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Science, Society and the Media

CAWET *

Introduction

The sciences indisputably constitute one of the major pillars of our present-day civilization, which has its consequences, for a number of reasons. First and foremost, there is the spectacular momentum of the development of knowledge. Scientists succeeded in unravelling the structure of matter as well as the dynamics of the universe. They are getting an ever-deepening insight into the mechanics that govern diverse forms of life. They are increasingly successful in formulating 'laws' and constructing models that describe the natural phenomena and the function of the systems conceived by man. Clearly, citizens who are able to participate in this increased amount of knowledge, in other words citizens who can understand and judge the acquisitions of modern science, have achieved a higher cultural value. Therefore, it is an important social task to set up initiatives, so that the greatest possible part of the population could be actively involved in this knowledge society.

In addition, a great many aspects of our daily life are increasingly marked by the application of the sciences. Mechanical engineering, electro-technology, chemistry and materials science, building and architecture, electronics and information science are, all of them, instances of applied sciences, which have generated products to enhance the prosperity and well-being of modern man. However, the working mechanisms of these products and the underlying principles tend to remain an unknown domain to many. The ordinary citizen is liable to get alienated from science and technology more and more. He is no longer able to assess the potential and limits of modern technology or to pass mature judgement on possible risks of products and processes. Hence, it is imperative that means should be looked for in order to open up science and technology to the public at large in a simple way, which should result in an enhanced technical-scientific involvement of the citizen. Only then could one expect a constructive contribution of the population to major decisions of a technical nature.

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* CAWET (Commissie van de Academie voor Wetenschap en Techniek) stands for Academy Committee for Science and Technology (Flanders, Belgium).

Next, in view of the increased scientific-technical dimension of the world we live in it is of the utmost importance that young people should be enthused for careers in science and technology. On the one hand, we need to make them aware of the vital role of science and technology as regards the realization of our present-day prosperity and well-being; on the other hand, we have to stress that they are the indispensable instruments to cope with the new challenges in our world. Science and technology have contributed to an ever increasing life expectancy, and have ameliorated the well-being of the sick and the disabled, the comforts of domestic work; they have humanized labour and affected the quality of our cultural environment. In times to come they can help us improve the conditions in the third world, solve environmental problems, manage the use of the resources of this planet more carefully and distribute them more evenly.

Finally, we are witnessing a rapid shifting of economic clusters of activity in this beginning twenty-first century: from Western to Central and Eastern Europe, from Europe to East Asia. These developments might well entail the dismantling of a great deal of industrial activity in our regions. It is therefore of paramount importance that we should keep playing an active role in the further development of our new knowledge society, not a passive one. It is vital to persuade young people to go into a dynamic and creative career in science and technology through the channel of carefully thought-out science communication. So we can be sure that new initiatives will be realized in our society and that innovation will not turn out to be mere rhetoric. Only in this way shall we be able to prevent Belgium and Europe from being pushed to a marginal economic position, so they cannot any longer play a major role globally.

Science communication in Flanders

Whenever the word 'science' is used in the text below, both 'science and technology' are meant, unless stated explicitly otherwise. Similarly, 'scientist' stands for 'scientist and engineer'.

Science communication, a democratic duty

Nobody will dispute that our society pivots on the foundations of science, while its development is also determined by it. Due to the advent of synthetic materials, television, computers, the Internet and the mobile telephone, our

lives were dramatically affected in a number of times during the past half century. In the eighties, the decade of the Third Industrial Revolution, we could see 'new materials' emerging, such as genetic engineering, the PC, telematics, micro-electronics, business automation, robotics, information society, domotics and environmental technology. Each of them is an example of techniques that have given our way of living a new dimension. One thing stands out: whoever wants to join in this society has to be thoroughly familiar with science and technology.

Most of the people consider the developments in science and technology to be challenging and useful, while at the same time threatening and beyond their grasp. Magazines such as EOS and *Natuur, Wetenschap en Technologie* (Nature, Science and Technology) can boast a wide circulation. It appears from the 2001 Eurobarometer[1] that 42.2 % of the Belgians are at least 'moderately interested' in science and technology; this percentage even rises to 56.9 % when medical interests are specifically inquired into. In North America these rates are still a lot higher. Only 11.7 % of the Belgians think they are not interested in any single domain of science. One Belgian out of ten says that he or she respects scientists. That much is clear: a fair number of people are interested in science. However, 64 % of the people that were surveyed (71 % of the Flemish population) think that they are badly informed. It is difficult to assess how well or badly the Belgians are actually informed: questions about antibiotics, electrons, genes, radioactivity, evolution, geology, the solar system are more often than not correctly answered, even though no fewer than 51 % of the Belgians are of the opinion that astrology is a science. At the same time people are apprehensive of science: radiation of mobile telephones and screens, radioactivity, carcinogens, high-tension networks, dioxin, genetic manipulation, computers, cloning, hormones in our meat and antibiotics in our fish. All of them have a negative connotation and are often associated with science. In the past this fear was mitigated by the 'white dress'. However, from the sixties on this authority was being eroded and distrust was growing; people were becoming more assertive and critical. They came to the conclusion that scientists are not by definition objective, but that, enthused by their technological optimism, they

