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Communication and the Social Representation of Scientific Knowledge

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☐—*This article examines the process of disseminating scientific information to the public. In general, the particular steps and strategies (on the part of scientists) in taking research findings to a popular audience are explored. Issues pertaining to the social status and economics of science production are analyzed. In particular, the publicization of cold-fusion research is examined to illustrate the general process of dissemination.*

STUDIES OF scholarly communication, including studies of scientific communication, revolve around one principal issue: the behavioral processes associated with the creation and communication of scholarly ideas, whether among researchers themselves or between the scholarly community and society at large. This encompasses phenomena ranging from micro-scale interaction among research colleagues to macro-scale representations of new ideas in the mass media. This article explores the types of communication that are involved in the presentation of scientific ideas and issues to the public. What communication processes are involved in the representation of new scientific knowledge to the society that supports its creation?

It is argued here that the scientific community employs various communication processes and structures in a strategic manner that help the community preserve the privileged status of scientific knowledge in American culture. This includes the strategic use of the mass media as channels for popularizing scientific ideas. Despite the conventional image of science and scientists as objective and disinterested, more and more researchers are going directly to the popular media with their findings, especially in fields where the intellectual and economic stakes are the greatest. It is no longer the unusual scholar who becomes, in Goodell's phrase, a "visible scientist" (1977).

In industrialized societies, science enjoys pride of place as perhaps the most

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"legitimate" or rational approach to understanding the world, especially when compared to such mechanisms as tradition, faith, or authority. The maintenance of science's privileged status among these competing "knowledge cultures" helps scientists ensure the continued economic and social support of science.

In this article the case of cold fusion will be used to illustrate how representations of scientific knowledge are constructed by the scientific community and then communicated to the public via the mass media, using concepts drawn from social representation theory (Moscovici, 1984; Roiser, 1987; Wells, 1987), theories relating the interpretative or constructivist tradition to the study of mass media (Gamson, 1988), and the three-stage cycle of scientific communication proposed by Lievrouw, Sampson, and Carley (1989). It is useful to begin by briefly reviewing some of the major issues involved in the study of scholarly communication, including the scientific communication cycle.

SCIENTIFIC COMMUNICATION RESEARCH

Scholarly communication, including scientific communication, is enjoying renewed interest today among communication researchers. As a subfield of research, scientific communication was studied extensively in the 1960s by investigators who focused on the explosive postwar growth of the scientific literature, drawing on the bibliometric techniques and studies of information science (Crane, 1972; Price, 1963). Despite occasional studies of so-called "informal" (i.e., face-to-face) communication in science, the bulk of scientific communication researches at that time were properly characterized as "artifact" studies because they were almost exclusively concerned with the significance and impact of scientific publishing (Lievrouw, 1988; Paisley, 1965), addressing only communication among scientists within scholarly institutions.

The communication of scientific ideas and issues to the general public, on the other hand, has more often been explored in the context of the mass media—for example, the reporting of scientific news in the press (e.g., Nelkin, 1987), and images of scientists and science in television and motion pictures (e.g., Gerbner, Gross, Morgan & Signorielli, 1981). A related body of literature has been devoted to the political influence of science and science writing on public policy and government funding priorities (Chubin, 1987; Dickson, 1984; Greenberg, 1967; Gusfield, 1981; Studer & Chubin, 1980; Yearley, 1988). However, this body of work tends to focus on the lobbying and economic aspects of science vis-à-vis the public.

Clearly, past studies of communication and science have been channel-oriented, tending to focus on particular media of communication and their artifacts (news stories, journal articles, etc.). However, recent studies have attempted to approach science and the communication behavior of scientists from a constructivist perspective, where knowledge is assumed to be a social construction of individuals who are constantly engaged in the process of interpreting and reinterpreting their surroundings, or "making sense" of their world (Dervin, 1983; cf. Lievrouw, 1988).

From this viewpoint, science is just one of many "knowledge cultures" that coexist in society (Pyenson, 1985). Thus it is somewhat more appropriate to speak of knowledge "creation" instead of "discovery," which is a more familiar way to

describe the knowledge-building process in science. Creation connotes a constructivist stance about knowledge and conveys the idea that scientific facts are not necessarily absolute truths but instead are "manufactured" by scientists who share a common cultural grounding and who agree on the validity of a fact through a social process of consensus (Knorr-Cetina, 1981). This approach is fairly novel in communication research, especially in mass media studies, but it has a long history in the sociology of science and the sociology of knowledge (Brannigan, 1981; Carley, in press; Lievrouw, 1988; Mendelsohn, 1977).

