0039-3681(94)00032-8

ESSAY REVIEW

Building a Global Infrastructure

*Michael Lynch**

Geoffrey C. Bowker, *Science on the Run: Information Management and Industrial Geophysics at Schlumberger, 1920–1940* (Cambridge, MA: The MIT Press, 1994), 191 pp., ISBN 0-262-02367-9, Cloth, £24.75.

A fine thing about this book is that its intellectual value does not depend on the reputation of its subject. The book describes the rise of Schlumberger Ltd, an international consulting firm based in France, which developed geophysical methods for locating oil-bearing strata. Schlumberger became highly successful after some initial failures in the 1920s and early 1930s, and is now a household name in the oil industry. Needless to say, it is not a household name in the history, philosophy and sociology of science. The company's scientific innovations were associated with the peculiarities of the oil business, and they were subordinated to strategies for making money. Consequently, Schlumberger's science does not provide the kind of 'pure' exemplar that was once favoured by historians and philosophers of science. Nor is it the sort of 'hard case' that challenges sociologists of knowledge to show how technology, economic interests, and political manoeuvring influence scientific development. In this case, the epistemic pollution lies at the surface, and there is no need to dig deeply to find it. Geoffrey Bowker faces a different kind of challenge with the humdrum science he takes up for study, which is to disclose some of the more subtle and non-obvious aspects of the political economy of scientific activity. At this task he succeeds brilliantly.

Unlike many of his contemporaries in social studies of science, who sometimes engage in a kind of conceptual art that is long on interpretation and short on detail, Bowker devotes most of his book to a matter-of-fact presentation of the gems he unearthed from the Schlumberger archive housed at l'Ecole des Mines de Paris. The archive included a series of detailed interviews of some of the key figures in the early history of the company. These interviews

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Stud. Hist. Phil. Sci., Vol. 26, No. 1, pp. 167–172, 1995

0039-3681/95 $9.50+00.00

were compiled by Anne Gruner-Schlumberger, a descendent of one of the founders, and Bowker incorporated them very effectively into his own story.

Not incidentally, l'Ecole des Mines also houses the Centre for the Sociology of Innovation where Michel Callon, Bruno Latour and some of their colleagues developed 'actor–network theory'. Over the past several years, and especially after the English language publication of Latour's manifestos on the subject,[1] actor–network theory has largely taken over the small world of sociology of science, and it has also reached into the adjacent fields of cultural and technology studies. Simply considered, actor–network theory licenses vaguely Machiavellian stories of how innovative persons and agencies manage to establish global networks for their fact-making and technology-producing enterprises. It is not a typical micro-political theory, however. Indeed, it should carry a warning label when sold to English-speaking customers in the social sciences. This is because the 'actors' in the theory are not social actors in the usual sense, and they certainly are not rational actors. Instead, they are modelled along the lines of semiotic 'actants' in the story grammar model developed by A. J. Griemas.[2] As I understand the concept, an actant is something like the subject position in a sentence. All manner of substantives can be plugged into the syntactic slot: mathematical entities ('The data indicated...'), inanimate objects ('Carbon combines with oxygen to form atmospheric CO_2'), collective agencies ('The National Science Foundation withdrew support for the project.'), psychic agencies ('His memory failed him.'), fictional characters, authorless texts, transcendent deities, autonomous ideas, etc. Furthermore, in actor–network theory 'networks' are not composed only of strong and weak 'ties' between persons, such as are described in the field of sociometry. Nor are they limited to the citational ties between texts and authors described in the sub-field of bibliometrics. Instead, actor–networks are associations between human and non-human actants which are held responsible for historical developments. Actors in such networks often form spontaneous and surprising alliances, and Deleuze and Guattari's term 'rhizome' has been suggested as a better term for capturing the appropriate sense of subterranean interconnection and sudden emergence.[3] Finally, actor–network theory is not a 'theory' in the usual sense. In Latour's hands it has become an ontology that assimilates humans and non-humans into a unitary field of action.[4] Unlike the brand of monism that attempts to reduce life and agency to inanimate mechanisms, actor–network theory animates anything that can be positioned in

[1]B. Latour, *Science in Action: How to Follow Scientists and Engineers through Society* (Cambridge, MA: Harvard University Press, 1987); *The Pasteurisation of France* (Cambridge, MA: Harvard University Press, 1988).

[2]A. J. Griemas, *On Meaning: Selected Writings in Semiotic Theory* (Minneapolis: University of Minnesota Press, 1987).

[3]G. Deleuze and F. Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia* (Minneapolis: University of Minnesota Press, 1987).

