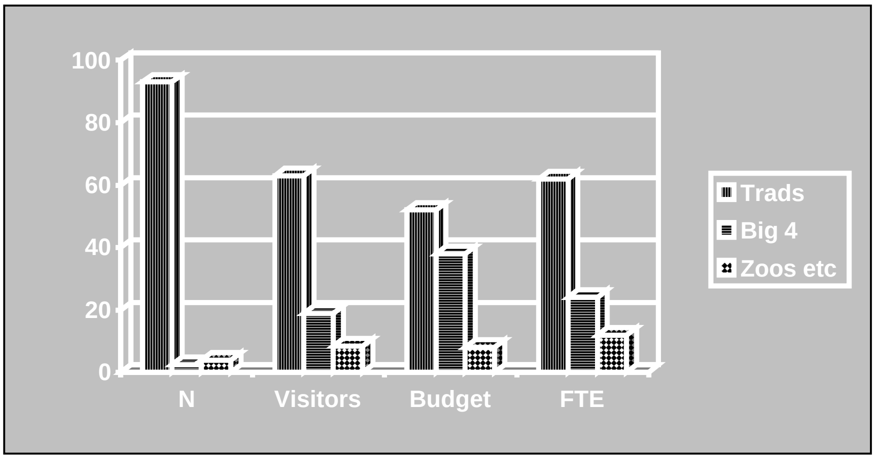
159 responses were received and were divided into four groups for the purposes of useful analysis, as explained above:

1) The "traditional science centres and science museums" which have been members of ECSITE for a long time.
2) The 4 "big" institutions.
3) The newly active field including zoos, aquaria, botanical gardens etc…
4) Valencia science centre (will only be considered in terms of visitors and budget)

**The relative weight of the four groups in the survey:**

| Group | No. of instits. | Visitors | Operat. Budget. | FTE[157] |
|---|---|---|---|---|
| | | | | |
| 1. | 93% | 63% | 52% | 62% |
| | | | | |
| 2. | 2,5% | 19% | 38% | 24% |
| | | | | |
| 3. | 4% | 8,5% | 8% | 12% |
| | | | | |
| 4. | 0,5% | 9,4% | 1,5% | 1,5% |

This table indicates clearly why it is imperative to make a distinction between these four groups. The four major institutions represent 19% of total visitors numbers and 38% of the total operational budget. We will see later that this situation has a major impact in several respects.




***Total Visitor Numbers***

This indicator is one way of measuring the impact/ reach of science centres and museums. In 2001, science centres and museums in the EU were visited by 23 million people. Over 7 million went for a visit to the "4 big" institutions and just over 3 million visited zoos etc. (that we have identified). The figures below are compiled from figures provided by ECSITE for a world wide evaluation exercise, during the 2nd Science Centre world congress in Calcutta (1999) and to the 3rd world congress in Canberra (2002)[158].

[157] FTE = full time equivalent.
[158] More details are available from www.ecsite.net

| **Region** | **Number of institutions (1997)** | **Attendance in millions (1997)** | **Number of institutions (2001)** | **Attendance in millions (2001)** | **Average visitors per institution** |
|---|---|---|---|---|---|
| North. Am. | 313 | 118.0 | 183[159] | >50M | |
| ***EU "Trads"*** | 124 | 22.5 | 152 (+21%) | 23.6 + 5% | 159.500 |
| ***EU "Big 4"*** | 4 | 7.0 | 4 | 7.2 + 3% | 1.750.000 |
| Latin Am. | 75 | 8.0 | 102 | 15.0 | |
| India | 32 | 5.0 | 33 | 5.9 | |
| Asia. Pacif. | 250 | 5.3 | 304 | 46.7 | |
| Africa | 18 | 0.5 | 13 | 0.6 | |
| China | 230 | 25.0 | 300 | 25.0 | |
| **Total** | **1.046** | **191.3** | **1.091** | **174.0** | |

The total numbers for the EU show an increase in total visitor numbers from 29.5 million to 30.8 million. (+ 4,5%). This increase has partly to do with the greater number of institutions considered (+ 21%) especially in the **UK** (thanks to the support from the "Millennium Commission" which initiated many new centres and the creation a special ECSITE UK network which stimulates local co-operation with local authorities). We can state that the increase in attendance is still taking place, and that the public also has more choices available to it, and so the total visitor numbers are spread over a greater number of institutions.

The rest of the world (excluding north America and Japan) considers a smaller field, (-2%). In terms of visitors the increase is however is +33.6%. In North America, fewer institutions were considered (-70%) in the second survey and consequently the attendance numbers have dropped, by 67%.

It is, of course, hazardous to make comparisons between networks or continents in this area. In his report on the data collected in Canberra, P-E Persson[160] comments: " I think the session clearly showed the kind of problems that we have trying to make international comparisons. (…) Different participants used somewhat diverging definitions on what to counts as a science centre (…) If anything the session should urge networks to do is to continue working for comparable statistics world wide'. Mr Persson estimates at the end that there are in the world about 1400 institutions, visited by 220 million visitors a year. The total budget of these centres is estimated by him to be about €2.1 billion. Europe would represent 14% of the total numbers of visits in this case.

[159] Note : the number of north American institutions under consideration decreased between 1997 and 2001 due to a change in the methodology used to define a science centre.

[160] Mr Persson is director of « Heureka », the Finnish science centre. www.heureka.fi

***Total Available Exhibition Space***

| Indoors space which is permanently available to visitors. | | |
|---|---|---|
| Total (in square metres) | | Average (in square metres) |
| | | |
| Trads | 672.226 | 4.511 |
| "Big 4" | 36.025 | 34.000 |
| Zoos etc | 663.510 | 132.702 |

This indicator allows us to compare one key resource at the disposal of EU science centres and museums – space. Space allows exhibitions and experiments to take place. The survey allows us insight to the amount of space available to the different institutions, and to estimate the average permanent exhibition space of European science centres and museums. It is clear from the figures that the difference between the main group and the "4 big" institutions is significant. We will read more about this when considering the indicators.

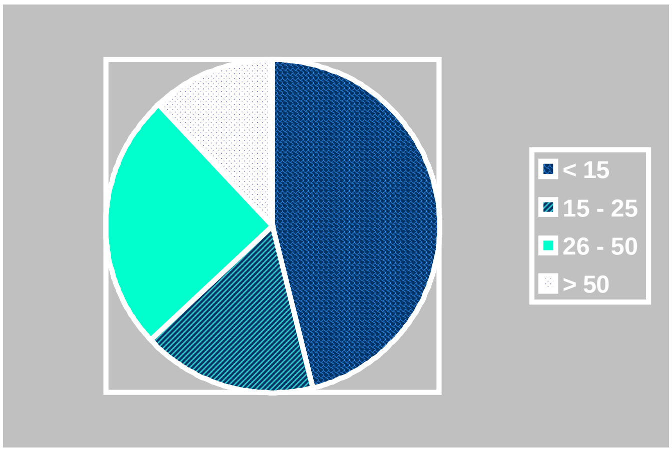
***Who are the Visitors?***

| **Age/ instit.** | **<15** | **15-25** | **26-50** | **>50** | **<25** | **>25** | **Students /groups** |
|---|---|---|---|---|---|---|---|
| Trads | 46% | 17% | 25% | 12% | 63% | 37% | 37% |
| Big 4 | 14% | 32% | 36% | 18% | 46% | 54% | 31% |
| Zoos etc | 25% | 11% | 46% | 18%% | 36% | 64% | 26% |

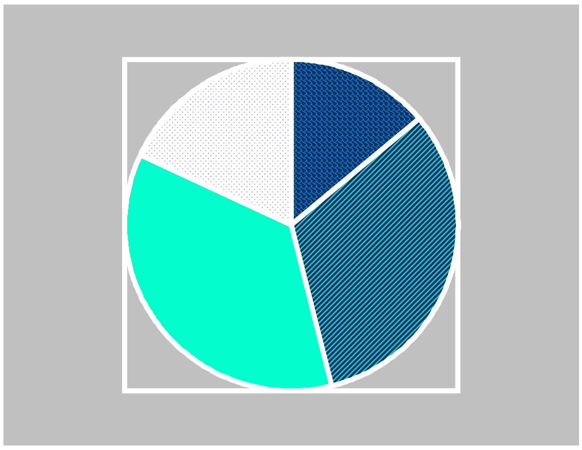
This indicator allows us to learn about the profile of citizens who make the active choice to visit a science centre or museum in the EU. Age seem to be one of the major indicators to evaluate the field. Science centres of average size and visitor numbers have a much younger visiting population than the other groups. For traditional science centres and musuems, 63% of visitors are aged younger than 25, significantly more than the "Big 4" institutions where only 46% of visitors are under 25. Interestingly, zoos etc seem to have even fewer young visitors. One exceptional case is the newly created "Eden project" in Cornwall where the visiting population aged over 25 represents 82% of the total, and 26% are over 50 years old[161].

We have more youngsters visiting the "traditional" institutions as members of a school group than in any other case. For our survey that would mean 11 million school children visiting the science centre and science museum field every year. The following charts represent the range of visitors to the different institutions.

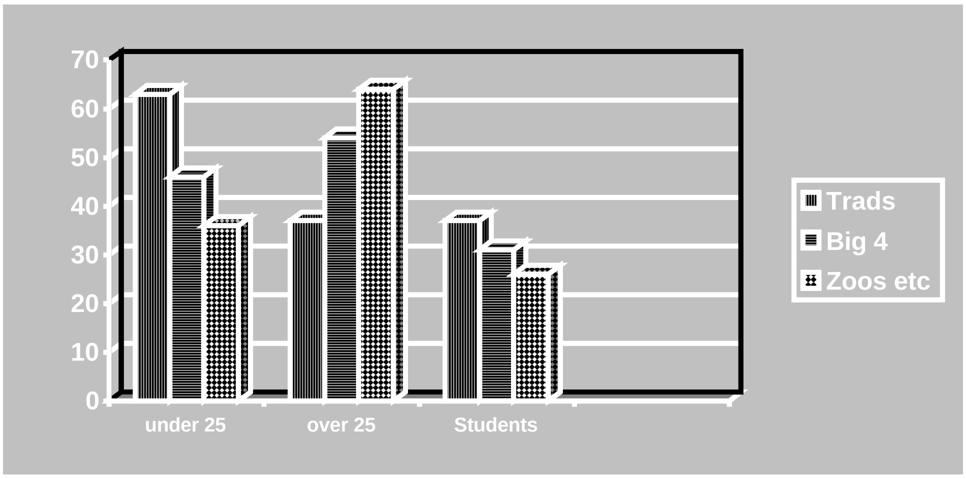
[161] http://www.edenproject.com/




**“Trads”**



**“Big 4”**



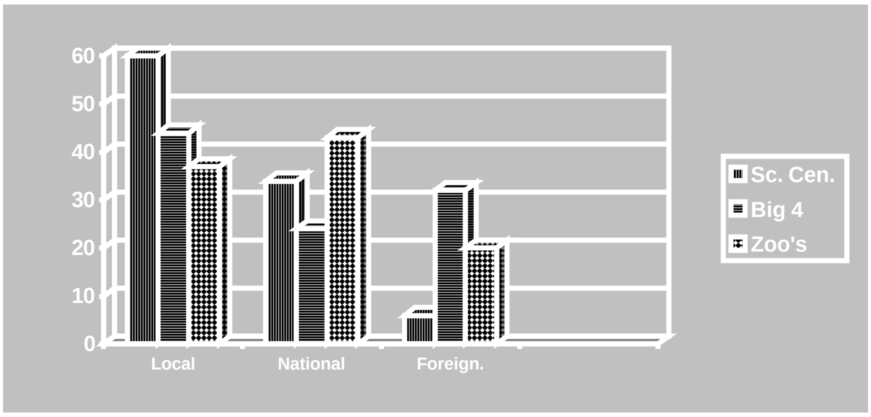

***Where do visitors come from?***

| **Origin. (%)** | **Local[162]** | **National** | **Foreigners** |
|---|---|---|---|
| | | | |
| Trads | 60 | 34 | 6 |
| | | | |
| “Big 4” | 44 | 24 | 32 |
| | | | |
| Zoos etc | 37 | 43 | 20 |
| | | | |

The figures indicate that the smaller institutions attract a higher proportion of local visitors. The “4 big” institutions attract many foreign visitors, even more than zoos and botanical gardens, which is an interesting result. The big science museums seem to pose a much bigger attraction to tourists than the other considered institutions. Does it mean that tourists have

[162] Local = within one hour’s drive.

enough on offer in that field at home, that large science musuems are more effective at promoting themselves or that a visit to the science museums has become a must when visiting Paris, Munich or London? Further investigation is required on this topic.




***Staff and Services.***

Visiting a museum, including one devoted to science, is a social experience as shown in the French survey later in this chapter. It also increasingly involves personal contact with an "explainer". Explainers work on the floor of the museum and are available to offer explanations to visitors if necessary– normally they are recruited for their interpersonal skills and approachable manner as well as their ability to explain the exhibits and experiments. They are seen as hugely useful both for school groups and individual visitors. Otherwise the science is presented as an affirmation by scientists "who know" for visitors "who don't know", which is an outmoded approach – it does not make a useful contribution to increasing public understanding of science.

It is thus important to figure out the quality of the service offered to visitors in science centres and museums. The indicator below considers the number of available staff and indicates the different types of services that visitors might expect during their visit. Eleven possible services directly linked with the communication of science have been identified. These range from labs for schools and libraries, to shops and Imax theatres (full list in annex).

| | **Total FTE staff** | **Average FTE per institution** | **Services offered** |
|---|---|---|---|
| | | | |
| Trads | 6.312 | 42,6 | 47% |
| | | | |
| "Big 4" | 2.473 | 618 | 80% |
| | | | |
| Zoos etc | 1.182 | 236 | 57% |

We see that almost 10 000 jobs (FTE) are provided by the EU science centres and museums which participated in this survey. We also see the striking difference between the institutions in terms of services. The large institutions offer almost all possible services to the visitors. In the traditional institutions however, only half of the possible services are provided. It interesting to note that the smaller centres generally all have labs for school visits, allowing hands on experience. The botanical gardens and so on have big spaces with less staff and a much smaller range of services. Plants and animals seem to be enough of an attraction in themselves! More conclusions can be drawn when we consider the indicators later on.

***Operational Budget***

Funding emerges from the survey as one of the key elements, as might be expected. The table below depicts the range of operating budgets in the field. A comparison with the rest of the world is presented, as with the visitor numbers above. We notice a large increase in average European operating budgets that has to do with the fact that a larger number of institutions are now taken into consideration – it is a fast growing sector with lots of newly created science centres and museums all over the EU (+24.2%).

| **Region** | **1997 total operating budget, in million €** | **2001 total operating budget, in million €** | **Average operating budget, in million €** |
|---|---|---|---|
| **EU - Trads** | 275.5 | 353 [163] (+ 28%) | 2.4 |
| **EU – "Big 4"** | 211 | 260 (+ 23%) | 65.0 |
| N. America | 1.113.5 | 717 | |
| Latin America | 22.4 | 66 | |
| India | 3.4 | - | |
| Asia. Pacif. | 42.5 | 319 | |
| Africa | n.a. | 1.2 | |
| China | 4.5 | 45 | |
| **Total** | **1.672.8** | **1.761.2** | |

In 1997 the average for the traditional institutions was €2.2 million per year, per institution. (+9%), which is much less than the average increase of the operational budget for the "4 bigs" which have increased their budget close to 25%.

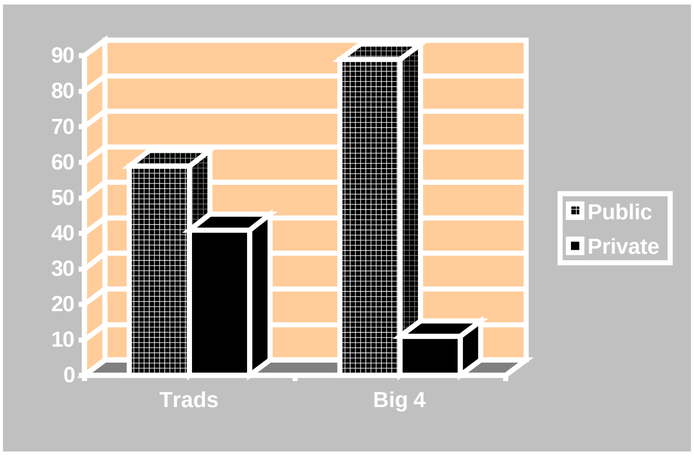
***Where does the money come from?***

We have only considered support to the operational budget so far. Figures for "earned income" have not been analysed. In the current situation in the EU, it is very difficult to make a clear distinction between "local" and national support. This is true for all sectors. Amongst the "Trads" for example "Technopolis" in Belgium gets 50% of its support from the regional Flemish government which is in charge of education and research. The Federal State is no longer responsible for this. The same is true for the Deutsches Museum in Munich. That is why it is also useful to consider public versus private funding. The table below presents a breakdown of the sources of funding for the institutions which participated in the ECSITE survey.

[163] This is the figure for 152 institutions.

| Source of support | Local/ regional government | Nat. government | Corporations and + Foundations | Other | Public/ Private |
|---|---|---|---|---|---|
| Trads | 27% | 32% | 10% | 31% | 59/41 |
| "Big 4" | 28% | 61% | 4% | 7% | 89/11 |
| Zoos etc | - | 85% | 3% | 12% | 85/15 |

It is notable that the large institutions that already attract the largest visitor numbers receive most of their funding from public authorities. The smaller institutions have to "fight" to obtain 40% of their annual support from other sources.



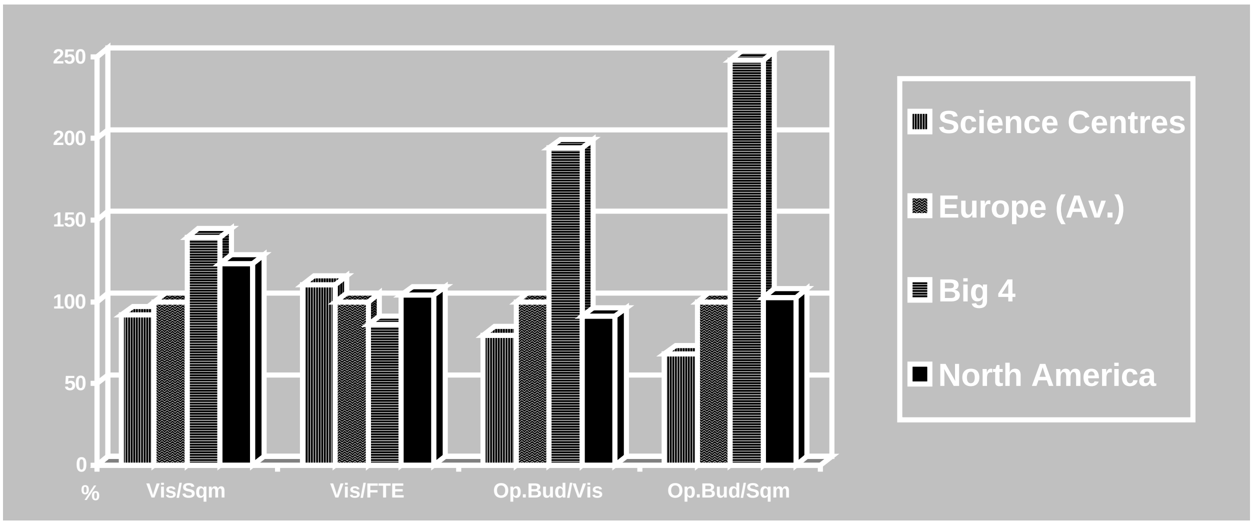

***Overview of indicators – what they tell us.***

| Indicators. | Vis/Sqm | Vis/FTE | Op.Bud./Vis. | Op.Bud/Sqm |
|---|---|---|---|---|
| Trads | 35 | 3.740 | 14.9 Euro | 525 Euro |
| Big 4 | 53 | 2.905 | 36.3 Euro | 1.916 Euro |
| Zoos etc/ | 5 | 2.675 | 17.6 Euro | 83 Euro |
| | | | | |
| Trads and Big 4 (averaged) | 38 | 3.383 | 18.7 Euro | 773 Euro |
| | | | | |
| **NA** | **47** | **3.525** | **17.0 Euro** | **793 Euro.** |

The indicators allow us an overview of the situation in the field. Major findings can be described as follows.

The "Trads" which represents most EU science centres and museums have a much smaller budget pervisitor than the 4 major institutions. The budget per sqm of the big four is also much higher. The question arises whether the big institutions are investing more in equipment and less in people – the cost per sqm is 4 times higher and the cost \visitor is only 2.5 times higher. This seems to indicate that running the services and equipment/ facilities is the major difference. When we look to the visitors' profile and the number of young visitors in school groups that need helpers/ guidance it seems to confirm our impression that a visit to an traditional centre is more likely to be an intensive visit with more personal contact with staff. This contact is important both for the learning experience and for role model reasons – contact with helpers in a science museum can have an influence on future interest in science or indeed career choices.

The table below presents statistics for the US and Canada which show the situation to be comparable even though the north American centres seem to invest a little less in the visitor and a little more on equipment and services.




### *Particular Surveys*

Numbers are important but very soon it appears similarly to other surveys of that kind that figures can tell more about the professional activity. The first question that comes up is who are we speaking to? Which of course is very important to determine programmes and exhibitions. Hereafter some results of a study performed by one of the four big institutions, "La Cité" in Paris[164].

*Age groups and gender of the visitors to la Cité:*

| | |
|---|---|
| < 12 | 24% |
| 13 – 19 | 15% |
| 20 – 29 | 24% |
| 30 – 49 | 30% |
| > 50 | 7% |
| | |
| Women | 48% |
| Men | 52% |

[164] « Les sujets de curiosité scientifiques des français » in La Letter de l'OCIM, number 55 (1998), Aymard de Mengin, head of the evaluation department at La Cité. See also http://www.cite-sciences.fr/

The numbers indicate that “La Cité”attracts a lot of tourists, who make up 22% of the total visitors. However, it has a lower proportion of youngsters visiting in school groups than any other institution in the field.

The study found that there are significant gender differences according to the themes of the galleries. There tend to be more male visitors in the permanent exhibition spaces and an important majority of women (68%) in the children’s area. This is likely, of course, to be linked to the fact that women are often the primary carers of children.

La Cité also queried the professional activity of its visitors:

*Stated profession of visitors to la Cité*

| | |
|---|---|
| Employees and workers | 7.0% |
| Technical professions | 8.5% |
| Managers and “intellectuals” | 19.0% |
| Teachers | 12.0% |
| Retired | 4.5% |
| Unemployed | 8.0% |
| Students(higher education) | 18.0% |
| School children | 17.0% |
| Others | 6.0% |

*Repeat visits*

In this particular survey, 42% of the visitors were visiting “La Cité” for the first time. 27% had been there before at least 6 times. 46% had visited twice or more. Again we can notice differences according to the galleries visited. The more the topic and activity of a gallery involves time and active involvement, the greater the likelihood of repeat visits. In the permanent exhibition spaces 61% were visiting for the first time and only 11% had already been there more than 6 times. On the contrary, visitors for the multimedia library were very much repeat visitors, 54% had been there at least 6 times and only 21% were paying a first visit.

With some additional data the above figures allowed the institution’s evaluation office to create a more detailed typology of visitors and draw some conclusions on the motivation of some visitors:

| | |
|---|---|
| - Want to discover the institution | 29% |
| - Fans | 10% |
| - Accompanying children | 12% |
| - Families sharing the discovery | 8% |
| - School groups | 11% |
| - Repeat visitors to specific activities | 14% |
| - Multimedia library addicts | 8% |
| - Neighbours (living close by) | 6% |
| - Conference participants | 2% |

* Man 15 to 24 years old.
Shows interest for all that's new and for science in general. He wants to learn and understand about new technologies. He is interested in what the future will bring and to try the innovative technology for himself.

* Woman 25 to 39 years old.
She is more curious about evolution and the cultural aspects linked to that topic. She is mostly attracted by themes linked to health and medicine. Her curiosity is strongly motivated further to her responsibility for children, the things the science centre can teach them and the career opportunities that result.

Having looked at the varying profiles and motivations of visitors it is possible to compare with surveys in other museums, either in the same field or in other fields such as art museums. The question arises: are people visiting of science centres the same as those visiting other museums? Little research has been undertaken until now, but if we compare visitors to the institution profiled above (la Cité) with visitors to the Conservatoire National des Arts et des Metiers[165] (CNAM), also in Paris, the results indicate that age is the major differentiating factor. The visitors to "La Cité" are generally young (those aged 15 – 24 years old form the largest group). At the CNAM which, in terms of science content, focuses on the history of science and the past, the biggest visitor group is 65 years old and over.

***Existing surveys on evaluation/ impact of science centres and museums***

Science centres, science museums and other visitor attractions devoted to science and technology represent one of the major tools for communicating science to a wide audience and contribute extensively to informal science education. They act both in connection with the school system and as part of lifelong learning efforts. During the most recent world conference of science centres (Canberra, February 2002), data was collected on the size of the field world wide[166]. Despite quibbles over definitions and criteria, the sector is obviously very important. From the literature we can try to define what science centres, museums, aquaria, zoos etc… bring to the promotion of RTD culture and public understanding of science. It appears that they have a considerable influence on science learning; changed attitudes to science; social experience; career direction, increased professional expertise and personal enjoyment.

