COURSE BIBLIOGRAPHY

• ABSTRACT

This paper describes the content, approach and rationale of the courses in social studies of science currently being taught at Deakin University in Geelong, Victoria, Australia. It sets these courses in their national and intellectual contexts, and describes the publications which have been devised to support them.

Science Worlds: An Integrated Approach to Social Studies of Science Teaching

David Wade Chambers and David Turnbull

Just over ten years ago, in the industrial port city of Geelong, Victoria, a new university was established bearing the name of Australia's second Prime Minister, Alfred Deakin. From the beginning, Deakin University was planned as a mainly off-campus institution, modelled on the Open University in the UK. All of its undergraduate majors in arts were to be strictly interdisciplinary, though surprisingly for these purposes, the sciences were separated from the arts, which were further divided into a School of Social Sciences and a School of Humanities.

The Founding Dean of the School of Humanities[1] believed that, among other things, the School should explore the cultural dimensions of science and technology, focusing upon, but by no means confined to, a humanistic critique of science and technology. Furthermore, the Vice-Chancellor of the new university came to the job from his position as Head of the Department of Liberal Studies in Science at the University of Manchester.[2] It is not surprising, then, that one of the first Humanities Course Team Chairs to be appointed at the new university was an historian of science.[3] By 1984, the number of continuing staff had risen to its present complement of five, all of whom are tenured.[4] Each year, a number of consultants were engaged to advise in a variety of disciplines not represented, in some cases writing textbooks for the

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off-campus programme. In addition, several part-time personnel have been associated with the programme, and full-time staff have been employed on contract.[5] Approximately five other Deakin academics have sustained an ongoing, though non-teaching, relationship with the programme.

The Deakin Social Studies of Science major consists of three year-long courses, the first two of which constitute one-quarter, and the third of which constitutes one-half, of each student's yearly workload.[6] The first-year course, placed on offer in 1979, has attracted an average annual enrolment of about 150 students. The current total enrolment over all three years is 330 students, and a total of nearly 2000 students have enrolled in the three Social Studies of Science courses in the first nine years. In all, about eighty students have completed the major, which has been in place for only four years. These enrolment figures indicate that the Deakin undergraduate programme has grown in size to equal any in Australia.

One of the programme's notable achievements has been the publication of more than thirty textbooks for use at Deakin, and available for general sale.[7] Deakin University Press, now the largest publisher of tertiary level textbooks in Australia, maintains high standards of production, achieved in part by close consultation with the academic authors on matters of pedagogical format and design. In 1979 and 1984, National Book Awards were presented by the Australian Book Publisher's Association to productions of the Deakin Social Studies of Science unit.[8]

The books are quite varied in format and design. They include textbooks or 'study guides' in the Open University style (such as *Imagining Nature*,[9] an examination of the perception of nature in science, art and everyday life), case studies (such as *Unwritten Knowledge*, a look at Micronesian navigation considered as a non-Western way of framing natural knowledge), monographs (such as *The Politics of Objectivity*, a scholarly analysis of the use of scientific advice in the social decision-making process), readers (such as the *Liberation and Control Reader*, an anthology of materials on the social, cultural, environmental and medical impact of modern science and technology), bound portfolios (such as *Putting Nature in Order*, a collection of images and quotations from art, science, literature and myth illustrating the kinds of order which cultures impose upon nature) and teaching modules (such as *Knowledge Making*, a set of introductions to advanced student research topics).

To understand why the progamme developed in just the way it did, it is helpful to consider three aspects of the context within which the course was conceived and constructed: institutional, national and intellectual.

The Institutional Setting: Deakin University

More than two-thirds of our students are situated off-campus, completing their work entirely through autonomous teaching materials. Most are Australian, but a few are scattered across Asia, Europe and North America. They are mature-age students, about 70% from the School of Humanities with 12% from Education, 12% from Social Sciences, 4% from Science and 2% from other faculties. Beginning this year, all Nursing students will be required to take our third-year Medicine and Society course, which will mean 120 extra students in the third year. We offer an elective course to Honours psychology and Honours mathematics and computing students, and expect our cooperation with the sciences to increase as they move towards off-campus courses. We also have close relations with the Koori Teacher Education Programme, a professional training course for Aborigines. Finally, we have a small number of students enrolled in Honours fourth year and advanced degree programmes, and expect this to be the next major stage in our development.

At the end of the first decade of operation and three years after the appearance of the first graduates, the Course Team has undertaken a full-scale self-assessment of all the courses, sending to all ex-students a questionnaire asking them to evaluate the courses in such terms as intellectual stimulation, usefulness in career, effects on attitudes towards science and technology, effects on political orientation and so on. The results of this survey were not expected to be in hand until the end of 1988. Currently 12.2% of Humanities graduates major in Social Studies of Science, making our programme the third most popular in the School of Humanities.

Although the programme is officially and entirely a creation of the School of Humanities, it is understood and accepted that our task involves a significant degree of input from disciplines throughout the arts and sciences. Most contributors from outside the humanities have been consultants from other universities. This came about mainly because staff throughout the new University were too busy setting up their own courses to collaborate across School boundaries. Hiring outside consultants, though costly, has enabled us to seek persons with precisely the expertise needed to complete particular projects. This has proved a distinct advantage with regard to interdisciplinarity. From beginning to end, the courses are highly integrated — though, inevitably, some compromise was required to accommodate the professional competences of full-time staff.

The National Context: Australia

Writing in *Technology and Culture*, a reviewer of one of the Deakin textbooks commented that the programme has become an important international centre for the development of teaching materials in the science, technology and society field, even though geographically speaking, it is on the 'periphery of the periphery'.[10] In most ways, save the distribution and marketing of these publications, we believe that our 'peripheral' location provides a most interesting vantage point from which to view the development of modern society.

Unlike many other nations of the world, Australians are only rarely tempted to think of themselves as the centre of the known universe. Indeed, it is often a struggle making sure that the course materials have adequate Australian content. Special attention is given to examples and case studies from Europe, North America, Africa, Asia and the Pacific region. While this particular international perspective is no doubt distinctively Australian, most of the books are relatively free of the nationalism and superpower rhetoric that sometimes creep into materials produced in those nations which bear the burden of international political and economic leadership. An important corollary of the programme's internationalism is its cross-cultural approach to questions of epistemology (see below). Here it is sufficient to note that the perception of nature and the wielding of technology in non-Western cultures, such as aboriginal Australia, is treated seriously and extensively.

