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# COMMUNICATION AMONG SCIENTISTS IN THE CENTER AND ON THE PERIPHERY

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## ABSTRACT

*Theories on communication among scientists have been developed in countries where central and big science has occurred throughout history. What is the meaning and what are the possible uses of these theories of communication among scientists in countries that produce peripheral or little science? How can science communication theory be extrapolated from a central science context to one of peripheral science?*

*By using different models of communication among scientists, it is theoretically possible to demonstrate the wasting-away effects of fragmented access, or of no access at all, to communication technologies and communication resources in the production of scientific knowledge on the periphery. By also revising peripheral science models and literature, we can understand the multidimensional, changing nature of peripheral science and the difficulties involved in defining policies and strategies for international communication among scientists. But then again, how can we design communication strategies for scientific development on the periphery, considering not just the most up-to-date knowledge of communication among scientists but also the complex dynamics of the particular systems for communication among scientists that exist in small scientific communities in developing countries? The purpose of this presentation is to address ourselves to certain aspects of these questions.*

## SCIENCE COMMUNICATION MODELS

The field of communication among scientists is an interdisciplinary one. In the Preface to *Handbook of Communication*, 1973, Ithiel de Sola Pool affirmed that there is no inherent limit to what can go into the study of communication and that, as in any other social science, communication takes all of society as its domain. This interdisciplinarity poses formidable challenges to analysis and raises many difficult questions.

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It seems reasonable to think that we can borrow models, concepts, and metaphors from general communication theory in the construction of a theory of communication among scientists. There are, of course, very different general models of communication as well as specific models and communication among scientists. For our discussion we have selected certain models for reasons that will appear in the course of this presentation.

Aristotle gave the first explanation of human communication. He identified three elements in rhetoric: the speaker, speech, and the listener. Today, after multiple theoretical elaborations, these three elements still appear in contemporary models of human communication.[2] From the Aristotelian point of view, scientists communicate as do any other human beings, except when they are talking about science. The communication systems used in the acts and processes by means of which scientists communicate among themselves are very special, as we all know nowadays.

In 1973, Ithiel de Sola Pool published a mathematical communication model that he described as follows: "A system has been defined as a continuous entity capable of two or more states. A communication system is one in which the states are connections and non-connections among objects".[3]

According to Professor De Sola Pool, communication systems may differ along six dimensions: One, the number of objects in the population. Two, the message capacity of the links. Three, the volume of message-flow through these links. Four, the net structure that includes: directionality, links permitted or possible, and probability. Five, the type of message carried and its form and content; six, the triggering mechanism that initiates the communication act. De Sola Pool asserted that "a complete description of a communication system is its characterization along all six of the above dimensions".[4]

De Sola Pool distinguishes between stable and non-stable equilibrium systems. He defines the first as those that tend to correct themselves as they deviate from their equilibrium position and the second as "those that follow a fixed, predictable,

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[2]. See, Luis Ramiro Beltrán, *Adiós a Aristóteles: Comunicación Horizontal.* UNESCO. Comisión Internacional para el Estudio de los Problemas de la Comunicación, 1987.

[3]. See, *Communication Systems* in *Handbook of Communication*. Edited by Ithiel de Sola Pool and Frederick W. Frey. Center for International Studies, Massachusetts Institute of Technology; and Wilbur Schramm, Nathan Maccoby and Edwing B. Parker, Institute for Communication Research. Stanford University, Rand McNally College Publishing Company, Chicago, 1973.

[4]. *Op. cit.*, page 4.

developmental sequence: ones that, once pushed forward, move in a certain direction such as growth, modernization or revolution".

According to de Sola Pool, "we are interested in a communication system insofar as it produces a certain outcome, such as attitude change, or some particular state of public opinion, such as contentment". For the purpose of our analysis, Pool's mathematical model clarifies, not only the six dimensions of a communication system, but also the importance of the outcome in human communication.

In 1973, Frederick Frey used a topological model that is very useful for understanding the notions of the social context and availability of communication and information as well as the concepts of access, exposure and impact of communications technology.

According to the notion of availability of various communications media, a human being, for our purposes, a scientist, may be in a position of access or non-access to communication. When a scientist has access to scientific communication and information, he or she can be a potential or actual user of systems for communication among scientists and a potential producer of scientific knowledge. This explains the nourishing effect of communication among scientists on the production of new knowledge. Let us consider some models of the effects of a system for communication among scientists on their productivity and on the development of the scientific disciplines.