Why do the considered institutions have this influence? A great deal seems to be the result of the following services: exciting hands-on presentations, accurate and validated scientific information, a safe environment, the newest technology for presentations, non-formal ways of learning, an interdisciplinary approach, exhibitions with relevance to visitors' daily life experiences and personal contact with staff. This appreciation is rather intuitive and results from experiences and interviews on the field. Not very much scientific research has been done to establish an accurate appraisal of the relative importance of the different on the above list. That is why a huge effort has recently been undertaken in the science centre field to put together existing evaluations and surveys. A summary of that report (March 2002) is attached in annex, but hereafter we detail some of the most important findings.

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[165] www.cnam.fr
[166] More information is available from the ECSITE office, or from Mr. Persson, director of Heureka, the Finnish Science Centre.

***Attitudes towards impact evaluation in the field – lessons for future benchmarking***

There is been a lot of debate in the field on the issue of evaluation. The first reaction a few years ago was very negative in the sense that science centres and museums did not consider they had anything to prove about their performances. The performance of an opera house is rarely questioned for example, either to show that spectators become good performers themselves or that they increase the sales of opera CDs! It is simply expected that there should be one opera house in each major city. Having a science centre should be the same, without questioning the direct impact on society and even on the research performance of a city or country. We still lack tools which are appropriate to measure how science centres and museums affect society. How to measure if someone became markedly better informed after a visit? How to establish how many researchers chose their career after a visit to a science museum? Many people felt that measuring the impact of the field according to visitor numbers and budgets was sufficient. The outcomes of their activity should not be measured. After all, they are not schools and they provide fun and emotions to visitors in the same way that an opera does.

Attitudes changed, however, over recent years. Below we sum up the elements of that change:

- First, the increasing need to be complementary with the formal education system, (science centres and museums seem to be more successful in this respect with youngsters because of the innovative way of teaching).
- Second, the growing competition with the recreation/ leisure market (theme parks developing their "educational" activities).
- Third, the pressure of public authorities who are hesitant to spent money on projects that have no demonstrably direct effect on the labour market or economy.
- Four, the evolution of the sponsoring sector that moved from "mecenas" to market driven strategies and which expects economic return for its support.
- Five, the demand for more students in science and technology to increase the research, development and innovation capacity of individual Member States or Europe as a whole.
- Six, the need to increase the scientific and technological literacy of the European citizens to create a great community of ideas for the future of Europe.

These reasons motivated work on the evaluation of the professional performance of the sector. A few trials have already been organised, in Australia for example and the results show that the field has become aware of the challenges to face misunderstanding in this matter. For example, one recent research finding is that visitors behave according to simple patterns. Notably, they tend to be attracted to exhibits devoted to topics they already know about an understand. What can the field aim to achieve on a large scale if this is a general trend?

So it seems that the fear of unfavourable results through performance indicators is a reality for the sector. Despite this anxiety, and due to the push-pull factors outlined above, an international initiative grouping 20 science centres world-wide has taken up the challenge of building appropriate performance indicators for the science centre and museum sector. The leading force is the Finnish Science Centre "Heureka". A project leader has been appointed thanks to the financial contribution of the participants amongst which the Europeans centres are the largest group. The launch document of the study states that:

> "We propose that a practical study on the impact of science centres on their surrounding communities be undertaken… Practical means here both doable and with a practical perspective, i.e. a CEO perspective rather than an academic one. The questions dealt with should be relevant to the leadership of an institution. It is about positioning, selling, competing, influencing, benchmarking, decision making. Doable means we start with a survey of what is known, collecting the data and analysing it from a leadership perspective. The assessment should provide a summary of what is known about science centre impact at the moment. It should help us formulate a research agenda for the future, and also to devise a method by which existing information can be made more widely available. Impact means here any way in which a science centre has a measurable influence on its surroundings (visitors, non-visitors, media, other institutions, enterprises, economy, land use patterns, political decisions). Surrounding Communities means everything around us at all levels (local, regional, national, international, human populations, non-human populations, behaviours, social structures and processes, physical structures. Finally, measurable means both quantitative and qualitative".

Below you will find a summary of the study which we consider as the best overview of existing literature and surveys undertaken to date.

## 5.6 Overview of impacts

### *Science centres' impact on education*

Piscitelli and Anderson (2000)[167] write, 'In the 1980s, Museum and visitor research studies were regarded as being in their infancy (Feher 1990). The intervening years have seen considerable growth and development in this field of research, although it can be regarded as having been in a formative stage throughout the past two decades. By the middle of the 1990s, there was widespread acceptance among researchers of the cognitive, affective and social aspects of the learning experiences of visitors in museums and similar institutions (Raphling and Serrell 1993). Rennie and McClafferty (1996); Rennie (1994); Roberts (1992) and Falk and Dierking (1992) had drawn attention to the physical, social and personal contexts in which learning occurs. The highly stimulating, novel and interactive physical and social environments of museums have been linked to ineffective learning outcomes by visiting school students by some studies (Kubota and Olstad 1991; Anderson and Lucas 1997). Other studies of the 1990s period have demonstrated that students enjoy visits to museums tremendously and that increased interest and enjoyment of post-visit activities constitute extremely valuable learning outcomes (Anderson 1998; Anderson 1999; Ayers and Melear 1998; Ramey-Gassert, Walberg III et al. 1994); that persist over time (Anderson 1999; Rennie 1994; Wolins, Jensen et al. 1992.'

Rennie and McClafferty (1995) synthesise educational research about learning in interactive science and technology centres from numerous sources and conclude that: 'visits to interactive science and technology centres, museums, aquaria, and zoos provide valuable motivational opportunities for students to learn science and they affect students' learning. Overall, the research suggests that students usually find visits enjoyable but both the amount and nature of their cognitive and affective learning vary. The factors examined in the research literature indicate that learning is influenced by the extent to which students are familiar with the setting, their prior knowledge, the match between the cognitive level of students and the thought processes required by the exhibits, the degree of structure of the visit, the provision and nature of the cues for learning, and the social aspects of the visit.

[167] Full references for the works cited are provided in the bibliography at the end of the report.

More recent studies have looked in depth at the change in students' understanding of science as a result of a visit to a science centre (e.g. Anderson 1999) and have found convincing evidence that students' understanding is changed as a result of a visit to a science centre. The learning that occurs depends on a variety of characteristics of the learner (e.g. prior knowledge, interest) and is mediated by other people (e.g. friends, parents, teachers) and is influenced by other sources of information in the student's life (e.g. books, TV programmes, school, the Internet, friends, family).

Rennie and Williams (2000) studied the effect of a visit to a science centre on the image of science held by adult visitors. Clearly, a visit to the Centre makes a measurable impact on most of the visitors. Given the short time of the visit, that adults often were in charge of children, and that they all bring unique combinations of background knowledge and experiences and consequently have different visit experiences, it is surprising that any effect was measured.' However, the authors express some concern that, as a result of the visit, visitors became stronger in their opinion that scientists agree with each other and that science provides definite answers – views that do not reflect an increased understanding of the way that progress in scientific knowledge is made.

A growing number of in-depth research studies are showing that a science centre visit may influence an individual in an idiosyncratic, eclectic way far into the future. For example, Spock (2000) interviewed museum professionals and asked them 'to tell stories about pivotal learning experiences they had or observed in museums'. He writes, 'Of 400 discrete narratives recorded in the interviews, nearly 200 described pivotal learning experiences and thirty to thirty five stories 'were identified as truly life-changing museum experiences'. The memories of the museum professionals in this study reinforce the qualities of a museum experience that Jensen (1994) found important in her study of children:

- a match to personal interests plus family and cultural backgrounds,
- control over content and pacing,
- some measure of independence from adults, and
- variety in activity and content.

***Science centres' influence on career choices[168]***

Although anecdotal evidence from science students and professionals suggests that visits to science centres and direct contact with scientists are highly influential on a person's subsequent career choices, there are few studies on the matter. Woolnough (1994) argued that extracurricular science activities encouraged students to study science at school and to pursue science careers. Similar findings were made by Salmi (2000) in Finland. There is also evidence that youth programs in science centres encouraged participants to pursue careers in science teaching (Siegel 1998).

***The societal impact of science centres***

Although science centres have put programmes in place that offer benefits to society, on the whole, they have not developed the methodology to measure the impact that they have at societal level. Sheppard (2000) makes a strong plea that they should do so

[168] It is recalled that the subject of science career choices is examined in depth in the parallel report from the expert group benchmarking human resources.

Witschey (2001) writes of the Science Centre of Virginia as ‘the power house of the community’ and describes a rich array of partnerships and programs that the museum undertakes with its community. This is undoubtedly the case in many communities that are served by science centres. Lipardi (1997) describes how the Città della Scienza (Naples) works with local councils, firms and research centres in order to enhance the development potential of a geographical area, with particular emphasis on the development of local industry.

***The economic impact of science centres***

During the past few years, some science centres have calculated their impact on the local community in terms of the extra money brought into the community by visitors to the science centre and extra jobs created by the science centre. In the UK, it was calculated that ‘for every pound sterling (€1.60) spent by visitors at the Museum of Science and Industry in Manchester, twelve pounds (€19.20) were spent elsewhere in the local economy. With 300,000 visitors spending £1.5 million in 2000, the contribution to the prosperity of the region was thus £18 million. To this can be added the goods and services purchased by the museum from local business, the employment of 120 people, and the investment in new exhibitions and building work.’ (Greene 2001)

***Other areas to be explored***

The science centre sector is constantly evolving and, as we have seen, is only beginning to systematically monitor its impact in a variety of ways. Several fields remain to be explored, for example Anderson (1999) mentions ‘the processes of learning resulting from museum-based experiences; the role of prior knowledge in learning resulting from museum experiences; the criteria for design of post-visit activity experiences; and effects of post visit experiences on subsequent learning.’ Anderson’s PhD thesis addresses these questions in case studies of five students who visit a science centre to study electricity and magnetism. Lynda Kelly, Head of the Australian Museum Audience Research Centre writes ‘There is a vast literature about how people learn and how they learn in informal or free choice contexts. There have been fewer long-term studies that have assessed the long-term impact on learning of a visit to a science centre.’

Very recently however the UK authorities ordered a survey on these matters in the UK[169]. Below we present its main findings in the form of a case study on the UK science centre scene.

5.7 CASE STUDIES

***Case study 1 - The UK Scene***

Science and discovery centres in the UK can be assigned to a number of categories, both by size and – in some cases – by speciality.

A **small centre** has an annual turnover of less than £0.5 million, or in some cases less than £100,000. Visitor numbers lie in the range 5000-50,000. Unless supported by a larger

169 Reference to follow.

umbrella organisation, they are struggling to survive – but for want of relatively small sums of money.

A **medium-sized centre** has an annual turnover in the range £1.5-2.5 million per year, and receives 200-250 thousand visitors. Operating costs are of the order of £10 (16,2 Euro) per visitor. More than two thirds of the visitors to medium-sized centres come from within 1 hour's drive time, and the population within this area is 1-1.5 million. Schools form an important share of their business, perhaps as high as 35%. All have additional educational facilities, such as classrooms, laboratories, planetaria, lecture theatres, discovery rooms and temporary exhibition space. Medium-sized centres tend to have extensive educational outreach programmes.

A **large centre** has an annual turnover of at least £3 million, and has probably opened within the last two years. Large centres have typically received some tens of millions of capital investment, and face considerable costs for the maintenance and refurbishment of sophisticated buildings and out-sourced exhibitions. Visitor numbers lie in the range 350,000 to 1.75 million, but are likely to stabilise in the range 250,000 to 750,000 until there is further major investment. The operating cost per visitor is likely to be somewhat higher (say £12/head, 19,5 Euro)) than that of the medium-sized centre.

Large centres tend to be in densely populated locations, with several million people living within one hour's drive time. They have a wider reach than the smaller centres, and receive perhaps 50-60% of their visitors from the «one hour» area. Schools represent 15-20% of their business, though there are extensive educational facilities in addition to the exhibitions, e.g. laboratories, classrooms, large format film theatre, planetaria. Exhibition space is typically in excess of 4000 sq metres, and 10-20% of this may be available to receive temporary visiting exhibitions.

*Specialist science centres and museums in the UK*

The UK has many science centres which cover a wide spectrum within the STEM (science, technology, engineering and mathematics) agenda. Others, however, have a more specialist remit: the National Space Science Centre and the Eden Project are two recent examples, but there are a number of others. Even the «specialist centres», however, are committed to a wide educational remit. It would be an over-simplification to consider them as separate providers or as the beginnings of a pattern which might lead to national coverage in a range of «scientific content» areas. They have to be «generalists» as well as specialists.
A number of established museums have «science centres» within their buildings. Launch Pad and Flight Lab were two early examples at the Science Museum, Xperiment at the Manchester Museum of Science and Industry is another. These facilities are interactive galleries which are more or less integrated with the rest of what is offered at the museum, and have distinctive schools programming and (in some cases) outreach activities. In a number of cases they operate within an existing funding relationship with the Department of Culture, Media and Sport.

*Current and break even turnover*

It is impossible to make more than a rough estimate of the «current total turnover of science centres», but it is believed to be of the order of Euro80-Euro95m (if you exclude the National Museums from this estimate). The current income of some science centres currently lags behind its annual liabilities by an amount, which is not yet clear in relation to its true requirement.

*Current geographic and population coverage*

With the exception of the National Museums and the Eden Project, which are major tourist attractions, the science centres typically draw 65-75% of their visitors from within a one-hour drive, and most of the rest from within 2 hours drive time

*Number of science centres supported by other EU/G8 countries*

There are no centres, which operate in the for-profit sector and achieve surpluses or indeed a balanced budget entirely through «earned income».

*Educational access and the contribution of science centres*

Science centres in the UK are fundamentally educational institutions. They have informal education at the heart of their missions, and in relation to the formal education system they provide support for teachers and enriching experiences for pupils. In relation to their approximately 11 million visitors each year, the science centres contribute actively to theie 'education and lifelong learning'.

*Perceived value for visitors*

This is almost always expressed in terms of:

- Access to experiences which are not otherwise available to schools or families
- Freedom to explore scientific phenomena ideas according to visitors' own preferences and direction (the «visitor-led» experience)
- Enjoyment and stimulation – the encouragement of realising that anyone can explore science, that this is not a specialised area confined to highly trained people in white coats – and the sense of personal empowerment which this brings
- Motivation to further exploration and learning
- Direct support for learning schemes to which the visitor is already committed.

*Links with higher education*

Almost all science centres, large and small, have extensive links with higher education. Some of these links relate to the expert advice, which is available from the HE sector, but more frequently there is a close relationship between the learning and teaching programmes of the science centre and the HE institution. Science centres provide an environment in which undergraduate students of sciences and engineering, business, architecture, design etc. can explore the practical application of these disciplines and undertake small scale projects. They contribute significantly to the pre-service and in-service education of teachers and, in one case, a science centre provides a Master's degree course in Communicating Science in collaboration with a local university.

***Case study 2 – the situation of scientific museums in France***

Scientific museums occupy an important position in France. The network of “local” institutions groups over 300 institutions of which 35 can be considered as science centres. The science centres, like the emblematic “La Villette”, attract many visitors every year. But the question remains: <u>how to generate the interest of the public in science centres</u>? As an example of how the French look at this question, we propose hereafter some outcomes of a broad analysis made in France in 1998 that tries to identify who are typical science centre visitors[170]. Thanks to this kind of study we know more about the profile of visitors to French science centres.

The social and demographic features of the public between science centres are quite similar. Nevertheless, some differences appear according to the exhibition themes and the way they are displayed. The public/ audience is mainly local and female. Men tend to be attracted to exhibitions about information technology and women by medical sciences. The average age is less than 50 years old. Some exhibitions are more attractive for schoolchildren, an others for seniors. Most of the visitors are professionally active people with a high proportion of teachers and students. Visitors often hold a master’s degree.

Concerning the frequency of visits, the study distinguishes four categories of visitors: first time visitors; teachers and students; “former Museum lovers” and Museum addicts.

Ÿ 40% of the people who go to a Museum are first time visitors. Therefore, we have a large potential public in this category. Most of the time the public comes from the local neighbourhood or surrounding area.
Ÿ The teaching profession is an important target public and represents 1/3 of the museum’s public.
Ÿ “Former Museum lovers”, that is to say people who used to go to museums but didn’t do so during the last five years, represent 11% of the visiting population. They are mainly attracted by exhibitions with both artistic and scientific angles.
Ÿ Current Museum lovers constitute 7% of visitor’s. They are attracted by novelty. In order to make these visitors come to the museums we have to improve the quality of the visit and renew their interest through large cultural events.
Moreover, it appears that a recent visit to a museum triggers a visit to others and therefore, partnerships between museums are useful in attracting the public’s interest.
The expectations and appreciation of the visitors fluctuate according to age categories and gender. Visitors between 15 and 24 years go to museums with an educational goal. School pupils go there in the school environment; the obligatory feature of the visit is strongly felt. On the contrary, college or university students are motivated by the improvement of their general knowledge, and the visit becomes a conscious personal enrichment.

Young women are interested in discoveries and being astonished. Young men are more interested in the technical and scientific value of the visit. This difference of perception between men and women can be observed at all ages. Between 25 and 44 years, men and women’s objectives are aimed at awakening the curiosity of their children. Women are interested in progress and modernism while men focus their attention on more precise subjects like information science, technology, space and new image technology. Between 45 and 59 years, the aim remains pedagogical. Men want to be aware of the evolution of art and

[170] Special issue of: <u>Lettre de l’OCIM</u> (Office de Coopération et d’Information muséographique). Nr. 55 (1998). ‘L’espace muséal scientifique et ses publics’. Directed by Jacqueline Eidelman, Chargée de recherche en sociologie de l’éducation. CNRS – Paris V. With a contribution from La Cité des Sciences by Aymard de Menging, director of La Cité’s evaluation department.

technology. The women's aims are to discover progress and evolutions while men's interest is directed towards projects and inventions.

According to the visitors' level of education, their expectations vary. Less well educated people tend to want to watch and enjoy the exhibition. When a visitor has graduated from high school, s/he wants to discover, learn and improve his/ her general knowledge. For college or university graduates, the personal interest and cultural enrichment factors are predominant. Those with the highest levels of education are motivated by the search for cultural interest, aesthetic and intellectual pleasure. A visit to a science museum is also a sociable experience, whether as an individual, with family or with friends.

Science museums' public is diverse because the range of issues covered is also diverse. There are heterogeneous centres of interest: natural history, anthropology and ethnology, exact sciences, history of sciences and current issues.

It is thus possible to establish a typology of science museums. Each type attracts a specific public, which is more or less regular. We notice that museums of natural sciences and museums of fine art have an inversely proportional ratio. Visitors only go occasionally to either kind of museums according to the creation of special events. Actually the key for success is the capacity of a museum to be felt as up-to-date through the creation of events and especially temporary exhibitions. Museums have to consult each other and develop synergies in order to learn from the success of other museums even if they are not scientific ones. They must join forces with the aim to increase their public's awareness of the renewal of the Museum's content. Museum networks represent the future of science museums – maximising mutual learning and optimum content for visitors.

## 5.8 Science and Society – debates and dialogue

There is an important new trend in the science centre/ museums field - renewed dialogue with the citizens through the organisation of 'informed public debates'. Public scepticism about major scientific issues has grown because of challenges/ crises related to the environment, food safety and privacy. Visitors started to reject presentations of science and scientists as having no doubts about the future, and the idea that they should accept scientific and technological progress as good/ correct. Today there is the feeling that we must listen to what the public has to say and find new ways to promote science and innovation. Debates with the public, are one way forward. The larger science institutions have always organised lectures and conferences to explain hot topics. We now have to take into <u>account the public as an actor of scientific opinion and not only a consumer of prepared ideas</u>. Experiments in dialogue work are currently taking place in several places such as the Science Museum in London, Heureka in Finland or the Experimentarium in Copenhagen. The most innovative initiative seems to be the one organised in France. Below is a short description of the results of the public's active participation with experts in a "mad cow debate" held at "La Cité des Sciences".

Title of the conference "The mad cow story: context and illustration of an uncertain situation". The conference was designed to include the public's participation at the same level as the subject "experts". The aim was to organise an informed public debate and to measure the evolution of the public's representation on a complicated scientific issue. Two groups of non-experts were created and discussed over two days in preparation for the conference. They were different in composition. One was created at random amongst regular "Cité" visitors. The other one was composed of professional that in one way or another were close to the topic (farmers, health sector, etc…) but all were laypeople in the specific field.

Staff at "la Cité" tried to identify the questions and ideas of the public and the discussion frame that might allow progress in views on the considered matters. The groups were asked to reformulate their views once scientific information had been provided.

The process used five steps:

- Identification of all ideas and views (right or wrong) of people when they first knew of mad cow disease (MCD).
- Identification of the messages sent out by various actors in the event and discussion on the impact of these messages on early public opinion.
- Learning from experts to be able to take part in the debate. (Not as experts but as individuals with an informed personal view).
- Reformulation of their initial views using the debate as a new source of information.
- Definition of their objectives and participation in the conference.

From experts who very often have opposite views on such matters, it was expected at that stage, that they express their differences and looked for ways to come to common ideas and solutions.

From the public it was expected to put forward a framework for decision making about scientific issues and most importantly to decide about the social acceptability of these decisions.

Findings: "La Cité" concluded that the active participation of the public clarified the debate because their concerns come from daily life experience and fears". Citizens may not provide solutions but can help experts to reformulate ideas in a new way. When citizens act as "informed citizens" who can react and comment without pressure, not as politicians who have to take quick decisions or scientists who have to tell the "truth" or even the media who have to "sell" information, their contribution is important and their role becomes essential[171].

### 5.9 Comments and Summary

Without a doubt, science museums and science centres in the EU are one of the key players in the field of science communication and education, and thus in the promotion of RTD culture and public understanding of science. Over 30 million visitors come through the doors each year, with the aim of learning about current scientific issues and preparing themselves / their children for a better future. These are actively interested visitors who have made a conscious choice to visit the institution and intend to get something out of the experience. Statistical surveys have shown them to be, on average, more educated than other citizens and a large number are youngsters visiting in the framework of a school activity.

[171] Special issue of: Lettre de l'OCIM (Office de Coopération et d'Information muséographique). Nr. 55 (1998). 'L'espace muséal scientifique et ses publics'. Directed by Jacqueline Eidelman, Chargée de recherche en sociologie de l'éducation. CNRS – Paris V. With a contribution from La Cité des Sciences by Aymard de Menging, director of La Cité's evaluation department.

From surveys we also know that science centre visitors are looking for real answers, either about scientific phenomena or their impact on education and society. We should consider them more and more as relays to their communities. They can be seen as scientific "opinion leaders". Increasingly, science centres and musuems are building up educational programmes which are linked to the school curricula and in this way they try to bridge the gap between informal and formal education systems.

Surveys show that visits to science centres and museums influence citizens images of science and potentially, their choice for a science careers. They show also that a big effort has to be made to increase the understanding of all the aspects of science and its influence on society. Science can not be portrayed simplistically as "the truth". Scientists have to come out of the labs, become human and and visible to citizens, in order to convince them about the great opportunities and risks associated with scientific progresses.

Long-term surveys and studies should be undertaken to provide statistical data and data on trends to confirm or challenge the statements by science educationalists and science centre professionals about the value of science centres in society. The global study undertaken in the context of the 3rd world congress in Canberra is a step in the right direction, attempting to develop appropriate benchmarks in this area.

From the statistical data it was possible to gather for this report, it is clear that there is a significant gap between the small number of large institutions and the rest of the field. The "big four" institutions in the EU receive disproportionate amounts of public money whilst the smaller ones have to fight for at least 40% funding from other (private) sources. It also seems that the budget of the large institutions is more focused on the management of services (Imax screens, etc) than on direct contact with visitors, and so although they play an important role as tourist attractions, it would appear that they offer fewer opportunities for personal learning experiences.

Proportionally the large group of smaller centres attract a much younger public. This means that from the policy making point of view, taking into consideration the need to support science career choices it would be advisable to support the smaller institutions which youngsters and local population tend to visit more.

Science centres are already active in stimulating dialogue/ debates with the public on major issues of societal concern/ hot topics. It should be noted that, from the point of view of the professional activities undertaken in science centres, this implies a dramatic change. The exhibitions policy, marketing, educational programmes and staff training now have to adapt to the new climate for two way discussion. New resources should therefore be made available to facilitate this adaptation, since science centres and their staff need support to develop new skills in order to meet the challenge.

### 5.10 Trends observed in the science centre field in the EU

One main trend identified is 'hybridisation' of the typology of institutions. This is shown in the growing interest of traditional museums for an additional 'hands-on' approach; plus the recognition within the science centre field of the importance of the 'real object' and/or living animals; plus the developing interest of leisure and theme parks in a science centre approach.

Attempts are being made to bridge the gap between formal and informal education systems. Adaptation of the educational products of science centres/museums for use in school curricula, and interest from teachers in new ways of science teaching as performed in science centres/museums. Creation of new 'learning objects' for schools on the basis of scientific content in the informal field including science centres and museums.