Finally, as a country of small population and intermediate economic power, developed and yet still highly dependent on the sale of unprocessed natural resources, Australia shares the problems and concerns of both the First World and the Third World. In the current economic climate, the 'science, technology and society' field is especially vulnerable to pressures that would tie such academic programmes, in both teaching and research, to purely technocratic aims associated with the production of goods and services. We claim to offer critical examination of the social and cultural processes through which science and technology are produced and consumed, and to identify those political and economic factors through which control is exerted. However, whilst we recognize that in the latter part of the twentieth century all criticism and analysis can be used to serve technocratic aims, we believe that establishment of the possibility of science criticism in the educational base is vital, not only to understanding ourselves and our social and intellectual environment, but also to the preservation of the democratic process.

The Intellectual Framework

Any serious discussion of the relations of science, technology and society must, of course, proceed from some understanding of each of these notoriously problematic entities. For many years philosophers of science took the central question to be the nature of science, which they identified with an abstract method — an identification which seemed unproblematic, as long as one didn't think too hard about it.[11] The philosophers were confident that they could iron out the few wrinkles that remained. Never mind the fact that the proffered definition of scientific method made no reference to the personnel, the instruments, the laboratories, the institutions, the funding, the administration — or, indeed, to virtually any aspect of science with which one must deal in science and society courses. Those aspects, one told one's students, weren't actually the substance of science; rather, they were what one called the 'social relations' or 'social structure' of science. Never mind that the definition of scientific method failed to shed any light whatever on the science/society interface. Don't worry about the fact that in everyday discourse, the term 'science' is used in a great variety of quite different ways.

Eventually, it became clear that the vision of science afforded by epistemologists was little more than an impossible dream, which obscured as much as it clarified. The philosophical issues raised by Popper, Kuhn, Feyerabend and others (for example, the problems of induction, theory-ladenness of observation, and the underdetermination of theory by data, all of which seemed to lead to an epistemological dead end) provided the grounds for the development of a full sociology of scientific knowledge. But the focus of attention was still on theory and theory change, rather than on the practice of science. Now, we believe that instead of losing students in the Popper–Kuhn debate or in abstruse philosophical discussions, philosophy of science (rather than setting an epistemological agenda) can be used as a lever to open the proverbial black box that science has become for the lay person, and even for the practitioner.[12]

Towards the end of the 1970s, it began to be clear that the sociology of science was capable of being developed in a whole new set of directions that went beyond the rather restricted analyses of the Mertonians.[13] As we approach the end of the 1980s, it is possible to discern an emerging maturity in the discipline in which many of its problems, contradictions and silences are in the process of dissolution.[14]

A fundamental problem is whether there is an identifiable discipline,

and how we are to define it. The area comes under various titles — history and philosophy of science; science policy; social studies of science; science; technology and society; science and technology studies; metascience — reflecting not only the ebb and flow of fashion, but also the widely divergent interests of its practitioners. Papers presented at the STS Teaching Conference at Worcester, MA, in November 1987,[15] graphically illustrate the theoretical grab-bag presented by most STS programmes, and also show the oppositional interests of those working within Schools of Science and Technology and those in Humanities or Social Sciences. Whilst its obvious interdisciplinary nature is in part responsible for this diversity, a lack of any consensus as to its object and theoretical approach has hampered the development of a coherent discipline.

Recently it has become possible for the first time to see the forest as well as the trees. A clearer idea is developing of the *what, how* and *why* of the metascience enterprise. At last it is possible to offer students working definitions of science and technology that relate directly to the issues with which academics, scientists, politicians and the public are all concerned. One approach to the STS disciplinary enterprise, reflecting that emerging coherence, takes as its central task the identification and study of the conditions for the production, transmission and use of knowledge in society — specifically of scientific and technological knowledge. In our courses we hold that the perspective that best displays those conditions sees what is taken as knowledge in society as the result of collective work. That collective work is sustained by a set of practices that together constitute what we can call a 'science world' (or following Wittgenstein, a 'form of life').[16] Typically, for something to count as knowledge in our society, work and associated practices (that is the forms of life that sustain it) are suppressed or made invisible, leaving only the institutional and methodological elements visible.[17] The task of the analyst and the teacher is to make the whole process visible, and as such is a conjoint sociological, philosophical and historical enterprise.[18]

Clearly, such an undertaking requires the active collaboration of potentially all the academic disciplines — certainly of history, philosophy, sociology, politics, economics, anthropology and psychology.[19] If it is recognized that the production of scientific and technical knowledge is a process, and as such is inherently historical; if it is recognized that science is the result of human action, and as such is inherently social;[20] if it is recognized that science concerns the way we learn about the world, and as such is inherently philosophical; then, quite clearly, at any given point in the analysis history, philosophy and sociology must dissolve into

one another and are simultaneously constitutive of each other. The end result will be a new and more complete picture of scientific activity: a set of landscapes of the 'science worlds'[21] inhabited by all those without whom science and technology could not exist or come to be.

In the rest of this paper we will look briefly at the three main disciplines contributing to the new understanding of the nature of science, with a few examples of how these are incorporated in Deakin teaching.

History of Science

The fundamental role of the history of science in our courses is not merely to trace the dates, times and names of the contributors, nor even only to depict science in its broader historical context. Rather, it is to show how changing historical conditions provide for the possibility of different understandings of the natural world, and of different ways of manipulating it. In other words, science is not separate from its context; science and society are mutually constitutive of each other. The western analytic tradition, especially in epistemology, has tried to separate knowledge from the conditions of its production in order to establish foundations for its truth and certainty. This analytic dichotomizing propensity has led us to conceive of society as a sort of bucket in which humans do their strange and peculiar thing — but everything is social, we are the bucket. Thus, the history of science can now transcend the old internal/external division. In our teaching we may safely ignore the old debates about whether history is continuous or discontinuous, and about whether there are periods in history.