In 1959, John Desmond Bernal used the irrigation system metaphor to depict communication in science. "He described a system fed from many sources, with individual plants (the users) depending on what reaches them at any given time. Ideally, each would receive the right amount at the right time; in fact, much evaporated, ran off in the wrong direction, or arrived late. At other times, the flow was so abundant that the user could not absorb what he needed".[5]

We have used Frey's topological model and Bernal's irrigation model to illustrate the nourishing effect of the communicational information flow in the context of access and non-access in Figure No. 1 on the following page. As can be seen, it is clear that the nourishing effect and the impact of communication among scientists appears only in the area of access and real exposure.

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5. Cited by, Compton, 1973, p. 756.

We see no problem in using Bernal's irrigation metaphor. After all, we know that in the theory of communication among scientists, they have successfully used metaphors, such as that of the famous term invisible colleges, since the founding of the Royal Society in the 17th century. And as we all know, the "invisible colleges" metaphor is still commonly used today in relation to bibliometric techniques and citation analysis.[6] At the present time, we all are familiar with the different uses of metaphors in science[7], but let us continue now with the analysis of models of communication among scientists.

In 1991, Leah A. Lieverouw and Kathleen Carley described the three stages of the science communication cycle this way: Today, "in a work environment filled with computers, telephones, fax machines and other communication equipment, scientists can engage in a new way of conducting their research: telescience". "The scientists' communication processes and structures that are typical of scientists' activity are summarized according to a three-stage communication cycle: conceptualization, documentation and popularization".

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6. See, Leah A. Lievrouw, *Invisible Colleges Reconsidered. Bibliometrics and the Development of Scientific Communication Theory*. Communication Research, Volume 16, No. 5, October 1989, p. 615-628.

7. For a recent analysis in this respect see, Michael Bradie, 1993, *Models and Metaphors in Science: The Metaphorical Turn*. XIX INTERNATIONAL CONGRESS ON THE HISTORY OF SCIENCE AND TECHNOLOGY. Zaragoza, August 22-29, 1993.

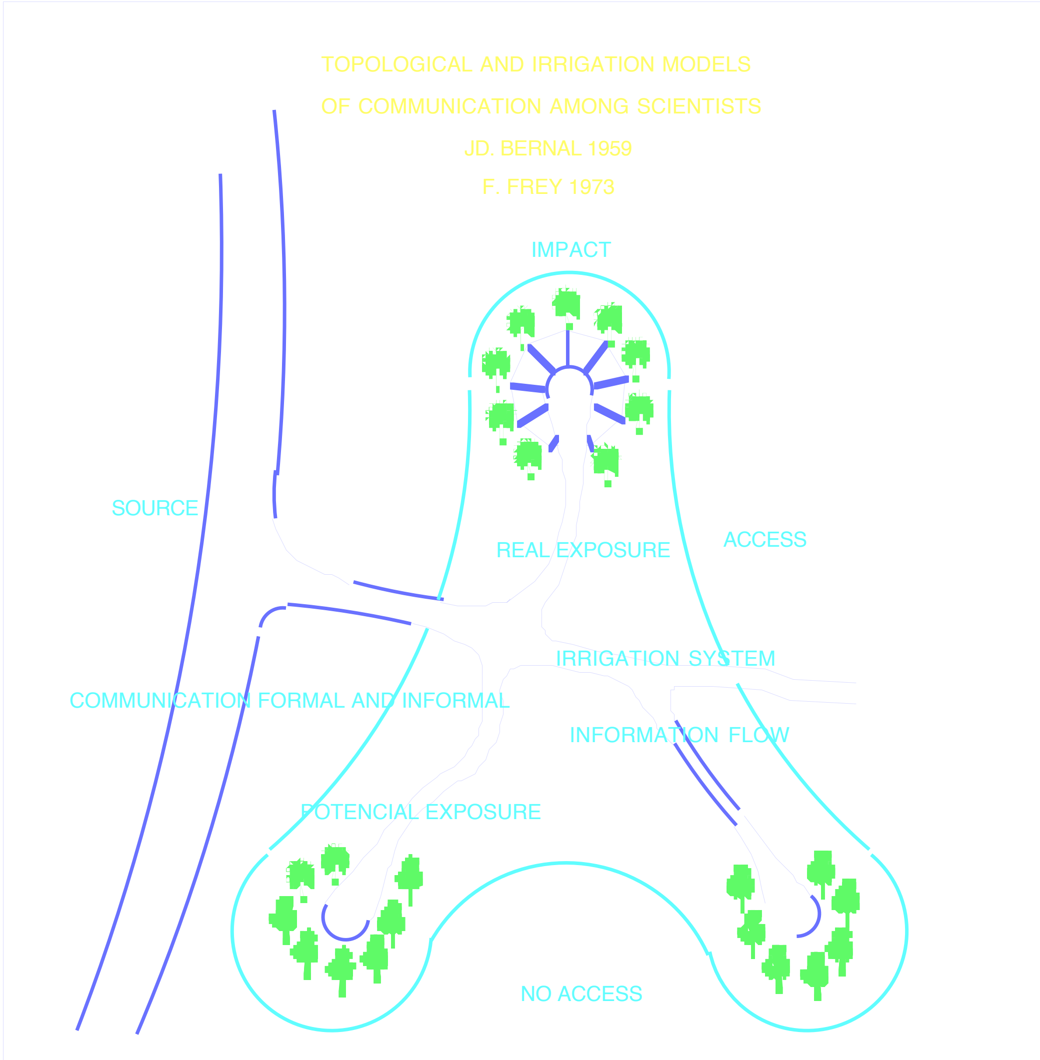
TOPOLOGICAL AND IRRIGATION MODELS
OF COMMUNICATION AMONG SCIENTISTS
JD. BERNAL 1959
F. FREY 1973
IMPACT
SOURCE
REAL EXPOSURE
ACCESS
IRRIGATION SYSTEM
COMMUNICATION FORMAL AND INFORMAL
INFORMATION FLOW
POTENCIAL EXPOSURE
NO ACCESS