[1] Eurobarometer: the European Union is monitoring public opinion in the member states with a view to helping them to draft texts, prepare decisions, and evaluate their policies. The results of the surveys are processed in the Eurobarometer, of which a great many have already been published. Eurobarometer 55.2 was drawn up in 2001 and was entitled: *Europeans, Science and Technology* (available on website:
http://europa.eu.int/comm/research/press/2001/pr0612en-report.pdf)

sometimes tend to minimize the real problems, at least for the outside world. This may be one of the factors which, among others, have on impact on the perception of nuclear energy. Fortunately, the citizen's confidence has not completely ebbed away. Doctors are heading the list of persons who inspire confidence (71 %), followed by scientists (45 %), engineers (30 %), judges (21 %) and politicians (7 %). Polls suggest that people prefer to turn to a scientist to be informed, whenever we are hit by a catastrophe (63 %), next to an environmental organization (60 %), and also doctors (53 %). 85 % of the population advises politicians to listen more to scientists. A majority of them assume that science is able to supply solutions for diseases and environmental difficulties. The people are also aware that, to a very large extent, it is the sciences that should be credited with our modern comforts and our economic prosperity. Yet, the citizens do not let themselves be bombarded with vague commonplaces: 80 % do not believe that science is able to solve all the problems, while 62 % doubt whether it can dispel poverty from the world.

Today people want involvement: so they want to be involved in the decision-making as to what direction society should be heading for, a society which is increasingly conditioned by science. In order to properly take advantage of his democratic right of choice, the citizen should be given an ever increasing understanding of science and scientific processes. But then again, understanding presupposes knowledge about the 'artefacts' of science, and the way that they were realized. And, very regrettably, this knowledge tends to be lacking every now and then. The consequences are fear, misunderstanding, and sheer rejection. Hence, reliable and clearly communicated information is a must. This is the first motivation for this chapter to be written.

A second motivation lies in the decreasing interest of young people in a scientific career, either as a researcher or an engineer. The number of students who started science courses at university dropped by 25 % in Flanders between the years 1999-2000 and 2002-2003. The number of students in the civil engineering departments was on the decrease, but then rose again in 2001-2002, because the entrance examinations were made less rigorous. However, in the year 2002-2003 there was another drop of nearly 20 % of students enrolled. The number of young people who started engineering courses at polytechnics fell by 25 % in this same period of 4 years. These are alarming figures at a time that everybody stresses the need for innovation. In an age when emerging economic superpowers are rapidly attracting modern technologies, innovation is the tool *par excellence* to keep

the performance of our economy on a high level. So, scientists and engineers are necessary in order to innovate. In Lisbon the EU decided that 3 % of the GDP needs to be spent on research. The situation being as it is now, Belgium will have to attract scientists from abroad to staff its laboratories and research centres.

In concluding, science communication is a must for the people in general as well as for the young, who must be insistently convinced of the usefulness of doing a course in exact or applied sciences.

What good science communication is about

Good science communication is more than an explanation, however clear and simple, of mere facts. It has to supply people with the capability to actively collect information themselves and to try to find out what science is all about.

Close to the people. Good science communication has to involve the public very closely. You cannot bring about new insights by way of mere theoretical approaches to subjects as gravitation, electromagnetism, DNA. But you may be successful, if you can present the theory via various points of view, such as sports, being in love, a backache, the pleasure of eating chocolate, but also its damaging effects. Being close to the public means presenting people with a variety of differentiated possibilities. It is advisable to initiate children in their own way. Seekers of information have to be given insight and background, those that seek confirmation want to have their insights tested, still others expect to obtain quick 'prepacked' data to be well informed and to be able to join in a conversation. Some people want to find reassurance or to have their anxiety assuaged, others are keen on 'ad hoc' information about their choice of a career; TV producers ought to try their utmost to entertain their viewers via infotainment, even if scientific topics are tackled.

Marketeers have been making differentiations for quite a long time. To the five standard P's of marketing (person, product, price, promotion and place) science communication adds a sixth one: 'pedagogics' as a means to arouse people's interest, remove anxiety, provide insights and underpin the careers choice. Depending on the target group involved, science communication has a wide set of instruments at its disposal: puppet shows for the under-fives, a course for the elderly about how to operate 'complicated' devices, such as a remote control unit, a video player and the

mobile telephone, a do-calendar in the kitchen, do-packages for the class-room, a science event, science theatre, stalls at fairs, TV programmes, and technology days. Science communication is multi-tiered and gets in touch with various people at various intellectual levels; it addresses them in a number of ways: rational, emotional and experience-oriented.

Clearly, science communication should preferably be integrated in a joint network of activities, regardless of who takes the initiative, ranging from industry to universities, schools of higher education or polytechnics, scientific institutions and academies. There is a need for a co-ordinating organization, which steers all initiatives as regards science communication and gears them to one another. The authorities have already made great efforts to supervise and streamline all the programmes financed by them. In order to get the other actors involved as well, it might be useful to set up an 'umbrella' organization, a High Council to advance science communication in a site, such as Technopolis, giving the incentives. All kinds of science communication would be automatically embedded in an environment where a well-functioning science centre is fully operative: a centre in which diverse aspects of services would originate. Such a science centre could be ideal to give these forms of service an integrated location at the market, and function as a showpiece for the entire array of 'products'.