Scientific knowledge could have been other than it is. This is true precisely because science and technology are the result of social and historical processes rather than the result of an asocial, ahistorical process of logical unfolding. Because science is an open-ended process, current results, laws, theories and methods cannot be taken as some kind of natural end point or 'truth' towards which past practitioners were struggling. Thus we use the history of science and technology not just to trace the development of ideas or the careers of the actors but also to provide the history of the 'worlds' in which science is generated, transmitted and applied. We attempt to display the development and transitions of the more visible and well-recognized practices that sustain science and technology: the modes of communication, the social and economic relations, and the material circumstances of its production and development in the form of instruments, technique and so on. Finally,

we look historically at the often invisible: the collective work, the strategies deployed in the struggle for authority, the social and physical spaces required for science and technology, the textual practices and the modes of discourse.[22]

Much of this thinking was implicit in the historical component of the Deakin Social Studies of Science curriculum when it was first devised more than ten years ago. The two historians of science on the Knowledge and Power course team found that many of the traditional categories and cases examined in standard texts were not very useful for STS purposes. The internal/external dichotomy seemed to frustrate every effort to offer an integrated teaching approach to the field. In the final result, perhaps one-quarter of the course is historical in character, though little of it is explicitly devoted to traditional historical categories. It left out most of what 'internalist' historians had deemed the central core of the discipline — causing, for example, the reviewer (in *Isis*) of one of our texts to ask, 'But where are the historians of science and technology?'.[23] The historians were there, but reorganized and with new points of emphasis.

The central historical unit in the Deakin first year course, called *On the Social Analysis of Science*, focuses entirely on such matters as the development of the scientific community, the formation of the scientist's social role, the professionalization of that role and the banishment of the layperson from the domain of science, the changing institutional setting, the compartmentalization of knowledge, general *versus* specialist educational practice, and the relationship of knowledge and power. Another example of how history fits into the general course schema is a case study of Watson and Crick's work on a model for DNA. Here the main concern is a concrete examination of what scientists actually do, how they are motivated, the social structures within which they work, and the management of research. A further Deakin example of an integrated approach to the 'science worlds' is found in a new third-year unit on the seventeenth century, 'The Problem of Experiment', prepared for us by Steven Shapin.

Philosophy of Science

Philosophy of science has all too frequently been taken as an essentialist or logocentric enterprise, and as such was likely to generate diverting and troublesome difficulties like 'incommensurability' and 'the problem of induction'. But, significantly, these difficulties seldom if ever prevent the social accomplishment of meaning and communication in science. Similarly, philosohical concerns with the foundations of true and certain

knowledge, or the logical relationship between theory and evidence, are conducted at a level which does not intersect with the social world of the historical actor. Indeed it has until recently been the practice of philosophers of science to ignore what scientists actually do, and to concern themselves in Olympian fashion with what they ought to do.[24] In our courses philosophy's role as epistemological arbiter has been abandoned in favour of critically analyzing the ways in which power and knowledge are related — that is, to explore 'what it is possible to ask' at a particular sociocultural juncture, through posing more illuminating questions about the ways in which knowledge structures and social structures interact.[25]

Thus sterile debates about what counts as objectivity, or futile pursuits of demarcation criteria, can be abandoned in favour of consideration of the consequences of their *social* accomplishment, as is done for example in the Deakin text *The Politics of Objectivity*.[26] Philosophical analysis can show that, counter to intuition, there is no unmediated access to reality, clarifying the difficulties that this raises for the canonical account of science. But it requires a 'sociological turn' away from a focus solely on language, words and propositions to recognize that scientists themselves resolve such difficulties by convention, by social agreement, struggle and negotiation — that is, through words *and* action.[27] This recognition enables students to make the important connections between philosophical analysis and scientific practice, a theme that runs throughout the Deakin course materials.

The relationship between knowledge and power is the major focus of the first-year course. The relationship between what it is possible to think and what it is possible to do are explored in the second-year course, especially in *Singing the Land, Signing the Land*, a book which contrasts European–Australian and Aboriginal–Australian modes of seeing and knowing. Aboriginal modes are shown to be both as complex and sophisticated and as bound to a form of life as our own, though resulting in a thoroughly different relationship to the natural world. In the third-year publication *Knowledge Making*, the thoroughly constructivist character of knowledge production is explored through considering the role of metaphor, classification and the struggle for authority, all of which issues are touched on in earlier courses.

Sociology of Science

Until recently, the sociology of science seemed to be irreconcilably split among the American Mertonian positivists, the British relativists and

the continental structuralists. In no way did it seem possible that those who thought that social determinants only affected the rate and general direction of scientific development could find common ground with those who held that scientific knowledge itself was susceptible to sociological analysis. This irreconcilability was due to a number of problems. The sociology of scientific knowledge was so eclectic that it was hard to identify a unified theoretical base from which to compare the plethora of case studies, and hence to discern any sense of coherence and progress. The inherent relativism and reflexivity of the programme seemed to make problematic the status of any its pronouncements and findings. The rather sketchy social theory that informed the programme frequently gave the impression of claiming that knowledge was socially *determined*.

If, as we have argued, the science/society relationship is an inherently dialectical process, old notions of 'reflection' or 'determination' can be jettisoned in favour of an open-ended contingent account. Relativism was simply misconstrued by its critics as being either self-contradictory, or as precluding having 'good reasons' for some belief — whereas all that is claimed is that there are no transcendental criteria for truth or knowledge, that we make our own. The claimed problems of grounding and contradiction are a consequence of the construal of science as essentially a body of knowledge, rather than as a network of practices. The reflexive necessity to subject one's own account to analysis is still a source of problems about style and presentation, on the one hand, and about political stance on the other. Instead of a confusing eclecticism we can now see an emerging synthesis — indeed, much of what Merton glimpsed in 1942 may now be possible.[28] The role of institutions and norms, or how trust and authority are manifested, are as important as how boundaries are sustained, how laboratories accrue power, or how the scientific paper can act as symbolic capital: but, central to all analyses of science, is the recognition that scientific and technological knowledge is a social accomplishment and results from collective work. Sociology's task is to reveal the practices that enable that work to occur.

One of the practices that constitute the formation of a 'science world' is the construction of a boundary between the public and science. The nature and consequences of the social definition of who is an expert is a theme running through all our courses. In *Worm In The Bud* we consider the great importance this question had in the pesticide controversy; in *Red and Expert* we consider the Chinese Cultural Revolution, an occasion when that boundary was explicitly redrawn; in *On the Social Analysis of Science* we look at how the process of professionalization officially excluded players who have, or might have had, a role to play in the doing

of science. In *Imagining Knowledge* we explore the differences in the ways in which that boundary is drawn in a number of different societies, both traditional and modern.

