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SCIENCE AND THE MEDIA: CHANGING RELATIONS

There has been a growing interest in the relations between science, the media and the public since the 1980's. The emphasis of these studies has ranged from science journalism, public understanding of science, scientific controversies and risk communication to scientists' PR-activities towards the media. In this essay I will consider some basic assumptions and findings of this research. My argument is that existing studies have usually been either too science-centred or media-centred in order to conceptualize the changing relations between the science system and the mass-mediated public sphere.

The research on 'science and the media' has been dominated by the media researchers, but recently the topic has also evoked increasing interest among sociologists of science. One symptom of this development is the founding of a new scientific journal, *Public Understanding of Science*, in 1992. The objective of the journal is to establish an "emerging interdisciplinary research field" (Durant, 1992: 1). Yet there have been rather few systematic attempts to relate these issues to the ongoing trans-

formation of the scientific institutions and social contexts of science¹. One dominant feature of this development is the increasing market orientation of universities and other scientific organizations, which has made the relations between science and the media even more important than before.

It seems that the relations between science and the media, the public image of science and the public understanding of science have increasingly become a political 'problem' as well. The inadequate 'scientific literacy' of the public or the 'distorted public image' of science have been suspected of endangering the social prestige and funding of science. Demands for popularizing or marketing scientific results have become an established part of political rhetoric. In this sense there is an obvious connection between the origins of a research problem and those of a political problem².

The picture which, according to research, can be drawn of the relations between science and the mass media is, for the time being, incoherent and incomplete. For instance, there are no really reliable evalua-

tions concerning the share of material dealing with science within journalism, or within the media in general. The reason for this is not only the lack of comprehensive research; the comparison is also made more difficult by the fact that the definitions concerning 'science' and 'science journalism' are different and controversial. The most trustworthy conclusion of Cronholm's and Sandell's (1987: 220) review of the research in this field is probably that "the volume of scientific information seems to be increasing".

A frequent comment, both in science policy discussion and in research, is that the media cover science and its results only sporadically and not very much at that. On the other hand, it is observed that the general public is usually quite interested in the findings of science, but their scientific literacy is inadequate. A large part of the public do not seem to be aware of whether the Earth revolves around the sun or vice versa, or whether electrons are smaller than atoms (Miller 1991, Durant et. al. 1989 and 1992). The reason for this is often considered, besides education, to be the media, which are claimed to communicate a superficial or misleading picture of science. Journalists are frequently accused of inflating environmental or health problems or introducing pseudosciences and attitudes against science without applying any criticism.

In the following I will attempt to problematize these assumptions so frequently repeated in research and science political discussion. I have condensed this dispersed research – more or less violently – into two 'paradigms', which at least facilitates the comparison of research settings. The division mainly concerns ideal types, rather than a covering classification of the research area. Research on the issue has been carried out around several disciplines and from many different starting points. My objective, however, is to make a 'representative' review in the sense that it will illustrate some of the central problems in the research on this subject. I will not deal with research methods or results in detail; instead, I will study those implicit or explicit points of departure which

serve as the bases for research problem setting. Finally, I shall outline some recent changes in science-media relations which stress the need for a new approach both in science and in journalism studies.

'The traditional paradigm'

In the United States the relations between science and the media began to arouse the interest of mass media researchers after the Second World War. One of the first books on the topic was Krieghbaum's *Science and the Mass Media* (1967), which included a good summary of the research on the field. It also presented most of the central theses which are still used to justify the importance of the popularization of science and its research. According to Krieghbaum, science and its applications increasingly affect the everyday life of people. The interest of the general public in the findings of science has also increased; especially questions dealing with health and ways of life, as well as inventions having an effect on everyday life, are considered important. However, the media cover science only sporadically and infrequently, often only in terms of individual sensations.

