

Nagel claims his 'policy-goal percentaging' (P/G%) technique solves the third difficulty, expressing goals in numerical form. With each possible decision, he associates a rating for each goal in its natural units, which may be a money quantity, a produced or consumed quantity, a ranking, a preference scale or even a binary variable (satisfactory/unsatisfactory). A percentage is calculated by adding up the scores of every choice, expressed in natural units, and dividing them into the score of each choice. Every goal is thus reduced to a dimensionless quantity.

This cheerfully pragmatic approach overcomes the so-called 'apples and oranges' problem of comparing the incomparable, although the reader is sometimes left feeling a quart has gone into a Klein Bottle. Nagel's approach also calls for weights to be assigned to each goal (by decision of the user) and allows for numerical transforms of the goal ratings prior to the percentaging.

The book is self-promotional, if candid. Other MCDM techniques are mentioned, particularly in Thomas Stanton's two thoughtful contributions on energy investment, but the work is dedicated to the P/G% technique, and Benjamin Radcliff's evaluation of seven alternatives boldly concludes that "Without question P/G% is the best of the available software". Nevertheless, John Cooley's computer-aided mediation case study concedes that after much creative effort from P/G%-toting consultants, plaintiff and defendant settled for a traditional monetary solution exactly halfway between their respective claims.

Are there possible weaknesses in this interesting approach? One such is its concept of hierarchy, and this returns us to our opening comments. P/G% protagonists seem to regard hierarchy as little more than a priority ordering. But a logical hierarchy establishes relations of dependence, not priority. Technically, it establishes a partially ordered or tree-like structure; number by its nature cannot represent a partial ordering.

In tree structures, a branch, once taken, rules out dependent alternatives, whatever the superficial similarities. In chess, a king-side and a queen-side opening lead to very different mid-games. In law, where Nagel is keen to establish a foothold, if a key witness is proven a liar, all

outcomes relying on his or her testimony change their ratings and weights. When siting hospitals in Yugoslavia, there are rules and criteria which cannot be known at the outset. The problem is not that information is incomplete, to use Nagel's formalism; it is that the extent of our possible knowledge alters as history proceeds.

Moreover, the decisions confronting us may be so complex that they cannot simply be represented on a numerical scale; there may in fact be more in heaven and earth than dreamt of in any philosophy. Logic, through Goedel's and Church's theorems, has helpfully proven its own limits. There is no harm in exploring and pushing against them but it would be unwise to presume that they do not exist.

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Stephen Doheny-Farina, *Rhetoric, Innovation, Technology: Case studies of technical communication in technology transfer* (The MIT Press, Cambridge, MA, 1992), 279 pp, ISBN 0-262-04129-4.

This is an important book drawing attention to a critical area in our understanding of technology, namely, the processes of alignment and communication which underlie the realisation of effective technology transfer and, indeed, innovation at large. The book is well written, with many literature references, and three case-studies which provide empirical evidence for the author's

rhetorical line of argument. At times the case studies exhibit an engaging story-telling style which reflect the author's own standing as an experienced technical communicator. A similar style is found in a useful Appendix containing a role-playing classroom application.

The book counterpoises the new rhetorical understanding of the nature of technology transfer processes to the traditional view which treats them as mere processes of information transfer, in which the technology is more or less a given object to be taken from emitter to receiver. The general statement is that technological processes are highly rhetorical in nature, that is, "*at their core* these processes involve individuals and groups *negotiating* their vision of technologies and applications, markets and users in what they all hope is a common enterprise. This means that the reality of a transfer does not exist apart from the perceptions of the participants. Instead, the reality, what the transfer *means* to the participants, is the result of continual conceptualizing, negotiating, and reconceptualizing" (p. 4).

This statement condenses well what I think are the roots of the strength and weakness of the book. The book's strength is an insightful and detailed demonstration of the centrality of communication and negotiation processes, across many boundaries, in the development of technology. Its weakness is the lack of systematic attention to the part played in this development by the specific nature of the technologies involved.

The statement largely reiterates the principles of social construction or social shaping of technology, which have been widely established by sociological or socio-historical approaches during the last decade or so. Here the author provides strong arguments and evidence for the validity of the view that the perceptions of participants are central to the fate of innovations. By delving deep into the problem of communication, Doheny-Farina highlights not only the difficulties of technology transfer as processes of negotiation but, also, the important part played by strategies, activities and people who can effectively realise what he describes as 'boundary spanning'. This is essentially the mediation of worldviews among different people or groups involved in the devel-

opment or transfer of technology. This is a role the author sees as ideally suited for technical communicators who can help bridge communication gaps not only between people from different disciplinary practices but, equally important, between the innovation and the eventual users of that innovation.