[4]B. Latour, *We Have Never Been Modern* (Cambridge, MA: Harvard University Press, 1993).

the 'actant' slot of a grammatical story. If it had billed itself as 'actant–rhizome ontology', the theory would never have caught on in the English speaking world, and for the most part its practitioners tend to restrain the formal potential for absurdity when describing historical cases of scientific and technological innovation. This is certainly the case for Bowker's book. When describing what otherwise might be considered as impersonal contingencies that stand in the way of making accurate measurements, Bowker occasionally uses words like 'parasite' to suggest how such 'factors' can seem to have a life of their own (p. 51), but for the most part his narrative follows fairly conventional lines. The persons, artefacts, objects, and forces in his story generally play the roles assigned to them in common language.

Like proponents of other current approaches in the sociology of scientific knowledge, actor–networkers aim to trap the technical contents of science within an explanatory net that also captures social, political, economic, and literary features of scientific practice. But unlike many of their science studies colleagues, they do not try to replace naturalistic accounts of discoveries and inventions with sociological explanations. Instead, they attempt to describe a field of science-in-action in which natural facts have not yet differentiated from the practical, semiotic, and communicative matrices from which they emerge. Having laid out the co-ordinates of a seamless web, social historians who follow the approach then try to explain how natural facts and technological artefacts become 'stabilised' as part of the furniture of the world. Such explanatory efforts can be confusing—it is not always clear what explains what—but the descriptions occasionally reveal complex aspects of the global careers of discoveries and inventions that are lost in stories about geniuses, flashes of insight, serendipity, consensus, and inevitable progress.

Bowker's book perhaps marks the beginning of a mature stage in the brief history of actor–network theory. He does not go to great lengths to justify his preference for the theory, and at times he is willing to put it aside in favour of continuing his story on its own terms. Nevertheless, his account is distinctive in ways that are relevant to the actor–network approach. The narrative begins in the 1920s and follows the efforts made by Conrad and Marcel Schlumberger to develop a consulting firm that made geophysical measurements for oil companies. The company's main service was to compile electrical resistance measures that, it claimed, would help the companies locate untapped sources of oil in existing fields. Schlumberger developed methods for lowering an electrode down a well shaft, and then recording changes and resistance between that electrode and another electrode at the surface. The graphs, or 'logs' as they were called, would then be correlated with core samples in other measures to identify patterns indicative of oil-bearing strata. Early in its history, Schlumberger faced an interesting set of problems that required it to undertake a kind of bootstrapping operation: in order to take geophysical measurements (and thus

to test its equipment and develop its expertise) the company needed to get access to oil wells, and not just single wells but extensive fields of wells. This required the co-operation of the companies that drilled the wells, but in order to gain such co-operation, Schlumberger had to convince the oil companies that it offered a scientific expertise that could not be duplicated by the oil companies' own geologists. Schlumberger emphasised the laboratory-tested reliability of its techniques, and deployed patents and journal publications to secure and control its scientific reputation, while at the same time it depended heavily on local knowledge and cumulative experience that could only be gained through systematic field testing at particular sites. Bowker identifies various modes of 'representational ambiguity' through which Schlumberger experimented with its methods while keeping them 'opaque' to the oil companies and other potential competitors. "Under the guise of normal readings, they could test hypotheses and thus use the oil fields as their laboratory" (p. 153).

This gambit initially failed in Texas, due to several contingencies, whereas it succeeded in the newly formed Soviet Union. In the latter circumstance, Conrad Schlumberger's socialist sympathies helped him gain a receptive audience. Perhaps more importantly, the Siberian fields, unlike those in Texas, were under uniform state control, so that there was no need to get permission from dozens of companies and wildcatters in order to map an extensive distribution of points in the field. By taking advantage of this situation, Schlumberger's geophysicists were able to gain the comprehensive experience needed to develop the effectiveness of their methods.

Schlumberger also developed a successful operation in Venezuela in the 1930s. Again, it ran a bootstrapping operation in which a range of negotiations and organised activities, which presumed (and promoted) a yet-to-be-attained scientific expertise, established conditions for vindicating that expertise with useful measurements. Although Bowker does not make a point of it, his story richly exemplifies Heidegger's conception of technology as essentially a matter of 'enframing' natural constituents in order to extract calculable forces from them.[5] When first entering the Venezuelan rain forests, Schlumberger's staff enlisted local labour to construct roads and transport heavy equipment to the well sites. The clearings for the well-heads and roads were carved out from the rain forest, sealed off from an encroaching nature, and defended against incursions from hostile natives and devious competitors. Schlumberger exported its own equipment and technical staff to take over the operation, gradually divesting itself of the native assistance and local knowledge that helped create the clearing in which the company performed its information extraction procedures. The nodes and corridors through which equipment, labour, expertise, and data were relayed from the company headquarters to the

[5]M. Heidegger, *The Question Concerning Technology, and Other Essays* (New York: Harper and Row, 1977).

peripheral well-heads were thus progressively demarcated from the surrounding human and natural milieus. This controlled space enabled the company to appropriate, transport, and protect geophysical data from methodological contamination, and not incidentally to protect it from the scrutiny of geologists working for the oil companies it served. Bowker relates this story in a detached but lively way, and he vividly substantiates his general insights about global scientific development. His story takes in a number of detailed aspects of the company's 'infrastructural work' used to develop a global network. These include a strategic use of patents and scientific publications.