One conceptual framework for scientific communication that borrows from the constructivist tradition has been proposed recently by Lievrouw et al. (1989). This model, the cycle of scientific communication, is based on two fundamentally constructivist definitions. The communication *process* is defined as any activity or behavior that facilitates the construction and sharing of meaning among individuals, that is considered by the communicators involved to be the most useful or appropriate in a given situation. The communication *structure* is defined as the set of relationships among individuals who are linked by the meanings they construct and share. According to this approach, the conduct of science can be viewed as a communication cycle having three progressive stages: conceptualization, documentation, and popularization (see Figure 1).

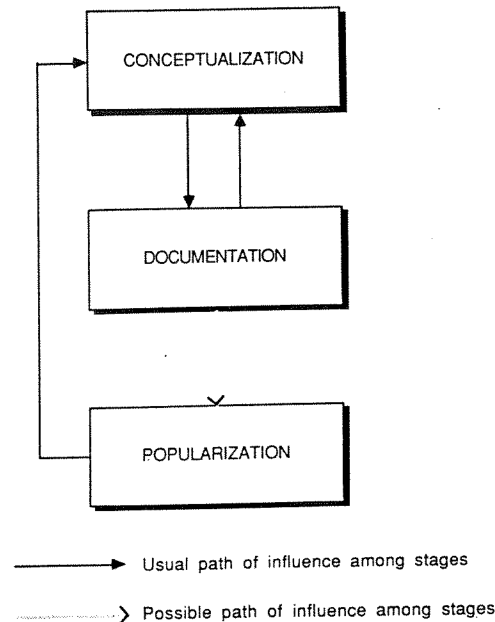

Figure 1. Three stages of the scientific communication cycle.

In the conceptualization stage, communication processes are typically interpersonal in nature, allowing individual scientists to refine and promote their ideas within their own immediate circle of colleagues and trusted assessors. These processes are ordinarily informal one-on-one or small group exchanges, such as working lunches, laboratory meetings, telephone conversations, electronic mail notes, or hallway chats. By the same token, communication structures at the conceptualization stage are composed of individual scientists who share a great deal of both social and scientific information, such as a common set of substantive concerns, common methodologies, and a common discourse. These structures are usually small—two to perhaps a dozen people. Examples include the mentor-student dyad, the research laboratory, coauthor groups, or cliques within academic departments.

In the documentation stage, communication processes are more formal. They include types of behavior that allow scientists to produce a documented record of a coherent body of research, such as the publication of scholarly papers and books or the presentation of research findings at professional meetings. Scien-

tists at this stage in their work tend to communicate in a more stylized, rule-bound fashion (Edge, 1977; 1979). Essentially, at this stage documents are produced for a larger audience than the original, tightly knit group of colleagues found in the conceptualization stage. The communication structures at the documentation stage are correspondingly larger and are composed of scientists who share a large amount of scientific information but less social information. These structures are more formal and are less socially and culturally homogeneous; they include groups like professional organizations, disciplines or subfields, university departments, and invisible colleges.

In the third stage of the cycle, popularization, ideas that have been developed by scientists at the conceptualization stage and then recorded at the documentation stage may be communicated even further to the society at large. The communication processes at this stage tend to encourage the acculturation of ideas; that is, they may accelerate the development of institutions or awards, facilitate the introduction of new words into the language, or encourage new social behavior as a result of scientific innovations or ideas. For example, special institutes may be founded; some scientists may be recognized with awards, like Nobel Prizes; or new terms like *superconductivity, cholesterol,* or *chaos* may become part of the everyday language of the general public.