The Trojan Horse. The task of a communicator is not always equally rewarding. He or she never knows whether the people will be listening to him/her or not. One thing stands out: the technique of the *Trojan Horse* can work miracles, or how to get difficult matters sold thanks to trendy packing. Good science communication knows how to go about in presenting science in a nice box with a brightly coloured ribbon: it tells tales, is fascinating, and offers drama and entertainment. The success story of the TV programme *Hoe? Zo! (*How? So!) and the radio programme *Jongens & Wetenschap (*Boys & Science*)* both on VRT (Flemish Radio and Television) show science to really catch on, when presented as pleasant entertainment (or infotainment).

*The so-called 'Aha-Erlebnis' (*Aha-experience*).* Yet, a communicator is not an isolated person. He or she has an ally, and its name is amazement, certainly if it leads to an Aha-experience. When it suddenly 'clicks', the feeling is very intense and enormously rewarding. Every researcher will assure you these few moments of sudden understanding make a whole career worthwhile. As the French philosopher Descartes put it, 'surprise makes one learn and helps to remember'. The process of sudden insight, or even mere

unexpected discoveries, provides gripping sensation, which is sometimes remembered throughout one's life.

However, 'Aha' is an experience that seldom occurs, if at all, with easily available, ready-made pieces of information. In other words, interactivity is of paramount importance. Science communication is bound to involve the people actively. Therefore, science centres, do-centres and interactive museums, such as Technopolis, Hidrodoe, Earth Explorer and Isotopolis, occupy a very important place in the field of science communication. They add a third component to the adage: 'I hear and I forget, I see and I remember', viz. 'I do and I understand'. This implies, among other things, that language is not the only tool of information transfer. Good science communication also makes use of non-linguistic forms of transfer: it appeals to all the senses, or to phrase it with an English term: it pursues a 'full body experience'.

Target groups for science communication and ways of approaching them

Science communication not only needs to be differentiated, it also has to be targeted at diverse groups: the public at large, education, the media, scientists, industry and the authorities. In what follows we are supplying a number of methods to reach these target groups as well as some messages to have them enthralled by the sciences.

General Public

A. Targets

Inspiring confidence. To inspire confidence it is no doubt useful to inform the public more often and more thoroughly: in other words the process of osmosis. Confidence can only be achieved through transparency. Scientific research in ivory towers and technical developments in secluded laboratories do not enhance confidence. Science and technology need to inform the people steadily and spontaneously about what they are concerned with, and to keep doing that for a long time, because it takes years to alter a reputation. Coming out with results regularly is not the same as spreading news with shouting hurray every now and then. The general public not knowing much

about science does not mean that they are stupid or underdeveloped. They do understand and accept that an engineer is not a magician and that findings and discoveries may also have drawbacks. Now developments are always intended to have useful applications, but abuses, undesired side-effects and even miscalculations are never to be totally excluded. Who can honestly admit this has more chances to win the people's confidence. In any case, the citizen must be given access to a quick and correct supply of information, also – and above all – at times when science and technology perform less well. It is inherent to human nature to be more susceptible to negative facts than to positive ones, and this predilection for 'bad news' also comes to the fore in the media. Owing to this, there is a real chance that 'spontaneous contacts' of the public with science and technology tend to be connected with unpleasant experiences. This is the very moment when science must be ready to inspire confidence. Or better still, the scientist must enjoy the people's confidence as the messenger of correct and objective information. It is precisely because people are little familiar with the world of scientists and what their research efforts are about, that pressure groups often succeed in associating researches with one party in a given controversy. In practice, things mostly happen like this: on one side there is the pressure group which claims to stand up for the public interest (the consumer's), on the other side stands the opponent (mostly industry) who defends his interests. More often than not the scientist sides with industry, as far as appearances go, while as an important expert he should stick to the mere facts and be able to supply unprejudiced and neutral insight. This perception of impartial expertise must, as a matter of urgency, be adopted by the community. This will succeed only if regular and clearly understandable information about science and technology is supplied.

Improving literacy. Participating in democracy also implies insight into its scientific developments, which requires satisfactory basic knowledge, in other words scientific literacy at a fair level.

A better understanding of what science can offer. 'Literacy' not only amounts to knowledge of scientific data, but also insight into the way science operates. However, there is a problem: the general public expects science to provide them with certainties, while science mainly works with probabilities and often weighs various hypotheses against each other. Researchers are very well aware of it that scientific 'laws' are seldom universally valid, and that nuancing is nearly always necessary. Probabilities rarely yield a usable 'sound bite' for the hurried media. People expect direct, straightforward understandable answers, which is an extremely difficult task. Indeed, the

domain where science is usually wrongly understood is that of risks, chances and probabilities. The public should be provided with means to understand probabilities better and to assess chances and risks more exactly. A chance of 'one in a hundred years' is different from 'every hundred years'. Yet, this does not necessarily imply that you can rest assured for the next century after the event occurred. That lightning has already struck once does not decrease the chance of it striking again. A minimal risk that rises with 300 % remains a minimal risk. Quite a lot of accidents hit more victims than disasters do, but the public often only demands measures against the latter.