The Relationship between Science and Technology

One of the classic problems that beset the sociology of science was what on earth was the relationship between science and technology? Were they fundamentally different, much the same, did one precede the other, if so which? Could any agreement be reached on what they are? These difficulties are lessened if both are seen as the embodiment of skills in collective work. In both cases, the line between practitioners and non-practitioners becomes not just a question of professional credentials but of relevant activity and competence. The differences between the two remain significant in certain respects, but for our purposes, as one of our reviewers put it, 'science and technology are not regarded as separate, self-contained entities; instead, they are viewed as intertwined activities carried on in a social matrix'.[29]

The historical and cultural range of forms of life that provide for technology are considered in *Knowledge Using* and *Science and Society*, where we move from the technology incorporated in Stonehenge and African iron smelting to technological innovation in Australia and the relationship between industrial work and technology.

Why Bother with the Social Studies of Science and Technology?

In the past, the social studies of science had one really severe problem: what is the point of it all? Scientists largely ignore the history, philosophy and sociology of science as irrelevant to their daily practice. At most, they either take it up as a hobby in old age, or use it as part of a legitimation strategy for new knowledge claims. Any attempt to become 'applied' in the science policy area seemed doomed to failure, as there was no way to link the policy back to the theoretical core. Attempts to incorporate a political analysis were dismissed as undermining any putative objectivity. The only resort was for the sociology of science to adopt the 'knowledge for knowledge's sake' legitimation strategy. This inability to distance itself from its subject, science, was problematic, since one of the achievements of the social studies of science had been to show

that science itself is constituted through the interests of its practitioners, and that 'knowledge for knowledge's sake' could not be accepted as the underlying virtue or rationale for so-called 'pure' science.[30] If the social studies of science itself adopted the rationale of knowledge for knowledge's sake, it would preclude the possibility of critically evaluating science and technology. Further, to try and develop a critique of science would be seen as being anti-science or ideological.

Now the point of it all becomes clear. There need be no forelock tugging in either the direction of the scientists or the politicians. On the one hand, revealing science as the product of collective work provides the conditions for the possibility of critique, and for scientific and technical knowledge being other than it is. On the other hand, the recognition of the centrality of skills, and their formation, in the enterprise of knowledge production will enable a genuine science policy and science education programme to be developed. Such a programme would provide for public understanding of science, technological literacy, and the introduction of skills-based science education. These understandings and changes would enable us to deal with the transformations of science itself, and of the international economy.

Finally, we need no longer be afraid of appearing to be 'anti-science', or even 'ideological'. Rather than being anti-science, this approach allows the transcendence of the current contradiction generated by the old orthodoxy. We seemed to be stuck with the problem that science and technology both provide the very conditions of progress and authority in our society, but at the same time are the apparent cause of waste, degradation and alienation. Further, when it comes to the crunch in the really difficult decisions, science seems to fail us; experts disagree about whether nuclear energy is harmful, or what the consequences of automation or *in vitro* fertilization will be. If we recognize that science and technology are not autonomous, that they do not have a determinate relationship to reality or a specific methodology; if we recognize that science and technology do not consist in knowledge, and the relations between ideas, alone, but also in the collective skills and work of human actors — then we can construct a policy for science and technology that will enable us more rationally to choose what is appropriate for what purpose in what circumstances.

• NOTES

1. Max Charlesworth, Professor of Philosophy, with special interests in ethics and the philosophy of science.

2. Fred Jevons, a former biochemist with interests in science education and science policy.

3. Wade Chambers, former co-chair of the interuniversity Science and Human Affairs Program at Concordia and McGill Universities in Montreal, and co-editor of the modular textbook series in use there: *Collaborative Studies in Science and Human Affairs* (Montreal: McGill University, 1970–75), now out of print. For extensive description of this early approach to an integrated social studies of science major, see articles and editorial in the Canadian journal *University Affairs* (March 1973).

4. In addition to Wade Chambers, Struan Jacobs, political theory and history of ideas, was a member of the original course team (as were the Dean of Humanities and the Vice-Chancellor). Lyndsay Farrall, historian of science, joined the university in 1979, bringing the experience of teaching history and philosophy of science in Papua New Guinea. David Turnbull, epistemology and sociology of scientific knowledge, was appointed to the Course Team in 1979. Jock McCulloch, politics and environmental theory, was added in 1984.

5. Notably, Terry Stokes, philosophy and history of modern biology, who served the programme from 1982 to 1986, and Barry Butcher, Australian science and the history of biology, who joined Deakin in 1984.

6. See Appendix One for a complete description of the undergraduate curriculum.

7. For a complete catalogue of Deakin Course publications and textbooks (many of which are available for purchase), see Appendix Two.

8. *Liberation and Control* (1979) and *Imagining Nature* (1984).

9. All Deakin textbooks will be referred to by title alone. Full bibliographic reference may be found in Appendix Two.

10. George Bindon, *Technology and Culture*, Vol. 24 (July 1983), 548–50.

11. See J. Schuster and R. Yeo (eds), *The Politics and Rhetoric of Scientific Method* (Dordrecht: D. Reidel, 1986), for a wide-ranging discussion of how and why method talk became central to science.

12. See M. Mulkay, *Science and The Sociology of Knowledge* (London & Sydney: George Allen & Unwin, 1979), for a discussion of the way philosophy of science provided the conditions for the possibility of the sociology of scientific knowledge. Even at the birthplace of the strong programme, the way in which philosophy used to make epistemology the central issue can be seen in the Course Bibliography prepared by David Bloor in 1975: 'A Philosophical Approach to Science', *Social Studies of Science*, Vol. 5 (1975), 507–18.

13. See J. Ben-David, 'Sociology of Scientific Knowledge', in F. Short (ed.), *The State of Sociology* (London: Sage, 1981) 40–59, for an example of the last flourish of the empirical Mertonians *versus* the British social constructivists.

14. An example of a self-generated silence in the sociology of science is to be found in B. Barnes and D. Edge (eds), *Science in Context* (Milton Keynes, Bucks.: Open University Press, 1982), 11: 'normative questions of how expert knowledge is best assessed, and how experts themselves are best evaluated and kept under a modicum of control, raise such intractable and viciously circular problems as to strangle speech'. The contradictory character of an analysis which denies such a legitimation strategy to its subjects can be seen in the following comment of Barnes: '[The sociology of knowledge] must examine that knowledge without any concern for the implications of its findings if it is to maintain

its own integrity': B. Barnes, *T.S. Kuhn and Social Science* (London: Macmillan, 1982), xi.