The interest for science in the zoo's, aquaria and botanical gardens that face the new challenge of sustainable development issues and look for scientific content inside the large field of scientific communication and primarily towards science centres/museums.

The specific situation in the UK that witnessed a spectacular expansion of the science centre field thanks to the millennium fund. At least 16 new science centres opened in 2000-2001.

The field is still growing but mainly in numbers of institutions, less in total budgets and visitor numbers. There is a big difference between the north and the south of Europe in numbers of institutions. More exist in the north and the numbers are growing. In Spain there are fewer but on average larger institutions and Portugal which has a well established science communication programme "Ciencia Viva" which has over the last seven years seen the creation of science centres in several main cities, funded by the public authorities.

### 5.11 Conclusions

- From all the above it is possible to draw the importance of the field for Europe. When we consider the results of the survey and some additional outcomes especially from the surveys of "La Cité", we may say the following. Science centres and museums attract millions of interested people every year. They are on the average more educated than in any other institutions. Above all the average age is very young. Which means that we have the future of science and research coming into the institutions today.

- Visitors tend to believe that the science presented is correct and neutral but want to see more expression of questions about science and the social implications. The science centres and museums are slowly going into the direction of creating a renewed dialogue with the public taking into account their concerns and the need to improve the science literacy of the population as a whole. In this sense, visitors are more and more considered as being "scientific opinion leaders".

- Links with formal education sector are increasing.

- Competition with leisure/ recreation industry is growing.

- There are some important differences between the very big institutions and the others. The most numerous group, of small and middle size institutions, has a younger and more local public, less services and financial means. Support comes in a large part from private sources. The Big 4 have an older, more differentiated public and provide all services with the help of a lot of public money.

- The renewed role for the field will impose more direct contact with the public and the largest group has the lowest resources to meet these challenges. Both in terms of numbers of staff members and in training.

- There is support within in the field to increase and improve benchmarking and to create appropriate tools for impact evaluation, not only for evaluation of the individual education improvement or vocations, but also to measure the economic and social impact of science centres and museums.

## 5.12 Recommendations

1. National governments should give high priority to partnerships with science centres and museums for any national policy in PUS[172].
Reasoning: Science centres and museums are successful tools for science communication and science learning. The ECSITE survey shows that they attract a great number of motivated and interested visitors. A large proportion visits as part of a school group, representing future European generations. Our report indicates that experiences in a science centre play a key part in youngsters' decision to follow a scientific career. Science centres therefore contribute to the future competitiveness of the EU in R&D as well as to the scientific literacy of the general population.
Actors: National and regional governments.

2. Special programmes should be set up in co-operation with science centres and museums to stimulate scientific vocations, especially targeted at girls.
Reasoning: As above, our report indicates that experiences in a science centre play a key part in youngsters' decision to follow a scientific career.
Actors: National and regional governments, education ministries, science centres and museums.

3. Special support is required for small and middle sized science centres and museums.
Reasoning: Our report demonstrates that small and middle-sized institutions, which compose a majority of the field, are particularly valuable since they respond to a real local demand and specifically address a young interested public. (46% of visitors to these smaller centres are under-15s.) They are currently obliged to find a large part of their operating resources through partnership or sponsoring since they receive lower average levels of public funding. New initiatives are needed to prevent their closure.
Actors: National and regional governments.

4. Co-operative projects between institutions should be supported (for example, travelling exhibitions and programmes, staff exchanges, training programmes, internet platforms for exchange of materials and expertise).
Reasoning: Mutual learning, optimising exchange of best practice and reduced costs for operations (economies of scale). Specific attention should be paid to co-operation between "traditional" science centres/ museums and the new emerging field in science communication represented by zoos, aquaria and botanical gardens. Specific training should also be provided to staff to help them to deal with their new tasks and responsibilities regarding dialogue with the public.
Actors: European Commission; local, national and European networks of science centres and museums, including ECSITE.

5. Support should be provided to science centre professionals to enable them to train other actors in cutting edge science communication/dialogue skills.

[172] Please see the recommendations in the "Education" chapter which also underline the need for co-operation between the informal and formal education sectors.

Reasoning: In the context of the recognised need to increase genuine dialogue with the public on science/ scientific issues, first efforts have been undertaken in science centres to bring different actors together, such as the debates at La Cité des Sciences. These have been successful and have demonstrated the need for further contact between the different actors. This is an area in which the skill level demanded is increasing. Action in this area could also make a contribution to capacity building in the candidate countries. This is a new domain for which no funding is currently available.
Actors: European Commission, national governments, science centres.

***Further work***

1. Initiatives have started recently where science centres contribute with their content and communication tools, to create new "learning objects" which should be of help to science teachers to improve teaching techniques – the effectiveness of these "learning objects" should be evaluated. Two web based learning objects are currently being developed, involving "Heureka", "La Cité" and "European School Net"[173].

2. Universities should undertake long term research on science learning through the science centre/museums experience, by initiating joint university-science centre "research-action" surveys, whereby a school based activity is tracked over several years. University involvement would bring methodological support as well as an independent analysis.

***Future indicators***

Effective benchmarking indicators are required to measure the precise impact of this sector in several areas, for example in education, career choices, employment, society, tourism and the local economy. The authors have chosen not to recommend specific indicators at this point, in anticipation of the results of the international study on this subject, taking place under the auspices of "Heureka", the Finnish science centre, which will be available towards the end of 2002. The study aims to build a consensus on appropriate indicators for this field.

[173] Please see the recommendations in the "Education" chapter which also underline the need for co-operation between the informal and formal education sectors.

# CHAPTER 6: SCIENCE AND MEDIA

## 6.1 INTRODUCTION

Nowadays it would be true to say that the media is ever present in our daily lives and that it has become the pivotal axis for transmitting scientific knowledge to the general public. This is particularly true of the audiovisual media, given that, for better or worse, they occupy a pre-eminent position. This chapter presents evidence for these assertions and presents trends in the different EU Member States.

The Eurobarometer 55.2 report "Europeans, Science and Technology" published in December 2001[174] provides a good illustration of the major information sources available to EU citizens about scientific developments. Citizens were asked to rate the following as sources of information on scientific developments. Adding together the high marks gave the following:

TV: 60.3%
Press: 37%
Radio: 27.3%
Scientific journals: 20.1%
Internet: 16.7%

Schools and universities are only referred to by 22.3% of the respondents, and although the Eurobarometer does not mention scientific popularization books or attendance at scientific lectures, it does point to the widespread influence of additional sources of information.

Apart from specialist scientific and education circles, scientific awareness is generally disseminated through several distinct means of communication including museums, books and conferences. Undoubtedly however the media overshadows these other means as it is much more powerful and pervasive. In their publication "Science in Public"[175], Jane Gregory and Steve Miller remind us that, "even major national museums – like London's Natural History Museum- can claim only as many visitors in a whole year as watch a single edition of *Horizon (BBC)* on television". This fact is born out by the data from the Eurobarometer "Europeans, Science and Technology" report. Professor Bertrand Labasse (Université Bernard in Lyons, France) supports this consideration in a report to the European Commission[176] when he notes that the number of tickets sold annually by *la Cité des Sciences et de l'Industrie* in Paris and all the science museums run by the French Ministry of Education (including the Palais de la Découverte and the Musée de l'Homme, and fifty or more other natural history museums throughout France) was more or less equivalent to the number of copies sold each year by just one science popularisation magazine: *Science & Vie.*

Regardless of the public's level of education or their access to alternative "methods of learning" such as museums, books and scientific conferences, the media therefore remains the fundamental medium through which the public learn about science. As the media plays such

[174] Eurobarometer 55.2 « Europeans, science and technology » European Commission, DG Research, December 2001.
[175] Gregory, J. & Miller, S. (1998) *Science in Public: Communication, Culture and Credibility* New York: Plenum Press (page 211)
[176] Labasse, Betrand (June 1999) *The Communication of Scientific and Technical Knowledge* (Report to Directorate-General XII of the European Commission)

an essential role in the public perception of science, it is therefore particularly helpful to analyse the techniques it uses to circulate scientific information.

## 6.2 DATA FROM EUROBAROMETER 55.2[177]

### *The public feels poorly informed*

In order to gain a better understanding of the attitudes of Europeans to scientific information, it is useful to combine the citizens' degree of information and their levels of interest:

| | |
|---|---|
| Informed and interested | 29.1 |
| Interested but not informed | 14.7 |
| Neither informed nor interested | 45.8 |
| Other | 10.4 |

When combining these results we can see that slightly less than one third of Europeans (29.1%) state that they are both well informed and interested in science and technology while, at the other extreme, 45.8% feel that they are neither informed nor interested. Finally, we learn that a far from negligible proportion (14.7%) is actually seeking information, since these people declare that they are interested but not informed. This percentage is at its highest in Greece (25.5%).

### *Preferred sources of information*

EUROBAROMETER 55.2 interviewed people from the 15 Member States in order to discover their preferred information sources for scientific issues.

| | BE | DK | GE | GR | ES | FR | IR | IT | LU | NL | AU | PO | FI | SW | UK | EU15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TV | 63.6 | 60.6 | 67.7 | 62.2 | 52.5 | 64.6 | 61 | 48.8 | 42.3 | 59.4 | 64.6 | 59.1 | 59.1 | 66.2 | 60.4 | 60.3 |
| Press | 37.3 | 39.3 | 43.9 | 30.1 | 25.8 | 34.7 | 39.1 | 28.1 | 29.5 | 49.2 | 41.2 | 22.8 | 50 | 46.4 | 42.2 | 37 |
| Radio | 29.7 | 22.7 | 25.5 | 33 | 33.6 | 33.7 | 39.6 | 15.9 | 24.4 | 35.7 | 41 | 28.3 | 21.4 | 24.6 | 25.6 | 27.3 |
| School or University | 24.8 | 27.9 | 14.2 | 28.7 | 24.7 | 17.4 | 20.5 | 34.3 | 19.1 | 26.9 | 14.3 | 19.1 | 26.6 | 23 | 22.9 | 22.3 |
| Scientific journals | 20.9 | 16.9 | 15.4 | 13.2 | 16.9 | 20.8 | 14.4 | 33.1 | 13.9 | 21.2 | 16.1 | 8.1 | 22.4 | 21.2 | 18.7 | 20.1 |
| The Internet | 18.4 | 15.8 | 13.7 | 10.4 | 13.5 | 9.5 | 20.3 | 23.7 | 14.3 | 23.3 | 16.4 | 13.7 | 18.3 | 14.1 | 22.8 | 16.7 |

To assess the use of the various media sources (TV, radio, written press, scientific journals, the Internet, school and university) conveying scientific information, the public were asked to classify them, giving each a "mark" of 1 (for the medium judged the most valuable) to 6 (for the least valuable).

Correlating the highest marks gave the following results:

[177] European Commission, EUROBAROMETER 55.2: "Europeans, science and technology", December 2001.

| | |
|---|---|
| TV | 60.3% |
| Press | 37% |
| Radio | 27.3% |
| School or university | 22.3% |
| Scientific journals | 20.1% |
| The Internet | 6.7% |

These preferences do not vary greatly from one country to another, although there is less enthusiasm for television as a medium in Italy (48.8) and a marked preference for the printed press in Finland, the Netherlands and Sweden (50%, 49.2% and 46.4% respectively).

On the other hand we can notice strong differences in cultural practices according to the age and education level of respondents. TV appears relatively universal, though those with a higher standard of education do not choose it as frequently. Elderly people are more likely to listen to the radio. The highly educated tend to read the general press (41.5%) and scientific journals (29.2%). As for the youngest and those who are currently still studying, they prefer to use the Internet (29.1% and 33.1% respectively).

***Attitudes towards the scientific information media***

Eurobarometer 55.2 asked EU citizens about their attitudes to the scientific information media:

| | Inclined to agree | Inclined not to agree | Do not know |
|---|---|---|---|
| I prefer to watch television programmes on science and technology rather than read articles on this subject | 66.4 | 23.8 | 9.9 |
| I rarely read articles on science and technology | 60.6 | 33.5 | 6.0 |
| There are too many articles and programmes on science and technology | 18.0 | 65.8 | 16.1 |
| Scientific and technological developments are often presented too negatively | 36.5 | 39.1 | 24.4 |
| The majority of journalists treating scientific subjects do not have the necessary knowledge or training | 53.3 | 20.0 | 26.7 |

The first evidence is that two thirds of Europeans “prefer to watch television programmes on science and technology rather than read articles on this subject”, which is an answer consistent with the overwhelming choice of television emphasized above. About the same number of respondents (60.6%) stated, that they “rarely read articles on science and technology”. But this answer is given by only 48.6% of those who have had the opportunity to undertake more extensive studies (who left school or university after the age of 20). Despite this low proportion of declared readers, this does not imply that there are “too many articles and programmes on science and technology”, as this opinion is rejected by 65.8% of respondents and 75.9% of those who have pursued more extensive studies.

As for the questions about the quality of information provided by the media, 36.5% of Europeans think that “scientific and technical developments are presented too negatively” but a higher proportion (39.1%) disagree. Moreover, 53.3% believe that journalists writing about scientific topics do not have the necessary knowledge or training. These two opinions show that a quarter of Europeans believe that scientific information is too pessimistically presented and that journalists are poorly trained.

### *Levels of confidence*

The same survey measured citizens' feeling of confidence in scientific professions using a general question concerning professions held in the highest esteem.

| | B | DK | GE | GR | E | F | IR | I | LU | NL | AU | PO | FI | SW | UK | EU15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Doctors | 74.3 | 58.9 | 64.4 | 68.0 | 68.0 | 80.4 | 69.6 | 67.4 | 79.2 | 72.2 | 65.2 | 76.5 | 76.0 | 73.9 | 78.0 | 71.1 |
| Scientists | 48.5 | 50.1 | 42.7 | 53.3 | 47.4 | 47.9 | 22.9 | 46.4 | 50.1 | 50.0 | 36.2 | 35.2 | 43.5 | 54.8 | 40.9 | 44.9 |
| Engineers | 31.5 | 28.7 | 26.6 | 24.7 | 32.1 | 33.8 | 24.3 | 27.1 | 31.9 | 29.2 | 16.5 | 26.4 | 27.5 | 24.5 | 36.3 | 29.8 |
| Judges | 21.3 | 41.9 | 35.5 | 26.0 | 20.9 | 20.0 | 24.0 | 23.3 | 32.5 | 39.1 | 29.0 | 30.4 | 26.3 | 37.4 | 27.2 | 27.6 |
| Sportsmen | 30.5 | 14.7 | 16.8 | 49.1 | 32.8 | 26.3 | 35.0 | 19.3 | 22.5 | 27.5 | 23.1 | 22.3 | 17.1 | 12.9 | 23.3 | 23.4 |
| Artists | 32.2 | 19.2 | 16.4 | 31.8 | 25.8 | 30.3 | 13.4 | 29.8 | 26.4 | 29.6 | 13.7 | 24.9 | 25.6 | 17.5 | 14.8 | 23.1 |
| Lawyers | 17.4 | 21.3 | 21.1 | 17.5 | 15.2 | 15.4 | 16.2 | 12.5 | 20.3 | 24.7 | 15.6 | 15.5 | 14.0 | 20.3 | 22.8 | 18.1 |
| Journalists | 20.3 | 8.8 | 8.6 | 24.4 | 26.7 | 17.6 | 14.1 | 12.3 | 26.8 | 15.9 | 8.1 | 25.8 | 10.0 | 9.3 | 5.0 | 13.6 |
| Businessmen | 17.8 | 11.9 | 9.0 | 14.5 | 16 | 10.6 | 18.4 | 18.1 | 17.1 | 13.7 | 16.0 | 15.6 | 18.6 | 11.2 | 14.6 | 13.5 |
| None of the above | 4.7 | 7.9 | 8.9 | 6.5 | 8.0 | 5.6 | 6.2 | 6.7 | 3.6 | 7.6 | 9.1 | 4.8 | 4.0 | 6.9 | 5.1 | 6.9 |
| Politicians | 8.7 | 13.1 | 7.8 | 5.8 | 6.2 | 3.2 | 6.1 | 4.5 | 16.8 | 14.9 | 8.7 | 5.9 | 7.1 | 9.8 | 6.3 | 6.6 |
| Do not know | 2.6 | 3.0 | 3.5 | 0.4 | 4.2 | 1.5 | 5.5 | 2.5 | 2.8 | 3.4 | 3.4 | 3.3 | 2.0 | 2.7 | 3.6 | 3.0 |

Esteem for the various professions proposed varies markedly - the three professions held in the most esteem are those with a scientific or technical dimension: doctors come first (chosen by 71.1% of respondents), followed by scientists (44.9%) and, in third place, engineers (29.8%).

Choosing doctors is linked not so much to cultural criteria as to the age of the respondent (78.0% among those aged 65 and over). The professions of scientist and engineers, on the other hand, are accorded greater esteem the higher the age the person was when studies were finished (59 %) or the higher the level of knowledge (59.0% and 38.3% respectively among those who have a knowledge "mark" of 11 to 13). Citizens of both France and Great Britain appreciate the medical profession more (80.4% and 78.0% respectively), while the scientific professions are held in greater esteem in Sweden (54.8%), Denmark (50.1%) and Greece (53.3%).

- Judges obtain 27.6% of the votes, lawyers 18.1% (the legal professions are more appreciated in Denmark and the Netherlands). But sportsmen (23.4%) and artists (23.1%) also take precedence here.
- Journalists and businesspeople are more or less at the same level (13.5% y 13.6%).
- Politicians, come last with an average of only 6.6% of the votes. Only three countries have a higher estimation of this profession: Luxembourg (16.8%), the Netherlands (14.9%) and Denmark (13.2%).

These results show us that there is a marked difference when it comes to esteem 4 journalists. For instance, we see that in the United Kingdom only a 5% of respondents chose journalists, whereas in Spain, Luxembourg or Portugal around 25 percent of respondents chose journalists.

## 6.3 STUDIES ON THE TRANSMISSION OF SCIENTIFIC KNOWLEDGE TO SOCIETY

In the European scene, very few studies are available on how the media transmit information on scientific issues to society, and this applies to quantitative as well as qualitative reviews. There seems to be a concurrent impression that the media trivialize scientific news items and convert them into a "show". This can be seen as a result of the long shadow which "fast thinking" imposes on audiovisual media, independent of the degree of difficulty involved in recontextualizing the scientific discourse delivered by experts. This frequently reshapes scientific news items into mere anecdotes and can involve a degree of misinformation.[178]

Comparison of various reports and studies concerning the issue of the dissemination of scientific knowledge seems to indicate that the main difficulty is that of bringing together two completely different systems of thought and action: that of scientific research and that of mass information and communication.

This systemic difference is expressed in two contradictory fashions:

**A**) indirectly, by the perspectives taken by a number of approaches, which reveal a unilateral conception of the processes at play. Attitudes may then be based on different ways of thinking:
- taking account only of dissemination bodies that are closest to the academic world and ignoring the major channels of dissemination;
- trying to transpose into the world of information and communication the standards that prevail in the world of science and analysing the latter according to the values of the former (or failing to analyse it at all);

**B**) directly, by other, often more recent works, which instead place emphasis on the "gap" between these two worlds and see it as the main problem concerning the dissemination of scientific knowledge. It might be noted, however, that these analyses, which tend to dramatise this tension, might also seem limited because they focus essentially on journalists[179]. This means they cannot claim to be based on a holistic view of dissemination processes.

We can therefore conclude, in both cases, that a better perception of the actual knowledge dissemination system is one of the main challenges to be met before any attempt can be made to improve that system. It is impossible to think clearly, let alone take action, when matters are so vague: if the dissemination of scientific knowledge is a serious issue, then it must be treated seriously. Yet we do not know of a single reference work that offers a genuine

[178] See:
- House of Lords (2000) *Science and Technology Third report*
http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm
- De Semir, Vladimir (2000) "Periodismo científico,un discurso a la deriva" *Revista iberoamericana de Discurso y Sociedad, volume 2 number 2* Barcelona: Editorial Gedisa
- De Semir, Vladimir (2000) "Scientific journalism: problems and perspectives" *International Microbiology volume 3 number 2* Barcelona: Springer-Verlag Iberica
http://www.ubxlab.com/imb/v3june/p3june009.pdf
- Tristani-Potteaux, Françoise (2001) "Du laboratoire au citoyen: les trois étapes de la communication scientifique" *CNRS Info nº 394 spécial 20 ans d'information et de médiation scientifiques* Paris: CNRS
http://www.cnrs.fr/Cnrspresse/n394/n394.htm
[179] "In a content analysis of 1600 television programs broadcast in the USA between 1969 and 1979, it was found that science appeared less in television news than it did in entertainment and science fiction programs. These programs often focus on situations of crisis and danger, and they portray scientists as forbidding and strange", notes Dorothy Nelkin in *Selling Science* (1987)

synthesis, on both the quantitative and qualitative levels, of the scope of the various channels of dissemination.[180]

On the other hand, the volume of scientific news items appearing in the mass media has notably and obviously increased in recent years. We are aware of one empirical study being conducted on this aspect of scientific communication. The project covers medicine and health news issues[181] as published in Spain's five most widely read newspapers (*El País*, ABC, El Mundo, *La Vanguardia*, and *El Periódico*). The study reveals that the number of medical and health news items in the past four years has grown as follows:

| | | | |
|---|---|---|---|
| 1997 | 1998 | 1999 | 2000 |
| 5,984 | 8,706 | 11,135 | 11,945 |

Thus, in three years, the number of medical and health news items has doubled in number in the Spanish press. Also revealed by the study is the fact that the number of specialized journalists in the aforementioned dailies has remained practically unchanged.

Despite the growing presence of science in the media, daily newspapers only hire – at the very most – two or three specialised journalists who are responsible for managing the entire information load generated in this field of knowledge. This means some science editors were responsible for practically 200 news pieces in the year 2000 (excluding any input they may provide in the drafting of other unsigned pieces). The underlying issue here is whether or not it is possible to maintain quality standards without investing in human resources. Can journalists meet sufficient standards of quality, rigor and depth when they are required to cover such a large number of news items?

We cannot extend these figures and questions to other countries or to other fields of scientific knowledge, but they provide evidence for what readers have noticed when reading generalist press, i.e. the fact that what they read does not always meet their expectations.

This noticeable increase in medical information, a fact we could practically apply, perhaps in a lesser way to other science and technology fields, originates in profound changes in scientific and medical news diffusion which have recently taken place. The use of Internet and press releases distributed by email has meant a significant quantitative increase in the distribution of news items from original sources such as scientific reference journals, universities, research centres, firms and so on. These have had a significant impact on the information reaching the general public. A paper published by *The Journal of the American Medical Association*[182] established that journalists are clearly influenced by certain notes incorporated into specialized reference journal press releases. This means, that when the news science "stories" are published, the final product often lacks a contextualization of the procedures applied in certain research projects or falls short in grasping the social and human

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[180] Labasse, Bertrand (June 1999) *The communication of scientific and technical knowledge* (Report to Directorate-General XII of the European Commission)

[181] Informe Quiral: Medicina,Comunicación y Sociedad (1997, 1998, 1999 y 2000) Barcelona: Observatorio de la Comunicación Científica-Universidad Pompeu Fabra http://www.fundacionvilacasas.org/ventanas/inf00.htm

[182] De Semir, V.; Ribas, C.; Revuelta,G. (1998) "Press Releases of Science Journal Articles and Subsequent Newspaper Stories on the Same Topic" *JAMA, July 15 -Vol280,Nº3*
http://www.ama-assn.org/public/peer/7_15_98/jpv80001.htm

implications. The articles also tend to set the news far from the public interest and often use simplified captions and information that fails to explain the expectation derived from the news piece. A recent well-known phenomenon is "the discovery of the so-and-so disease gene..." a regular news item that is not well understood by the public and may end up making them lose interest in science issues.

In this sense, another point to reflect on is whether or not all the issues that appear in scientific reference journals are truly relevant or are merely published in pursuit of media impact, a situation that in the long run negatively affects science popularisation. In 1995, when Philip Campbell became the director of *Nature*, he declared, "*Nature* will continue its quest for independent scientific excellence and journalistic impact"[183].

Now, are these really compatible goals?

***Media and scientific information: a survey for the Science Media Centre (April 2002)***

The Science Media Centre was created within the Royal Institution to promote the voices, stories and views of the scientific community to the news media when science is in the headlines. In April 2002, it published a survey conducted by MORI (Market and Opinion Research International) about attitudes to science and the media[184]. A nationally representative sample of 1,987 adults was interviewed across Great Britain in March 2002. Key findings were:

Nine in ten adults use the media to obtain information about science issues or scientific research and its social and ethical implications. Television (82%) is most commonly used, with TV news, documentaries and current affairs programmes seen as the most common specific sources. The radio is used by around 4 in 10 citizens.

The press is a common source of information for just over 6 in 10 people, with national newspapers often being referred to, but with local newspapers also mentioned (49% national press and 35% local press). Headline news in both the broadsheets and the tabloids are the most widely read press sections for science information.

However, a majority of the public stated that newspapers are not the source of most influence on their views about science[185]. In this way, public trust in their abilities to give accurate and balanced information about the MMR combined vaccine [186] was low compared to the trust placed in doctors.