Humanization of the image of the scientist. Scientists will surely benefit from the humanization of their image; so, they should be more 'visible' in society. Their participation in game and quiz shows, drama serials on TV, novels and parliament seems to be indicated. However, it is difficult to make 'humanization' compatible with the image that scientists create of themselves: detached, objective, aspiring to truth as their only objective, 'reason' being their only instrument on that score. In textbooks and journals you can read how, through a process of logical reasoning, the researcher comes to a hypothesis, which he or she wants to have empirically proven. However, nothing is said about the ways that have led to a dead end, irrational brainwaves, obstinacy, mere chance, failures, envy and strife, even though the covered-up human traits and chance may have been as essential as the reasoning itself to reach the right conclusion. The straight and rational exposition in the form of the eventual publication is a *post-factum* construct. Science does have human features, which should be put in the limelight more often.

Emphasizing the benefits. The results and derived products of scientific research have a bigger impact on our daily lives than most people are aware of. This ought to be stressed more strongly and brought to the attention of the young first and foremost. The applied sciences created products that have considerably contributed to our material comfort. In this context we could cite the sensational developments of medicine, which have increased our life expectancy spectacularly. But there is a drawback to our high standard of living generated by science in terms of all sorts of problems, such as environmental pollution. However, it needs to be stressed that these negative effects are not due to science as such but to the (wrong) use of it. Indeed, it is precisely scientific research that offers hope of proper solutions; a good case in point are the techniques of environmental treatments. The message of social 'relevance' is best combined with the one that scientific knowledge, just like art, can be an objective in its own right, and that conquering new

'territories', also in the field of knowledge, is inherent to man's craving for adventure. A project that tries to focus on this facet is *Wetenschap in de kijker* (Focusing on science), which invites pupils from the highest grade of secondary schools to visit research institutions.

B. Suggestions: ways and methods

According to the Eurobarometer 55.2 the public gather two thirds of their scientific information from TV programmes. TV is the outstanding means to reach people. In Flanders VRT produces science programmes, such as *Overleven* (Surviving) and *Hoe? Zo!* (How? So!). On radio *Jongens en Wetenschap* (Boys and Science) enjoyed high listening ratings. But there are many more opportunities. In the field of science communication the Flemish authorities do not lag behind, and on Internet they had the site developed *Wetenschap maakt knap* (Science makes you smart), which, by definition, addresses a large audience. By the side of audio-visual media and the Net, science has at its disposal an array of means to get its message across: the written press, campaigns and events, conferences and *ad hoc* courses.

This message need not be necessarily anchored in programmes covering science communication. Why not embed it in a (popular) drama serial or docudrama that presents the researcher or engineer as a human being of flesh and blood with his/her problems, emotions, defeats and successes, both in the professional and the personal field? To some extent this could be a programme comparable with the numerous serials on TV featuring doctors. So, in the Naples region a drama serial is/was broadcast, in which one of the leading actors is a staff member of the local science centre; some of the episodes are even shot in the centre itself.

Another possibility might be TV programmes and contributions in magazines about scientists – the greater as well as the lesser gods – in which the picturing of their lives and aspirations is at the centre. Possibly it is desirable to point out the impact of their work on society. Here we could consider the consequences of the nuclear bomb, the use of the paperclip and the 'Pritt' tip, or the results for transport by train.

Maybe it is desirable for Flanders to look beyond its borders and use, as its model, the Dutch *Kennislink* (Knowledge link) on the internet, which everybody can consult for their scientific queries and where they are likely to get an answer as well.

Having the general public participate in societal decisions about new techniques, through broad social discussions, panels, hearings and referenda, is another thing to increase the involvement of the man-in-the-street.
Proven advertising techniques, such as the British have implemented in the project 'Science on the buses', may also catch on in Flanders. The posters on the London buses served as the carriers of scientific questions and slogans, somewhat in the line of the poetry posters in our country. This approach could also be worked out in Flanders on trains, trams and buses. And why not actively involve newspaper kiosks and shops?

A science night could give the Science Week and the Science Event[2] an extra dimension. Again, we can find some inspiration in The Netherlands, where a yearly event with this heading enjoys a great deal of public attention.

Education

A. Objectives

Science education should exceed the mere methodological transfer of knowledge, theory and concepts. It is vital for young people to be able to experiment on this knowledge empirically and test it against reality. In so doing, they will realize that the theory driven home is perfectly meaningful and has its usefulness. However, time is sadly lacking at school. On this score, do-centres and various scientific attractions constitute a wonderful substitute, where young as well as older people discover the use, the 'how' and 'why' of scientific applications in a 'playful' environment. In this way they may get aware of it that a scientific and/or technical career opens up new perspectives and can be fascinating at the same time. As a matter of fact, 'fiction' about scientists and initiatives such as the 'Day of Technology' and the 'Science Week' will support this attitude. Extra initiatives like these must be conducted in consultation with schools in order to come to an integrated process of communication.

It has also been established that who goes into a non-scientific branch or simply takes up a professional career, quickly tends to 'forget' the most elementary knowledge of mathematics, physics and chemistry, the reason being that little scope remains for contact with science in daily life after school time. Subjects such as geography and history do not fade away that easily, because they regularly turn up in the news bulletins on TV, in

[2] Science Event: see http://www.innovatie.vlaanderen.be/knap/acties/iedereen/wetenschapsfeest.htm

newspapers and periodicals and so are part of the topics of the day. The sciences are less likely to get into the public light. Yet, information about breakthroughs in the field of medical research and 'innovations' fairly rapidly scores in news bulletins on TV or papers. By contrast, apart from medicine news, items from the domain of the exact and applied sciences get less attention. Yet, there is no denying that open and well-founded background information in reports about environmental disasters and accidents resulting from the transport of hazardous materials, among other things, might prove very useful.