Krieghbaum's book also had a clear normative point of departure, which has dominated subsequent research. The objective is to improve the communication on the findings of science, the standard of scientific journalism, and through it, the public understanding of science. The research problem rising from the popularization model was how objectively, reliably and accurately the media cover science and research. In other words, the relation between science and the media was thematized as a problem of "transmitting" and "translating". These so-called accuracy-studies have been carried out mainly in the United States and, to some extent, in Germany, and they have been published especially in the journal *Journalism Quarterly*. The characteristic research setting is this: the object of the research are newspaper articles which popularize the re-

search results, and the scientists or other experts used as their sources evaluate the articles according to how correct and how accurate information they contain. A paradigmatic example is the research of Tankard and Ryan (1974), in which the scientists were mailed newspaper clippings of the articles for which they had acted as sources. The most important result was that the science news contained more mistakes than newspaper news in general. The individuals assessing the clips regarded as the most typical mistakes the facts that the headlines were misleading, some information concerning essential results or research methods had been omitted, the sources were quoted inaccurately, etc.

Along with the correctness of individual facts, accuracy studies have also compared the picture communicated by the media of a given field of research or environmental and health risks with 'objective facts' or 'objective risks' (eg. Kepplinger, 1991). Although these studies have generally unearthed many deficiencies within journalism, some later studies have drawn the conclusion that scientific journalism is no more deficient or incorrect than journalism at large (for an overview see Dunwoody & Peters, 1992). Neither do the scientists in general appear to be especially dissatisfied with the way in which the media cover science (e.g. Ottosen, 1988; Hansen and Dickinson, 1992).

The other traditional research area is the "public understanding of science". Actual reception studies have not been carried out overmuch, but citizens' understanding of science and attitudes towards it have been studied quite extensively in the United States and several European countries. The central concept of these studies is 'scientific literacy', which is formed of three elements: "understanding of the intellectual products of science, i.e. scientific knowledge; understanding the formal processes of scientific inquiry, i.e. scientific method(s); and understanding of the institutional structures of science, i.e. scientific culture" (Durant et al., 1992: 164). In other words, this is a question of how familiar an individual is with the

methods and results of science and how well he or she is able to make use of scientific knowledge.

The central result of the research is that the 'scientific literacy' of the general public is highly inadequate. For example Miller (1991) argues that only about 7 percent of the adults in the United States are 'scientifically literate' and there has been little improvement since the late 1970's. A large part of the public lack either the interest or basic knowledge to understand information about science. The corresponding British studies have also pointed out the discrepancy between people's keen interest in science and their ignorance of it (Durant et al., 1989; 1992). The studies also emphasize the differentiation of the audiences; i.e., differences between men and women.

The problem of these studies is the question of what they actually measure. Their starting point is a 'deficit model' of sorts, according to which science is a certain well-defined body of knowledge, and the conceptions of the people are evaluated in accordance to how well they know and master this body of knowledge. Questions measuring the public level of knowledge deal with certain central research results, technical terms and methods of inquiry. These studies lack any reference to the third dimension: the nature of science as a social institution (Durant et al., 1992: 165).

The perspective of the popularization model and the public understanding of science approach has clearly been science-centred: science itself and its relation to society has not been thematized as a problem, and the objectives of popularization have been defined from the point of view of the scientific community's assumed interests. As a result, public understanding of science tends to be equated with the public appreciation of science in society (Lewenstein, 1992: 45). The ideal recipient of popularization has been the 'informed citizen' and the 'informed consumer' who acts rationally and adjusts to technological developments. Science journalism has often been equated more with PR-activities than with journalism in gener-

al. Thus, the relations between science, the media and the general public have principally been conceptualized only as information and communication problems. The point of departure has been, besides science-centred, also paternalistic and pedagogic: the goal has been to educate people by applying 'correct' information.

'The critical paradigm'

Especially since the mid-1980's the popularization paradigm has been joined by more critical research approaches, which conceptualize the relations between science and the public sphere in a new way. According to them, science and journalism form two – or more accurately, several – different cultures with their own institutions, language usages, legitimation needs and social interests. It is not possible to justify a special position for science on the basis of which it should be covered in a special way in the public sphere and media practices.