One-quarter do not expect a 100% guarantee from science on the safety of medicines, but 6 in 10 do. Nearly nine in ten consider science to have had a positive impact on society overall.

By a factor of almost 4:1, the media is seen as being negative, rather than positive, in its reporting of science issues. However, it is not only the media, which is criticised: eighty-five per cent feel that scientists need to improve how they communicate their research findings to

[183] Editorial from Nature, 14th December 1995
[184] Details at www.sciencemediacentre.org
[185] Just 17% said the 'front-end' of newspapers most influences their views about science issues or scientific research and its social and ethical implications; and just 13% said this of the 'back-end' of newspapers.
[186] Measles, Mumps and Rubella

the public through the media. Scientists are also generally expected to present an agreed view on science issues to the public.

***How journalists and the media work***

Like many professions, journalists and media groups tend not to be particularly receptive to studies about their own activity (except perhaps to those which deal with marketing) and even less to self-criticism of the way that they operate.

Thus far, only those media professionals who have entered the university world and become academic specialists on journalism have progressed in the analysis of the methods used by communication professionals and the mass media. There remains much to do in this area and this may explain why there are so few studies about the transmission of scientific knowledge to the society through the media.

The first factor that we would like to underline is that the spread of the Internet has changed the way journalists worked in the past. A recent poll about media, journalists and new technologies[187] shows that "the web is now the first source of information for journalists" and that "e-mail is the preferred way for journalists to receive press releases". In general, 90% of journalists consider that the Internet has a positive impact on the quality of their work.

The second factor we would like to point out is the strong dependence on scientific scientific journals such as *Science* or *Nature* and from press releases generated by these magazines. Easy, well-practiced scientific reporting consists of drawing information from professional journals, such as *Nature*, *Science*, *The Lancet* and *The New England Journal of Medicine*. The rigorous review system used by these journals assures reporters that these sources provide reliable, thoroughly researched information. Due to the heavy reliance of the news media on these sources, journals send out advance weekly press releases to accredited reporters, that nowadays are spread by e-mail all over the world... The purpose of this practice is to give reporters time to develop news items on findings that would soon appear in scientific journals, although the lay media cannot report these items until they have appeared in the journal. A press release simplifies the information and interprets it in a context that transforms it into news. But press releases not only assist reporters in preparing news items, they also reflect a certain rivalry between scientific journals that compete for citation in the mass media -as well as for the scientific author and the social prestige that results. The consequence is that science reporters are coming to rely increasingly heavily on scientific journals as sources. Scientific journals with weekly press releases, such as *Science* and *Nature,* are more general and cover a diverse array of scientific topics, so they are the most useful for scientific journalists. They also tend to offer fewer review articles, which do not offer "news" in the sense of novelty, a quality that reporters find very useful in "selling" news in their respective newsrooms.

When news media are analysed, emphasis is often placed on how news is reported and not on what news is reported. The selection of news is fundamental because that is how the media directs public opinion of what is "important". Issues thus become "important" by attracting attention via the mass media, not because they are intrinsically more relevant in terms of the advancement of science or social applications.

[187] Hopscotch-Sofres, April 2002, poll done in 14 countries: France, Italy, Spain, United Kingdom, Germany, Netherlands Sweden, Denmark, Finland, Norway, USA, Japan, Australia, South Africa www.hopscotch-europe.com/fr/Etudes

This has consequences in understanding the image of the scientific world and may help explain the widespread impression that there is a lot of information available about science, but paradoxically the public feels poorly informed. The wide variety of information from the press releases of scientific magazines means that work in press offices is often undertaken at a distance – or at least, this is the perception among scientists and scientific institutions. There are many spectacular news stories about scientific progresses which have no practical advantages to citizens' lives. The result can be the impression that science is an interesting or curious phenomenon which is irrelevant to our daily lives, and specifically that it is the produce of a remote world. This could be one reason for the drop in scientific vocations among young Europeans.

***Science, gender and the media***

We have seen that no European level exists about what science is published in daily newspapers. Furthermore, the issue of gender remains conspicuously absent when analysing the few studies that do exist on the relationship between science and the mass media. Undoubtedly gender is an argument generously used in advertising, just as much as it is present in mass media in general. Various references can be found on gender and advertising[188], but practically none include science in their scope.

A systematic study on the transmission of scientific knowledge via the mass media covering the issue of gender would be of utmost interest. One possibility would be to pinpoint specificities of the discourse analysing widely influential specialised magazines, such as "women's magazines".

## 6.4 SCIENCE & MEDIA: A HISTORY

In 19th and early 20th century, the diffusion of knowledge was performed in diverse ways. Very different information sources were generated by scientific societies and the activities they supported such as conferences, public debates and the publication of books and journals. From the mid 19th century on, scientific books began to contribute to the industrialisation and growth of the publishing industry, sustaining a strategic role in the formation of large publishing groups such as Hachette and Larousse in France, and Macmillan in the UK[189].

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188 **Gender & Mass Media** Newsletters International newsletter published in Sweden to exchange information about research and activities concerned with sex roles in mass media. Formerly titled Sex-roles Within Massmedia.
Douglas, S. J. (1994) *Where the Girls are: growing up female with the mass media.* New York: Times Books
Franckenstein, F. (1997) 'Making up Cher - a media analysis of the politics of the female body', in *European Journal of Women's Studies,* 4 (1): 7-23.
Hayes, B. C. and Makkai, T. (1996) 'Politics and the mass media: the differential impact of gender', in *Women and Politics,* 16 (4): 45-74.
Hurtz, W. and Durkin, K. (1997) 'Gender role stereotyping in Australian radio commercials', in *Sex Roles,* 36 (1-2): 103-14.
Sylvie, G. (1997) 'Facing difference: race, gender, and mass media - Biagi, S, Kern Foxworth, M', in *Journalism and Mass Communication Quarterly,* 74 (2): 435-36.
Walsh, Clare (1998) 'Gender and mediatized political discourse: a case study of press coverage of Margaret Beckett's campaign for the Labour leadership in 1994', in *Language and Literature,* 7 (3).
Worden, J. K., Flynn, B. S., Solomon, L. J., Walker, R. H. Secker, Badger, G. J. and Carpenter, J. H. (1996) 'Using mass media to prevent cigarette smoking among adolescent girls', in *Health Education Quarterly,* 23 (4): 453-68.

189 Bensaude-Vincent, Bernadette (2000) *L'opinion publique et la science* Paris: Institut d'édition Sanofi-Synthélabo

These circumstances help explain for example how the French publisher Flammarion was founded: In 1880, Camille Flammarion, astronomer, writer and profuse lecturer, supported by an initiative put forth by his brother Ernest, was able to publish his work *Popular Astronomy*, a book that sold 100.000 issues, practically meeting Emile Zola's record sales of his social literary works at that time. At the same time, another astronomer, José Comas Solá, a Spaniard, was a prolific writer in La *Veu de Catalunya* and *La Vanguardia*, two Catalan newspapers to which he contributed hundreds of science popularisation pieces (mainly astronomy and physics), publishing more than 1.500 articles in *La Vanguardia*[190] alone.

This publication's phenomenon spread throughout Europe and paved the way for the launch of eminent scientific publications, both reference journals addressed to and written by scientists, as well as science popularisation magazines. Today we still read and consult some of these long-lived publications. Among the first group, there is no way we can avoid devoting a few words to "Nature", the British journal that was first published by the Macmillan group in 1869, and has grown to become one of the most influential reference journals worldwide. Among the second group, we can mention the French publication *Science et Vie*, a monthly that was first published in 1913 and that surpassed the 1000-issues landmark in January 2001.

Few authors have devoted their efforts to studying the history of scientific journalism, but they do seem to agree on placing the origin of this development in the interest convergence of scientific societies and press agencies that followed the First World War, and became particularly clear at the end of the Second World War when a new world order emerged. In 1945, for the first time in history there was an extended understanding of the destructive capacity of which human beings were capable. Two antagonistic blocks were developing, each with its respective ideological and economical conception: the capitalist and the communist worlds. On Wednesday, August 8 1945 – just after the dropping of the first atomic bomb and before the real extent of the damage inflicted was known - the main dailies titled the event as a "great scientific revolution"[191].

This brutal conquest of the peace led to the Cold War that placed two large blocks in opposition, each one fighting to convince the entire world of the success of its societal model. The space race began in 1957 and was highly symbolic evidence of this rivalry. It started with the launching of the first Soviet Sputnik and ended when the first human being – American citizen Neil Armstrong - left the first human footprint on the moon in July 1969. The atomic bomb and the space race - both components of a propaganda war in which the protagonists were struggling to attain worldwide ideological primacy – were decisive in the consolidation of scientific journalism as we know it today.

As a result of such scientific-technological evolution, the first newspaper sections specialising in scientific communication were created. The *New York Times* created its section named *Science Times* in November 1978, by which time most European newspapers such as *La Stampa, Le Monde, La Vanguardia, El País, Die Welt,* and *The Guardian* were including scientific journalists in their offices. In Europe, the first pages and supplements dealing with science topics appeared during the 1980s and 1990s. The section below analyses current scientific content in selected European newspapers.

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[190] Cebrián, J.L. "Comas Solá, divulgador científic" Doctoral thesis– Barcelona: Journalism Studies, Pompeu Fabra University

[191] See *Le Monde* cover page dated August 8, 1945

## 6.5 Science in the Media: an analysis

### ***Science in newspapers***

In the early 1990s, Pierre Fayard, professor at the University of Poitiers (France) conducted a comparative study[192] in which he noted the relevance that science issues had acquired in the written European media, mainly as weekly supplements. This had become a trend followed by many European dailies in the 1980s such as *La Stampa*, in Italy; *La Vanguardia*, in Spain; *Libération*, in France; *Publico*, in Portugal.
The following table, a summary from Fayard's 1993 study, details the different countries and their newspapers that included science in their pages by publishing separate supplements. Today, many of them no longer have such supplements, but do continue to provide news on science and technology in their daily editions.

[192] Fayard, Pierre (1993) *Sciences aux Quotidiens* Nice: Z'Éditions

| COUNTRY | NEWSPAPER | PRINT RUN | TITLE OF SUPPLEMENT | DAY OF PUBLICATION | NUMBER OF PAGES | NUMBER OF ARTICLES IN EACH PAGE |
|---|---|---|---|---|---|---|
| GERMANY | *Frankfurter Allgemeine Zeitung* | 400.000 | Natür & Wissenshaft | Wednesday | From 2 to 4 | 7 |
| GERMANY | *Süddeutsche Zeitung* | 550,000 | Umwelt und Wissenschaft | Thursday | From 3 to 4 | 3 |
| GERMANY | *Die Welt* | 230,000 | Umwelt & Wissenschaft | | 1 | From 2 to 3 |
| BELGIUM | *Le Soir* | 160,000 | Sciences et technologies | Weekend | 1 | From 1 to 2 |
| BELGIUM | *De Standaart* | 80,000 | Kultuur & Wetenschap | Daily | From 1/3 to 1 | 5 |
| SPAIN | *El País* | 400,000 | Futuro | Wednesday | From 8 to 12 | From 1 to 2 |
| SPAIN | *La Vanguardia* | 200,000 | Ciencia y Tecnología | Saturday | 16 | From 2 to 3 |
| FRANCE | *Le Figaro* | 400,000 | La vie Scientifique | Daily | 1 | From 3 to 4 |
| FRANCE | *Libération* | 250,000 | Eureka | Wednesday | From 6 to 8 | From 1 to 4 |
| FRANCE | *Le Monde* | 500,000 | Science et Medecine | Tuesday/ Wednesday | 3 | From 2 to 3 |
| UNITED KINGDOM | *The Guardian* | 400,000 | Science | Friday | 1 | From 4 to 6 |
| UNITED KINGDOM | *The Independent* | 390,000 | Science and Technology | Monday | 1.5 | 4 |
| UNITED KINGDOM | *The Times* | 440,000 | | Once or twice every week | 1/2 | 4 |
| ITALY | *Il Corriere Della Serra* | 800,000 | Scienze | Tuesday | 4 | 4 |
| PORTUGAL | *O'Publico* | 75,000 | | Daily | 1 | 1 Articles and from 3 to 4 short articles |

The editorial initiative of a separate science supplement evolved on the model of*The New York Times*, which in 1978, developed various weekly supplements (published daily), establishing Tuesday as the day for the science supplement. The underlying idea was to increase sales by capturing new groups of readers interested in the specific issues being covered, as well as offering a new advertisement platform for the corresponding business sector involved. This trend picked up quickly in the US, both because of the attention it drew and the readership increase that ensued, as well as for the fact this science supplement coincided with the boom of PCs and its subsequent emerging advertising market[193].

[193] Diamond, Edwin (1994) *Behind the Times:Inside The New York Times* New York: Villard Books

In Europe, however, only the first part of the plan was achieved. In his study, Fayard explains that most of the dailies that developed science supplements increased their distribution by 10.000 to 20.000 issues on the days accompanied the science supplement appeared, but this distribution increase was not followed by an increase in advertising. After a decade, by the mid 1990s, supplements gradually disappeared due to associated costs such as an increase in the price of paper-, and to the lack of impact in the advertisement market. Science information was gradually incorporated into standard sections, such as “Society”. Special daily pages created for this purpose contributed to the decline of supplements as happened within the French newspapers *Le Monde* and *Le Figaro*. In any case, the existence of these supplements had a decisive impact in capturing new readers specifically interested in science issues, proving that continuous and high quality information was the best option when trying to create a demand, plus learning this type of reader was a particularly loyal follower. Concurrently, the existence of supplements lead to the development of a training movement interested in educating journalist and popularizing science, addressed both at the journalists who chose to specialize in science issues as well as to the scientists interested in collaborating with the press and getting to know and understand the constraints imposed by the media.

Thematic supplements allowed journalists to deal with science information with more rigour and more space, two facts that probably lead to the creation of this type of news piece as they were met the requirements associated with science popularization. These same circumstances would have been far more difficult to achieve in daily news sections, where space and time requirements are stringently imposed on news generating topics.

### *Science in news agencies*

Major international news agencies such as Reuters + Associated Press, etc.; and national press agencies such as EFE in Spain, LUSA in Portugal, DPA in Germany or France Press in France are important diffusers of scientific, medical, technological and environmental information. Almost all have established specific sections for each subject. Their news feeds almost all press offices in a continuous way: both the printed press, and radio and television broadcasters. That is why it is important to consider its role in spreading major scientific knowledge although its work is not obvious to the general audiences/public. In major press offices the role of news agencies is less obvious because the agency is used as an inspiration for their own work, the news received on the wire is usually rewritten, though the initial alert of the novelty has come from the agency. Radio and television broadcasters use agencies as sources, but rarely credit them. Only in those newspapers that publish fewer issues, mainly regional, agency news is credited. It is understandable that for regional which have a strong influence on specific territories- news agencies are very relevant sources for their daily informative tasks, because regional papers have fewer journalists, and do not usually have specialised journalists, for example, in science.

In this way it is very important to recognise the scientific and technological content of the information they offer, as well as their sources and the real impact in the spread of scientific culture. Such data from news agencies could help to create some useful indicators about public perception of science.

### *Science in popularisation magazines*

Science popularisation is also performed through magazines. The Spanish General Media Analysis (Estudio General de Medios) claims that in Spain approximately 5.5 million readers purchase popularisation magazines, and the number can be increased up to 7.5 million if magazines specialised on computers and Internet are included. It is highly significant that the 4th most popular magazine, after *Pronto*, *Hola* and *Lecturas*, *Muy Interesante*, a science popularisation magazine that distributes 290,422 issues every month. *Muy Interesante* is one of the magazines through which many people, (particularly young male readers) become interested in scientific issues, even if this interest begins at a decidedly popular level, it may well direct them to search for science information in other media. The professional Spanish media journal *Noticias de la Comunicación* recently showed the distribution of circulation per subjec topic in Spanish weekly and monthly publications. Following the leading “women’s magazines”, totaling 2.642.636 issues (20,9 per cent of the magazine market share), and home decoration publications, with 1.682.562 issues (13,3 per cent), the third segment in relevance corresponds to science popularisation publications, with 1.118.841 issues, i.e., 8.9 per cent of the market[194].

In the case of Spain, it is significant that while generally magazines sales have decreased in the year 2000, the two most representative science popularization magazines, with editions throughout Europe -- *Muy Interesante* (popular level) and *Investigación y Ciencia* (high level, Spanish edition of *Scientific American*) have either increased or remained stable during this general crisis, from which only some “sweetheart” magazines or TV programme publications have escaped. More specifically, *Muy Interesante* circulation has increased from 273.469 issues in 1999 to 290.422 in the year 2000. *Investigación y Ciencia* readers have remained approximately the same, from 24.559 in 1999 to 24.731 in the year 2000. The opposite, however, has proved for other publications, such as *Newton* –the Spanish version of a Japanese magazine- that was first published in April 1998 and was discontinued in August 2000, despite reaching an average circulation of 63.731 issues last year. *Focus*, the English version of *Muy Interesante* was selling 87.473 issues last December (2001).

*Muy Interesante* and *Scientific American* are, as we have previously mentioned, the only science popularisation monthlies published in several EU countries, and thus can be considered as an indicator of the interest exhibited by their respective readers in science popularisation[195]. Particularly if we take into consideration that purchasing a magazine is an active decision and proves the readers’ interest. This is not the case when referring to TV audience indexes, as TV is a passive activity and varies greatly depending on what is programmed on other channels.

| | Germany | France | Italy | Spain |
|---|---|---|---|---|
| Population of MS | 82.2 m | 59.4 m | 57.8 m | 39.4 m |
| *Muy Interesante* | 450.227 | 229.012 | 768.625 | 290.422 |
| *Scientific American* | 132.963 | 50.713 | 71.800 | 24.731 |

It would be desirable to have a detailed market study for each country, with information on other publications in this area, in order to draw conclusions for each case. For example, in the Spanish market *Muy Interesante* competes with other publications, such as *QUO* (171.515 issues) or *CNR* (75.218). In France there exists an intermediate science popularization segment that is absent in the Spanish market and which includes *Science et Vie* (349.212 issues) and *Sciences et Avenir* (250.427). In Germany, *GEO* magazine is the market leader (347.899) and the content of the German edition is significantly different from the

[194] Noticias de la comunicación, March 2001.
[195] National Geographic is not considered here as a specific science popularisation publication.

"European" edition. The German version includes science popularization issues while other European GEO editions are more focused on travelling and nature. In the UK, *New Scientist* (135.837 issues) is the reference publication within quality science popularization, and appears weekly.

Future studies should establish the circulation of scientific magazines and circulation variations in a specific period to observe readership trends in each member state. In the case of sister-editions of the same magazine, such as *Muy Interesante, Scientific American* and *National Geographic*, the indicators could be very efficient. We insist on the idea that to buy a scientific popularization magazine is one of the voluntary acts which is directly indicative of an interest in scientific information.

### *TV: pervasive reach but poor quality science content?*

The Eurobarometer 55.2 published in December 6, 2001 reveals that, in general, most Europeans gather their information and knowledge from television, this being equally applicable to scientific issues. However, with the exception of the UK, (see case study, on BBC program) and Germany (with its GEO documentaries and the TV channel ARTE)- in most countries TV programming is scant of decent science programs. Indeed Roger-Gérard Schwartzenberg, former French Research Minister requested an increase in the frequency of scientific issues in the programs aired from Dominique Baudis, President of the Audiovisual Council (CSA).[196]

This lack of science content programmes becomes evident when we analyse the data for specific European Union Member States. For instance, if we examine the situation in Spain, with a population of approximately 40 million citizens, audience data for September 2001[197] were as follows:

- 31,1 million watch TV (89.3%)
- 18,6 million read magazines (53,5%)
- 18,1 million listen to the radio (52,2%)
- 12,5 million read newspapers (36%)
- 6,5 million surf the Internet (18,6 %)
- 3,6 million go to the movies (11 %)

At the same time, despite the fact that news programmes have increased the time devoted to science issues, in the opinion of the author no quality content science programs are being aired.

It would appear that promising progress on this front is being made at EU level since in February 2002 the Belgian delegation to CREST put forward a document entitled "Science, Technology and Innovation in the Media", recommending closer cooperation between European public broadcasting companies (PBCs) and suggesting that "a common European initiative, focused on the PBCs, should be one of the cornerstones of a multi-dimensional and

[196] Report in http://www.csa.fr/html/dos139-1.htm
[197] Published by the General Media Analysis (Estudio General de Medios)

multi-modal strategy for the promotion of science and technology" [198]. Belgium is now taking the lead on this issue, in the context of the complimentary actions proposed in the Science and Society Action Plan[199] and it is hoped that this will stimulate the production of quality science programming, through cooperation and shared experiences.

## 6.6 CASE STUDIES

### *Case study 1 - Science on television: the BBC experience*[200]

In the book *Communicating Science*[201], published by the U.K.'s Open University, Bennett focuses on science on television and particularly on the case of the programme *Horizon* (BBC2). Her words are appropriate to this preliminary study because they can be applied to other European countries and show what needs to be done for successful science on television:

> "We are in a world of fewer and fewer captive audiences. Audiences are also seeing their time as a form of leisure expenditure, which they will decide how to broker for themselves. They will make the choice between theme park and museum, between a BBC programme and a computer games console. The media will have focus clearly on what it can and cannot do … [T]he BBC has become more audience focussed and less paternalistic in its science programme provision. Given that we … have less and less influence over what people watch, this seems to be the right focus."

Of all the national television agencies, the British Broadcasting Corporation has had the longest history of broadcasting science. The BBC currently has a team of science reporters to deal with news and short features, as well as units making magazine and documentary-style programmes. It should be noted that the BBC is funded by a licence fee, levied on viewers.

The Corporation's first – short lived – attempt at television science was *Inventor's Club*, which tried, unsuccessfully, to tap into the wartime ingenuity of demobbed service men and women. *Science Review* (1952) was the first full-length science documentary, watched by 4 million viewers, 10% of the then British population. In 1953 came the BBC's first effort at television science fiction. *The Quatermass Experiment* was a serial about a space mission that went wrong, and attracted 5 million viewers weekly. Since the 1960s, generations of British children have been brought up on *Dr. Who* and his battles against the Daleks and other evil aliens.

The BBC's Natural History Unit has an equally long history. *Zoo Quest* – a mixture of science and safari – commenced in 1954, with David Attenborough as one of the early presenters. *Zoo Quest* reached 20% of the British population. Since then Attenborough has presented many major series from *Life on Earth* (1978) to *The Blue Planet* (2001). Natural history programmes consistently attract eight figure audiences.

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[173]"Science, Technology and Innovation in the Media". This document built further on the observations and ideas contained in the CREST reprot on Science & Society (CREST 1206/01) in particular point 8: "Enhancing the role of the media in the promotion of S&T". The CREST report was a follow up of the Commission's working document "SCIENCE, SOCIETY AND THE CITIZEN IN EUROPE", SEC (2000) 1973.

[199] See for example Action 5 of the Action Plan which states that « The creation of products for broad dissemination (television programmes, paper publications etc.) will be promoted (…) »

[200] Based on information from J. Lynch and K. Hadadi at the BBC plus J. Gregory and S. Miller. *Science in public: communication, culture and credibility*. (Plenum, New York. 1998.) pp. 41-45.

[201] Scanlon, Eileen; Whitelegg, Elizabeth and Yates, Simeon (1999). *Communicating Science: Contexts and Channels* New York: The Open university.

Astronomy has also been a television favourite in the U.K. *The Sky at Night* is currently television's longest running series. It started in 1957, the year of Sputnik, as has been presented throughout the last 45 years by Patrick Moore, Britain's most recognisable astronomer. Major series in this subject over recent years include *The Planets* (1998) and *Space* (2001).

While medical concerns are now routinely treated in drama, with highly successful series such as *Casualty*, in 1958 the National Health Service[202] was still rather novel and the public seemed unsure how to deal with doctors in the new relationship. In response to this, the BBC presented *Your Life in Their Hands*, which gave viewers an opportunity to watch surgeons carry out operations. The series was presented by actual doctors – an early "fly on the wall" documentary. The successors of *Your Life in Their Hands* include programmes like *Hospital Watch*, following the daily life of a busy U.K. hospital. Also, in 1998 the landmark series *The Human Body* revealed our inner workings from birth to death. For animal lovers, operations on a variety of pets can be seen on *Animal Hospital*.

*Horizon*, which started in 1964, has been the BBC's flagship general science documentary programme for nearly 40 years, covering subjects from cosmology to nanotechnology, and from evolution to intelligence. In the 1970s, *Horizon*'s tone shifted from pure reportage, to include some criticism of science as well. Previously, that had been almost completely confined to drama series such as *Doomwatch* (1970) which involved a team of environmental detectives tracking down dangerous polluters. A more recent example, the drama "Fields of Gold" which questioned the safety of GM crops, reignited a national debate on the topic.

Another long-running series is *Tomorrow's World*, on air since 1965. This – as its name suggests – makes predictions about how we will be living in years to come. It has a particular emphasis on technologies and gadgets.