Another drawback is that students who do postgraduate work (for a doctor's degree) are less attracted by a career in industry, because here research is often assigned a second-class place. In addition, in expansion operations enterprises can be sold without the staff getting any information, let alone participation.

There is still a great deal of work to be done to make readable instruction leaflets available, not only for medicines, but also for all sorts of products and appliances, such as mobile telephones and radio sets, PC's, household appliances, detergents, beauty products, adhesives, plastic furniture, flowers and plants.

B. Ways and recommendations

Making young people familiar with the 'kick' of discovering (their experiences in Technopolis, Hidrodoe, Earth Explorer and Isotopolis, simple experiments and practical work in the classroom) can be a means to get them to like science. At the same time they may find that the sciences, after all, offer good career opportunities. Pupils ought to be made enthusiastic to undertake something, invent things, solve practical problems, and choose a technical training. A prerequisite condition is that technical education is made attractive.

Many textbooks contain short biographies of researchers, background stories and *petite histoire*. However, these pages are seldom part of the subject matter. Wouldn't it be advisable to integrate such material into the teaching package proper?

A better underpinning of the subject 'Technological Education' might be achieved by easy admission to the workshops of the technical department for pupils from the so-called A.S.O. (General Secondary Education). The same goes for their teachers! In all the educational programmes, also in the

humanities, the sciences should be given a slot; similarly, scientists will benefit from subjects like philosophy of science, historical methodology, etc. Schools should take initiatives to get parents more involved in technical education. It is desirable to start the introduction of science at primary school level, even as early as the very first year. This could be realized by various means, such as the TV programme *Curieuzeneuze*[3], *OntdekWaaiers*[4], science theatres, puppet shows and do-packages. In order to come to scientific literacy science has to be assigned a place in all the curricula throughout, including the humanities at universities. Persuading young people to join in European contests, 'Olympics', and other scientific projects can have positive effects. Perhaps these opportunities and their collateral results have to be more and better advertised. The promotion of 'scenario contests' at school for scientific programmes and television drama serials is still another way to give the interest in science a new impetus. Centres for Pupil Counselling, the so-called CLB's, could benefit from more aid and objective information about possible choices of study, certainly when exacting but less appealing jobs are involved. Both the authorities and industry have a task to fulfil here.

It is desirable that the career opportunities for scientists should be brought into the foreground, at school as well as the CLB's. A means to achieve this is inviting people from science and industry to secondary schools to have them talk about their professions. Good examples in this context score are the Technopolis project *Blikopeners*[5], the British 'Engineer from around the corner', and a project set up by the Federation of the Chemical Industry of Flanders. It would be a major step forward if teachers in the science subjects were to succeed in getting across their own professional enthusiasm to their pupils – admittedly, an extremely difficult task. The motivation emanating from them may well be contagious. It is perhaps also advisable to extend the compulsory subject matter of the science courses with a chapter 'practical applications' (things that we are faced with in our daily lives). Workshops in which teaching experiences are exchanged will undoubtedly enhance the level of scientific education. Such experiences can be: demonstrations, small

[3] *Curieuzeneuze* is a TV programme intended for primary school children, in which, together with the presenter himself, a 'Sherlock Holmes', aged between 10 and 12 years, searches for answers that seem to be *prima facie* odd scientific queries.

[4] *OntdekWaaiers* (more or less: "Discovering Spectra"): figurative cards for young people, featuring a number of scientific experiments to be tested out at home.

[5] This is another Technopolis project, in which schools participating in *Blikopeners* are paid a visit, at a moment agreed on, by a scientist, an engineer or an expert from the region, who introduces sixth-formers (last year of ASO or TSO) to what the job they have opted for is all about.

tests, presentation of self-made apparatuses, computer programmes, self-devised websites. In addition to a reward, the best should get an opportunity to give presentations at conferences, workshops, schools, or at a Science Event. And why not integrate science communication as a separate subject into the curriculum of future teachers? Teachers ought to be encouraged to attend seminars organized for them by industry or scientific societies. The ideal would be for science teachers to be given a chance to be in training in industry at regular times. The remuneration for these training periods could be in the form of special vouchers. Universities have to pay more attention to good teaching. They can reward lecturers for good teaching methods and their efforts to make the subject matter of science classes more attractive by means of better promotion opportunities. As things now are, only good researchers qualify for promotion, whether they are good lecturers or not.

University students have to be taught how to write proper texts that are not exclusively intended for specialists. Therefore it is advisable to offer science communication as an option course (even an compulsory one?) in all the scientific curricula (bachelor, master, engineer, doctor), say in the third bachelor year. And, again, the same goes for the subject history of science. Science communication ought to be a compulsory component in the curriculum of communication studies. Similarly, the history of science should be an obligatory course in the history departments (as is the case in the US), or as an option for students taking science as their main course. It could prove worthwhile to consider widening the scope of the curricula in higher education by combining 'arts' and science subjects in all the study programmes.