15. This 'Conference on the State of Science, Technology and Society Programs in Western Europe, North America and Australia' was held at Worcester Polytechnic Institute from 18–20 November 1987, and co-sponsored by WPI and 4S. A collection of mimeographed conference papers was compiled and edited by John Wilkes.

16. Treating science as the product of *work* is meant literally. This means that scientific knowledge is not merely a set of propositions or laws or relations between ideas. Precisely because it is the result of *praxis*, theory and practice, it is intimately linked to the material constraints and social relations inherent in labour. Consequently, the analytic approaches of the Radical Science Journal Collective are entirely appropriate: see, for example, 'Science, Technology, Medicine, and the Socialist Movement', *Radical Science Journal*, Vol. 11 (1981), 3–70; B. Young, 'Science is a Labour Process', *Science For People*, No. 43/44 (1979), 31–37; Young, 'Science *is* Social Relations', *Radical Science Journal*, Vol. 5 (1977), 55–129. The concept of collective work is developed in H. Becker, *Art Worlds* (Berkeley and Los Angeles, CA: University of California Press, 1982), from whom we have taken the apposite phrase, 'science worlds'. An example of a fully developed analysis of science as the result of the collective practices of a large number of actors, some of whom are invisible, is the seminal work, S. Shapin and S. Schaffer, *Leviathan and the Air-Pump; Hobbes, Boyle and the Experimental Life* (Princeton, NJ: Princeton University Press, 1985). The kinds of social and literary work required to construct facts, transmit them, and have them accepted are displayed in the equally seminal work of B. Latour and S. Woolgar, *Laboratory Life: the Social Construction of Scientific Facts* (London: Sage, 1979), and more recently Latour, *Science in Action* (Milton Keynes, Bucks.: Open University Press, 1986).

17. This suppression is required by the pursuit of knowledge without a knowing subject: the ultimate and paralyzingly contradictory aim of foundationalist epistemology. If knowledge were completely independent of human affairs, it would have no bearing upon them.

18. This puts all elements of the process on a par, and requires the symmetrical causal explanation advocated by the strong programme: see D. Bloor, *Knowledge and Social Imagery* (London: Routledge & Kegan Paul, 1976).

19. Scientists, engineers and laboratory technicians also have an important role in this collaboration, perhaps a more important role than metascientists have generally acknowledged.

20. Though, in our analysis, we have started from a sociological perspective, what we are arguing for is in no sense a social reductionist approach — rather, as we argue later, the notion of society as distinct from human practices has to be abandoned. Society is constituted by our practices, including scientific ones, and the task of analyzing it is open to as many approaches as there are problems. This dissolution of the social is apparent in the subtitle of the revised second edition of Latour & Woolgar, op. cit. note 16 (Princeton, NJ: Princeton University Press, 1986), which omits the word 'social'. Latour and Woolgar discuss the demise of the social in the postscript (281). It has lost any significance, because if everything is social there can be no society against which to set science or technology or anything else.

21. 'Techno-science worlds' might be a more appropriate phrase.

22. For recent bibiographies, see S. Shapin, 'The History of Science and its Sociological Reconstructions', *History of Science* Vol. 20 (1982), 163–211; M. Mulkay, 'Trend Report: The Sociology Of Science', *Current Sociology*, Vol. 28 (1980), 1–342; Barnes & Edge, op. cit. note 14.

23. M. Kranzberg, *Isis*, Vol. 73 (1982), 291–92.

24. This reached the pinnacle of absurdity with I. Lakatos, 'The History of Science and its Rational Reconstruction', in R. Buck and R. Cohen (eds), *Boston Studies in the Philosophy of Science* (Dordrecht: D. Reidel, 1971), 91–136, where he advocated rewriting history according to a rationalist prescription.

25. See, for example, M. Foucault, *Knowledge/Power* (Hassocks, Sussex: Harvester Press, 1980).

26. R. Albury, *The Politics of Objectivity* (Geelong, Victoria: Deakin University Press, 1983).

27. The propensity of philosophy of science to privilege theory, and consequently to portray science as a network of statements rather than as a network of practices, is discussed by J. Rouse, *Knowledge and Power: Toward a Political Philosophy of Science* (Ithaca, NY & London: Cornell University Press, 1987).

28. R. Merton, 'The Sociology of Knowledge', in Merton, *Social Theory and Social Structure* (New York: The Free Press, 1968), 510–42.

29. Kranzberg, op. cit. note 23.

30. But see note 13.

• *APPENDIX ONE*

Deakin University Course Bibliography

First Year: **KNOWLEDGE AND POWER**

The first year of the Social Studies of Science major is focused on the idea of expertise, how experts are made, what they do and the social and political roles that they play. Science and technology are considered as social networks, communities and institutions focused on an array of problems and disciplines, techniques and skills, knowledge claim and beliefs, values and interests.

The Deakin textbooks, which introduce these ideas, form autonomous, self-study units, arranged in any order that may suit the background and interests of the individual student. Thus, the structure of the course is modular, highly flexible and easily adapted to a variety of pedagogical purposes. Most of the basic readings are extracted at the back of each book, though additional suggested readings are also listed. Because the course is largely directed towards first-year Humanities students with no background in science, social science, history and philosophy of science, or science and technology policy, supplementary reading is often required when the Deakin texts are used at other universities or at the postgraduate level. No effort is made comprehensively to cover the scholarly literature; rather, the entire focus is on the straightforward exposition of the themes described above, with careful attention to questions of clear presentation and stimulating pedagogy.

Several of the texts provide thematic and theoretical overview of the basic issues, while the remaining books constitute case studies which systematically apply the general theoretical issues of the course to concrete examples in different cultures. Students are encouraged to start their work with a case study, turning then to one of the thematic guides for fuller exploration of the general scholarly issues under discussion. Over the years, assessment has been both by essay and examination.

The thematic text *On the Social Analysis of Science* by David Wade Chambers, is

principally concerned with social history, touching only briefly on questions of epistemology and the sociology of knowledge. Readings from J. Haberer are used to introduce Baconian and Cartesian ideas for a seventeenth-century look at what the social role of the scientific expert might become. This is followed by readings from F. Znaniecki on the concept of social role itself. J. Ben-David, E. Ashby, E. Mendelsohn, G. Basalla, S. Kohlstedt, and others are used to discuss the historical formation of the scientist's social role, with special attention given to how the social role became specialized, institutionalized and professionalized. A selection from E. Schrödinger shows how the social role of the scientist may directly affect both the rate and direction of scientific change. M. Cooley, A. N. Whitehead, L. Trilling, and E. F. Schumacher raise some of the social problems associated with specialization. Readings from S. Cotgrove, N. D. Ellis, and A. Gorz look at scientists situated in industry and government, as opposed to those in the university. C. Wright Mills addresses the relationship of 'men of power' to 'men of knowledge', while the unit ends with a preliminary introduction to the sociology of science. The revision of this book, now in preparation, will incorporate more material on the social role of engineers, and technology as such, and will also include recent writings which analyze science as the collective work of its practitioners.

