Invisible Colleges: Diffusion of Knowledge in Scientific Communities by Diana Crane (review)

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dent of the relationship between firm size and technological progress.

His next essay, "Catastrophe and Utilitarianism in the Development of Basic Science," has as its thesis that demand, not supply, plays the dominant role in the support of basic science. Regardless of the motives of the persons performing the research, society, whether represented by the kaiser of Bismarck's day or the National Science Foundation, has supported basic research because of a perceived demand for that research. This perceived demand is in turn a function of the desire for development or the furtherance of some other national policy.

The final two essays are a call to economists to treat technological change as an economic activity and not as something exogenous. In a gentle voice he chastises the profession for pushing refinements of static economic models which treat technology as a "given" rather than recognizing the dominant role played by technological change. For example, he shows that "inventive activity in a capital-goods field tends to vary directly with the output of the capital goods concerned" (p. 77). This means that R & D is most often the effect of high demand for capital goods and not its cause.

The last half of this volume contains over 400 time series on patent activity by industry, many of the series going back as far as 1837. These series and the methodology used to develop and classify them should provide the raw material for the increased empirical work needed in this area.

The overall impression one gets from reading this volume is an immense respect for the patience and scholarship that Schmookler brought to the study of the economics of technological change. His wisdom and insights stand in stark relief against the chaos of this difficult field.

Fred A. Tarpley, Jr*

Invisible Colleges: Diffusion of Knowledge in Scientific Communities. By Diana Crane. Chicago: University of Chicago Press, 1972. Pp. x + 213. $9.00.

In this slender volume, Professor Crane has consolidated a highly important advance in the sociological understanding of science. To be sure, her focus is on the extension of "pure knowledge" rather than its technological implementation, but her work can be valuable in establishing baselines against which the more complicated processes of technological innovation may be compared.

In working through her thesis that "the logistic growth of scientific

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knowledge is the result of the exploitation of intellectual innovations by a particular type of social community” (p. 2), she clearly establishes the critical importance of social organization—specifically, the invisible college or “scientific community”—in scientific development. Her central finding, announced almost simultaneously by Griffith and Mullins (Science 177 [September 1972]: 959–64), that invisible colleges are remarkably similar in structure and growth pattern throughout science, provides a provocative framework for questions concerning relations among different research specialties and, more broadly, for attempts to revivify a “sociology of culture” that will study the social factors involved in the production of all cultural products.

She begins, in chapter 2, with an examination of various proposed models of the growth of scientific knowledge (drawn from Kroeber, Kuhn, Toulmin, Holton, etc.) and concludes that the role of scientific communities in this process has been largely ignored. But since the growth of a research specialty must obviously entail the diffusion of a shared view (or paradigm) of the topic under consideration, a model of growth must take account of the social structures through which these views are disseminated.

Crane’s approach is essentially inductive, building upon a thorough command of the empirical literature. In the end, she comes close to suggesting that science is basically a congeries of active research specialties, each of which follows the classic S-shaped or logistic growth curve (when certain other factors are present) without much regard for what is happening elsewhere in science. This “pluralistic” view is modified when she reviews the relationships among different scientific communities, but the conclusion that “research areas seem to have tendencies toward both a high degree of specialization and toward receptivity to external ideas” (p. 113) is not sufficient to alter substantially the picture drawn here.

In chapters 3 and 4 she undertakes a rigorous review of research on communication links and groupings of scientists as these relate to the growth of knowledge, determining that invisible colleges in many fields exhibit a number of common characteristics. Not only do they follow a logistic pattern of growth, but all tend to feature a core of high producers who are surrounded by successive circles of moderate producers, aspirants, transients, and defectors. Without the industry and charisma-like attributes of these high producer/leaders (as reflected in their recruiting, socializing, and guiding the work of new members), it would be impossible for such a group to go through this standard growth cycle. Studies of research-oriented contacts among scientists, including Crane’s own intensive work on two invisible colleges (one in rural sociology, one in mathematics), provide the data for chapter 3, while intellectual contacts among scientists as recorded by footnotes (making use of the “Science Citation Index”) supply the empirical foundations for chapter 4.