Media

Scientific reporting is reasonably well covered on radio and TV. However, every now and then their reports are not exact. Here, a scientific information centre for the media, possibly under the auspices of the Royal Flemish Academy, could be a useful instrument. What we have in mind is a centre with 'counter' facilities, which either directly answers the questions of the journalists or refers them to an expert in a given domain. Indeed, this would be a welcome supplement to the network of informers that journalists often develop on their own. Far too often the media picture industry in a negative setting. Rather than focus on outdated and therefore more polluting factories, they should highlight modern installations and new technical developments. This means opting for a positive stance, even though this is an extremely

hard nut to crack, given the generally accepted journalistic maxim 'good news is no news'.

What tasks could be fulfilled by such an information centre? For one thing, it could provide background data as to particular scientific developments, which journalists would gratefully accept, provided they can get easy and immediate access to them. A database that can be directly drawn on and which provides general principles, explanation and background concerning a whole set of key words, may prove very useful to them; this base could also contain clarifying information about great scientists. If there is a 'news cluster', such a background story will be ready-made material for the interested journalist to use. See, for instance, biographies in the MacTutor History of Mathematics Archive.[6] Magazines are not pressed for time that much, and their subjects are less closely related to current events. Here well-drafted portraits will be welcome material. As a matter of course, the information centre should give absolute priority to Belgian researchers. The media are flooded with numerous cut-and-dried press releases from American universities, so they will be tempted not to pursue a time-consuming search for a Belgian authority in the domain at issue. Investigating in the research centres of our own scientists and drawing the attention of the media to their results is another task to be performed by this information centre.

In this context the education of scientific journalists is a must. The quality media, in fact the only ones employing full-time scientific journalists, engage graduates with a broad field of interests and then teach them the 'tricks' of journalism on their own. Such people will hardly benefit from a supplementary science course. However, in the popular media, science is often looked after by someone who happens to be interested in it – or who has only a weak excuse for shying away from this so-called secondary responsibility. Background information about the way science functions and a basic knowledge of the diverse branches of the sciences can give some hold to these persons. Whenever science is not correctly dealt with in the media, this is more often than not due to a lack of background on the part of the journalists involved. The primary information was mostly right – albeit not in readily understandable phrasing – but things went wrong as soon as the interpretation of facts came into play.

[6] www-groups.dcs.st-and.ac.uk/~history/

Scientists

When new paths of research with social-ethical implications are followed, such as cloning, or GGO (*Genetisch Gewijzigde Organismen* or Genetically Altered Organism), it is of the utmost importance that scientists should realize the consequences of their experiments. This is called the principle of carefulness. In extreme cases they have to be able to agree on a moratorium and/or safety measures; here we refer to the conference of Asilomar when gentechnology was beginning to be developed. In still other cases they must inform society in the most straightforward way possible. In any case, they have to be able to answer the ethical (or merely worried) questions of the public with due caution, if necessary.

Scientists have to be convinced of it that popularisation is of the utmost importance. Therefore, this has to be encouraged and supported through subsidies among other things, but also through peer review and appreciation. It may be worth considering to give popularising contributions the same weight as articles in specialist journals. Popularisation is understood to mean: books, articles in magazines, interviews, scripts, giving advice for TV programmes, training packages, talks for schools and organizations, informative websites. The scientists can be rewarded for these efforts by means of a system of marks for their list of publications, extra funding and awards, preferential treatment in career matters, travelling grants for congresses.

Popularisation is founded on a fluent way of communicating. With a view to this, media and communication training need to be promoted and be integrated in the curriculum as a possible option. Not only the individual researchers and universities, but also the scientific societies should be encouraged to communicate with the press and the general public. They can do so through training packages and talks. Popularising press reports ought to be taken for granted for all congresses. Another possibility is appointing a spokesman. In any case, efforts need to be made to involve the press actively; an available means to achieve this is explaining topical events through background information.

In order to stimulate researchers at universities participation in popularising communication could be used as a criterion for the evaluation of someone’s career (lecturers and professors). A consequence of the 'alienation' of our scientists is that our Flemish, Belgian and European research projects come off very poorly in the press. Whenever an opportunity presents itself, they must learn to step up to the press themselves with the results of

their work. Faculties and/or departments could consider laying down standards for the rate at which press reports need to be spread. If communication with the public at large were given greater weight to qualify for appointments and subsidies, scientists would be stimulated to deploy networks with journalists of their own. When people expect large-scale reports about touchy topics or sensational news items that are linked to background information (environmental disasters, explosions of hazardous materials), it is advisable that the scientists themselves should get in touch with the press, either as a preventive measure or by way of feedback. If journalists are not given a rap on their knuckles whenever they can offer only inaccurate information, or even nonsense, they will never realize that they are actually doing so, or they will never be encouraged to enter the names of competent scientists into their list of addresses.

The setting-up of a website that the 'visitor' can get help from as to his questions about science, and on which he can rely for prompt and straightforward answers, may well boost the scientist's readiness to listen as well as an open attitude to deal with the public. The same holds for science shops, open house events and the designation of a science communicator. Solid scientific websites deserve being awarded a quality label. Experience with the abundance of so-called 'bio' labels in the food industry has taught us that such a label has to be reliable and widespread before people attach any credit to it.