This critical approach has defined as its object of research the social and cultural status of science as well as the various social contexts of the use of research. It does not study the relation between science and the mass media only as popularization; instead, it attempts to take a closer look at the processes through which scientific information and public presentations of science are produced. The research objects are the discursive practices of science, the ways of producing and presenting information and the social relations affecting them. In his critique of the popularization model Whitley (1985) comments that one should not study the relations between science and the media only as a translation problem. The transfer of information, or more to the point, its representation from one context to the other, also changes the information itself.

It has been characteristic of the popularization mode of thought to draw a strict line between scientific and popularized information. According to it, the former is objective and rational, the latter appropriate simplifi-

cation or, at its worst, a distortion of scientific knowledge. The idea is based on a two-phase model, in which the scientists first produce scientific knowledge, which the media subsequently communicate to the general public in a simplified form. This hierarchic separation of different forms of information has also acted as an ideological basis for the "boundary work" practiced by scientists, which attempts to categorically separate genuine scientific information from popularized information or genuine science from pseudoscience (Hilgartner, 1990: 519–520). This distinction provides scientists and other experts basing their authority on scientific knowledge with a possibility to use the information as a political resource. On the other hand they reserve themselves the right to define what is bad popularization and misrepresentation practiced by the media.

The critical paradigm can not as such be considered a unified school. The connecting factor between these studies and research trends is first and foremost their critique on the popularization model. Some of the studies have also been influenced by social studies of science: the intention is to study the nature of science as social activity, the social significance and status of science and the role of scientific information in terms of social practices. Such research has been carried out from a loose sociological framework (Wynne, 1990; Hilgartner, 1990; LaFollette, 1990), from a relativist (Collins, 1987) and a constructivist oriented textual analysis (Hornig, 1990) perspective. From the constructivist perspective science is only one "knowledge culture" among many and it can not be given a privileged position. Scientific facts – like journalistic presentations – are constructions, which are perpetually being created and re-interpreted in various contexts (Lievrouw 1990: 2).

The most programmatic formulation of the difference between the critical paradigm and earlier research has been presented by Dornan (1989). He argues that "the critical camp sees the labour of mass communication not in terms of the transmission of information or the propagation of 'effects', but as a

process whereby the terms in which reality is to be publicly apprehended are constructed so as to benefit specific social interests: its ultimate concern is with the role of the media in the maintenance of hegemony" (1989:102–103). In this vein some critical mass communication researchers have studied the forms of communicating science to the public as "ideology" (Hornig, 1990) and the media as "promoters of commodity culture" (Barns, 1989). According to these studies, communicating science in the media has largely turned into public relations activity, whose objective is to legitimate the institutions of science in society.

It appears typical of the television science documentaries to mystify the process of research into a story of the inevitable progress of science, of revealing secrets and of new inventions. This results in stories, which resemble the detective ones, of how science makes new breakthroughs, invents new techniques and equipment, overcomes diseases, etc. (Collins, 1987; Murrell, 1987; Hornig, 1990). The narrative form of the TV programs obscure the nature of research as a social activity. Television documentaries present a highly idealized picture of science, its results and the nature of the research process. The uncertainty factors, problems, economic and political couplings or controversies between researchers are usually left unmentioned. In this way science journalism on its part promotes the mystification of science into an esoteric culture of experts.

From information problems to legitimation problems

In the light of existing research, the communication of science in the public sphere seems to have changed from sporadic popularization of scientific results into active public relations efforts and public marketing of science. There is, however, reason to inquire to what extent this 'change' is in fact due to the different ways in which the 'traditional' and 'critical' paradigms conceptualize their objects of study. One may also ask whether

we are even dealing with the same object of study: the traditional approach has mostly studied the press and the public understanding of science, the critical approach for its part scientific documentaries on TV and, besides realistic forms of presentation (news broadcasts, documentaries, etc.), to some extent also fictions. Additionally the comparison has to take into account the dimension of time and place. Science cultures, media cultures and the relations between science and society vary for example between the United States and Western Europe.