Chapter 5 considers variations in scientific growth, covering such topics as competition between paradigms, the questionable existence
of "fashion" in science, and the relationship between various kinds of knowledge and the different growth patterns associated with them. On the last point, she suggests that growth in the humanities and in technology does not ordinarily follow an S curve but is different in each case. For the former, she characterizes growth as discontinuous but cumulative (p. 134), and, for the latter, the pattern may more closely resemble stairsteps, with "a relatively slow accumulation of information over a period of several decades followed by a rapid acceleration of activity just prior to the development of the major innovation" (p. 97).

Chapter 6 moves on to look at the flow of information among scientific communities, drawing upon studies of sociometric choices by scientists, data on cross-journal citations, and types of cross-fertilization. Crane suggests that this should be the next major focus of the sociology of science—a view not at all inconsistent with the general feeling now that the sociologists ought to begin to pay attention to the substance of science as well as to the social relationships among its practitioners.

In chapter 7, Crane examines various proposals for improving scientific communications in the light of her foregoing analysis and, not surprisingly, fails to come up with anything beyond the sober conclusion that "the problems of scientific communication can be understood in terms of the interaction between a complex and volatile research front and a stable and much less flexible formal communication system" (p. 128). Finally, chapter 8 is a brief but stimulating discussion of the prospects for a "sociology of culture" in which the potential utility of the invisible college idea, together with that of the concept of paradigm, is sketched out for studies in art, literature, and religion.

While the body of the book occupies only 142 pages, a forty-six-page appendix supplies twenty-eight tables and eighteen figures in support of the analysis, and a twelve-page bibliography provides an extensive overview of the literature on scientific communication.

Crane's basic thesis, while intriguing and persuasive, is not yet the final word in this area. One should note that the importance of "spontaneous" intellectual innovations by great scientists (in the sense that their origins are not otherwise further examined) as the foundation of invisible colleges is not necessarily accepted by all sociologists of science. Nicholas C. Mullins, for instance (in a preprint from Indiana University, March 1973), has proposed that "accidents" in the location of certain scientists in the normal communication network of science, whereby they reap exceptional benefits in terms of incoming information, may be sufficient to engender the innovations around which invisible colleges form. If one assumes a roughly equal potential for innovation among most scientists, this view would give primacy to the communications structure itself as an explanation of the development of invisible colleges, rather than to an implicit "great man" hypothesis.
Finally, hidden in Crane’s book are some useful hints for anyone intent upon a successful career in science: “Work published by relatively unproductive authors in the early periods [of a research topic’s history] was more frequently utilized or cited than work published by such members later on. Relatively unproductive authors who published for the first time in the later stages of the development of these areas had little influence upon these fields” (p. 83). The lesson, it would seem, is that greatest success for least effort is to be gained through identifying a promising area early, publishing a few sound articles in it, and then leaving for the next new merry-go-round. (One hopes, however, that those now identified with the sociology of science—itself almost a classic example of the invisible college—will not take this advice seriously.)

To conclude, Crane’s book, while peripheral to the interests of most readers of this journal, will stand for some time as a major landmark in the progressive explication of the intricate relations among social organization, communication, and the extension of scientific knowledge. It is sound, comprehensive, and thoroughly deserving of inclusion in the library of anyone concerned with the social nature of science.

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Cultural Development: Experience and Policies, By Augustin Girard. Paris and New York: UNESCO, 1972. Pp. 144. $4.00.

The author of this report has compiled a set of original and critical comments upon an unusual subject: the public subsidizing of cultural activities. His career has been made in the research department of the Ministry of Cultural Affairs in Paris; he has also worked for the Council of Europe and for UNESCO. His report was based partly upon his own judgments and partly upon the cross-national studies of cultural policy that were initiated by UNESCO. The report evaluates the policy dilemmas and the cultural experiments of various European and developing nations.

Rather strikingly, the book is written in two distinctive but complementary modes. The first, in a splendid introductory chapter, formulates the logical questions: How can the citizens of a mass-consumption society be taught to conquer the alienation and depersonalization of industrial life; how can they be induced to explore the cultural potential of the media of communications and to turn the “bondage of leisure” to creative and satisfying purposes? That citizens require cultural fulfillment and therefore enjoy a civic right to cultural satisfaction is axiomatic to Girard’s argument. His introduction lucidly recapitulates an important theme of contemporary

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