In addition, the communication processes during the popularization stage tend to isolate the scientist even further from the small original audience of colleagues and from the public as well. The scientist's message can no longer be conveyed by one-on-one conversations or journal articles read by a small coterie of colleagues. Instead, third parties, such as reporters, publishers, agents, or talk show hosts, become intermediaries or brokers of the scientific information that reaches the public arena. Accordingly, the communication structures at the popularization stage are quite large, ranging from thousands to possibly millions of people. The most important among them is the general public, defined as individuals within the same society who share relatively little information, whether scientific or social, but who do share a common culture. Other communication structures include particular audiences, such as the readers of a particular magazine or the viewers of a television talk show.

It is important to point out that not all scientific ideas become popularized; most of the time, scientific ideas are developed in a process that moves back and forth between conceptualization and documentation. However, occasionally a concept or issue carries enough general interest to transcend the first two stages; recent examples include cold fusion and superconductivity. The issue becomes part of the popular discourse through various mass media channels, such as news reporting, awards and the publicity surrounding them, technology transfer, or even marketing.

Scientific communication, then, can be seen as a cycle that evolves through the stages of conceptualization, documentation, and popularization. The communication processes and structures that characterize each of these stages allow scientists to create new knowledge and to promulgate their discoveries. We now turn to the question posed at the beginning of this article: What communication processes and structures are involved in the presentation of new scientific knowledge to the society that supports its crea-

tion? For the answer we must focus more specifically on the popularization stage and the representation of science to the general public.

SOCIAL REPRESENTATIONS OF SCIENCE

Popularization has been described here as the stage of the scientific communication cycle in which a particular scientific idea, via its representation in the mass media, becomes part of the everyday discourse of the lay public. But precisely how does an idea become part of the public discourse? How does it reach the popular agenda, becoming in effect a cultural "buzz word"?

Gamson (1988) links the constructivist tradition to the study of mass media by considering how the media shape public discourse in general. (He uses the development of "scientific" public opinion polls as his primary example.) However, his approach can also be applied to the specific case of how the media shape public discourse about science, represent science and scientific knowledge, and help preserve the privileged status of scientific knowledge (in Gamson's phrase, how the media "reproduce the dominant culture"). As he points out, every issue (including scientific ones) has a "relevant public discourse," that is, "a particular set of ideas and symbols that are used in the process of constructing meaning" (Gamson, 1988, p. 165).

The "relevant public discourse" in this sense is similar to the concept of social representations as articulated by Moscovici (1984). He defines social representations as "culturally conditioned ways of understanding the everyday or 'common-sense' world (Wells, 1987, p. 433). Representations are generated by a dual process of *anchoring* (classifying an unfamiliar phenomenon into a set of categories) and *objectifying* (converting the unfamiliar and abstract phenomenon into a familiar and concrete phenomenon by developing an image of it, which is eventually assimilated into everyday discourse; it "becomes an element of reality rather than of thought" [Wells, 1987, p. 444]).

Gamson (1988) describes the organization of the popular culture world from which individuals construct their understanding of reality, proposing that the general popular culture gives rise to smaller "issue cultures" that have their own particular "catalogues" of "metaphors, catch-phrases, appeals to principle, etc." (p. 165). These catalogues in turn are organized into clusters of elements, or "packages," which themselves have an internal structure consisting of a frame and a story line or scenario. He argues that an issue can gain prominence in the media through the production of an issue culture when the issue draws on "cultural resonances" (i.e., it fits into themes, like technological progress), is the object of certain sponsor activities (sponsors being organizations that want to promote the issue and discount detractors), and can take advantage of or fit into the organization and practices of the media (such as the journalistic norm of "balance" or "fairness").

An issue that is popularized, then, is one that successfully becomes part of the relevant public discourse because it is depicted as a social representation that succeeds in becoming the center of an issue culture:

1. The idea is anchored and objectified, and is thereby transformed into a social representation.

2. The representation becomes the central element of an "issue package" once it is given a frame and a story line.
3. The issue package is picked up in the media when it (a) has cultural resonances, (b) is promoted by sponsors with an interest in its success or failure, and (c) fits into certain media practices.

Not all ideas become the focus of an issue culture; not all scientific discoveries become popularized. But those that do become part of the public's understanding of the "state of the art" of science and its current workings. The popularized scientific idea is a social representation of science for the general public; it is by definition part of the relevant public discourse.