One of the most important differences between the approaches has to do with the conceptions about science. The traditional paradigm leans on a strict definition of science, which refers to the *contents* of science and to information produced by applying certain methods. In contrast, the concept of science behind the critical paradigm refers to the nature of science as a social activity and institution.

From the traditional perspective we are first and foremost dealing with a problem of demarcation, in other words with a problem of separating scientific knowledge from for example 'lay knowledge' or popularized knowledge as well as separating good and bad popularizations. I have attempted above to show that this perspective is narrow and science-centred. First of all, there are several justified views about what science is. Secondly, science and the production of science are defined by various social contexts and interests. Thirdly, science in the public sphere must be studied as a special phenomenon in its own right, not merely as a form of communication about science.

The "deficit model" and the concept of "scientific literacy" are based on a rather narrow and technical definition of science. The mastery of certain arguments taken out of their proper context (scientific results) and technical terms (methods) does not necessarily tell us a whole lot about how individuals appreciate, evaluate and apply scientific knowledge in different contexts.

It is also questionable how important it is for laypeople to have knowledge of the in-

formation contents and formal methods of science. Research fields are nowadays so far removed from each other that any researcher can be a layman as regards some other research field. For example according to Wynne (1992a), citizens' attitude towards science and scientists does not depend as much on their capacity of understanding technical information as on their trust in the institutions of science. The indifference of people in terms of science and its results can also be 'active ignorance'. People experience science socially, not in an abstract, purely cognitive form. The public understanding of science cannot therefore be separated from the different contexts of producing, legitimating and applying scientific information in which different people act on one another.

The concern expressed about the deficiencies of science journalism and the inadequate literacy of the general public seems indeed to be connected to the legitimization problems of scientific institutions and technical expert cultures. Demands for increasing the popularization of science have grown stronger at the same time as discussion about the negative consequences of scientific-technological development (e.g. environmental problems, scientific malpractices, economic and political couplings and other ethical problems) has increased. In this situation it is understandable that new objectives have been set for communication on science and marketing of science in order to legitimate the social position of science.

In the critical paradigm, the essential factor is not the formal content of science as much as that social activity which produces, transforms and uses scientific knowledge. At this point it is of interest how scientific information is applied as a resource of legitimation, authorization and political activity and how science acts as an institution.

Problems in the critical approach concern its way of limiting its object of study and conceptualizing the relations between science and the media. This can be discerned especially in terms of communications theory oriented studies. It is questionable to what extent it is possible to generalize research re-

sults about television's scientific documentaries to cover the entire field of science in the public sphere. The television has its own special narrative forms, and as a category TV documentaries differ in many respects from science journalism at large. A dramatizing form of presentation which mystifies science appears to be typical of the TV science documentaries, but it does not necessarily correspond to the general way in which the media cover science. Some critical mass communication researchers have also conceptualized the public representations of science too hastily as ideology that "serve to legitimize the decisions made by elites" (Hornig, 1990: 12)

In spite of this, the sociologically oriented studies in which science has been studied as a part of different social practices and problems, have proved more interesting than the research into the actual scientific journalism. These studies have attempted to conceptualize the problems relating to science in the public sphere expressly as social and political, not merely as information and communication problems. At that point the interesting questions become the knowledge-power-relations between various actors (scientists and other experts, journalists, laypeople, etc.) and the representation of these relations in the public sphere. This approach is used, e.g., in some studies on risk communication (eg. Peters, 1992; Wiedemann et al., 1991; Wynne, 1990) and in studies on the changes in scientific practices (Felt and Nowotny, 1992).

How to conceptualize the relations between science and the media

The research on the relations between science and the media has largely dealt with science journalism, i.e. popular science magazines or TV documentaries on science. However, they clearly make up only a part of what can be called the public discourses and representations of science. The mass media cover science mainly on other forums than the actual science pages or science

documentaries. The use of scientific information and scientific or professional experts has permeated the entire field of journalism and the media.