**Figure No. 1**

Until the past decade, the pace at which the processes of conceptualization, documentation, and popularization took place was relatively slow compared to the potential velocity at which they can now be carried out thanks to the latest technologies of telescience, and the speed of these new developments continues to increase each day.

For these two authors, a communication process is "any activity or behavior that facilitates the construction and sharpening of meaning among individuals, that they consider to be the most useful or appropriate in a given situation; and a communication structure is a set of relationships among individuals who are linked by the meaning they construct and share".[8] The most important point that Lievrouw and Carley raised in their work is the potential behavioral, social, and policy implications of the growth of telescience in the social context of the contemporary research university. For the future, one of the most important questions regarding telescience is the possible collaboration among scientists in both the center and the periphery.

Nowadays, we all are interested in communication systems among scientists because we know that the outcome of the said communication systems is the production of scientific and technological knowledge.

In summary, in today's world, at least theoretically, we have an enormous amount of tested, useful knowledge on the subject of communication among scientists that we may use for the purpose of defining policies. Based on the analysis of different communication models we can conclude that science in developing countries is small and peripheral because, among other things, it is uncommunicated and isolated. But until now, this characteristic of peripheral science has not been fully taken into consideration in the definition of advancement policies for science in developing countries.

**THE TWO CONTEXTS OF SCIENTIFIC PRODUCTION**

For researchers with experience in conducting studies in both developed and developing countries, the difference regarding scientific information and communication resources in the two contexts is very clear.

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[8]. *Op cit.*, p. 459.

In Colombia, for instance, some studies have demonstrated the acute information and communication problem within the small community of scientists working in the country.[9]

If we realize that the small scientific communities in developing countries are almost always found to be in a situation of no access or insufficient access to the flow of scientific communication, it is easy to discover one of the reasons for their marginal role in the production in scientific knowledge.

There is presently a worldwide consensus that the scientific development of a country depends to a large extent on the activity carried out by scientists within the country. In developed countries, where central science is produced, the scientific community has the benefit of excellent working conditions and is provided with the means to carry out its research work. Scientists and academics are grouped in invisible colleges that permanently communicate, not only in meetings of colleagues, congresses, symposiums, and so on, but even more so by means of modern information and communication technologies. A vast majority of scientists in developed countries have permanent access to telescience technology. In contrast, in Third World countries, where peripheral science is carried out, university professors and researchers have to do all the work on their own, with very little or no contact at all even with their peers in their own country, much less with colleagues in the developed world. Very few have computers, fax machines, or electronic mail. Latin American universities have extremely deficient library collections, which are administered with a lack of systematization by people with very little or no training in library science. Faculty professors and researchers cannot interact successfully with university librarians, and universities have no funds available to invest in communication and information technology. Third World scientists live in what are known as "uninformed, uncommunicated societies".

In the case of Colombia, we are now convinced that we have been an uncommunicated, isolated scientific community up to now. We also know that it will take formidable economic effort for us to translate the knowledge of the theory of communication

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9. For studies that diagnose the Colombian case see: Ligia Parra Esteban, Enero 1991, *Ciencia periférica y Comunicación entre Científicos*. Colombia Ciencia y Tecnología. Vol. 9, No. 1, Enero/Marzo 1991 or, Octubre 1991, *Comunicación y Desarrollo Científico en Colombia*. Fundación VOC Serie Documentos de Trabajo, 51 pages. Also, Elsa Martínez Cáceres, 1982, *Comportamiento de los Investigadores Colombianos en Relación con la Información*, ICFES, Edgar Reveíz, Eduardo Aldana y V. Slameca, 1984, *La información en el Desarrollo Colombiano*, COLCIENCIAS/FES.

among scientists now available to us into practice in our own country. To express it in the terms of this symposium, we are well aware that we have to transform the scientific knowledge of science communication that we have already acquired into culture and behavior.