There are many occasional science documentary programmes, such as the marathon two-hour programme *The Restless Earth* (1972). This was one of the first popularisations of the theory of "Continental Drift". Nearly three decades on, the BBC produced its biggest ever science/natural history series: *Walking with Dinosaurs.* This six-hour scientific spectacle, with full and realistic animation, was the television event of the year in 1999. Its estimated audience share was 52%, meaning that roughly 19 million viewers watched each programme. (The following April, *Walking with Dinosaurs* made a splash in the U.S., on the Discovery Channel.) *Walking with Dinosaurs* has been followed by *Walking with Beasts*, which looks at the creatures that followed after the extinction of the dinosaurs.

History is a popular television subject and archaeology, in particular, presents opportunities for a degree of science to be included. A recent BBC series, *The Vikings* (2001), made much use of new techniques to track the Y chromosome to find out what proportion of Britons could trace their ancestry back to the Scandinavian invaders of the tenth and eleventh centuries.

The BBC makes extensive use of other media to amplify its science and technology coverage. Historically, books have accompanied TV series, published to give viewers a chance to recap on what they have seen, or to anticipate what they can expect. Today, the BBC's website -

[202] The launch of the UK NHS introduced health care free at point of use for all citizens

http://www.bbc.co.uk/ - is full of material about all branches of science and technology, including links to news stories as well as dedicated pages for some of the bigger productions. And it is interactive. Once there, if you like, you can cast your vote as to what you think killed the dinosaurs!

### *Case study 2 - Science, advertising and the media*[203]

Advertising may be considered as a new realm of mass communication, representing a discursive activity present in all ways of life. It may easily be the mass media to which most of us are most exposed. Due to its obvious nature, simplicity, brevity and flashiness, advertising earns limited media analysis attention. However, advertising is not only a staple element for the consumption economy, it depicts ideologies and lifestyles. Advertising has multiple discursive forms: it describes products, provides features, performances and information. Advertising tells stories, reenacts situations, etc. Essentially it establishes a public dialogue including invitations, temptations, respectful or casual approaches, inquiries, riddles and challenges aimed at the addressee. Advertising specialists put their imagination to establishing an effective dialog between the entities, they aspire to engage and gain the audience's maximum collaboration, participation and, to connect with the audience. This dialogue encourages establishing a relationship between the communication characters involved, rhetorical procedures are highlighted, as this dialogue not only blends images and words, it appeals to the desires, beliefs and values of the audience.

As Sophie Moirand noted,[204] the science-society interaction is no longer triangular (scientific community/mediator/citizenry), it is progressively becoming an area where a variety of social agents merge, question the role each plays and present the need to redefine communication roles.

Manufacturers, leaders, citizens, scientists and journalists are striving to find their position in these new communication challenges. Firms, in this context, have started to treat the advertising sphere as a direct, intermediary-free media, in order to introduce the audience to research being conducted and to share their views on current controversial issues with a general audience.

The incorporation of technological and scientific references in advertising is an old strategy used to support arguments such as novelty, progress and trustworthiness. As early as 1870, when Evolutionism was the hot topic of the day, Spanish manufacturers of Anís del Mono (an anisette by the name of The Monkey) proposed including in their brand representation a simian whose face resembled that of Darwin, holding a scroll that read: «It is the best. Science said so, and I never lie».

A more recent phenomenon is the introduction of biological knowledge applications in the realm of manufactured products and the enactment of the goals they strive for in mass media

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[203] Contribution from Helena Calsamiglia, professor of Discourse Analysis (Pompeu Fabra University-Barcelona) An extended version of this text can be found in *Quark nº 12 Biotecnologia y sociedad* June-Sept 1998 Avalaible on line in http://www.imim.es/quark/num12/

[204] Moirand, Sophie: «Variations discursives dans deux situations de communication scientifique: astronomie vs vache folle, plantes transgéniques...», Communication presented in the workshop «Sciences et médias: transversalités linguistiques et discursives», Paris, November 1998.

advertising campaigns. To some extent, this is also science popularization (as information is being broadcast) on new techniques that have been developed as a result of scientific advances, while manufacturers popularise their usefulness and role in the near future (making people believe in the product).

These comments aim to encourage reflection on the role of advertising in relation to the promotion of PUS. Analysis of linguistic representation (the presence of a new nomenclatures rather than a substitution of traditional ones) and advertising discursive forms, propaganda and popularisation leads us to the fact that via mass communication media, certain values are being incorporated into citizen minds. The new combinations of participants aiming to defend diverse interests, all undoubtedly perfectly legitimate, are also transforming what was considered classical science popularisation into a «popularisation debate».

### *Case study 3 - Biotechnology and the media*

Pharmaceutical and biotechnology companies have in recent years enjoyed a rapid increase in media coverage, mainly in economy & financial specialised newspapers and the health sections of newspapers. Clive Cookson, science editor for the *Financial Times*, wrote of the:

> "sustained rise in the number of Financial Times stories and articles about biotechnology over the past decade, from just 124 in 1991 to 1,117 last year - almost a tenfold increase (Table 1). The number of articles in the FT about pharmaceuticals rose from 783 in 1991 to 3,092 in 2000 (Table 2). The New York Times, the leading national newspaper in the USA., has also expanded its coverage of biotechnology and pharmaceuticals. Its biotechnology coverage grew from 339 articles in 1991 to 637 in 2000, with a peak in the early 1990s (Table 1) This increase reflects the increased resources newspapers are having to put into covering the sector. At the beginning of the 1990s, the FT had only one specialist reporter covering the whole span of the chemical, pharmaceutical and biotechnology industries. Now there are half a dozen of us writing about pharmaceuticals and biotechnology. There is a similar pattern in the NYT's pharmaceuticals coverage (Table 2)." [205]

Table 1 *Articles about biotechnology in the Financial Times (FT) and New York Times (NYT)*

| ***Year*** | ***FT*** | ***NYT*** |
|---|---|---|
| 1991 | 124 | 339 |
| 1992 | 225 | 394 |
| 1993 | 248 | 350 |
| 1994 | 433 | 280 |
| 1995 | 512 | 266 |
| 1996 | 603 | 254 |
| 1997 | 668 | 260 |
| 1998 | 837 | 363 |
| 1999 | 902 | 409 |
| 2000 | 1117 | 637 |

Source Lexis-Nexis database

[205] "Pitching Pharma", in HMS Beagle-The BioMedNet Magazine, November 9, 2001. Mr Cookson's source was the Lexis Nexis database.
See: http://news.bmn.com/hmsbeagle/120/viewpts/pressbox?print=yes

Table 2*Articles about pharmaceuticals in the Financial Times (FT) and New York Times (NYT)*

| ***Year*** | ***FT*** | ***NYT*** |
|---|---|---|
| 1991 | 806 | 1217 |
| 1992 | 783 | 1188 |
| 1993 | 1692 | 1360 |
| 1994 | 1896 | 1165 |
| 1995 | 2231 | 1146 |
| 1996 | 2037 | 1222 |
| 1997 | 2122 | 1202 |
| 1998 | 2537 | 1442 |
| 1999 | 2543 | 1553 |
| 2000 | 3092 | 1824 |

Source Lexis-Nexis database

Another interesting study on biotechnology and the media is Eurobarometer 52.1 "The Europeans and biotechnology" (March 2000). This offers interesting information about European citizens' attitudes in relationship with the media:

*"I would take time to read articles or watch television programmes on the advantages and disadvantages of the advances in biotechnology"* - 72% of those interviewed say that they "mostly agree" with this proposal, compared to 19% who "mostly disagree" and only 9% who "do not know". People are most likely to agree with this in Denmark and Sweden (83% each), France (82%) and Luxembourg (80%), whilst they are most likely to disagree in Spain (27%), Portugal (26%), Belgium (24%) and Greece (23%).

73% of men compared with 70% of women "mostly agree" in this instance, a response that is once again most common among those aged between 25 and 39 (76%).

*"I feel that I am adequately informed on biotechnology"* - the reverse is true for this statement: only 11% say that they "mostly agree" whilst 81% are likely to disagree, with 9% unsure either way. Nonetheless, the response "mostly agree" is chosen by 20% in the Netherlands, 19% in Austria, 15% in Denmark and 14% in Luxembourg. However, the response "mostly disagree" records peak scores in Sweden (96%), France and Finland (88% each), and Greece (87%).

13% of men compared with only 9% of women agree with this statement while those most likely to agree with it are in the intermediate age categories: 12% for people between the ages of 25 and 54. Apart from this, the generic pattern applies in relation to the other sociodemographic variables.

*The newspapers and magazines which report on biotechnology* - do good work for society according to 59% of Europeans, while 18% of them think the opposite and 23% are unsure. In four countries, more than three-quarters of those interviewed feel that “they do good work for society”: the Netherlands (92%), Finland (86%), Greece (80%) and Austria (75%). Those most likely to answer “they do not do good work for society” are the United Kingdom (30%), Sweden (27%), France (25%) and Ireland (22%).

60% of men and 57% of women believe that newspapers and magazines which report on biotechnology “do good work for society”. Support decreases as the age of those interviewed increases.

*Which source(s) of information do Europeans trust?* Of all the sources of information suggested, consumer organisations record the best result (26%), just ahead of the medical profession (24%) and environmental protection organisations (14%). These three sources of information were a great deal more popular than universities (7%), the responses “none of the sources suggested” or “do not know” (6% each), television and newspapers (4%), international institutions (also 4%), animal protection organisations (4% once again), farmers’ associations (3%), national public authorities (also 3%) or religious organisations (2%).

27% of men and 24% of women choose consumer organisations, 22% of men and 25% of women opt for the medical profession, while 13% of men and 15% of women trust environmental protection organisations most.

As far as the age variables are concerned, those aged between 25 and 39 years are the most likely to trust “consumer organisations” (28%) and “environmental protection organisations” (15%), but they are least likely to trust “the medical profession” (22%).

*Other trusted sources:* Here, “environmental protection organisations” record the highest results (31%), followed closely by the two most popular sources of information from the first section, which have equal rating in this case: consumer organisations (29%) and the medical profession (also 29%). “Animal protection organisations” (21%) are the fourth most popular source of information, followed by universities (19%), television and newspapers (16%), international institutions (13%), and then three other responses which each record 12%: farmers’ associations, national public authorities and “do not know”. All of the other suggestions record less than 8%.

The overall classification of the sources of information on biotechnology trusted by Europeans

| | 1st | Others | Total | Classification |
|---|---|---|---|---|
| Consumer organisations | 26 | 29 | 55 | **1** |
| Environmental organisations | 14 | 31 | 45 | **3** |
| Animal protection organisations | 4 | 21 | 25 | **5** |
| The medical profession | 24 | 29 | 53 | **2** |
| Farmers' associations | 3 | 12 | 15 | **9** |
| Religious organisations | 2 | 7 | 9 | **11** |
| National public authorities | 3 | 12 | 15 | **9** |
| International institutions | 4 | 13 | 17 | **8** |
| A specific industry | 0 | 3 | 3 | **12** |
| Universities | 7 | 19 | 26 | **4** |
| Political parties | 0 | 3 | 3 | **12** |
| ***Television and newspapers*** | 4 | 16 | 20 | **6** |
| None of these (SPONTANEOUS) | 6 | 5 | 11 | **10** |
| Do not know | 6 | 12 | 18 | **7** |

## 6.7 Training in Scientific Communication and Journalism

If there is one issue on which all, or nearly all, commentators agree with, it is the importance of improving training in scientific communication for both scientists and media practitioners.

The 1999 Labasse Report prepared for the European Commission[206] argues:

> "In the case of the press, for example, it is quite obvious that the few training courses specialised science journalists do not solve the overall problem of the treatment of subjects with a scientific content, which might be covered by political correspondents (technological risks) or economic correspondents (high-tech enterprises), legal correspondents (genetic testing, doping, etc.) or journalists writing specifically for women (diets, astrology...), etc. Now scientific issues usually have only a very small place - if they have one at all - in general journalism courses. Trying to promote a "science quota" in these courses, assuming we ever get that far, would be nothing more than an artificial and symbolic imposition. The issues that we have mentioned - genetic engineering, technological risks, diet, etc. - are not only scientific: they are also political, economic, legal, etc. We have to think in a much broader way if we are to meet one of the real challenges in this field: the journalistic coverage of complexity."

The relative novelty of scientific communication training within the spectrum of journalism education and its practical non-existence in the scientific world are highly significant facts. The first evidence we have of this is the seemingly scarce presence of scientific journalists in newsrooms. Some data are presented in a 1997 study[207] that states that of 30,000 French journalists, it is estimated that only 300 could be labelled as science specialists or, in other words, one per cent of the total number of journalists. This also means that there are ten-fold more professionals devoted to sport news than to science. The study also reveals that these journalists hold no leading positions in their newsrooms, and are granted particularly unstable jobs, given that practically a fourth of the male journalists (23%) and almost half of the females (46%) were "pigistes", a French term applied to journalists who are paid per published news item. For comparison purposes, when taking the profession a whole, only 17 per cent of the French journalists are paid per published item. Unfortunately, no EU-wide analyses or indicators are available establishing the presence of specialist science journalists in newsrooms.

Another contribution of the 1993 Fayard study is that only large European daily newspapers can offer positions for science journalists and the number of positions per daily never exceeds 4 or 5. Compared to other sections, political, sports or finance sections are staffed with no less than 15 journalists (please bear in mind these are general data and can vary significantly). Today, when almost ten years have elapsed since this study, the situation does not seem to have improved. *La Vanguardia* is Barcelona's main daily and one of Spain's principal newspapers. Currently three journalists covering science, environment, medicine & health staff its science section. The situation seems even more precarious in the audiovisual media, with the exception of documentaries.

University courses providing specific training on science communication, in journalism or science departments are for the most part new, as are most Masters degree programs offered in Europe (more data is available in the publications of the EU ENSCOT[208] network). If we take Spain as an example, only two universities provide some optional credits on Scientific

[206] Labasse, Bertrand (June 1999) *The communication of scientific and technical knowledge* (Report to Directorate-General XII of the European Commission)
[207] Tristani-Potteaux, Françoise (1997) *Les journalistes scientifiques* Paris: E. Economica
[208] European Network of Science Communication Teachers http://www.ucl.ac.uk/sts/enscot/

Journalism in their curricula and there are only two Masters degree programs in "Scientific Communication" or "Science & Society" (Salamanca and Barcelona). On the other hand, not one of the many Science faculties in the various universities offers courses in Scientific Communication addressed to future scientists (the Universidad Pompeu Fabra, in Barcelona does plan to include such a course in its Biology curricula for the 2002-2003 academic year). In France, three universities –Paris VII, École Supérieure de Journalisme de Lille and Louis Pasteur in Strasbourg- offer training in scientific journalism or communication. In Italy, the University of Trieste offers a Masters Degree in Science Communication and so do the Universities of Belfast, Imperial College, UCL and Open University in the UK. In Germany the Free University of Berlin also offers such a Masters. In the autumn of 2001, the University of Oulu in Finland launched an education programme intended for students with basic education in natural science who aim to become scientific journalists.

## 6.8 INTERNET, THE INTERMEDIATION BOOSTER

Communications in the developed world experienced a revolution when use of the Internet and the World Wide Web became widespread in the 1980s and 1990s. Communication methods explaining the scientific method as the way to reach a scientific thesis or discovery from preexisting knowledge- have undergone radical changes.[209] The result has been easier access to the work and results of the scientific community, given that new technological tools have also contributed to greater recognition of what is done in the most "modest" countries on research and development. It has, in this way, fostered the visibility of scientific activity among the general public. We therefore have to take into account that apart from the "traditional" mass media sources there exist unexpected possibilities for direct communication and interaction between the scientific community and the public, that will undoubtedly modify consolidated habits concerning the way people are informed of and learn about scientific and technological developments.

Internet is a qualitative jump with respect to audiovisual media as it provides a combination of text and audiovisual material, and allows users to download information and use it at their convenience. Add to this the fact Internet represents the possibility of recapturing a younger population, which, according to the Eurobarometer has lost interest in science popularisation. Taking into account concerns regarding "cyberbole", the Internet should become an essential vehicle for any alternative plan to place science closer to society.

Data published in 2002 concurs that although TV is the leading source of <u>general</u> information on science and technology for Americans (as for Europeans), when Americans seek information on a <u>specific</u> scientific issue, they are most likely to turn to the Internet.[210] So, it's clear that the Internet will have a relevant place in our future lives as <u>a tool to obtain information and to learn more about science</u>.

Recent data show the following figures for the internet use in European Union Member States:[211]

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[209] Jane M Russell, "Scientific communication at dawn of the XXI Century" *InternationalJournal of Social Sciences nº 168 Science and his culture* June 2001

[210] Science & Engineering Indicators – 2002, from National Science Foundation in USA. www.nsf.gov/sbe/srs/seind02/start.html

[211] Source : Estudio General de Medios, EGM.

| **Country** | **%** |
|---|---|
| The Netherlands | 63.8 |
| Sweden | 60.7 |
| Denmark | 58.6 |
| Finland | 50.2 |
| United Kingdom | 49.3 |
| Ireland | 47.6 |
| Austria | 47.2 |
| Luxembourg | 43 |
| Germany | 38.4 |
| Belgium | 36.4 |
| Italy | 33.5 |
| France | 30.1 |
| Portugal | 26.1 |
| Spain | 24.7 |
| Greece | 9.9 |
| **EUROPE** | **37.7 %** |

In the last two years the number of new users of the Internet has grown significantly, but there are still countries with low penetration rates such as Greece, Spain and Portugal. This may be due to the current hardware and software of individual users. Not all users have appropriate equipment to access the Internet. We should not forget that a number of people access the Internet from their place of work.

A recent study[212] reveals the difficulties prospective readers have to access European research data and information that has not been published in the English language reference journals currently dominating the scientific communication market and addressed to experts (*Nature*, *Science*, *The Lancet*). *Alphagalileo* is the only exception. Access to universities' and research centre's information is difficult for citizens, a communications gap that needs to be dalt with in the near future. Internet is the way!

### 6.9 European Initiatives

***CERN***[213]

CERN (the European Centre for Nuclear Research) is financed by many European and non-European countries and institutions. The laboratory was founded in 1954 and has an office responsible for links with the media, among other functions. The main tasks carried out in this office are writing articles about any current interesting experiment or event for any internal publication; preparing press releases and press conferences; providing information about the organisation to anyone that contact the press office; showing CERN facilities to the media, particularly to TV channels that want to broadcast a programme on physics research or any related issue; providing documentation, slides or other requested material to journalists, school or university teachers etc…

[212] Lecoq, Eveline (2001) *European Science at the Web* London: Imperial College of Science, Technology and Medicine

[213] European Organization for Nuclear Research http://www.cern.ch

The team of this office is mainly made up of journalists and some writers with a scientific background who usually write articles for more specialised publications within the organisation, and do not undertake other tasks in the press office. There is always a student journalist from a CERN member state. The student usually spends four months working in the organisation and for that period she/he writes articles for the internal publication, gives information to journalists or other people interested in the activity of the organisation, prepares press releases, reads newspapers to detect news about the organisation etc.

From this point of view, CERN offers useful work experience for future scientific journalists and becomes a second "practical" school for them. The internship for students journalists is paid, which indicates that the organisation understands and supports the idea of educating a scientific journalist.

***EICOS (Germany)***

EICOS (The European Initiative for Communicators of Science)[214] is a programme that aims to improve communication between journalists and scientists. During an eight day hands-on laboratory experience they work side by side at the cutting edge of scientific research. The course generally takes place in early spring. Professional journalists from any European country and any media with at least two years experience can apply. A scientific background is not necessary, but reasonable competence in English is mandatory.

EICOS receives its primary funding from the "Stifterverband für die Deutsche Wissenshaft" and, since its foundation from the "Gottlieb Daimler und Karl Benz Stiftung". The Max Planck Institute for Biophysical Chemistry offers the infrastructure and the manpower necessary to guarantee a successful hands-on laboratory, and the host institute covers their expenses during the extended laboratory assignments.

***Initiative from the Council of Europe***

On 18th December 2001, the Culture, Science and Education committee of the Parliamentary Assembly of the Council of Europe adopted a resolution about scientific communication. [215]

The report focuses on the role played by scientists and science journalists in passing on scientific information to the general public at a time when science is advancing extremely rapidly. For the general public to develop informed opinions on scientific subjects and exercise influence from a position of knowledge over the policy-making process, scientific communication must be improved. Practical measures could be taken by political decision-makers to enable scientists and science journalists to fulfill better their role of accurately conveying scientific information.

The report considers that scientific communication must be improved for the general public to develop informed opinions on scientific subjects, including on bioethics and new information technologies and exercise influence from a position of knowledge over the policy-making process. In its resolution, the Assembly advocates concrete measures to enable scientists and

[214] http://www.eicos.mpg.de/
[215] This document is available at http://assembly.coe.int/doc/doc01/EDOC9300.htm

science journalists to fulfill better their role of accurately conveying scientific information. Among the priorities are the training of scientists in communication and journalists in science, the institutionalisation of regular contacts between the two groups and the setting up of a technical platform on the Internet to host scientific archives and exchange fora.

### 6.10 Summary of findings

Public TV - As Eurobarometer 55.2 “Europeans, science and technology” and other surveys have shown, the general public is principally informed by television. This explains why it is appropriate to promote scientific culture and in the schedules of Member States public service TV channels. It is imperative that the public feel scientific developments as something local/ close and not as something extraordinary and distant, with little relevance to their daily lives.

News agencies – These national information/news agencies are key transmission sources for all types of news items, including science. Their role in the dissemination of information which can contribute to the promotion of RTD culture should, therefore not be neglected.

Media Studies - Few studies undertaken in the Member States have analysed how the media disseminate scientific knowledge among the population, and there is no European wide analysis, despite the fact that mass media is the main medium for transmission of scientific information to citizens.

Training for journalists and scientific popularizers - If scientists’ communication skills are not improved, increasing society’s capacity for scientific communication and discussion is going to be an impossible goal. If more and better informed scientific journalists are not available, it will be difficult to balance representation of this field in the mass media.

Promote the Internet as a communication medium – the Internet’s position as an efficient form of communication/ media is consolidating, proving that it is capable of attracting the youngest age groups for example. It is therefore necessary to encourage institutions which produce scientific information to use the potential this new media offers, improving their communication with citizens.

### 6.11 Recommendations

The recommendations that follow consist of actions to be taken in order to improve public perception/awareness of science, a process in which the media play a pivotal role. These suggestions should in no way interfere with the free and democratic action of mass media, may these be public or private. They should, however, be considered – particularly by the public media – whenever decisions are to be taken, especially when dealing with issues of information management and when making things easier for journalists in their daily work. Freedom of expression is unquestionable, but we argue that citizens also have the right to receive such information as enables them to be active and critical participants in the “knowledge society”.

1. Promote the presence of science issues and scientists in public television through specific science programs and debates, where possible, with *special emphasis on local scientists and local TV networks* this will show the public that science, like politics or other issues, is something close to their daily lives.

Reasoning**:** According to various surveys, including the Eurobarometer 55.2, television is the main source of science information for the lay public. Individuals tend to perceive scientific developments as having little to do with their everyday life, and so, do not feel involved. Increasing the presence and visibility of local scientists on public television, particularly in local networks, could help overcome this (e.g. as with the experience of Barcelona public TV). Science is fairly well represented in most television channels, but pressure on schedule space and time leads to information simplification and the transformation of news pieces into a sort of showbiz. A rebalancing of scientific information and its showbiz like treatment is needed.
Action**:** Governments (national, regional and local), national TV councils, media schedulers.

2. Increase the number of science journalists working in public news agencies and information services, and thereby *increase the number of news items on science developments* and news released by those agencies.
Reasoning**:** National information agencies act as a reference for all types of news items and exert a great influence on the media agendas. There is a need for more specialised science journalists in these agencies.
Action**:** National public news agencies

3. *Promote awareness of the value of the Alphagalileo news service* amongst science journalists and information officers of research services, universities and other scientific institutions. This agency should be extended to other Member States and Candidate Countries.
Reasoning**:** Alphagalileo is an up-and-running service that is successfully diffusing scientific knowledge between European researchers and specialised journalists. But its representation is currently limited to 6 Member States: Finland, Germany, France, Greece, Portugal and the UK.
Action**:** Appropriate ministries; European Commission; Alphagalileo.

4. Increase the number of science communication training courses for professional media communicators.
Reasoning**:** In general terms, the Labasse report[216] showed that university journalism degrees lack science communication courses. Additionally, science degrees pay little or no attention to the acquisition of (popular science) communication skills[217]. To increase the amount and quality of science items in the media seems an impossible goal unless journalists' and scientists' interest and skills in science popularization do not improve.
Action **:** Education ministries, Universities, Research Centres.

***Further research***

It is necessary to establish national and EU-wide[218] studies on how the media disseminate scientific knowledge, and make those studies possible through the setting up of networks of university research groups. These studies may include science popularization books, a form of science dissemination not contemplated in Eurobarometer 55.2 but which has relevant impact in the formation of European scientific culture.

[216] B. Labasse, *The communication of scientific and technical knowledge*. (European Commission DG XII, Brussels. 1999.)
[217] On this point, please see the recommendations of Chapter 3 on the Scientific Community.
[218] Framework 6 clearly has an important role to play here.