THE CASE OF COLD FUSION

To understand how communication plays a role in popularization and how some scientific ideas may become part of the public discourse, let us consider the recent example of "cold fusion" research. Chemists at the University of Utah and the University of Southampton believed that they had discovered evidence of nuclear fusion, with a corresponding release of energy, in a chemical experiment that used inexpensive materials and that did not require the extraordinary environmental conditions considered necessary by most researchers working in the field (Crease & Samios, 1989). According to the dominant theoretical (that is, physical) understanding of fusion, the Utah experiment could not possibly have produced the results that were reported. Nonetheless, cold fusion was a major story in the national news media for weeks. How did such an abstract idea gain such prominence?

Cold Fusion as Social Representation

As a scientific idea, cold fusion was a likely candidate for popularization because it lent itself readily to both anchoring and objectification. It was easily anchored in the existing public perception of fusion energy, which for years had itself been the subject of extensive debate and media coverage as a means of generating electric power. Traditional ("hot") fusion power was seen as expensive and risky; cold fusion offered an attractive, clean, and cheap alternative.

The objectification process was similarly straightforward. Fusion, which is a difficult and intangible idea for most members of the lay public to understand, was suddenly described with familiar, concrete terms, like "cold." Cold fusion could be generated with simple equipment like electrodes and water, in contrast to the complex plasma generators and particle accelerators that were typical of traditional fusion research and were difficult to describe and comprehend.

Cold Fusion Issue Culture

The idea of cold fusion became the center of an issue culture because it was easy to package, once it had been anchored in more familiar conceptual territory and objectified with concrete descriptions and images—that is, once it had acquired an effective social representation. Cold fusion carried its own catalogue of metaphors (e.g., cold vs. hot) and appealed to principle (e.g., fusion

energy could be made "cheap, abundant, [and] safe" [Crease & Samios, 1989]). It had a central organizing idea or frame that suggested to the lay public what it was about (nuclear energy). It also had a story line that meshed with the frame of fusion energy: the conflict between scientists who were already heavily invested in traditional fusion research and the upstart proponents of cold fusion. Of course, most media messages, such as television news stories, are produced around conflictual story lines. Indeed, this point enhanced the likelihood that the cold fusion story would fit into the routines and practices of the media, as we will see shortly.

The Cold Fusion "Package"

Cold fusion, then, successfully emerged from scientific research in general as a social representation at the center of an issue culture. It also satisfied the criteria for organization as an issue package, having both a frame and a story line.

In addition, the cold fusion issue package became prominent in the media. First, it "resonated" with social themes like progress and efficiency. The Utah research team's findings seemed to suggest that the expensive, labor-intensive, and protracted approach to fusion energy that physicists had been pursuing for 40 years was wasteful and unnecessary. American taxpayers, who found themselves in the late 1980s with a number of serious and expensive social problems and an enormous federal budget deficit, saw the Utah discovery as a cheap and safe shortcut to fusion power. At the same time, cold fusion seemed to render nuclear power "cleaner" than it had seemed in the past, less dangerous and easier to accomplish. To a nation facing continuing economic and environmental problems with oil, cold fusion seemed to offer a simple solution to energy problems.

Cold fusion also became a prominent media issue due to the efforts of its sponsors. As the story evolved, it became clear that a number of large institutions had a public relations stake in the Utah research, including most research universities receiving federal grants for fusion research, the federal agencies involved in awarding those grants, and of course the University of Utah itself, whose administrators saw the public debate as an opportunity to put the institution on the map of major research universities. The chemists who sparked the controversy made their initial announcements at a press conference they called at about the same time as the annual meeting of the American Association for the Advancement of Science in Washington, D.C.

The press conference brings us to the third point that allows an issue package to become prominent in the media: The issue must be able to exploit (or at least fit into) the organization and practices of those media. In this case, the researchers took advantage of the fact that most of the national media would be covering the AAAS meeting at the time of their announcement and would be attuned to breaking news of scientific discoveries. The timing and national coverage of their press conference also ensured that the Utah team's findings would be scrutinized almost immediately by all of the most important scholars working in the area of fusion power. Although that scrutiny might result in criticism—which in fact came quickly and ruthlessly—it would also bring the researchers and the university into national prominence, virtually overnight.