> What is interesting in this tension between local and global is the double process that is going on. In the first process, Schlumberger were defending their patent by claiming it gave the correct historical account of the development of electrical logging—a technique that was globally applicable. In the second process, they were changing the nature of well digging so that electrical logging was the only possible adjunct to the drilling process. Thus, they were, in a messy way, creating the hegemony that they already claimed was the correct account... (p. 160).

Although emplotted in a more complicated nexus of material fields, corporate strategies, legal battles, and political alliances, the hegemonic operation Bowker describes is relevant to some of the classic cases in the history of science It recalls, for example, Feyerabend's account of Galileo's opportunistic strategies for promoting theoretical claims that he and others were able to vindicate experimentally only after a credible space had been secured for them.[6] It also recalls Shapin and Schaffer's account of Boyle's "technology of virtual witnessing", the various descriptive, demonstrative and pictorial methods for securing credibility, which ran ahead of the possibility of replicating the air pump experiments while setting up receptive audiences for Boyle's experimental programme.[7] More obviously than in these cases, Schlumberger's methods were not wholly 'scientific'. From beginning to end, the company's methods comprised an unholy mixture of available technologies, geophysical principles, and ad hoc adjustments to local conditions. Readers might object that Bowker's historical account has little to do with the history of science, and is more of a description of business strategies and technological applications. But, as many recent social–historical accounts have shown, less questionable sites of scientific research also tend to be thick with commercial patronage, industrially produced technology, and alliances of various kinds. Moreover, Schlumberger made explicit and effective use of 'scientific' methods, credentials, and publication outlets. These accoutrements of science had much to do with the tenuous foothold it managed to stake out in the oil fields. Although Bowker does not claim to have described an exemplar of all science, his case study

[6]P. Feyerabend, *Against Method: Outline of an Anarchistic Theory of Knowledge* (London: Verso, 1975).

[7]S. Shapin and S. Schaffer, *Leviathan and the Air-Pump* (Princeton: Princeton University Press, 1985).

certainly depicts a significant, if often ignored, part of the landscape of the sciences.

Contemporary approaches to the social–history of science are often identified (and sometimes identify themselves) with anti-realist or relativist philosophies of science. Although Bowker does provide an account of the social construction of a global techno-scientific enterprise, and he also goes into considerable detail about problematic aspects of the production and interpretation of geophysical measurements, the relativistic aspects of his story are less than threatening. He does not, for example, suggest that Schlumberger 'made up' their logs, or that the alleged correlations between graphic features and geological properties simply reflected the geophysicists' vested interests. He says nothing to discount the fact that the data transported from Venezuelan oil wells to the company's headquarters were of some value for locating oil-bearing strata. Without dismissing the eventual adequacy of Schlumberger's graphic and interpretative procedures, Bowker describes how scientific authority was attained through an entire series of collateral operations which set up the necessary social and technical infrastructure. Regardless of what one concludes about the validity and accuracy of Schlumberger's resistance measures, Bowker's account makes clear that their credibility and very existence depended on a complex series of socio-technical ventures through which the company secured its epistemic foothold in the oil fields.

In keeping with the actor–network approach, Bowker allocates 'agency' even-handedly to things as well as people. He says, for example, that there were times when "the earth itself would conspire" to defeat the geophysicists, attempts to generalise their measurements: "The early torsion balance methods did not work well on hot days when there were thermal currents—they worked best on cloudy nights. And the magnetic methods remained local in space..." (p. 50). The language of conspiracy and parasitism is fanciful, and in some ways suggestive, but the narrative is not all that far removed from a more banal account of the contingencies of oil exploration. The references to the realities faced by the geophysicists do not necessarily trace back to a realist metaphysics. In Bowker's story an autonomous 'nature' does not simply stand in judgement of human resourcefulness and folly. Instead, the strata, drilling mud, thermal currents, and other sources of electrical resistance variously join forces with or conspire against the humans in the story. Readers will be hard-pressed to find a clear-cut explanation of why Schlumberger became so successful. Instead, they are more likely to develop an appreciation of the fragility of technical success, and of the many ways this success story might have turned out differently.