Also the drawing-up of a code of conduct for dealing with the press is worth considering, the first commandment being: you shall regularly communicate with the media. Not: you shall not put yourself in the limelight; rather, it is good and proper to put yourself in the limelight, provided you do not ignore the competition. Management or decision science, risk assessment and popularisation ought to be part and parcel of any scientific education programme. It deserves recommendation for universities and/or departments to designate a science spokesman. Why not organize a preliminary meeting or briefing for the general public (or at least the press) in all cases when scientific congresses are held? And – in general – if scientists were persuaded to impart their enthusiasm for research to the young and other people, this would be a major step forwards. However, imparting enthusiasm inevitably comes down to communication.

Industry

Industry has to be convinced of the usefulness of sponsoring popularisation activities and joining in them. Possible ways for establishing contact with the people are: offering teaching packages, inviting speakers, such as the project *'Blikopeners'* (literally: Can Openers) of the Flanders Technology International (FTI) Foundation, organizing open days (Day of Technology), and setting up a website supplying not only commercial but also scientific-technical information about their products. The internet contains a great deal of inaccurate data. Industry can have an active part here in filtering out the nonsensical items. Therefore, the enterprises should keep a shrewd eye on the information given by colleagues/competitors, and promptly counter the disinformation spread by pressure groups.

In the last year (or sixth form) of secondary education manuals about home appliances, instructions for use, all sorts of information leaflets and advertising leaflets can be used as didactic material for purposes of scientific clarification easy to grasp. Far too often the public at large comes into contact with technology in a rather counterproductive way, owing to confusing, badly drafted and almost unreadable manuals and instruction leaflets. They sometimes contain faulty information. Or even worse, they are intended, first and foremost, to provide the manufacturer with judicial protection in case something goes wrong with the apparatus. Confusing or misleading manuals are not conducive to a positive image of science and technology. Instructions for use should be checked in terms of their correctness, clarity of expression, easily accessible language, and didactic approach. This checking procedure ought to be made compulsory for every new product that is being launched. This is a first option. A second option consists in granting every manual, submitted for approval, on a 'voluntary' basis, the official recognition as 'legally approved operating booklet', in case the product has been actually accepted. Clearly, the manufacturer can freely make use of it for advertising purposes afterwards. Science popularisation cannot but benefit from this manual or booklet being supplemented with a comprehensible explanation about the underlying scientific principles that the product is based on. Of course, such information first needs to be assessed by a competent body, which is expected to verify the correctness of the contents as well as its accessibility to the reader. A good case in point here are the instructions for the use of medicines, which are not easily comprehensible for most people, though officially endorsed.

Industry has to realize that it is in their interest to convince youth and their teachers that enterprises are not only polluters and 'guzzlers' of (natural) resources. On the contrary, they should keep hammering at it that companies underlie our modern comforts and prosperity. This ought to be included in their advertising. On this score, joint sensibilisation campaigns per sector are worth considering. It would be advisable to push enterprises so far that they regard it as an honour for them to be able to inform the public that they are joining in European programmes, such as Framework[7] and Eureka[8], much in the same way as they are proud today to announce that they have obtained an ISO 9001. Enterprises have to be encouraged to go public not only with their financial results and annual reports, but also with their scientific and technical achievements. It should be stressed that it does not suffice to include a standard and nicely illustrated chapter in the paper version of the annual report, while at the same time this tends to be omitted from the press release. Far too often enterprises shy away from publishing any information about their research for reasons of competition and patent rights; yet, the public is mainly interested in general facts, which, as a matter of fact, are already known to the competitors.

Here, special training programmes for teachers organized by industry, after the example of initiatives taken by VKW (*Verbond van Kristelijke Werkgevers en Kaderleden*, 'Union of Christian Employers and Executives') and FEDICHEM (*Federatie van de Chemische Industrie van België*, 'Federation of the Chemical Industry in Belgium') are outstanding Belgian achievements. Teachers need to be urged to attend such courses. Unfortunately, we see that research is often given little attention in industry, if any at all. Yet, research underlies innovation and guarantees the best chances for enterprises to maintain a satisfactory competitive level. A change of attitude is urgently needed. It is in the interest of industry to employ a better trained staff. A project like the Dutch *Jet-net* would prove useful in our country as well. Five of the biggest Dutch enterprises launched a campaign to motivate more people to opt for a technical education or training and they gradually enthused the rest of the enterprises. 'Jet-net' stands for *Jongeren en Technologie Netwerk* (The Young and Technology Network).[9]

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[7] Framework is an organization sponsored by the EU to promote research and technological developments.

[8] Eureka is a joint European programme for applied market-driven research, in which no fewer than 31 European countries take part. Let it be stressed that Eureka is NOT a research programme of the European Union as such..

[9] www.jet-net.nl.

Authorities

Via *Wetenschap maakt knap* the authorities sponsor activities promoting science communication, many of which are resumed in the suggestions below:
- These actions are rather little known. Therefore, more energy has to be invested in advertising them; in this context there are promotion programmes, both for scientific research and product development in the various companies. The results of these programmes have to be made public, too. The same holds for European programmes such as Framework and Eureka (see section Industry).
- Budgets for Education and Training (O&O) ought to be given priority, and the ones concerning popularization deserve having a permanent and long-term status.
- The volume of the budgets should be (directly) proportional to the competitive potential of the subsidized research unit.
- It is advisable to make the support of deserving institutions, such as the educational services in museums and do-centres, more permanent and to extend it to a longer period of time.
- Scientific events, like a Science 'Happening', an outreach of institutions, science camps and conferences, ought to get more incentives from the authorities.
- And why, in the support provided to the media, not earmark a small amount of extra money for science communication? (*Hoe? Zo!,* the periodical *EOS*, *Jongens&Wetenschap*, the science sections in newspapers, contributions in the popular press).
- The authorities can also contribute to the coordination of useful initiatives promoting science communication.
- Enterprises which continually do their best to supply correct and reliable information deserve encouraging.
- Finally, it is also possible for the authorities to grant their support to an 'umbrella' platform that surveys science and scientific activities or, alternatively, to set up such a platform themselves. The same goes for technology assessment.