The aspect I find controversial in the statement is the positing of the participants' perceptions as the reality of technology (reality—what the transfer means to the participants). This has implications for the analysis and understanding of technology. Thus, often meanings can be successfully negotiated but the technology is not there to deliver what is being perceived as possible; or, people find that the nature of technology imposes specific kinds of problems which other technologies would not raise. Indeed, I think that the three case studies contain evidence of the important influence exerted by the specific nature of the technologies on the course of events and outcomes of the stories. To name just one example, the third case study deals with a specific kind of software that is described as complex and, as the book makes clear, it "was this complexity of code that made problems difficult to analyze and fix" (p. 179). Indeed, the book tells of how the people working on the problem refer to this software with a name which could be part of a taxonomic entry for products of a different nature. They called their code "brittle code... because you made one change to it, and it fell apart, caused fifty problems for every change you made" (pp. 179–180). My view is that there is here a kind of reality which underlies perceptions and meanings, whatever these perceptions and meanings happen to be. More generally, it is plausible to suggest that different technologies tend to offer different terrains for the unfolding of processes of perception-building, negotiations and so forth. In these processes the technology is certainly socially shaped but the how and the what are themselves conditioned by the specific nature of the technology. A systematic recognition and integration of this aspect is needed for a fuller understanding of the development of technological processes. Only then, can the analysis evolve from the social to the truly sociotechnical. This

systematic treatment of the nature of technologies is largely absent from Doheny-Farina's discussion and this seems to me largely consistent with his definition of reality.

I wish to stress my initial statement that the book is an important contribution to the debate on the nature of technological processes. My comments are intended more as a challenge to the rhetorical approach to go further rather than to diminish the value of its considerable insight. The book is likely to prove a very useful addition to the curriculum of technology studies courses.

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Bengt-Ake Lundvall (Editor), *National Systems of Innovation: towards a Theory of Innovation and Interactive Learning* (Pinter, London, 1992) pp. 317, £45 (hardbook) ISBN 1-85567-063-1.

Dr. Lundvall and his colleagues at Aalborg University in Denmark are to be congratulated for writing and publishing this collection of papers. They both reflect the research results generated by the IKE Group over the past 10 or more years, and make a major contribution to the growing literature on national systems of innovation.

This literature appears to have two objectives. The first is to describe, compare and analyse the national institutions, competencies and incentive structures that generate and diffuse the technological knowledge that is essential for economic growth. The second is to develop a theory of technical change that goes beyond the well-established, but empirically unsatisfactory, notions that technical gets generated and applied as codified information, and/or embodied in machines, and/or as automatic by-product of production (i.e. 'learning by doing').

Other writers in this tradition include Freeman, Nelson and Porter, and the Aalborg authors also acknowledge the earlier work of List, Veblen and Schumpeter. Unlike many other contribu-

tions, the Aalborg book is organised along thematic rather than national lines. It has a number of theoretical chapters that compare analytical approaches from a variety of traditions, particularly neo-classical with Schumpeterian-evolutionary. Considerable emphasis is given to institutions and interactions between them, with chapters on institutional learning, producer-user interactions, work organisation, industrial networks, financial systems, formal scientific and technological institutions, and public policy. It is also recognised that national innovation systems, although distinct, are integrated within an international economic system, so there are chapters on export specialisation and structural competitiveness, and on the role of multinational firms.

The authors naturally base a good part of their empirical analysis on the Scandinavian experience. But like all good Scandinavians, they are thoroughly professional and internationally aware in their approach, with a higher proportion of references to foreign sources than is normally found in contributions from larger European countries, or (even less) from the USA. The book is therefore an invaluable reference document for those working in the field, whether analysts or policy-makers.

It should also be made compulsory reading for all economists interested in the economics of technical change in general, and the 'new growth theories' in particular. For the authors show that technological knowledge is most often not generally available and codified information, but tacit knowledge accumulated through deliberate learning, that interfirm trust contributes to such learning, and that institutions and competencies are just as important as incentive structures for its development.

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Daniele Archibugi and Mario Pianta, *The Technological Specialization of Advanced Countries; A*