The criticism and the resulting contro-

versy over the Utah findings also created a classic scenario of conflict that is a stock story line in both print and electronic news stories. This, of course, is a prime example of the exploitation of a media practice: the emphasis on the conflictual aspects of an event that enables the newspaper or television journalist to "sell" it as a story.

DISCUSSION

As the example of cold fusion illustrates, a number of complex phenomena come into play in the popularization of a scientific idea. It is important to note that all these phenomena hinge on the behavior of scientists in their role not only as "discoverers" or creators of knowledge but also as promoters of that knowledge both inside and outside the scientific community. One of the important functions of scientific communication in the popularization process is the promotion of new knowledge, because the scientists involved in its creation depend on the acceptance of their ideas by colleagues and the general public for continued support and the acquisition of the resources necessary to doing their work. To this end, scientists (especially those engaged in expensive, labor- and resource-intensive projects) are often involved in constructing representations of their ideas that will "read" well with audiences beyond their colleagues and that can be assimilated into the popular culture at large.

The promotional aspect of the cold fusion case is particularly clear, especially since the Utah research team went to the mass media with their findings before their work had appeared in a peer-reviewed publication. Some observers associate the promotion of a scientific idea in the public arena with fraud or mistaken findings and therefore assume that media coverage of a scientific issue alone somehow taints it or makes it intellectually suspect. Indeed, "going public" in this way is often derided by scientists in competition with those whose ideas become popularized. Critics of the popularized idea often appeal to the traditional scientific norm of disinterestedness as a sign of good science. For example, Crease and Samios (1989) look at cold fusion as a case of "pathological science" because the researchers involved did not try to "kill the discovery"—on the contrary, they promoted it in public. Goodell (1977) has pointed out that, once they have popularized their ideas or their fields, "visible scientists" tend to be repudiated by their colleagues, essentially because of their visibility and regardless of the validity of the popularized ideas. This taintedness may be exacerbated even further in a case like cold fusion, where the researchers have delayed the peer review process and gone directly to the mass media.

The popularization of a scientific issue, however, may have very little to do with its intrinsic validity or usefulness. Since many successful scientific ideas, such as the association of cholesterol and heart disease or the development of superconducting materials, are promoted just as vigorously by the scientists associated with their discovery, perhaps some of the conventional truisms or norms about the "disinterestedness" of scientists should be modified or discarded. (Mitroff (1974) supports this idea in his study of Apollo "moon rock" scientists. The researchers who were most highly regarded by their peers were those who defended and promoted their ideas most aggressively. In the words of one interviewee, they were the most

"fanatical" in promoting their ideas.) Furthermore, it is exactly this lack of disinterestedness, this willingness to promote ideas through the media, that suggests that scientists are indeed creators and not just discoverers of new knowledge and supports the constructivist approach to understanding scholarly communication. Scholars, including scientists, may become identified with their work and develop a strong sense of ownership about their findings that prompts them to seek wider audiences by popularizing their ideas.

Sociologists of science have also considered the promotional activities of scientists, especially with regard to obtaining funding or other support for research. This is a major theme of a study of the National Cancer Institute by Studer and Chubin (1980) and lab studies by Latour and Woolgar (1979). Latour (1987), in particular, has detailed the processes of "insider" scientists who must spend a majority of their time outside the lab in order to reach the public, politicians, granting agencies, or corporate sources who may provide funding.

Communication, of course, is central to these activities. Popularization can secure or ruin the prospects for support of certain lines of research, especially those receiving public funding, but resource-gathering goes on at all stages of the scientific communication cycle. Communication at the popularization stage is distinguished from communication at other stages by the fact that, in order for an idea to become the center of an issue culture, in order for it to become popularized, it must somehow fit into the values or beliefs of the larger culture that fosters it. Scientists as a subculture share very similar values about their work and can persuade one another of the value of their research based on a reasonably consistent set of standards and conventions. It is a more difficult task, however, to persuade the general public of the value of an idea. To do this scientists must tap into the social themes and values that are shared by most of the general public—social themes that are reflected in and supported by the mass media.

Popularization is not only the process by which a scientific idea gains currency in the everyday discourse of the general public. It is also essentially a communication process that facilitates the gathering of resources for pursuing certain lines of research. Scientists who are comfortable with this promotional role can have a great deal of influence on the public's perception of and support of science as a social good and as a productive activity. □

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