International examples of successful science communication

Science coming to you

Experion: An interactive display in a trailer, which comes to the customer (*i.e*. the school). By means of a thrilling story and challenging assignments young people are stimulated in this 'science trailer' to implement scientific work. Experion, which is operated by the Flemish do-centre Technopolis, was praised in 2002 as one of the best practices in science communication by the American National Institute of Standards and Technology. Owing to the huge success, Experion will, after 2004, be continued in another trailer featuring new experiments, in line with the same global plan.

History bus: In the (Dutch) province of Gelderland science was presented to the people by means of a 'history bus'. The bus recorded a TV programme on the spot with the aid of the locals. The project approached the population via their interests in the history of their village or region. In the Netherlands even a 'bible bus' is now touring the country.

Science circus: A circus pitches its tents in one of the local villages of the Dutch province of Limburg. The show demonstrates, almost in passing, some basic principles of science and their applications. Via the channel of entertainment information is supplied in a virtually unnoticed way. The show, as a whole, is unpretentious and easily accessible. In Flanders, Technopolis is now performing something similar with the 'science theatre' *Kaat Karaat* and *Wasda?* and the puppet show *Reuske Reuske*. And in England a project in the domain of science theatre is running, in which a controversial scientific application, such as xenotransplantation of genetically manipulated food, is transferred to the environment of somebody who is faced with it in his/her daily life. More profound information can be obtained via CD and a website.

Creative use of existing channels

Pub Genius, Science on the buses. The University of West England in Bristol supplied science quizzes for the popular British quiz circuit in pubs.[10] It also set up posters with scientific questions at the checkouts of shopping centres. Some time before, public transport had been used to run a poster campaign

[10] http://www.uwe.ac.uk/fas/graphicscience

featuring poetry, which was followed by Science on the Buses. Large posters could be seen on double-deckers containing intriguing questions or thought-provoking statements. The aim was to set people thinking and to point to the importance and impact of science and technology on their daily lives.[11]

Technika 10 and the like. This responds to people's natural inclination to flock together in clubs, in this case 'girls-only' technology clubs in the Netherlands, which reach some ten thousand girls aged between 8 and 14, assigned to different age groups, and organize visits to businesses and workshops. The best known among these is Technika 10 for the ten-year-olds. Some schools have already introduced these activities into their curricula.

The TQ track. At the Flemish do-centre Technopolis pupils can apply to any computer in the exhibition area by means of a special electronic key. There they are given particular assignments related to one of the displays, specifically geared to technical thinking and acting. They have to solve a number of problems, after which they obtain a certificate. In this way the 'technology quotient' is brought to the fore, as contrasted with the well-known intelligence quotient, and so pupils other than the so-called 'clever' ones are rewarded and put in the limelight. This approach is also used for tours dealing with other exhibits.

Field Conferences. This is a creative use of the 'open day' system. A three-day visit 'in the field' is annually organized for American politicians who are concerned with the environment, water supplies, etc.; such a visit provides more insight into the issues they have to decide on and it enables them to make direct contact with the population involved as well as with the experts. It is highly valued by the politicians and is organized by the geology department of a university. Since 2001 there has been an adapted version for the general public.[12, 13]

Science via the media

All over the world there are several TV channels dealing with science, the best known of which are Discovery and National Geographic. Various countries are currently planning to launch a science station.

[11] http://www.uwe.ac.uk/fas/graphicscience
[12] http://www.nist.gov/public_affairs/Posters/geological.htm
[13] http://www.kgs.ku.edu/Publications/GeoRecord/1999/vol5.3/Page3.html

Science through the Web

Dive and Discover. This is an American website that takes you to a virtual submarine voyage. You get involved in the daily lives of the researchers through an interest in nature and fascination for undersea life. A special technique was developed to transmit the massive quantity of data via a vessel at sea.[14]

Virtual Worlds. This allures young people via fascination with the Web. There is a virtual world in which you can walk around, built by researchers, and another one which has been designed in such a way that pupils can build a world of their own. Visitors can walk about by means of an avatar (virtual body).[15]

Science@Nasa. This runs a number of successful websites, each of them intended for a different public, ranging from the interested people[16] to the young[17], children[18] and teachers[19]. Among other things, young people can fetch an applet to follow satellites with.

Virtual laboratories. Preparation and working out of the actual laboratory work, or even a substitute of it. It has people experience that science is a process.[20]

Knowledge link. The Netherlands has a number of websites that deal with science, like *Kennislink*, which focus especially on Dutch research.

[14] http://www.divediscover.whoi.edu
[15] http://www.scicentr.org/virtualworlds.asp
[16] http://science.nasa.gov/)
[17] http://liftoff.msfc.nasa.gov/
[18] http://kids.msfc.nasa.gov/
[19] www.thursdayclassroom.com
[20] http://biointeractive.org