This is so because we know that scientific communication is many things. It is the collective memory of the scientific work done in all disciplines in a given country. It is the collective memory of all countries and all scientific disciplines of all times. It means having real access to these national and international memories. Scientific communication is also the communication technology of old printing machines as well as the new telescience technology. Communication in science is "a social system based on social institutions, governed by social norms, and best measured through the behavior and the culture of individuals".[10]

**PERIPHERAL SCIENCE MODELS**

The debate about peripheral science has been going on ever since the late sixties. It has resulted in a very fruitful analysis characterized by conceptual plurality, different emphases, different foundations and styles. Clear conceptual advances have been achieved since George Basalla's first three-stage historical model of scientific development in 1967 and Sal Restivo's approach of the sociology of objectivity in 1985 (p. 147-156). However, an analysis of authors like Basalla (1976; Price (1973); Moravcsik (1976); Vessuri (1987); Aguilar (1987); Arvanities and Chatelin (1987); Arboleda (1987); and many others would take both time and effort that clearly exceed both the possibilities and the purposes of this paper.

According to the study published under the title of *Science in Latin America. How much and along what lines?*, by M. Krauskopf, R. Pessot, and R. Vicuna, 1986, on the basis of scientific publications registered in the "Science Citation Index" (ISI), Third World participation represented only 5% of the scientific production reported. In spite of the fact that we now know that this type of statistical measurement shows a bias against Third World science, it is more than legitimate that Latin American researchers should be trying to discover why they remain outside the margin or the mainstream of world science today.

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10. W. D. Garvey's definition of science communication, cited by Bertita Compton in *Scientific Communication* 1973, p. 765.

If we return to the three-stage cycle of the production of knowledge: conceptualization, documentation, and popularization, it can clearly be seen that the distance between the center and the periphery is bound to grow.

As far as we know, only two scientists have as yet clearly emphasized the role of communications in peripheral science development. The first was M. J. Moravcsik, in his article, *Do Less Developed Countries have a Special Science of their Own?*[11] He selected four universal, necessary components of international collaboration between central and peripheral science in order to be able to determine, not only the degree of success in science, but also to be able to define what science is and what it is not.

According to Moravcsik, the first of these universal components is cumulativeness of scientific knowledge that allows us to claim that an ever-increasing set of natural phenomena become (one way or another) understood and predictable. The second feature is collectivity based on a universal methodological consensus within the scientific community. The third characteristic of any science is the requirement that it be constantly compared with and hence guided by experimental, empirical perceptions. The fourth feature is the ability of any science to predict specified future occurrences. Based on the four above-mentioned components, Professor Moravcsik lists three *sine qua non* prerequisites: First, "since science is cumulative, being well aware of scientific knowledge already acquired is an absolute prerequisite for making further progress, no matter in what direction this progress lies". Second, "since science is collective and possesses a consensus, a highly developed opportunity for international communication among scientists is also a must, without which science in the developing countries will develop only very slowly, if at all". Thirdly, "since successful science must be based on empirical evidence, collaborative programs aiming at improving the capacity in developing countries to undertake such a comparison with experimental information are indispensable". In our opinion, it is clear that all three prerequisites listed by Professor Moravcsik refer to different moments, elements and dimensions of the broader multidimensional phenomena that we recognize as scientific communication.

The second scientist that we know specifically emphasized the role of communication in scientific development in the periphery was Professor Ithiel de Sola Pool in his paper *The Role of Research in the New Structure of International Communication*, presented at the

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11. See, INTERCIENCIA, Vol. 3, No. 1, Enero/Febrero 1978, p. 8-13.

Congress of the International Association of Mass Communication Research (Caracas, 1980). The central thesis of his presentation was that research in communication needs to probe into the wave of new communications technology that will appear, keeping the 20 or 30 latest technical innovations in communications technology in mind. In other words, it should be more useful to develop experimental studies that will teach us what communications systems will be like in the future and what impact new communications technologies will have, than to carry out descriptive or historical studies. We first heard Professor Pool's elaboration of this hypothesis in his office at MIT in October 1982, when we discussed the VOC Project with him. At that time he explained to us his prophetic vision to us of telescience and the way in which scientists of all countries will communicate around the world by computer networks in the nineties.[12]

We hope that this presentation will draw attention to the crucial role that scientific communication plays in the development of peripheral science.

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[12]. See Working Document No. 2, of the VOC-Project, Communication for Academic Development. Cambridge, October 30, 1982, Universidad de los Andes, Centro de Investigaciones CIFI de la Facultad de Ingeniería.

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