### *Future indicators*

There are few indicators relating citizen's *expressions* of interest in scientific culture to their actual *consumption* of scientific culture. In future, indicators that appear in media studies - readerships of popular science magazines and books, hours of science broadcast on television and radio, for example - could be cross-correlated with the data of Eurobarometer surveys to offer a more exact picture of the various public attitudes in the different Member States.

# CHAPTER 7: INDUSTRY AND THE PRIVATE SECTOR

## 7.1 INTRODUCTION

Industry is a key actor in the diffusion of technologies. It transforms knowledge into objects, products and processes whose use deeply change culture. For economic reasons, in a media dominated society, industry cares about the way its productions are received, seen and enjoyed. It is increasingly concerned about its potential responsibility towards the good health of citizens and the environment. As a consequence industry tries to explain what it is doing, for what purpose, with what intent and what are the benefits to be expected for the public from using its productions. Most of the promotion is done through advertisement, but information is also offered on the cultural scene using channels such as Museums and the Internet or by suggesting educational material for schools. Industry museums are well established in Europe and were set up very early (in the 19th century) as show cases for technology and products. The co-operation of industry with museums in Europe is still very much alive today.

This chapter presents an inventory of the strategies used by industry to promote PUS in their own interest. Industry is diverse and wide ranging, so we thought it would be useful to concentrate on the sectors most likely to be involved in some sort of PUS activities, namely those which are having some difficulties with public opinion, such as the energy sector, the chemical industry, the new area of biotechnology or those which are closely associated to new technologies such as computers and communication companies.

The title of the chapter is enlarged by the words “private sector”. Those were deemed necessary when it appeared that some large Foundations, linked to industry historically or currently, are active partners in PUS activites. One important “private” sector/ sphere is, unfortunately, not covered by this report because of a lack of time and of the great dispersion of actors. This concerns the actions of Associations and non-govermental organisations (NGOs). Some of these are very active on scientific and technological topics, they range from consumers’ associations to almost political NGOs with a myriad of educational associations caring for scientific leisure of young people and local groups promoting environmental issues or heritage interests in between. It seems that citizens’ associations are increasingly voicing their opinion on the world scene, about economical and environmental topics, to the large public and private organisations which dominate the market economy. A similar trend may be in the making in PUS. For example, more than 20 NGOs and associations working in the field of science popularisation or popular education, including those which organise “Expo-sciences” in co-operation with the education system (see below), held a three day meeting in Paris in January 2002. This event was organised with the support of local elected bodies in the Paris area and without too much participation of ministeries, research organisations or museums. It asked for more support and affirmative action in favour of the diffusion of scientific culture in France[219]. The work of these actors in the promotion of RTD culture and PUS merits further consideration – it is certainly something to watch in the future.

## 7.2 METHODOLOGY

[219] « Assises Nationales de la Culture Scientifique et Technique », Unesco, Paris, 11-13 January 2002

The benchmarking exercise did not involve any national contact points besides the authors and some colleagues representing the HLG[220]. This hindered the collection of information on the situation in some countries. It is clear that when a direct testimony could be obtained, the results were far more complete (for Austria for example[221]). In the short time available Internet was the fastest way to gain an overview of what prominent companies were doing for PUS in each Member State. Indeed a wealth of information was collected and significant national differences emerged. Some big pieces of information may be missing, however, either because they were not found on the net or because they are not displayed there at all. This limitation of our work should be kept in mind.

Internet searches were limited to four areas: the sites of industrial museums, energy producers, chemical enterprises and biotechnology companies. The relationship of communication and computer companies with schools to promote the information society was added since useful data were available through an Eurydice report. Additional information on other industrial partners such as automobile companies or banks was added when found.

### 7.3 Principles of the country by country review

This review was also established through Internet consultations[222]. Most companies have web sites on which they provide all sorts of information and try to build an image of themselves on the Net. Those sites are more easily available than company reports or other printed literature, not only for the authors of this report but for all citizens. The data on these sites are in the public sphere for everybody to consult. Links to web addresses are provided on advertisements and correspondence materials, which make the information easy to collect.

The contribution of industries and the private sector to the establishment or sponsoring of science centres and museums was examined. It should be noted that "natural history" museums were not taken into account in this section[223].

For the PUS policy of industries the search was limited to large companies in those industrial sectors which have image problems or which are involved in controversies. The sectors investigated were:

- Energy, utilities, and nuclear energy
- Chemical Industry
- Biotechnology

These correspond to elements of knowledge belonging to the basic academic disciplinary fields: physics, chemistry and biology.

Biotechnology is a topic dealt with in some detail in "Educating the European Public for Biotechnology"[224], a project supported under the "Raising Public Awareness of Science and Technology programme" of the European Commission. They "explore, survey and evaluate educational measures aimed at the general public in the area of biotechnology". The final

[220] High Level Group on Benchmarking, Mapping of Excellence and Networking of National Programmes.
[221] We thank Reinhard Schurawitski for his help in this regard.
[222] Some URL are given. Connections can be easily obtained from the names cited with the help of any search engine, for example www.google.com
[223] For more details please see Chapter 5 « Science Centres and Museums ».
[224] http://www.boku.ac.at/iam/ebe/

meeting of this project was held in Vienna on April 25th 2002 and the final report is now available on the web site cited above. For the handling of biotechnology by the media please see the Case Study in chapter 6 of this report.

To a lesser extent the telecommunication sector was also reviewed especially in connection with data in the "ICT@Europe.edu"[225] report, "Information and Communication Technology in European Education Systems". This report, produced by DG Education and Culture at the European Commission, contains a section on Public/ Private partnerships.

In the annexes to the present report, country profiles are accordingly divided into five sections: industry related museums; energy and utilities; chemistry; biotechnology; and ICT equipment for schools. Case Studies have been added to some country reports where appropriate.

## 7.4 Issues and Activities

### *Public Trust in Industry*

The Eurobarometer 52.1, from March 15 2000, dealing with biotechnology, contains data n public confidence in various people and organisations connected to biotechnology. The degree of confidence in industrial sources (and political parties!) is very low and the media, although they score higher, do not reach the levels of trust recorded for consumer organisations and the medical professions. The negative reputation of the industry as a communicator on potentially controversial scientific topics should be disturbing for European Union authorities since a declining interest and support from the public at large for industrial operations in Europe may lead to serious economic troubles and a decline in competitivity. Indeed, developing the EU as the most competitive knowledge based economy in the world is one of the origins of the present benchmarking exercise.

The notion of risk is central to the debates on new technologies or the effects of industrial operations on people and the environment. Many academic studies[226] have been undertaken on the variety of problems, technical as well as human, associated with risk analysis and prevention in our society especially the balance risk-benefits on issues related to health, safety, and the environment. Risk assessment is a multidisciplinary endeavour which demands the cooperation of several disciplinary fields. Besides technological advances create constantly new conditions. The popularisation of those studies is limited and an effort should be made to diffuse them to the public as well as to policy makers.

This concern is shared by academic bodies with close links to the industry such as Euro-CASE (European Council of Applied Sciences and Engineering) which brings together the Academies of Engineering of Europe. They develop an action through meetings, colloquia, reports and joint academic-industry initiatives to develop an awareness of the problems connected with risk assessment and risk perception, safety, the economy and employment, among politicians, educators, the media, and the public at large. The aim is to reduce the perceived gap between the scientific and technical community and society. In schools they try

[225] http://www.eurydice.org/Documents/Survey4/en/ICTcover1.pdf
[226] See for instance http://www.emre.umd.edu/ctrs/

to promote "a greater awareness of the importance in everyday life of a general knowledge of scientific and engineering principles." [227]

Other European scale industrial "lobbies" with facilities in Brussels also develop a policy of public understanding of science on the national as well as on the European level with the objective to build a good image of their particular area of interest. Examples of active "lobbies" are CEFIC (European Chemical Industry Council), EuropaBio (biotechnology), FORATOM (nuclear energy producers) … Other "lobbies" may occasionally have a PUS action such as scientists' lobbies (the Eurosciences group) or "women in science" lobbies. Large industrial companies originating from Europe have a world wide field of action. To enhance their image and as marks of goodwill towards society interests many of them have developed a "citizen approach" and have programmes for sponsoring the Arts, helping education and supporting initiatives to build a better environment. This trend seems to come from business practices in North America, but significant efforts in Europe on that model can be seen at least in some countries.

***Industry involvement in Science and Technology Museums***

The idea of collecting objects connected to the arts, crafts and industry emerged at the end of the 18$^{th}$ century (creation in 1794 of the "Conservatoire des Arts et Métiers" in Paris) following the publication of the Great Encyclopedia. But it is with the Industrial Revolution that Museums and displays became part of a political and industrial strategy in Europe. The new power and wealth associated with the manufacture and selling of all sort of goods was illustrated by the universal exhibitions starting with the Crystal Palace event in London in 1851 and regularly organised in different cities in Europe until the end of the century. They were symbols of progress in action, they were creating faith in science as a promise of a better life [228]. Industrial Museums, although some were started earlier, were the by-products of those exhibitions notably the Science Museum in South Kensington (1853) and the Deutsches Museum in Münich (1903). Their existence is due to a combination of the will to expose the general public to the powerful machinery and cleverness associated with industrial processes and products; the desire to provide material to reinforce popular education, and the ambition to create urban landmarks in the form of large and impressive Museums [229]. Companies were involved in the creation of these first industrial Museums. Some of them were conceived as show cases for the manufactured products. The philosophical (and somewhat nationalistic) idea was to build permanent monuments to the glory of Progress, which contributes to the strength of Nations. To exist these Museums, large or small, depend on the combination of political will (sometimes local), with an academic capacity to handle collections and/or education, and financial resources, public or private.

The missions of industrial type museums were at first essentially collector's ones, sometimes associated with glimpses on the social history associated to the machinery presented. There are thousands of them in Europe, including open air Museums initiated in Scandinavia at the end of the 19$^{th}$ century and mostly dealing with agricultural techniques and way of life. Many

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[227] « Linking Knowledge and Society : a Euro-CASE Contribution » Proceedings of the Conference at Royal Academy Palace Brussels, October 16 2001, 80pp. Euro-CASE Paris, 2002

[228] « La Belle Epoque » Le temps des expositions universelles 1851-1913, Musées Royaux d'Art et d'Histoire Bruxelles, Catalogue de l'exposition 26 octobre 2001- 17 mars 2002, 226pp.

[229] A complete description of the origin of industrial Museums can be obtained, especially for Germany, the UK France and Sweden from the book by Brigitte Schroeder-Gudehus « La Société industrielle et ses musées » demande sociale et choix politiques 1890-1990. Editions des archives contemporaines, Paris, 1992

European industries have or support Museums. Generally they focus on a particular industrial theme associated with local interests and very often in an historical context which may be a nostalgic one. They are set in the framework of an industrial heritage concept. The fields concerned cover the main area of the industrial revolution: railways, ships, aeroplanes, cars, mining operations … and also practices in agriculture, clothing or home industries. With their traditional displays, they were not very influenced by the "hands-on" drive, which has influenced many other science Museums since the 1970s.

Temporary exhibitions are very often held in Museums. Many of those exhibitions are sponsored by industry and sometimes entirely produced by an industrial staff. One 2000 example is the exhibition on "hair" sponsored by "L'Oréal" which is a mixture of some scientific (biological) information on hair with games (see how your face is changed with a wig!) and recommendations for the use of adequate products. This exhibition is now touring European Museums (at Den Haag in early 2002). It met with success because it deals with an important part of the body, a known subject of interest. Besides it does not involve any controversial aspect. Another example, a display whose contents were entirely set up by industry, is the "Michelin" exhibition on tyres first presented at la Cité in Paris in 1999. In that case the intention was to convince visitors of the high technology used by the company and especially its concern for safety. Exhibitions are part of the communication strategy of enterprises. Enterprises have significant expertise to share and some groups are important actors in the promotion of RTD culture as it is in their interest to show how advanced their technology is (the automobile industry is a good example). Museums all over Europe enjoy a large number of visitors per year, they offer an attractive visibility, well echoed by the media, and consequently they may be important partners for the Industry which uses them to sponsor cultural events or directly as places to exhibit intents or products. In recent years the attention given to financial problems and return on investment, the introduction of assessment indexes (such as the number of visitors or audience evaluation), has introduced some strain in the managing of museums, especially facilities with high operating costs which depend on public money. They need now to hunt for external resources and the collaboration with sponsors in the industry is becoming an absolute necessity [230]. Recently some prominent science museums or science centres have taken over a new task, which is explaining the relationship between science, industry and the Citizen. They are becoming active in the public sphere as places where democratic debates can be held on hot issues and information can be collected by people concerned[231].

Although many local industrial Museums are small places, they provide a very efficient way to achieve greater public understanding of science. This because they focus on a single scientific background to a practical, industrial outcome which more easily captures the attention of visitors than the variety of the numerous displays in large science Museums. Three examples can be cited in this regard: a museum in Regnéville (Manche, France) is set close to huge old furnaces which produce lime. It explains the inbound maritime commerce with specific type of vessels between the local port and Wales (to provide the coal for the furnaces) and the outbound export of lime to nearby Brittany, a region which has no limestone. In the process the visitor learns, not only about local economic history, but also about the chemistry associated with the decomposition of calcium carbonate … Another old metallurgical site (les Forges de Buffon near Montbard in Burgundy) provides a complete explanation of the way in which iron is extracted from ore. The reconstructed / renovated mill

[230] « Industrial Museums in the New Millenium » by Neil Cossons (Chairman English Heritage), available on the Web

[231] More information on these new activities can be found in Chapter 5 on Science Centres and Museums.

village at New Lanark in the UK explains water power and weaving techniques and is a major tourist attraction developed with European Union structural funds.[232] There are many other examples in Europe. Their existence depends on the combination of the enthusiasm of local amateurs or Learned Societies, regional authorities who want to attract visitors, especially in tourist area, or to preserve a valuable heritage from the past (with the help of the State then and/or European sources), and sometimes the direct support of a concerned industry.

Many of the European industrial Museums have web sites, they have then a better chance to be included in international or national web databases, but some are not. For example the two French Museums mentioned above, although they can be discovered in local (or even national) tourist guides and pamphlets, are not recorded in the database of the French Ministry of Culture.

***Industry involvement in science and technology education***

The concern of Industry with education is an old one. Many companies developed early their own schools to train their future personnel (for instance the automobile industry). Today the lack of qualified people together with the alarming trend observed in the taste for scientific and technical careers among youngsters [233] induces companies to propose attractive schemes. One of them is the setting-up of competitions with prizes among classes or individuals on topics with scientific or industrial interest or connected with the good will concerns of the companies (e.g. action on environmental problems). The results are well advertised. For instance the competition for the CEFIC Award [234] given each year to a secondary school class for a collective project with a scientific flavour is organised on a national basis (including candidate countries and Norway). Selected national projects are submitted to an international Jury in Brussels. This event is in fact an example of the new educational trend for science education through specific projects. This pedagogical approach to science and technology was proposed in 1996 by the US National Academy of Sciences ("inquiry-based teaching and learning") [235] as a response to the growing disinterest of the young for the contents of academic scientific curricula. It has now been accepted in the States but it implies a profound change in the way teachers handle their tasks. Similar, but much less ambitious approaches, have met with resistance from teachers' unions in European countries (namely in France), but one European country (Portugal) supports it officially on a large scale and it seems that the northern European countries have been using this pedagogical approach since sometime now. Some of the European industrial contests for young people are targetted at girls in particular (see Case Study 4). Project oriented education is also supported by Expo-sciences. These are "science fairs" of Canadian inspiration and are organised in co-operation with school authorities at national, European and international levels by several popular education associations. One of them MILSET [236] is in charge of the European and international events. Displays of the results obtained in numerous science–oriented projects done by classes or individuals are presented to the public by the children themselves. Projects are chosen by children and teachers, and in many cases, they will deal with topics reported by the media, from dinosaurs to cloning. Projects need centres of resources to collect the information. Such resources are Museums, libraries, the Internet, visits to industry and interviews with qualified

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[232] http://www.newlanark.org/

[233] Please also see the report benchmarking human resources.

[234] http://www.cefic.be/activities/science-edu/award/award.htm

[235] Inquiry and the National Education Standards A Guide to Teaching and Learning, National Academic Press, Washington D.C. 2000, 202 pages

[236] MILSET Mouvement International pour le Loisir Scientifique et Technique

people. They provide a good opportunity to organise children-industry meetings through visits. CEFIC has provided a guidebook for school visits to factories, which can be downloaded from its web site.

A second way for Industry to help schools is the donation of equipment. The favoured item is computers and in some countries there has been a very significant contribution of the industry to government plans to provide schools with access to multimedia and help children train on on modern machines. This is detailed where appropriate in the country by country profiles in annexe to this report. The possibility of distance education and e-learning has also induced industrials to provide on their web sites content of educational value especially, but not only, in their field of interest. One observes that some industrial sites present attractive topics, unrelated to their activity, whose contents can be part of normal teaching or are likely to be chosen as projects or which are quite often highlighted in the media for children. An example is a complete folder on "Antarctica" on the site of a multinational utility[237]. Search engines can then bring interested children to the site. The idea is that the Web is a powerful teaching tool, which can bring information where it is needed. Also the habit of manipulate data on the web may be part of the necessary skills of future workers, in order to work or to be educated.

### *Industry and the scientific information of the general public*

Museums and education actions can be considered as part of a long term effort to create a friendly image of the industry. But to communicate to the general public the Industry must talk to the media. All of the big companies have press offices, they organise tours for journalists, they print brochures and leaflets, annual reports. Some have monthly or yearly journals, which report on technical issues and may be distributed for free.

Industry web sites carry all sorts of practical and commercial information, but also science popularisation pages, which are mostly intended for schools. In the case of hot topics, special folders can hold arguments, demonstrations, data, and also links to other sites. That makes those sites a working tool and point of reference for debates in the public sphere. TV, or radio, programmes can also be sponsored but mostly in specialised broadcasts (economically oriented for instance). There is in Europe a wide audience technical press, which publishes many reports on industrial results. They cover mechanics, electronics, computers or general subjects [238]. Industry produces a large number of documentaries, some for internal uses, but others are available from mediatheques, cine-clubs or data banks, they may be presented in festivals (there is a large number of science and technology film festivals, usually organised in medium-sized cities). Visits are also organised for the general public by appointment (for instance in the summer months for tourists). Industries have a range of efficient ways to make themselves known and to present their point of view, it is the primary purpose of advertisements of course[239]. Some of the adverts or information provided on labels can be said to contribute to the scientific culture of the public (for instance the composition of food, or of bottled water or the "E-numbers" representing artificial colouring and other ingredients) as

[237] http://www.vivendienvironnement.com

[238] The example of a genereralist industry magazine can be « L'Usine Nouvelle » in France, a visit to any newspapers stand will convince the reader that monthly technical magasines are indeed very numerous. Unfortunately we have not collected data on their circulation. There is also another category of « technical magasines » with a fair content of science and technology, those dealing with health and medicine.

[239] More details on the role of advertising can be found in the case study on advertising in Chapter 5 « Science and the Media ».

they are often checked by the consumers. People on a diet are often highly informed about the basic chemistry of food : sugar, fats and protein …

An industry like chemistry has a world-wide programme to take into account its social responsibility. Called “Responsible Care” it is implemented by the International Council of Chemical Associations (ICCA). It is “the platform through which the ICCA encourages the world’s chemical manufacturers to embrace the environmental principles of sustainable development.”[240] It has of course to be transposed into company-specific action programmes. Among those there are education-industry partnerships, the promotion of public awareness, appropriate emergency response or communication and in general measures to improve health, safety and environment (HSE). The industry is now convinced that “dialogue with …the public at large is more necessary than ever. Fear, doubts and criticisms must be taken seriously”.[241]

Industrialists are conscious that they cannot use too much technical language when talking to the public. Some of their staff members are now authorised to speak at public events such as the “café des sciences” in France, a, informal meeting in a non-academic setting where hot topics can be debated in a sometimes tense atmosphere. Politicians are also willing to organise face to face meetings between the population and industrials when this is needed, plus round tables, citizens’ juries, or consensus conferences (for instance with food industry/ biotech experts in public and private research institutes and experts from industrial companies in this field). The concept of crisis communication on technical matters flourishes. Inquiries on the interests of the public today show that it is first of all concerned by everything related to the body from cosmetics to medicine, then by the environment, then by the new technologies. It would appear that people are much less interested in academic disciplines such as chemistry, physics, biology or mathematics. [242] This induces of course a lot of anxiety about what may happen to the body and the environment and obliges communicators to speak of scientific and technical subjects in a way different from the academic vocabulary and habits, which is a tough challenge …

Government bodies generally act in a reactive fashion, when opinion is becoming sensitive to a particular problem connected with science and technology. Experts from industry contribute along with academics and lay members of the public to inquiries undertaken by investigatory bodies such as Parliament committees. The documents made available or the reports published after wide consultations by public entities such as Elected Bodies, Ministeries, Academies or personalities in charge of a specific mission can therefore be considered as trustworthy[243]. Sometimes their diffusion is confidential although they are increasingly available on the Internet. These reports may provide a basis for a European central database of

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[240] « sustainable development is a development that meets the needs of present generation without compromising the ability of future generations to meet their own needs ».

[241] Citations in this paragraph extracted from the ICCA Chemical Sector report to UN Environment Programme (UNEP) for the preparation of the world submit on sustainable development in September 2002, January 11 2002 available on the CEFIC web site : http://www.cefic.be/

[242] See in Paul Caro and Jean-Louis Funck-Brentano « L’appareil d’information sur la science et la technique » Tec et Doc, Lavoisier, Paris, 1996 pp 46-47, a table with results from inquiries conducted by the Departement Evaluation et Prospective of the Cité des Sciences et de l’Industrie in Paris under the direction of Aymard de Mengin who confirmed the trends in a personnal communication in November 2001. TV audiences expectations’ surveys show the same trend. For example « Etude Tendances 1998 » International Media Consultants Associés (IMCA), 88 pp, July 1998, for ARTE.

[243] For examples see http://www.assemblee-nationale.com/documents/index-oecst.asp or http://www.parliament.uk/parliamentary_committees/science_and_technology_committee.cfm

reports or review papers, giving access to data and authentic material produced by credible and independent channels, or on an open debate basis. For example during the year 2001, the European Parliament collected three kinds of contributions on the topic "human genetics and other new technologies of modern medicine": from the public through a mail box, from academic and industrial experts who participated at meetings, and answers from a questionnaire sent to scientific experts. The results were used to draft a report to suggest policy orientations. The documents are on the web[244].

The availability of scientific and technical information is useful to boost competitiveness and share knowledge. Such a service is also important for the information of citizens, its organisations, and public and private officers. Japan for instance has an on-line information service created by Japan Science and Technology Corporation[245]. Japan also has a service comparable to the USA EurekAlert, or Europe's Alpha-Galileo, offered by the National Institute of Advanced Science and Technology (AIST) in Tsukuba which provides descriptions of new advances in any research and industrial field[246]. The Asian Technology Information Service provides public reports on advanced technologies and their consequences[247]. Similar reports which popularise the state of the art in one industrial or technological domain could be collected in Europe on a section of a centralised database oriented towards informing the public and the press and offered free of charge. Free access is an important point since several institutions produce reports to be sold.

***The influence of the entertainment industry on scientific culture***

The Entertainment industry plays a major part in shaping the public image of science and technology. There is some continuity between science "Museums" and theme parks which may have sections devoted to scientific themes (space for instance). Many of the movies produced today have some "scientific" part or character in their plot [248]. Science-based TV productions can generate controversies with scientists as it is the case now (May 2002) with the BBC series "Fields of Gold", a thriller on the topic of genetically modified crops [249]. Some wide audience productions especially attractive to children are entirely built on science fiction themes made more or less realistic by the help of real scientists (catastrophe movies,[250] or dinosaurs [251]). The day-to-day information flow by itself can contribute to enhance the image of science and industry as associated with power, sometimes a wild power. Comics read at a very early age by children shape the image of some sciences (say chemistry) and frame it into the conventional folkloric archetypes of fairy tales [252]. Along those lines tabloids sometimes build spectacular stories on scientific themes. Newspaper's science reporting uses on a regular basis the same folkloric literary tricks, recipes for good story-telling (clever use of them produces good reporting) [253]. As a result those parts of science which have a poetic or mythical content are over-represented in the media. As they are mostly fundamental research,

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[244] http://www.europarl.eu.int/comparl/tempcom/genetics/contributions/contri_pub.htm
[245] http://www.jst.go.jp/EN/
[246] http://www.aist.go.jp/
[247] http://www.atip.or.jp/
[248] Donald J. Wink *Journal of Chemical Education* 78 (4), April 2001, pp.481-483
[249] The Observer (London) June 2nd 2002
[250] For instance « Deep Impact » prepared with the help of scientists specialised in the « KT boundary catastrophe » which took place 65 million years ago.
[251] « Jurassic Park » of course ! Michael Crichton, the author, has a scientific training.
[252] Paul Caro : Faut-il psychanalyser la chimie ? L'Actualité Chimique Avril-Mai 1995 pp.5-10
[253] Paul Caro : « Science in the Media between Knowledge and Folklore » in The Communication of Science to the Public, Science and the Media,. Fondazione Carlo Erba, Milano 1996, pp 111-132

such as astrophysics or prehistory, with little practical influence on society, one might argue that their image of "purity" contributes to a devaluation of more engaged/ applied "dirty" research, associated with material consequences. Since the beginning of the 19th century science has provided bad guys (and sometimes good guys) for stories, novels and movies ("From Frankestein to Folamour" [254]). This is in fact one way in which science has pervaded general culture since the beginning of the 17th century [255] and it is also the way in which many youngsters are attracted to science (Jules Verne!). Industrialists however, are quite often cast into the role of "bad guy". Large entertainment conglomorates operate worldwide and wield influence in almost all countries.