The second major theoretical text is the new book *Science Worlds*. This is about to be circulated to students in draft form, and combines sections of three older units: *Theories of Science, Introducing the Sociology of Scientific Knowledge,* and *Whither Technology?* Though the final text will not appear until 1990, the current version is based on readings from J. Ravetz, M. Polanyi, N. R. Hanson, P. Duhem, T. Kuhn, K. Popper, P. Feyerabend, A. Chalmers, J. Krige, H. Brown, B. Barnes, D. Bloor, L. Laudan, M. Charlesworth, and S. Shapin. The material from *Whither Technology?* currently focuses on J. K. Galbraith and David Dickson, but these are to be replaced in the new book with readings largely from the 'new sociology of technology'.

Liberation and Control by David Wade Chambers, is a thematic unit which also includes two case studies: the uranium-mining controversy in Australia, and risk assessment with special reference to asbestos. The unit begins with a look at the relationship of science and technology to the idea of progress, with special reference to social and environmental effects, to the changing public image of science and technology, and to mechanisms for their control. Nearly one hundred readings are collected in the *Liberation and Control Reader*, which includes writers as diverse as J. B. Bury, B. Commoner, H. and S. Rose, S. Terkel, R. Merton, B. Barber, B. Easlea, W. Leiss, T. Roszak, R. M. Young, J. Bronowski, J. Ziman, A. Lovins, W. Lowrance, A. Benn, and I. Illich.

Unwritten Knowledge by Lindsay Farrall, is a case study of the navigators of Micronesia, presenting an alternative knowledge system, a look at the social role, intellectual skills and training of its practitioners, and oral *versus* literate modes of thought. The readings are based on T. Gladwin, D. Lewis, R. Horton, J. Goody and others.

Red and Expert by David Wade Chambers, is an intensive examination of the role of experts in the Chinese Cultural Revolution, looking closely at the boundary between specialists and the general public, theory and practice, distrust of foreign expertise, technology and modernization, and the problems of democratic decision-making in relation to science and technology. A general introduction provides a brief survey of science and technology in traditional China. Historical readings are from C. P. Fitzgerald, J. R. Levenson, J. K. Fairbank, M. Elvin, J. Horn and J. Needham, with modern commentary by P. Buck, L. R. Graham, R. W. Lee, and many others.

Winner Take All by Fred Jevons and Terry Stokes, tells the story of the construction of the double helix model for DNA, considering the nature of scientific work, the behaviour

of the scientific community, the role of discovery *versus* invention in science, the management of research, and scientific morality. Readings include the Norton Critical Edition of James Watson's book, as well as pieces from A. Sayre, P. Pauling, and a large number of reviews of Watson's book.

Second Year: **NATURE AND HUMAN NATURE**

The course is introduced by a series of eight unusual textbooks, edited by David Wade Chambers, which attempt to break new ground in the teaching of social studies of science. Their general subject is the perception of nature in art, in science, and in everyday life. The title volume, *Imagining Nature*, provides a philosophical and historical introduction to problems of perception and representation. It examines the boundaries traditionally drawn between nature and culture, between the natural order and the social order. It pursues the various historical meanings of the idea of nature, and explores the notion of naturalistic representation. The final volume, *Imagining Knowledge*, attempts to construct a working analytical framework with which students may address a selection of real world situations requiring that technical, social, moral and political judgements about nature be made.

In the six remaining volumes, these problems are visually argued and documented. The books are conceived and structured as a progression of museum exhibits designed to develop the viewer's skills of visualization and visual problem-solving. Through juxtaposition of images of nature from both art and science and from many cultures, the basic issues of perception and cognition are approached, while the reading of abstruse text is almost entirely eliminated. The aim is to make these epistemological issues come alive for many students who in the past may have mastered the ideas, but who isolated their academic understanding from the world in which they live. The series draws heavily on the work of E. Gombrich, R. Arnheim, N. R. Hanson, R. L. Gregory, E. Sapir, B. L. Whorf, J. Berger, R. Collingwood, C. Glacken, B. Barnes, R. Layton, M. Hagen, G. Bateson, N. Wade, J. Bronowski, D. Thompson, P. Stevens, J. Dean, A. Koestler, T. Stokes, J. M. Powell, Y.F. Tuan, B. Smith and many others.

Imagining Landscapes opens with an exhibit of American landscape painting, based on The Natural Paradise, an exhibition originally mounted in 1976 by the Museum of Modern Art. Students are invited to explore the meanings of such concepts as 'naturalism' and 'truth to nature'. The paintings are contrasted with relevant written comments by the artists. In turn, students are invited to compare these comments with those made by scientists. The next exhibit is based on Gombrich's comparison of Chinese and English ways of seeing the English Lake District. The following three exhibits look at Canadian and Australian landscapes through the eyes of the invading English, the longer term European settlers, and the native inhabitants, contrasting perceptual modes, notions of order and chaos, nature and culture, and environmental values.

Is Seeing Believing? is a small portfolio of optical illusions, drawing on the meaning of such phenomena for the understanding of epistemology. The three exhibits are entitled 'Seeing is Interpreting', 'Context Matters' and 'Perceptual Worlds'. It uses the work of Kuhn, Gombrich, a number of psychologists, and concludes with an essay by J. Ross. *Putting Nature in Order* has seven exhibits, including such titles as 'Order: Inherent or Imposed', 'Systems of the World', 'Form and Symmetry in Nature', 'Science Imposes Order', and 'Where Do You Draw the Line?'.

Beasts and Other Illusions explores the role of cultural artefacts such as symbolism and convention in our representation of the natural world, looking especially at the depiction

of animals. The book is a veritable 'multi-cultural bestiary', exploring in greater depth the questions of realism and naturalism raised in the other volumes. 'Style' here is viewed not as ornamental overlay but as an array of graphic devices, which, though showing cultural variance, precisely constitute the vehicle used to depict the creatures observed. Throughout, the connections between art and science are emphasized.