At the same time, there have been changes in the institutional development of science which re-define the relation of science to the public sphere. The mass-mediated public sphere has become one of the arenas for legitimating science in society. In order to conceptualize these changes, it is useful to separate three perspectives:

- 1) science and scientists as a topic and object in the media;
- 2) scientific institutions and scientists as active actors towards the media;
- 3) scientists and professionals as expert-sources in the media

Science in 'newsproduction'

It is typical of the development of the mass media that a perpetually increasing number of fields and topics become the raw material of 'newsproduction'. The interest of the media in science and research is affected first and foremost by how science produces innovations, inventions or solutions which are likely to interest the general public and relate (at least potentially) to the everyday life of people. Most typically, these criteria are fulfilled by the research results of medicine and scientific-technical innovations. According to several studies, the most interesting news are considered to be the medical news concerning the health of the people (Cronholm and Sandell, 1987; Durant et. al., 1989).

Science relatively seldom produces "hard news", with the exception of medical and technical inventions. The concept of "hard news" as such, however, is a relative one, as the cold fusion incident so aptly proved. The publicity around cold fusion was a prime example of the ability of active marketing and public relations to create 'scientific breakthroughs'. However, the story of cold fusion was not only an example of PR-activities in order to collect funds for research – it was also an example of creating images of sci-

ence and its usefulness in the solving of social problems.

The breakthrough of cold fusion in the public sphere could hardly have been so effective without the utilization of simple metaphors, on the one hand, or without the high expectations expectations toward energy research, on the other. The name cold fusion alone provided a firm hold for mental pictures. As a name cold fusion is very simple, compared to the general scientific terminology. At the same time it offered an alternative for the general conceptions about dangerous and expensive 'hot' fusion or nuclear energy (Lievrouw, 1990). Cold fusion was advertised as a clean and cheap source of energy. The most promising feature was that it seemed to facilitate almost limitless possibilities of energy production. Thus it was worthwhile to spend the taxpayers' money on it, unlike on the normal fusion research involving expensive equipment. Additionally, the interest of the media was increased by the disputes which developed between researchers around the topic; the dissension of the researchers offered an interesting drama, which the media were quick to seize.

Environmental problems are also a typical example of a social problem which science and researchers are expected to solve, or at least to interpret in a new way. Even this case is not a question of the mere popularization of scientific results. Although environmental news are often 'bad news', in other words they fulfill the traditional news criteria in this respect, their appearance in the media depends on several factors. For example the theory concerning climatic change and the greenhouse effect did not make a breakthrough in the United States until after the hot summer of 1988, when the everyday observations of people 'affirmed' the research findings. The discussion around the greenhouse effect illustrated how the findings of science, public discourses and the everyday observations of the public intertwine in new ways, and how the media produce and reproduce interpretations about the relations between science and environmental problems (Ross, 1991).

Public relations

According to the traditional view, the reciprocity between science and the media is essentially a one-way street; the media need researchers, not vice versa. Scientific communities have been considered to be rather closed and self-sufficient. However, current research on the relations between science and the media supports the notion that scientific institutions and researchers are often in an active relationship with the mass media (Dunwoody 1986; Lievrouw 1990; Felt and Nowotny 1992).

Hansen and Dickinson (1992) analysed science coverage in the British media and made a survey of the sources quoted or referred to in the science stories. The respondents were asked how they wound up as a source for a media story and the main object of the study was to analyse the relations between scientists and journalists. The result was that about a quarter of the media stories were source-initiated, i.e. triggered by press releases, press conferences or scientists' direct contact with the media. Besides that, nearly a fifth emerged from the science forum, in other words from publications in learned journals and conference presentations. On the other hand, nearly 40 percent of the stories were media-initiated. According to Hansen and Dickinson "this suggests a more active role for the scientist source in the source-communicator relationship than is frequently supposed by critics of the media coverage of science". They argue that this activity is not only typical to 'visible scientists', but "instead that contact with the mass media is a routine and planned part of scientific work for a significant proportion of scientists" (Hansen & Dickinson 1992, 371).