### 7.5 Analysis of data collected

Industries like to have their messages perceived by a large number of people in a friendly atmosphere, they want to be present where the action is. This is why large science and industry museums in large cities are places where they are likely to invest in permanent or temporary displays of their professional skills and concerns for society. This goes beyond simple sponsoring involving name waving, for instance for artistic events, which is akin to advertisement. Many European countries have such facilities. Several industrial sponsors contribute to at least one prominent Museum or Science Centre in Austria, Denmark, Finland, France, Netherlands, Portugal, Spain, Sweden, United Kingdom.

There are significant differences in the contribution to PUS of the different industrial branches investigated. In general, companies involved in the production of energy, whatever form, are eager to provide detailed information, knowledge and data on the scientific and technological principles behind their operations. This is true all over the EU (with the possible exceptions of Belgium and Ireland) with maybe more efforts directed to the public in southern Member States and in the UK. There is a climate of competition between several sources of energy, old ones but also brand new "alternative energies" (such as wind or sun), which can explain the attempt to provide as much technical information as possible in a competitive market. But as suggested in a footnote to Case Study 2 on energy in Finland (below), opinion on energy depends on the knowledge of the citizen and s/he can be considered better informed in the northern Member States (as suggested by Eurobarometer 55.2). Some of the efforts undertaken in the southern Member States (in France in the case of nuclear energy versus the greenhouse effect as reported in the footnote mentioned) are apparently wasted. A particular element of knowledge connected to a specific problem ("Does nuclear energy contribute to the greenhouse effect?") may be used to build a performance indicator on the model of the Finnish survey.

The chemical industry on the other hand does not try to provide basic information on the complex worlds of chemistry, so diverse, but strives to attract young people to the field. Certainly because they are much afraid of a shortage of technical skills in the future but also genuinely to improve the image of the chemical activity. Chemical industry is one of the major industries in Europe. Chemical companies have an active policy towards the educational world in Austria, Finland, France, Ireland, Italy, Sweden and the United Kingdom.

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[254] Roslynn D. Haynes : « From Faust to Strangelove » Representations of the Scientist in Western Litterature, The Johns Hopkins University Press, Baltimore and London, 1994

[255] Anna Marie E. Roos : « Luminaries in the Natural World », The Sun and the Moon in England 1400-1720, Peter Lang Publishing, New York, 2001

We were surprised to discover that industries involved in biotechnology were until recently not doing much to explain the science and technology behind their business to the public. Meanwhile problems are becoming acute in that area not only because of the controversies about GMOs but also for intellectual property rights problems. In particular, concerns are rising about the patentability of living material, a major financial potential at stake. Member States are divided on the subject especially about the consequences of the application of the July 6 1998 European Directive[256]. Information of the public is in this way a democratic issue.

During the period of this benchmarking exercise, things have changed - with the commitment of large multinational companies, such as Aventis, or national industrial associations, such as the Belgian biotech association[257], to provide information for the public not only in the form of pieces of knowledge but also as partners in the organisation of public debates. The European Commission now supports (July 4 2002) the Aventis action “Science generation initiative” with a € 1.44 million grant. Aventis has engaged actions to promote bio-sciences through citizen’s groups, colloquia and Internet forums,[258] with the help of the academic community. It hopes to reach students, parents, teachers, researchers and journalists and engage them to debate together. This is to be extended to Sweden (through IVA, the Swedish Academy of Technology) and Italy (through FAST, Federazione delle Associazioni Scientifiche e Tecniche) with the help of Euro-CASE[259]. Information for the public from the biotechnology industry was scarce in Europe but of course academic bodies and research institutions, and even political entities, were trying to fill the gap. One can see here the difference between an “old” industry, such as energy, which is eager to communicate (in a context of rivalry between several sources of energy however, including hot new ones …), and a new one industry, such as biotechnology, which is just beginning to feel the need to explain what it is doing and for which purposes.

Telecommunication and computing companies have contributed in unequal ways in Europe to equip schools with information and communication technologies. The main countries where an active contribution has been made are France, Germany, Greece, Ireland, Italy, Netherlands and the UK.

### 7.6 GOOD PRACTICES DETECTED

In the science - society area companies have two different strategies. One is to try to provide effective scientific and technical knowledge on their operations (as the energy companies are doing). This is needed if the educational system does not cover most of the topics concerned in enough detail. The other approach is to forget about technical side and to concentrate on the societal, ethical, economical and moral problems around the industrial activities involved in an attitude open to dialogue with diverse communities on those subjects. This is the aim of the Econsense Forum in Germany (see Case Study 4 below) and is also a trend in the chemical industry (with the commitment to sustainable development). It underlines the action of Euro-CASE and can be seen in practice in the Finnish survey on energy sources. This is then more PUSH than PUS[260]. Recent exhibitions in large Museums are presenting the *results* of the industrial activities without much explanation on *how* they were obtained and discuss at

[256] see « Le Monde Economie » January 29 2002
[257] http://www.BelgoBiotech.be
[258] http://www.science-generation.com
[259] http://europa.eu.int/comm/research/index.html
[260] For a discussion of these distinct concepts, please see the relevant section of the Introduction to this report.

length the *consequences* to be expected from their *uses* (for instance the prosthesis section in “L’Homme réparé” now showing at la Cité des Sciences in Paris).

It is of course very difficult for scientists to give away expectancies to explain the core of a knowledge and to concentrate instead on the uses by society of the things, machines, materials or processes, real or virtual, it has allowed to create. Science and technology then became unattractive black boxes that only specialists may enter and about which they cannot speak to their neighbours. Even the training of those specialists may be jeopardised by the bad prospect of a long and severe learning process.

The Science Society Action Plan insists on the necessity of “knowledge” for European citizens (“democracy requires citizens to have a certain scientific and technical knowledge as part of their basic skills”). But what kind of “knowledge”? Whatever criticisms one can make of Eurobarometer 55.2 it is clear that by using slightly outdated formal knowledge questions it succeeded in showing a better understanding of scientific issues in the north of Europe which seems to affect attitudes and contributes to judgement. Can this be only the result of a difference in quality of education? The Action Plan rightly insists on improving education in science and technology. The dissemination of information through different channels including the industrial ones is being done, but it is difficult to assess how effective this is just as it is difficult to benchmark the efficiency of the pedagogical strategies used in technical Museums and by “scientific lectures” provided on the Internet.

The Science Society Action Plan also insists on dialogue (“science policies closer to citizens”, “a true dialogue must be instituted between science ad society”). And dialogue can be engaged even without any precise knowledge of the technical whereabouts of the question debated (as seen frequently in meetings around biotechnology issues). Then the emotional aspects can be decisive as potent mythical figures dominate the representations of science and technology. Dialogues or debates can be a source of frustration especially for industrials and scientists whose point of view cannot be understood because of an evident lack of scientific culture, even very basic (“knowledge deficit”). It is then also difficult to benchmark the efficiency of dialogue unless one conducts a micro-study of a precise question.

From the fact that benchmarking is difficult one should not conclude that the two approaches are desperate enterprises. We are in a long term process and the results of industries’ actions will not be known for several years, maybe a generation or more. Benchmarking can only record what is going on now. As we have seen, many activities are being conducted by the industry and by the private sector (and we should not forget associations and NGOs). Some of them try to open the black boxes for everybody, others concentrate on the consequences, good or bad, of the existence of the black boxes. The two roads should be followed in parallel and if possible combined. This is what the Science Action Plan implies, but it does not draw a clear distinction between the two forms of actions that our analysis reveals in the industry strategy in Europe.

Industries such as biotechnology companies clearly show a deficit on both potential roads in many European countries. A good practice would be to recommend that they set up mechanisms to make their science better known; encourage them to accept debates and try to use the occasion to clearly present basic notions (as has been done in “consensus conferences”). One should remember also that the contents of some former “black boxes” (the Copernic system for instance) were made familiar through processes which have nothing to do with formal education or social dialogue, but with pleasure and entertainment such as reading science fiction novels.

There is a drawback to industry supported PUS (or PUSH) actions: they depend on an economical conjuncture and may disappear because of financial pressures, decisions of Boards, or sharp changes in allocation of resources. Such changes are reported for some countries (see section on Portugal). As a consequence one good practice to recommend will be the commitment for an extended period of time of industry to a particular action, either on the knowledge side or on the social one. It is of course better to act on both.

## 7.7 CASE STUDIES : GOOD PRACTICES AND EXPERIENCES WORTH SHARING

### *Case study 1 - The attitudes of the Finns towards various energy forms, Finland*

The Finnish Energy Industry Federation Finergy presents (in English on its Web site [261]) a study of Finnish attitudes towards energy issues, 1983-1999, which describes the pro and con of the different sources of energy available in Finland. During this period, the same questions were asked about five central energy sources that are used in Finland today: coal, peat, natural gas, nuclear power and hydropower. In 1999, hydropower was the most popular form of energy (59% in favour of increase, 5% in favour of decrease). But attitudes towards natural gas (52%, 10%) and peat (56%, 17%) were in the same range. Nuclear power divided opinion (34% in favour of increase, 36% in favour of a reduction). (In 2001, after a long debate, Finland decided to build a fifth nuclear electricity generator). Coal has a very bad image: 10% want more, but 55% want a decrease in its use. With respect to the classical sources of energy the alternative ones (sun, wind, wood) were seen very favourably.

Over the years there were some significant changes in Finnish attitudes. Natural gas was popular, but it has constantly fallen, maybe because it is seen as a non-renewable fossil fuel. On the contrary hydropower remains a favourite all along. The support for peat goes up and down, this depends on conjuncture as it is a national energy source. Since autumn 1986 the support for coal has shown a sharp decrease as it is connected to the effects of acid rain on forests. Attitudes towards nuclear power are relatively stable over the years.

Attitudes towards the methods of electricity generation were studied in details for the five energy sources plus wind and wood. Ten questions were asked. To classify the most environmentally benign method wind wins, for the most economical it was nuclear power. The highest degree of domestication was allocated to wood. The most reliable production was designated as hydropower. The production technique seen with the most positive effect on employment was wood, the most dangerous was nuclear energy. Wind was on top of the list of the techniques not suitable for extensive use. Coal was seen as accelerating the greenhouse effect by 77% (10% held that opinion for nuclear energy [262]). Natural gas was considered as the most unreliable source of energy (it is of foreign origin) and wood was seen to contribute

[261] http : //www.sci.fi/~pena/eas99eng/eng-eas99.htm

[262] There has been a survey in France in 2001 about « the social representations of the greenhouse effect » done by ADEME, the national agency in charge the environment and energy problems. It was found that 60 % of the French (59% in 2000, 61% in 2001) believe that nuclear plants contribute significantly to the greenhouse effect. More, 38% of people with a University degree still held that opinion. The obvious difference with Finland confirms the facts reported about the greenhouse effect pages 25-27 of the 2001 Eurobarometer survey showing that citizens have a better knowledge in the north of Europe.

to welfare and improve standards of living (it is a national resource). The survey therefore established a profile of the energy forms according to public opinion in Finland.

As to the attitudes towards nuclear power, gender and age differences were clear as “there is more understanding for nuclear power among men (46% support it) than among women (14%)”. The support also increases with the age of the respondent: “younger groups are more opposed to nuclear power”. For men; support for nuclear power strongly increases with education but this is the contrary for women. “People in a leading position, professional people and entrepreneurs have the most positive attitudes towards nuclear power”.

In 2001 Finland finished a long debate on whether to build a fifth nuclear power plant or not. The decision made was in favour of building the plant. The Decision-in-Principle on the fifth nuclear power plant unit was adopted in the spring of 2002.

***Case study 2 - Fondation Villette Entreprises, France***

La Cité des Sciences et de l’Industrie (CSI) in Paris is associated to la Fondation Villette-Entreprises, created by the Cité jointly with industrialists. The aims are threefold: joint ventures between the Cité and industry for producing exhibits, improve the scientific industrial and technical culture of the public at large, suggest to companies actions in favour of young people to improve their education, formation, or jobs. The Foundation organises yearly Colloquia (“Les Entretiens de la Villette”) between scientists, engineers and teachers on technical topics. It also produces information and software for classes and has produced a series of 12 minute documentaries, broadcast on a French public TV network, on the theme of innovation, realised in collaboration with 27 large French companies and Siemens. It has also participated with the French Academy of Sciences and “la Cité” in the creation of an answering service for journalists (“Sciences Contact”) to help them establish contact with scientists. As a Member of ECSITE the Fondation has contributed to the project ”Chemistry for Life” designed to improve, at the initiative of CEFIC, the image of chemistry and to design experiments for 14 European Science Centres. For exhibitions at la Cité cooperation with industry can take several forms. It can be simple sponsoring for an exhibition designed by la Cité’s staff. For instance the French insurance company MAIF sponsors the “Cité des Enfants”, a large hands-on area for young children. Or, the exhibition can be a co-production either for permanent or temporary display. There has been a large number of exhibits of that type at La Cité since 1986. The third form is when the Cité acts simply as a host providing space for an exhibition entirely conceived by the industry (Michelin on tyres for instance). The Cité can also be rented in the evening for public relation events organised by companies or at the week end to give free access to companies’ personnel. Besides the Cité the Fondation acts also in the Parc de la Villette to help organise events in “La Grande Halle”. There, the very successful exhibition on environmental problems “Le jardin planétaire” in 2000 was, for instance sponsored by “Gaz de France”. The Fondation has 14 Corporate Members and 21 Associate Corporate Members including several industry federations (Metallurgy, Oil, Pharmacy, Electrical Utilities, Insurance etc.).

***Case study 3 - Siemens and the Econsense Forum, Germany***

The Siemens family was at the origin of the Deutsches Museum (and of the Science Museum in London in 1876) and the firm is still much concerned with the public. Siemens has a worldwide commitment to sustainability: “by sustainability, we understand long-term economic growth coupled with environmental awareness and social commitment ». It is a founding member of the Econsense Forum [263] – a Forum for Sustainable Development - to which 20 German-based multinational companies belong. Econsense was created in summer 2000 in Berlin. Its ambition is to be “a place for the problem-oriented and open exchange about central problems of sustainability, joint solution approaches and subjects of conflicts”. It is interested in ecological as well as economical and socio-political questions and of course in the science-society relationship. Its motto is “Thinking – Communicating – Acting”. Among its Members, besides Siemens, are chemical companies such as BASF and Bayer, communication companies, Bbanks, the automobile industry (Daimler, BMW, Volkswagen) and many others. One Member, Robert Bosch GmbH, has a foundation of its own[264] which has a special interest in “science in society” (“Wissenschaft in der Gesellschaft”). Among its various interests the Foundation has appropriated €37.3 million in 2000.

The corporate citizenship mission implies contributing to the education of people. Siemens is heavily involved in arts and culture sponsoring but science exhibitions do not appear as a priority. The company has a long tradition of collaboration with schools, universities and other scientific institutions essentially to build bridges between theory and practice (a long standing goal of German education). They have launched a « Youth and Knowledge » action in the multimedia domain with competition between teams of students to solve challenging problems, 34 000 students participated in 2001. A multimedia road show is also touring Germany. They organised a « Girls’Day » to allow young female relatives of their employees to visit their facilities in Erlangen « to get a taste of science and technology »: a successful experience which is being repeated in other towns in 2002. Girls’ teams will enter the multimedia competition to create their own presentation. The Siemens Foundation seems to be more US oriented in its education initiatives. With respect to communication at large they declare that they are always ready to engage dialogue with the general public, politicians and NGOs. They manage Siemens Forums (in German) to discuss a variety of socio-political and technological subjects. “Last year (2000), the Siemens Forums welcomed around 200 000 guests, who visited exhibitions on issues such as "Internet Economy" and "City of the Future". Conferences and discussion groups also provided opportunities to ask questions about corporate citizenship”. However the web sites of the company do not have much to offer in terms of scientific culture, such as popularising folders with useful scientific or technical content.

### *Case study 4 - The Wellcome Trust, United Kingdom*

The Wellcome Trust is an independent charity, which is engaged into a multimillion pound action “to raise awareness of the medical ethical and social implications of biomedical sciences”[265]. It supports the National Museums of Science and Technology (which include the Science Museum, the National Museum of Photography, Film and Television, the National Railway Museum). It has contributed 48 million pounds to the new “Wellcome Wing” of the Science Museum whose scenography and activities are examples of the recent implication of Museums into science & society issues. It has also supported the “Science for Life” exhibition now at Manchester Museum, the International Centre for Life at Newcastle upon Tyne, and other facilities. Besides museums the Wellcome Trust is engaged in affirmative action on education. For instance it has encouraged the teaching of controversial issues in the classroom, providing support for teachers in the perspective of the introduction (in England)

[263] http://www.econsense.de/
[264] http://www.bosch-stiftung.de/
[265] http://www.wellcome.ac.uk/

of Citizenship Education in 2002. It promotes the introduction in the curricula of the social ethical and legal implications of science, the production of educational materials to analyse socio-scientific issues, and the training of teachers (teaching packs, newsletters). It has a programme to place young PhD researchers in secondary schools for four days to talk about their work (and to encourage science career choices). It has contributed to the Nuffield Science Bursary which allows hundred of young people “to experience work within a science-based organisation”. “Science Centrestage” is a programme to address critical issues through the use of theatrical performances in secondary schools. Science writing competitions for students are organised, and there is a Wellcome Trust Book Prize. There is also a “Medicine in Society Programme” to facilitate public debates and provide support to policy makers.

### 7.8 Main findings

* The traditional policy of industries using museums as show cases is still going strong. Either through local heritage places, or through exhibitions at large museums and science centres in big cities.

* Some industries offer information in an attempt to increase knowledge on area connected to their activities especially almost all of the energy and utilities enterprises in Europe.

* Some industries, especially the chemical industry, target young people at schools, support pedagogical experiences, or provide educational material and information in order to promote the image of their activities

* Some industries, such as start-up biotechnology companies, have not been doing very much directly for the public at large or schools, and have relied instead upon the efforts of the academic community. But in the beginning of 2002, the situation is changing. A large international company such as Aventis and other smaller ones have engaged actions to promote bio-sciences through citizen's groups, Colloquia, Internet Forum[266] with the help of the academic community. [267]

* Associations of very large industrial companies, or lobbies connected to the industry, support, in some countries, an approach to science society relationships based on the development of dialogue through forums or other actions instead of trying to specifically increase public knowledge first.

### 7.9 Recommendations

1/ Industries must take the lead in making the public aware of their work, including work on new technologies. They should be encouraged to act in the public sphere both as providers of formal knowledge and organisers of dialogues. They should participate directly in discussion on their work.
Reasoning: Some industries have not undertaken PUS activities until now, They have let the academic community shoulder the responsability of communicating about their work. Biotechnology is a good example of such an industry (although the situation is changing, see above). The acceptability of biotechnologies and biological sciences at large is now at stake

[266] http://www.science-generation.com
[267] On July 4, 2002 DG Research decided to support the « Science generation initiative » launched by Aventis, see the recent press communication at http://europa.eu.int/comm/research/index.html

because of the public's unstable opinion. The lack of an informed dialogue on this and other "hot topics" could damage the EU's competitivity and ultimately result in serious economic difficulties.
Action: industrial associations and lobbies in Brussels (e.g. Biotechnology lobby groups), companies (e.g. European BioTech companies) and the European Commission (DG Research and DG Enterprise).

2/ On the model of the growing involvement of scientists in public communication, engineers and technicians from industry/private sector should communicate directly with the public in cooperation with and using the help of their Press Information Officer (PIO).
Reasoning: Personal contacts with people directly involved in industrial research and development, who may be local actors, are efficient in the transfer of information and the development of informed opinions / attitudes. This has been seen during the open door industrial operations organised at science weeks (in Germany for instance) or during summer tours of industrial facilities.
Action: Engineers and technicians in the private sector, industry associations, European Commission - DG Research and DG Enterprise

3/ The main problem of industry is trust in the information it provides because of the fear of confusion with advertisement or propaganda. On controversial topics, industry in Europe should cooperate to provide access to data and authentic material through credible and independent channels, such as open data bases or public access to comments and reports of independent experts, especially parliamentary bodies.
Reasoning: There exists across the Member States, a large number of reports or inquiries of parliamentary origin, or coming from academic entities or from public services or Ministries about controversial science and society problems connected uses of new technologies, or industrial risks. Some of them could be collected from the Member States or European Union entities into a common data base open to the public and the press. As a matter of fact the data collected by this benchmarking exercise may be the nucleus of such an information system which could also be useful for future benchmarking.
Action: Industry associations, individual companies, European Commission staff responsible for developing information systems.

4/ Public support is necessary for the provision of information on risks and for the dissemination of expertise on various subjects, for example through lectures, meetings and broadcasts.
Reasoning: Publicly supported information campaigns are necessary not only for a balanced and active dialogue on "hot" topics but for continued discussion of less controversial topics which are also of relevance to citizens' lives. An example of a "hot topic" may be "mad cow" disease (see chapter on the media), a less acute example might be "food additives", both are a human health concern, one of the main interests of citizens.
Action: Governments, European Commission DG Research and DG Enterprise.

5/ Local industries should be encouraged to use public facilities (e.g. museums or town halls) to exhibit information about their activities and to be more active actors in the public sphere.
Reasoning: The public is interested, as shown by the popularity of local industrial museums, to know how local factories and industries work. Open doors limit the black box effect which may generate fear.
Action: Local industries; local, regional and national authorities.

6/ Industry should support the development of educational projects involving industrial partners in primary and secondary schools on the model, for instance, of what the chemical industry is doing in many Member States (for details see the Annex to the report).
Reasoning: Industry can bring an exciting, "real life" aspect to school projects. It is also an essential component of the economic activity and wealth of a nation.
Action: Industry associations in partnership with local education authorities, Ministries for Education, DG Research and DG Enterprise to support existing schemes and new ones in the making, for instance in biotechnology.

7/ The involvement of industry in science centres and museums should be recognised and welcomed.

### *Further Research*

1. How much industry declares it is spending on PUS related activities, as a proportion of their turnover/profits? Statistical units of the European Union may draft a questionnaire to know that.
Action: Eurostat – see below potential indicator.

2. Ways and means of the diffusion and use of science and technology in specialised communities such as agricultural ones or impoverished suburban areas (this is important in relation to educational problems in less favoured populations where technical knowledge may be an asset).
Reasoning: In this report we were only able to examine information targeted at the general population. In the future it would be useful to look at information available to, or targeted at, specific communities. There is significant scientific knowledge in the practice of agriculture today. In impoverished suburban areas, experiments in education[268] show the importance of technical knowledge and skills (i.e.mechanics, or computers or electronics) as a way of building a social status.

3. More social studies are needed on public perception of risk; management of risk by industry and the communication of information on risks to the public.

### *Future Indicators*

1. Precise data on the number of visitors to local industry sponsored or heritage museums.
Action: these data could be collected from National or Regional Statistical Offices in Member States
2. Percentage of turnover dedicated to PUS activities by key companies in the EU (both large companies and SMEs).

[268] *Pour* "Eduquer, Ruptures et enjeux", n°142, 1994, pp 37-56

# 8. CONCLUSIONS

Rather than repeating the findings and recommendations from our study, which are already given at the end of each chapter and in the Executive Summary, here we outline the more general lessons to be drawn from this first benchmarking cycle.

## 8.1 THE FIRST ATTEMPT TO BENCHMARK THE PROMOTION OF RTD CULTURE AND PUS

This first ever exercise to benchmark the promotion of RTD culture and PUS across the European Union has produced the first ever overall picture of the scale of activities and the range of policies in this area. The collection of such information – albeit less comprehensive in some areas and countries than in others – shows that undertaking such an exercise was important. It is now possible to compare experiences, with the aim of developing better programmes, as well as to assess the opportunities and difficulties facing RTD policy makers in terms of the public climate for such efforts.

***Methodology***

The Expert Group had solid knowledge of previous work on the ways and means of promoting scientific culture. Some members had professional experience of science popularisation/teaching, others of managing institutions or programmes in the field. None had experience in the field of benchmarking, however. It was clear that no homogeneous statistical data were available for this cultural field, unlike the situation for the other four areas being benchmarked. The Group therefore decided to break the field into areas dominated by six "key actors": Governments and their agencies; the scientific community; education systems (formal and informal); science museums and centres; the media; and industry/the private sector.

***Actor strategies***

The very different strategies of these actors had not previously been recorded and analysed on a European scale. The present work has shown a variety both among Member States, and within the actor categories, which strongly depends on the specificity of the national context /history. A phase of description was consequently needed as a first step of the benchmarking exercise. The highlighting of case studies worthy of attention was one way to induce mutual learning from comparisons, and provides a minimal framework for benchmarking. Original data were also obtained during the course of this study, however: a preliminary analysis of the results of the Eurobarometer 55.2 and a new survey of science centres and museums. New fields were opened such as the inventory and analysis of industry activities. Up to date data were collected for education and media. The complex part played in the process of supporting RTD culture by governments and the scientific community was also set into perspective.