Maps Are Territories: Science is an Atlas by David Turnbull, intensively examines the metaphor of 'theories as maps'. Theories are frequently taken as self-evidently map-like. Maps, however, assume a wide variety of historical and cultural forms. An exploration of this variation, including Australian–Aboriginal maps as well as Western maps from many sources and periods, shows maps to be indexical, conventional and embedded in 'forms of life'. These explorations in turn throw light upon the nature of theories.

Singing the Land, Signing the Land by Helen Watson and David Wade Chambers, is a portfolio of readings and visual exhibits focused on the Australian landscape. It looks at questions of cultural perspective, social and economic interest, historical experience, spiritual values and perceptual modes in the understanding and exploitation of a particular and distinctive case: the island continent. European and aboriginal perception and use of the natural environment are compared and contrasted.

The second half of the course is concerned with the ways in which scientific and social views of human nature influence and reinforce one another, and uses M. Mulkay, *Science and the Sociology of Knowledge* (London & Sydney: George Allen & Unwin, 1979) and S. L. Chorover, *From Genesis to Genocide : the Meaning of Human Nature and the Power of Behaviour Control* (Cambridge, MA : MIT Press, 1979), as the main texts. Students are introduced to its themes in *Nature and Social Power; the Relationship between Biology and its Cultural Context* by Lyndsay Farrall, in conjunction with B. Young, 'Evolutionary Biology and Ideology: Then and Now', *Science Studies*, Vol. 1 (1971), 177–206. They are then required to work through all the following units: *Darwin and Social Darwinism* by Rosaleen Love, which starts by examining Darwin's theory as a product of the social context using P. Appleman (ed.), *Darwin* (New York: Norton, 1979) and D. Worster, *Nature's Economy* (New York: Doubleday, 1979), and then, through a series of readings, examine the ways in which Darwin's theory affected the social context; *Phrenology: the First Science of Man* by David Turnbull, a case study which considers the ways in which the biological ideas of the phrenologists and their critics can be seen as reflecting their social position, using as a reading S. Shapin, 'The Politics of Observation: Cerebral Anatomy and Social Interests in the Edinburgh Phrenology Disputes', in R. Wallis (ed.), *On The Margins of Science: The Social Construction of Rejected Knowledge* (Keele, Staffs: *Sociological Review Monograph* No. 27, 1979), 139–78; *Science at Work* by Richard Gillespie, which examines the application of the social sciences in American industry through a consideration of the work of Frederick Winslow Taylor on scientific management, Hugo Munsterberg on industrial psychology and Elton Mayo on industrial sociology; *Racism in America* by Alan Johnston, which examines the scientific contributions to the nineteenth-century race debate; and *The Night of The Dolphins* by Gavin Daws, which explores the ways in which the boundaries have been drawn between humans and other animals, by looking at the case of dolphin kidnapping.

Third Year: **SCIENCE IN CULTURE**

Medicine and Society

Introduction to Medicine and Society by Richard Gillespie
This unit provides a broad introduction to the major issues in Medicine and Society, drawing on historical, sociological and anthropological studies of medicine. Its central assumption is that medicine can only be understood in a social context, and that medical knowledge and social organization are closely inter-related. After reading C. Drinker, 'The Tuberculosis of William Drinker', in Drinker, *Not So Long Ago: a Chronicle of Medicine and Doctors in Colonial Philadelphia* (New York: Oxford University Press, 1937), 67–90, the unit is divided into three themes in which the students are given the following readings, in addition to the set text L. Doyal and I. Pennell, *The Political Economy of Health* (London: Pluto Press, 1983):

The social construction of health and disease
H. T. Engelhardt, Jr, 'The Concepts of Health and Disease', in Engelhardt and S. F. Spicker (eds), *Evaluation and Exploration in the Medical Sciences* (Dordrecht: D. Reidel, 1975), 125–27, 133, 134–41; N. Waxler, 'Learning To Be A Leper: a Case Study in the Social Construction of Illness', in E. G. Mishler et al., *Social Contexts of Health, Illness, and Patient Care* (Cambridge: Cambridge University Press, 1981), 169–94; N. D. Jewson, 'The Disappearance of the Sick-man From Medical Cosmology, 1770–1870', *Sociology*, Vol. 10 (1976), 225–44.

The therapeutic relationship
B. Sicherman, 'The Uses Of a Diagnosis: Doctors, Patients and Neurasthenia', *Journal of the History of Medicine*, Vol. 32 (1977), 33–54; V. Turner, 'A Ndembu Doctor in Practice', in Turner, *The Forest of Symbols: Aspects of Ndembu Ritual* (Ithaca, NY: Cornell University Press, 1967), 359–77, 385–93; C. G. Helman, '"Feed a Cold, Starve a Fever": Folk Models in an English Suburban Community and Their Relation to Medical Treatment', *Culture, Medicine and Psychiatry*, Vol. 2 (1978), 108–09, 112–37.

Medicine and social control
B. and J. Ehrenreich, 'Medicine and Social Control', in J. Ehrenreich (ed.), *The Cultural Crisis of Modern Medicine* (New York: Monthly Review Press, 1978), 38–79; C. Smith-Rosenburg and C. Rosenburg, 'The Female Animal: Medical and Biological Views of Woman and Her Role in 19th Century America', *Journal Of American History*, Vol. 40 (1973), 332–56.

The introduction is followed by a series of research units in which students are introduced to the literature in particular areas: *Medicine and Its Critics* by Jock McCulloch; *Drugs in Social Context* by Evelleen Richards; *Aboriginal Medicine* by Jan Reid; *The Politics of Cancer* by John Mathews; and *The Medicalisation of Childbirth* by Belinda Probert.

Knowledge Making

Knowledge Making: an Introduction by David Turnbull
This course introduces students to the sociology of scientific knowledge by looking at a range of historical, sociological, philosophical and contemporary issues. The introduction provides the rationale for a constructivist approach, using B. Barnes and D. Edge (eds), *Science in Context: Readings in the Sociology of Science* (Milton Keynes, Bucks.: Open University Press, 1982), as a text. The students first read G. Lakoff and M. Johnson, 'An Experientialist Account of Truth', in Lakoff and Johnson, *Metaphors We Live By* (Chicago, IL: The University of Chicago Press, 1980), 179–82. They are then asked to work through a series of themes and readings as follows:

Classification
B. Barnes, 'On the Conventional Character of Knowledge and Cognition', *Philosophy of the Social Sciences*, Vol. 11 (1981), 303–33; J. Dean, 'Controversy Over Classification; a Case Study from the History of Botany', in B. Barnes and S. Shapin (eds), *Natural Order: Historical Studies of Scientific Culture* (London: Sage, 1979), 211–30.