The increased activity of research organizations towards the media was also documented by Baerns' study (1990) on the German press agencies. It revealed that about one third of the science stories published by German press agencies were based on press releases and other public relations efforts. The activity of researchers and sci-

entific organizations appears thus to have a significant effect on which topics break into the public sphere.

The social standing and justification of science are no longer built on the intrinsic value and cultural significance of producing knowledge as much as on the role of science as a social 'productive force' and source of innovations (Lyotard, 1984). Science is forced to compete with other institutions for public and private funding. Therefore the public sphere has become a forum on which the various organizations attempt to justify their activity and need for funds. At the same time the publicity of science is professionalized; the mediating role in the relations between science and the media or between science and the general public is assumed by new occupational groups, such as information specialists, science writers and science editors. On the other hand, science organizations and occupational organizations are trying to make the scientists themselves appreciate the significance and rules of public relations activities (Nelkin, 1987; Lievrouw, 1990).

Scientists as expert sources

However, the most important question as regards the relation between science and the media is not the popularization of research results or public relations efforts; instead, it is the role of scientific information, researchers or professional experts as expert sources in the public discussion on various social problems.

The relation between sources and the media is one of the key questions in journalism. This relationship can be called symbiotic (Väliaverronen, 1992). The media need experts, not only to fill the pages or program times, but also to raise their own prestige and credibility. Science, and experts leaning on science, serve the legitimation needs of the media: besides new knowledge, there is a call for authoritative interpretations and the latest 'scientific opinions' in the public sphere.

On the other hand, the activities of scientific institutions and professional experts are dependent on public appreciation. Research knowledge and science-based authority have become important resources through which different institutions, organizations and professions legitimate their own activities in public. Through publicity the professions create a call for their own production of information and services (Larson 1990). The need for publicity is increased by the competition between professions for social positions and authority, or by public criticism of them. Science, of course, is in many respects different from other professions, say, physicians or lawyers, because it does not have a clear institutionalized clientele. Yet, for example, in environmental controversies, science tends to become identified with "political clienteles", proponents and opponents (Weingart 1983: 84). This kind of politization challenges the presumed objectivity of science and the impartiality of scientists as experts.

The symbiosis of the media and experts begins to waver when one party becomes too dependent on the other. This is the case if journalists feel that their capacity and liberty of action are being threatened or when they notice that professional institutions and groups are using them for PR-purposes. Respectively scientists and experts may feel that the media only try to legitimate their own arguments through the authority of experts.

The media coverage of environmental problems demonstrates how research results and scientists have become a central source of knowledge and authority in the public sphere. It is difficult to imagine a public discussion on nuclear power, air pollution, hazardous wastes, depletion of the ozone layer or forest damages without the presence of scientific knowledge. This kind of 'scientification' of environmental discourse means that the media are dependent on scientists and other expert sources in reporting environmental risks and hazards.

The Gulf War also illustrated in its own way the new structuring of a system of media experts. The mass media used their 'own' experts on weapons technologies, military

strategies or international politics to immediately comment on the changing war situations. Environmental catastrophes or wars only provide an extreme, if illustrative, example of the relation between experts and the media. The dependence of the media on expert sources is typical also in the coverage of other social problems.

However, the role of scientists and scientific knowledge in the media is rather controversial. In public discussion about environmental problems, the production and application of scientific knowledge has turned into a topic and cause of conflict. As a result science itself has become a "source of uncertainty" (Lau, 1989: 431). When defining environmental problems and risks, scientific and expert communities are often divided into two or more camps, into experts and counter-experts (Nowotny, 1979; Beck, 1986). Scientists and other experts act in media discourses not only as informers and interpreters but sometimes also as 'representatives' or 'witnesses' of different interest-groups. This means that the conception of popularization as linear transmissions of objective, disinterested and undisputed knowledge is problematic in many respects. It is difficult to be an 'informed citizen' or an 'informed consumer' when you have to choose between contradictory expert statements.