***Future work***

During the benchmarking exercise, the Expert Group assembled a considerable body of knowledge. We hope our work provides a starting point for a more quantitative approach to the evaluation of the promotion of scientific culture in Europe, progress much needed in a knowledge based society. If implemented, our suggestions for future steps in benchmarking, presented at the end of this section, should lead to a better appraisal of the RTD cultural situation in Member States.

## 8.2 COMPARISON OF THE ACTORS

### *Image*

The public image of science and technology in Europe has changed historically; sometimes there have been overoptimistic expectations, at other times, science has been seen as rather threatening. This public image defines, in part, the attitudes of the citizens and the vocational direction of young people. A variety of means have been used to generate positive images. The direct involvement of individual scientists and engineers in the public arena is clearly very important, in this respect. Government leadership in this area is also crucial in setting the scene.

### *Statistics*

The actors' actions have a qualitative value; quantitatively, their effect may be benchmarked in terms of the public reached, and in terms of the number, nature and intensity of their activities. Governments and scientific institutions should be aware that it would be useful for future benchmarking to keep precise statistics on these activities and events. The Commission might provide a uniform administrative framework to record and analyse those data, with the aim of further mutual learning.

### *Science and fantasy*

A future benchmarking study should set some rules to evaluate the quality of scientific information distributed and the nature of that contribution to the democratic debate. This is of course a difficult task. Information ranges from the "scientifically correct" from the point of view of the scientific or industrial community, to the "emotional", passing through a twilight zone where it borders with fantasy, the irrational, or science fiction… even within the same publication, broadcast or round table.

### *Models based on case studies*

Judgement is also subject to political appraisal, for instance in the interpretation of environmental data. To extract benchmarking data from the existing data or to propose efficient new ways, more intelligent social studies are needed. However, this report shows that models to follow may be proposed from national case studies, as a first step for action.

### *Budgets*

Precise information regarding the amount of money spent by each of the actors in the field would provide useful insight. In this exercise, we established that such information is not readily available. Collecting such dispersed data was also unrealistic, given the short time span allowed for the study – our primary objective was to establish who was doing what. There is also an intrinsic difficulty in determining what resources are being devoted to the development of scientific culture. It is often not easy to isolate resources aimed at general measures to promote RTD culture and PUS in some budgets (education for instance); they are often embedded in wider programme budgets. Nonetheless it should not be impossible for a future benchmarking exercise to identify these resources, at least to an order of magnitude, by a proper interrogation procedure of national authorities and private actors. Such a questionnaire may be derived from the results of the present study.

***Knowledge, risk and dialogue***

An evolution of the strategies from provision of knowledge to organisation of dialogue was recorded in each of the sectors investigated. This brings a major change in the perspective of the nature of scientific culture and public understanding of science. We are consequently not in a frozen situation; we are facing a time of rapid changes, in particular, under the pressure of events which can produce an emotional reaction in the European population, situations connected with health/food safety or environmental problems. The question of risk is central in the mind of citizens, especially in local contexts. As a rule, more democratic involvement on scientific and technical issues is needed and procedures should be established for this. This relates directly the acceptability of technical progresses (thus competitiveness) in Europe; it should be noted that some differences that are observed with Europe's competitors result from cultural differences (biotechnology is an example).

***Education***

In the education sector, as demonstrated in our report, there are already plenty of data on formal education, and the main problem is to evaluate the different ways of teaching using a proper knowledge assessment procedure. Some insight may be obtained from a careful examination of Eurobarometer data. Surveys of that type but especially designed for younger people may provide some evaluation of the national educational efforts in terms of scientific culture. The situation is much less clear in the area of informal education – science clubs, visits to science centres, summer projects, etc. Here, more information is required, such as extra-curricular activities; these can be key to shaping young peoples' futures (both vocational and otherwise).

***Museums***

For science museums and science centres, this study provides a survey that records comparable quantitative data on a large number of establishments in Europe. The methodology used in the ECSITE survey should be extended to all kinds of science and technology museums in Europe including open-air ones (ecological or heritage displays). Already botanical gardens, zoos, and aquaria are included. There are many small places all over Europe with very good educational potential sponsored by industry or local authorities or associations.

Central and local authorities (who often have a better idea of the situation locally than the national bodies) should use the framework of the ECSITE survey to collect data. An effort should be made also to create or improve the actual databases on Museums in Europe, which are very incomplete. Those data bases also can benefit from taking into account the categories defined by the ECSITE survey.

***Media effects***

The mass media have a critical effect on public opinion, including their attitudes towards science and technology. Media studies can provide useful data, which we were not able to gather in the time available, such as audience evaluation for television shows or figures on circulation of magazines. To obtain meaningful benchmarking data for European comparisons, it is necessary to compare what is comparable, for example magazines with roughly the same style and content, or TV series built on the same principles. There are of course significant national differences, despite the existence of some international publications. The practice of “round tables” on television which allow different/ contradictory viewpoints to be expressed, on science and technology subjects (such as biotechnology) should be encouraged. This political style of debate may not be ideal for the promotion of knowledge, but it is essential to allow the expression of different feelings.

***Industries***

Industries in Europe follow different strategic pathways. Some try to improve the knowledge of citizens by providing detailed information/ explanations. This is the case for the nuclear energy industry and for alternative energies. Data are offered as support for choices in a climate of competition between energy sources and political debates. The public appears to be reasonably well educated in this field, especially in the north of Europe. Industrial branches suffering from a shortage of skilled personnel try to convince young people to select their trade/ profession. Consequently some use a seductive strategy and provide additional resources for schools. Others are more interested in in-depth progresses in the methods of science teaching and support experiments in science education. The latter are long term activities whose benchmarking may be a subset of the knowledge survey of young people suggested above or may enter the analysis made by the group benchmarking human resources.

***New industries***

New industrial branches operating at the frontiers of research should be encouraged to engage more directly with PUS action and public debates if they want to convince citizens of the importance and interest of their field of activities. European companies in these new areas seem to be shy of coming out in public compared, for example, with their US counterparts. For industry at large, future benchmarking data can be obtained by asking for details of financial investments made by companies in PUS activities (available from the public relations section of major operators). There may be some regulatory set up to obtain this information from companies at European level. It will be extremely useful for benchmarking in a single step a large spectrum of actions. Tax incentives could be of paramount importance (in producing a spirit of corporate social responsibility).

***Concentration***

The present report shows a tendency to the concentration of public or private financial investment in PUS on a small number of places with high visibility, or science TV shows of exceptional quality and wide audiences. This is the case for a few giant museums in large cities. Today, business methods insisting on efficiency and profitability are increasingly applied to society’s cultural assets. This trend may lead to unpleasant consequences. In order to attract more people, the temptation to use entertainment “tricks” may bring the scientific and technological educational content down to a low quality and level. This can already be witnessed in many facilities, especially the new ones, which operate in between traditional science centres, and theme parks, and is a current practice on many television "science" shows. This evolution is worth mentioning in an area where qualitative evaluation is essential before collecting data.

## 8.3 Future benchmarking goals

### *More work on local level activities*

For the purposes of this benchmarking exercise, we had to restrict the depth of detail to the "top" levels of each of our key actors. We have, for most countries, looked only at central or federal governments, and where we have looked at regional bodies, it has been by way of examples rather than in a comprehensive fashion. For countries like Germany, local and regional governments are important players that should be looked at in future. For the scientific community, we have examined "leading" academies and societies. But much activity is undertaken on a personal basis, and at the very least one would want to look at the university sector, as well as at establishing a more comprehensive picture of the all the science and technology societies. Similar layers of localisation are required for the other actors – we have already highlighted how multinational companies can have nationally tailored activities, and these may show more fractal structures at local level, particularly in centres of industry.

### *Other actors*

One key group of actors we have omitted in this exercise is the non-governmental organisations, which are very influential with individual citizens and have fairly high levels of public trust. No picture of the climate for promoting RTD culture and PUS can be considered complete with these actors omitted. There are difficulties here: there are well established groups like *Greenpeace* and *Friends of the Earth* as well as the trades unions; other activities may result from short-lived coalitions around single – possibly acute and localised – problems, such as an instance of water pollution or the siting of controversial industries. Moreover, in this exercise we have chosen to view the public as homogenous and to benchmark programmes that are relevant and available, in principle, to all citizens. But there are interesting programmes targetted at specific population groups, such as farmers, fishing fleets or patient groups, that should be examined.

### *Group composition*

While it is impracticable to have huge expert groups responsible for writing reports, a mechanism for ensuring good coverage, for comprehensive information gathering across the Member States, is essential. This will increasingly be the case with enlargement of the European Union. A small group of people can find information - if it exists - in printed literature and on the Internet. However, they cannot be expected to have the *local* knowledge required to appreciate what information corresponds to policies and programmes that are significant and what information is merely "apple-pie and motherhood" statements, or activities that have never really been successful. A format that involves a workable expert group (probably ten or less), supported by designated national contacts who can supply information and check to see if the significance has been correctly estimated, is essential to ensure that benchmarking is as uniform and effective across the Member States as possible.

***Further research***

It is depressingly usual for reports to ask for yet more research, but we do feel this is an area in which *trans-European* studies are remarkably lacking. There are projects looking at specific science subjects - biotechnology, for example - that are proving valuable. But more wide-ranging studies are needed. We would identify the area of the media as being particularly in need of attention, and the role of the broadcast media to be especially important, given what Europeans now say about their sources of information. Similarly, the potential for the Internet to be used in developing dialogue and debate, and the genuine involvement of citizens in science and technology policy issues, is worthy of further study. Investigating the history of *public* science and technology – an area often overlooked in the history of science – could help us avoid the mistakes of the past and learn from exemplars of science communication. These are just examples, however, and we could list many other important areas. Framework 6 could provide an excellent vehicle for resourcing such studies.

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# BIBLIOGRAPHY AND SOURCES

## Background documents


- Het beeld van de wetenschap in Nederland. (June 2001)
- American historical perspective on public communication of science
- European Science and Technology Week 4 - 10 November 2002.
  www.cordis.lu/scienceweek/home.htm
- La culture scientifique en 2001: Constats pour agir demain “Constater, Impulser, Agir”.
- Observations on the Communication of Scientific and Technical Knowledge – Bertrand Labasse. (June 99)
- S&T culture meeting: proposed European initiative - Lisbon May 2001
- Science and Governance in a Knowledge Society : The Challenge for Europe. International Conference 16-17 October 2000
  www.jrc.es/sci-gov/back
- Commission working document – Science, society and the citizen in Europe (October 2000)
- Science and Society – The Danish Institute for Studies in Research and Research Policy (June 2000)
- Science education – a case for european action?
  www.lip.pt/IP/whitepaper/wp1.html
- Declaration on science and the use of scientific knowledge (July 1999)
  www.unesco.org/general/eng/programmes/science/wcs/eng/declaration_e.htm
- Informal meeting of education and science ministers. Uppsala, 1-3 march 2001
- Science and Engineering – Indicators 2000
  www.nsf.gov/sbe/srs/seind00/frames.htm
- Science and the Public. A Review of Science Communication and Public Attitudes to Science in Britain. (October 2000)


## Benchmarking methodology


- Benchmarking in Europe website - http://www.benchmarking-in-europe.com/index.asp
- Benchmarking progress report, European Commission, June 2001.
- Commission methodology November 2000
- Conference on the the benchmarking of RTD policies in Europe
- First Results of benchmarking of national RTD policies - paper by Commission services


## Education systems - formal, informal and popular


- Ce que vos enfants devraient savoir. Ouvrage de Alain Auffray (Janvier 2002)
- Désaffection des jeunes pour les études scientifiques. Rapport de Guy Ourisson. (Mars 2002)
- Education in Science and Technology, an International concern – some initiatives.
  folk.uio.no/sveinsj/NOT-%20Appendix.html
- Europe-USA Seminar on Science Education, Washington 2000
- Evaluation et statistiques de d'éducation. (Avril 2002)
  www.education.gouv.fr/dpd/default.htm
- “Grossology – Not for the faint hearted”.
  www.newscientist.com/opinion/opinterview.jsp?id=ns232216
- Ministero dell'Ambiente e della Tutela del Territorio.
  www.minambiente.it/Sito/settori_azione/iar/FontiRinnovabili/ragazzi/parco_giochi.htm
- OECD education indicators - http://www1.oecd.org/els/education/ei/eag/
- Key data on education in Europe - http://www.eurydice.org/Documents/Key_Data/En/FrameSet.htm
- Les jeunes et les études scientifiques. Rapport de Maurice Porchet. (Avril 2002)

- "Les enfants mobilisés contre l'effet de serre". Article in "Le Soir" – 28 Février 2002.
- Making a European Area of Lifelong Learning a Reality. (November 2001)
- Linking Knowledge and Societry: a Euro-CASE Contribution. (October 2001)
- International Review of Curriculum and Assessment Frameworks. (June 2000) www.inca.org.uk/pdf/science2000.pdf
- Science Education curriculum in Secondary School. http://www.stao.org/backgrnd.htm
- Task Force on the Physical Sciences. www.sciencetaskforce.ie/links/transnational.htm
- Quand la science séduit les "ados". Le Figaro – 26 Février 2002.
- Science and Technology in Education – Current challenges and Possible Solutions. (March 2001) http://www.uio.no/~sveinsj/
- Science and Education – A white paper on science education in Europe. (September 1995) www.lip.pt/IP/whitepaper/wp1.html
- Widening the appeal of science in schools. (October-November 1998) www1.oecd.org/publications/observer/214/Article3-eng.htm

## ENSCOT documents[269] (various, at discretion of chairman).

http://www.ucl.ac.uk/sts/enscot/

- ENSCOT Attitudes to raising awareness
- ENSCOT Broader National Developments
- ENSCOT European Union perspective
- ENSCOT Initiatives and the media
- ENSCOT National Perspectives
- ENSCOT Public participation initiatives
- ENSCOT Science and Political Purposes
- ENSCOT Science's own self-interest
- ENSCOT Traditional types of initiatives
- ENSCOT Understanding or awareness?

## Eurobarometer Survey 52.1 - Europeans and Biotechnology

- Europeans and Biotechnology
- Press Release
- Questionnaire
- Sociodemographic Variables
- Summary Report
- Tables: national breakdown

## Governments/ agencies

- Austria 2.5% +research strategy - resumé by R. Schurawitzki
- Austrian PUS programme - resumé by R. Schurawitzky
- Municipal Government Order – Municipal Plenary Session Council, October 29,2001.
- Technopolis – RCN in the Public Understanding of Science. (December 2001) www.technopolis-group.com/reports/RCN/RCN_BR09.pdf

[269] European Network of Science Communication Teachers (ENSCOT). http://www.ucl.ac.uk/sts/enscot/

- Enscot – Political Initiatives – Public Understanding of Science - By Steve Miller. (25 July 2000)
- Enscot – Political Initiatives - Excellence and Opportunity: a science and innovation policy for the 21st century – By Steve Miller. (28 July 2000)
- Enscot – Political Initiatives – Science and Society – By Steve Miller. (24 July 2000)


## Industry and Commerce


- "Public awareness of science and technology in Europe and its regions. Building bridges with society". Conference organised by the Belgian presidency, Brussels 17-18 December 2001. http://www.eurydice.org/Documents/Key_Data/En/FrameSet.htm
- Agoria Vlaanderen. "What Industry does, Industry in the Field" – conference paper by Geert Vanhaverbeke. 17-18 December 2001.
- Industry and Commerce Data – Paul Caro. (November 2001)


## Media


- Alphagalileo Europe. A media research service for science and technology. http://www.alphagalileo.org
- CNRS info – 20 ans d'information et de médiation scientifique. www.cnrs.fr/Cnrspresse/n394/n394.htm
- Declaration of the Second World Conference of Science Journalists – Budapest 4 July 1999. www.esf.org/eusja/Declaration.htm
- European Association of Science Editors. www.ease.org.uk
- Les français et la recherche scientifique. (29 novembre 2000) www.sofres.com/etudes/pol/291100_science_n.htm
- Les français et la recherche scientifique – enquête réalisée du 15 au 17 novembre 2000. www.sofres.com/etudes/pol/291100_science_r.htm
- European Union of Science Journalist's Associations. National Associations. www.esf.org/eusja/national_associations.htm
- Guidelines on Science and Health Communication. (September 2000) www.sirc.org/publik/guidelines.pdf
- Scientific journalism: Problems and perspectives – by Vladimir de Semir www.ubxlab.com/imb/v3june/p3june009.pdf
- The European Secretariat for Scientific Publications. www.seps.it
- Study conducted for The Royal Institution of Great Britain's « Science Media Centre ». (April 2002). http://www.sciencemediacentre.org/


## Science and Society


- The Science and Society Action Plan (COM(2001)714 Final) European Commission, December 2001. http://www.cordis.lu/science-society
- Science in Society: Towards a New Contract – Budapest 26/6-1/7 1999 www.unesco.org/science/wcs/background/21st_forum_ll.htm#2.4
- UNESCO – Science: the Gender Issue. http://unesdoc.unesco.org/images/0011/001181/118131e.pdf
- Background documents to informal meeting of EU education and science ministers – Uppsala, 1-3 march 2001.

## Science museums and centres


– ECSITE membership questionnaire February 2002.

- Anderson, D. (1998). An analysis of the importance of informal and formal science learning contexts to each other: An overview perspective. Learning Science in Informal Contexts, Questacon, Canberra, Australia.
- Anderson, D. (1999). The development of science concepts emergent from science museum and post-visit activity experiences: Students' construction of knowledge. Brisbane, Australia, Queensland University of Technology.
- Anderson, D. and A. M. Lucas (1997). "The effectiveness of orientating students to the physical features of a science museum prior to visitation." Research in Science Education **27**(4): 485-495.
- ASTC. (Summer 2001) "Statistics 2000." Washington.
- Ayers, R. and C. T. Melear (1998). Increased learning of physical science concepts via multimedia exhibit compared to hands-on exhibit in a science museum. National Association for research in science teaching, San Diego, California, USA.
- Bitgood, S., B. Serrell, et al. (1994). The impact of informal education on visitors to museums. Informal Science Learning. What the research says about television, science museums, and community-based projects. V. Crane, H. Nicholson, M. Chen and S. Bitgood. Dedham, USA, Research Communications Ltd**:** 61-106.
- Bodo, S. (Marzo 1998) "L'esperienza internazionale degli science centre." A cura della Fondazione G. Agnelli, Torino.
- Bradburne, J-M. (1999) "Dinosaurs and white elephants: the science centre in the twenty-first century." PUS – UK.
- Coventry, V. (1997). Major influences on career choice: a study conducted on behalf of Scitech Discovery Centre, Perth, Western Australia. Perth, Western Australia, Scitech Discovery Centre,**:** 4.
- DeAnna, BB. (November 2000) "After school: a window of opportunity." Dimensions. Washington.
- Delacôte, G. (April 1998) "Most common mistakes in designing a new science centre." Be'er Sheva Seminar.
- Demazure, M. (2001) "La stratégie, l'offre, le rayonnement et l'organisation." Rapport d'activité 2000 de "La Cité des Sciences". Paris.
- Edition de l'OCIM. (Janvier-Février 1998) "Qui visite les musées des science?" sous la direction de Jacqueline Eidelman. Dijon.
- Editions de l'OCIM. (mars 2002) "Enfants ou élèves?." Dijon.
- Falk, J. H., Ed. (2001). Free-choice science education. New York and London, Teachers College, Columbia University.
- Falk, J. H. (2002). "The contribution of free-choice learning to public understanding of science." Interciencia **27**: 62-65.
- Falk, J. H. and L. D. Dierking (1992). The Museum Experience. Washington, D.C., USA, Whalesback Books.
- Falk, J. H. and L. D. Dierking (2000). Learning from Museums: Visitor Experiences and the making of Meaning. Walnut Creek, AltaMira Press.
- Feher, E. (1990). "Interactive museum exhibits as tools for learning: Exploration with light." International Journal of Science Education **12**(1): 35 **-** 39.
- Ferlin, A. and A. Lefebvre (Avril 2001) "10 ans et toutes ses dents." Enquête. Nausicaâ, Centre National de la Mer. Boulogne/mer.
- Greene, P. (2001). Reinventing the science museum - The Museum of Science and Industry in Manchester and the regeneration of industrial landscapes. The European Museum Forum Annual Lecture 2001, Gdansk, Poland.
- Gutmann, R., B. Heilbronner, et al. (2001) "Jahresbericht 2000." Deutsches Museum. Munich.
- Jensen, N. (1994). "Children's perceptions of their museum experiences: A contextual perspective." Children's Environments **11**(4): 300-324.
- Journal "Le Monde". (mars 1991) "Science, pouvoir, citoyen. Le chercheur dans la société contemporaine." Colloque: Les cinq ans de La Villette. Supplément "Le Monde". Paris.
- Klein, HJ. (2000) "Go West. Die Besucher des Deutsches Museums und ihre Meinungen über das Neue Verkehrsmuseum." Karlsruhe.
- Krakauer, T. H. (2001). The North Carolina Museum of Life and Science: Economic Impact Analysis. Durham, North Carolina, The North Carolina Museum of Life and Science**:** 1.

- Kubota, C. and R. Olstad (1991). "Effects of novelty-reducing preparation on exploratory behavior and cognitive learning in a science museum setting." Journal of Research in Science Teaching **28**(3): 225-234.
- Lévy-Leblond, J-M. (19 November 1993) "Last exit to science." ECSITE conference. Copenhagen.
- Lipardi, V. (1997). A strategy to build links with local community: the experience of Città della Scienza. ECSITE Annual Conference, Brussels.
- Meneer, D. (October 2001) "Eden Project. Market research." Summer 2001. Cornwall.
- Morey and Associates, I. (2001). Economic Impact Analysis of The Tech Museum of Innovation on Santa Clara County 1999, The Tech Museum of Innovation**:** 30.
- Persson, P-E. (July 1996) "Science centres: dedicated to inquiry and exploration." Physics World.
- Persson, P.-E. (2000). "Community Impact of Science Centers: Is there Any?" Curator: The Museum Journal **43**(1): 9-18.
- Persson, P-E. (2000) "Science centres are thriving and going strong!". PUS-UK.
- Piscitelli, B. and D. Anderson (2000). "Young children's learning in museum settings." Visitor Studies Today **3**(3).
- Ramey-Gassert, L., H. J. Walberg III, et al. (1994). "Reexamining connections: Museums as science learning environments." Science Education **78**(4): 345-363.
- Raphling, B. and B. Serrell (1993). Capturing and measuring affective learning. Current Trends in Audience Research and Evaluation. Washington DC, American Association of Museums. **7**.
- Rennie, L. J. (1994). "Measuing affective outcomes from a visit to a science education centre." Science Education **24**: 261-269.
- Rennie, L. J. and T. P. McClafferty (1995). "Using visits to interactive science and technology centers, museums, aquaria, and zoos to promote learning science." Journal of Science Teacher Education: 175-185.
- Rennie, L. J. and T. P. McClafferty (1996). Science Centres and Science Learning. Studies in Science Education. E. Jenkins and J. Donnelly. Nafferton, University of Leeds. **27:** 53-93.
- Rennie, L. J. and G. F. Williams (2000). Science centres and the image of science. Annual meeting of the American Educational Research Association, New Orleans, USA.
- Roberts, L. (1992). Affective learning, affective experience: What does it haveto do with museum education? Visitor Studies: Theory, Research and Practice. S. Benefield, S. Bitgood and H. Shettel. Jacksonville,AL, Center for Social Design. **4:** 162 - 168.
- Salmi, D. H. (2000). Career choices and Heureka. Unpublished memo (in Finnish). Finland, Heureka: The Finnish Science Center.
- Sheppard, B. (2000). "Do museums make a difference? Evaluating programs for social change." Curator: The Museum Journal **43**(1): 63 - 74.
- Siegel, E. (1998). "The Science Career Ladder at the New York Hall of Science." Curator **41**(4): 246-290.
- Spock, M. (2000). "'When I grow up I'd like to work in a place like this'." Curator: The Museum Journal **43**(1): 19 - 32.
- Tisadal, C. and C. Klein (October 1997) "Links between formal and informal learning environments: Developing a research agenda." ASTC conference. St. Louis, Missouri.
- Witschey, W. (2001). Many roles to play: the science centre as community powerhouse. Richmond, Science Center of Virginia**:** 3.
- Wolins, I. S., N. Jensen, et al. (1992). "Children's memories of museum field trips: A qualitative study." Journal of Museum Education **17**(2): 17 - 27.
- Woolnough, B. (1994). "Factors affecting students' choice of science and engineering." International Journal of Science Education **16**: 659-676.


## Scientific community and research organisations

- Scienceline UK
  http://www.sciencenet.org.uk/
- The crazy world of Stephen Hawking.
  www.independent.co.uk/story.jsp?story=98993
- European Science Foundation
  http://www.esf.org/
- ALLEA the European federation of national academies of sciences and humanities
  http://www.allea.org/

# ANNEXES

The annexes are provided in a separate document.