The symbiosis of the media and experts is, however, not only a matter of 'peaceful co-existence', but of competition and conflicts as well. Furthermore, the relations between scientific institutions and the mass media seem to be changing: the media are not satisfied to be mere transmitters of knowledge, the objective of the media is to act more and more as interpreters and as representatives of their public. This development has undermined the previous hierarchic relation between science and the media, scientists and journalists. Especially the coverage of scientific controversies has 'secularized' the way in which the media cover science and researchers. Journalists have begun to interpret science in the same vein as they interpret politics: a power play,

in which the parties apply different strategies, tactics and rhetorics to present themselves as credible (Välvirronen 1992).

'Publish or perish' versus 'be seen in public or perish'?

Since the 1980's, the relations between science and society have been reformulated in terms of efficiency and competition. This new era of "promotional culture" (Wernick 1991) and "marketization of public discourse" (Fairclough 1993) is typical not only of universities and research organizations but of other public institutions as well. Scientific organizations are required to raise an increasing amount of their funds from private sources. Financially and administratively they have become more autonomous but on the other hand more dependent on 'markets' and public relations. Science is evaluated and legitimated not only inside scientific communities but also increasingly outside them with new criteria and mechanisms of evaluation by different research funding agencies.

Universities and research institutes do not perhaps yet think that ten seconds of prime time television is better than to publish an article, but things seem to be changing. For example, the new 'hit parades' ranking universities and research institutes have raised wide discussion and sometimes anxious debates in the public sphere. Universities and research institutes consider a negative evaluation and low ranking as a threat to their status and reputation. These reactions imply that scientific communities have become more aware of and concerned with their public image. It is assumed that these new rankings may change the traditional reward system of science.

Communicating science outside scientific communities is usually seen as something distinctive from the scientific enterprise itself. However, several social studies of science have attempted to prove that this concept is in many respects questionable. More accurately, scientific communities are "transepistemic arenas of research" (Knorr-Cetina,

1982), which in many ways act reciprocally with the rest of the society. The research takes place in networks, in which research and its funding intertwine; in order to carry out research, scientists have to persuade their 'patrons' to finance their projects by promising to deliver them solutions for practical problems. Popularization or translation are not separate from science but a part of scientists' practices as well (Latour, 1987).

In their networks "scientists are busy not only in researching but also securing funds, building up new collaborative ventures, talking to the media, and so forth, and thus in organizing their scientific work in a strategically optimal way" (Felt and Nowotny, 1992: 508). One important feature of this development is that the boundaries between scientific publishing and communicating science outside scientific communities get blurred. The cases of cold fusion and high-temperature superconductivity have shown that scientists may present their results in the media before publishing them in the scientific forum. This means that 'new findings' and 'breakthroughs' are published in the media before they have been critically discussed and evaluated in the scientific communities.

Especially the scientists working in the fields of 'strategic research' consider the formal review mechanisms before publication too slow. This kind of strategic use of the media is not only typical of the commercialized areas of research but also of scientific controversies. And, it should be stressed, this development is not solely driven by the public relations efforts of scientific institutions. The media are also continuously seeking novelties and 'fresh scientific opinions' on various social issues. The effect of these tendencies and their relation to scientific practices is an area which should be studied further.

NOTES

- 1 One exception is the introductory textbook *Die Sozialen Kontexte von Wissenschaft* by Felt, Nowotny, and Taschwer (1992) which devotes a chapter to "science and the public sphere". It discusses the

changing relations between science and the media and the role of experts in public controversies. This notion of public sphere, stemming from the German *Öffentlichkeit* refers not only to the media but also to other forms and arenas of public communication (Koivisto and Väliverronen, 1993).

- 2 This connection in the U.S. political debate and research has been proven in an interesting way by e.g. Dornan (1988) and Lewenstein (1992).

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