Metaphor
B. Barnes, 'Metaphor in Science', in Barnes, *Scientific Knowledge and Sociological Theory* (London: Routledge & Kegan Paul, 1974), 49–52, 56–58.

Communication, credibility and control
R. Albury, 'Politics of Truth: A Social Interpretation of Scientific Knowledge with an Application to the Case of Sociobiology', in M. Ruse (ed.), *Nature Animated* (Dordrecht: Reidel, 1983), 115–29.

The role of interests
S. Shapin, 'Professional Vested Interests and Sociological Explanation', in Shapin, 'History of Science and Its Sociological Reconstructions', *History of Science*, Vol. 20 (1982), 164–67, 186–203.

Relativism
B. Barnes and D. Bloor, 'Relativism, Rationalism and the Sociology of Knowledge', in M. Hollis and S. Lukes (eds), *Rationality and Relativism* (Oxford: Blackwell, 1982), 21–47.

Knowledge making in the laboratory and the wider society
M. Zenzen and S. Restivo, 'The Mysterious Morphology of Immiscible Fluids: A Study of Scientific Practice', *Social Science Information*, Vol. 23 (1982), 447–73; B. Latour, 'Give Me a Laboratory and I Will Raise The World', in K. D. Knorr-Cetina and M. Mulkay (eds), *Science Observed: Perspectives on the Social Studies of Science* (London: Sage, 1983), 141–70.

The introduction is followed by a series of research units in which students are given a structured entrée to the literature in particular areas: *The Problem of Experiment* by S. Shapin; *Demarcation* by David Turnbull; *Scientific Revolutions* by Struan Jacobs; *Galileo and The Catholic Church* by John Schuster; *Science As Text* by Ian Reid and Terry Stokes; *Women and Science* by Evelleen Richards; *The Safety of Recombinant DNA Research* by Ditta Bartels; and *Science and The Media* by David Dickson.

Knowledge Using

Technology: an Introduction by Jock McCulloch
Using Langdon Winner, *Autonomous Technology* (Cambridge, MA: MIT Press, 1977), the course begins by exploring some general themes and the concepts of technical progress and technological determinism. The students are then asked to consider three views of technology through the following readings:

Marxism and technology
K. Marx and F. Engels, 'Bourgeois and Proletarians', in Marx and Engels, *The Communist Manifesto* (Harmondsworth, Middx: Penguin Books, 1967), 80–89. Marx and Engels, 'The Rise of Manufacturing', in *The German Ideology*, Part 1 (New York: International Publishers, 1970), 72–79; Marx, 'The Struggle Between Worker and Machine', in Marx, *Capital: A Critique of Political Economy*, Vol. 1 (Harmondsworth, Middx: Penguin Books, 1976), 553–62; Marx, 'Capital', in Marx, *Grundrisse: Foundations of the Critique of Political Economy* (Harmondsworth, Middx: Penguin Books, 1973), 505–11; Marx, 'Critique of Political Economy', in Marx, *A Contribution to the Critique of Political Economy* (Moscow: Progress Publishers, 1970), 21, 220.

The conservative view
W. W. Rostow, 'Politics in Pre-Newtonian Societies', and 'Politics of the Preconditions for Take-Off', in *Politics and the Stages of Growth* (Cambridge: Cambridge University Press, 1971), 26–30, 51–53, and 56–63, 98–102, 176–77.

An ecological view
Here, the views of J. Galtung, *The True Worlds: A Transnational Perspective* (New York: The Free Press, 1980) are considered, and the students read F. Fanon, 'This is the Voice of Algeria', in Fanon, *A Dying Colonialism* (Harmondsworth, Middx: Penguin Books, 1970), 53–73.

The introduction is followed by a series of research units in which students are given a structured entrée to the literature in particular areas, and continue into the second section, *Science and Society: Megalithic Science* by David Turnbull; *Technology and The Third World* by Lesley Instone; *Self-reliance and the African Buildings Material Industry* by John Lea; *Reproductive Technology* by Pam Atkins and Caroline Clark; and *Work and Technology* by John Mathews.

Science and Society

The research units studied are: *Doing Time in Modern Society* by David Biggins; *Suppression in Science* by Brian Martin; *High Technology in Australia* by Stuart McDonald; *Knowing in Culture* by Helen Watson; *African Iron Technology* by David Dorward; *The Lessons of Lysenko* by David Wade Chambers; and *Book Study of Our Original Aggression* by Lyndsay Farrall.

• APPENDIX TWO

Deakin University Press: Publications in Social Studies of Science

Most of the following publications have been described elsewhere in this paper.

Currently Available for Purchase

Politics of Objectivity, by Randall Albury, with an appendix by Ditta Bartels
80 pp, ISBN 0 949823 10 4, (250g), A$6.50.

Beasts and Other Illusions, by David Wade Chambers
68 pp, ISBN 0 7300 0158 X, (450g), A$10.00.

Imagining Landscapes, by David Wade Chambers
76 pp, ISBN 0 7300 0156 3, (450g), A$15.50.

Imagining Nature, by David Wade Chambers
56 pp, ISBN 0 7300 0154 7, (400g), A$12.50.

Is Seeing Believing?, by David Wade Chambers
32 pp, ISBN 0 7300 0157 1, (300g), A$10.00.

Liberation and Control: The Uses of Knowledge and Power. Study guide and reader. Compiled by David Wade Chambers, with chapters by David Wade Chambers, Chris Ryan, Jim Falk and Richard Gillespie.
Study guide, 159 pp, ISBN 0 7300 0087 1, (700g), A$12.95.
Reader 276 pp, ISBN 0 86828 273 1, (750g), A$12.95.

On the Social Analysis of Science, by David Wade Chambers
102 pp, ISBN 0 86828 065 8, (550g), A$7.95.

Putting Nature in Order, by David Wade Chambers
60 pp, ISBN 0 7300 0155 5, (400g), A$10.00.

Red and Expert, by David Wade Chambers
153 pp, ISBN 0 86828 304 5, (400g), A$5.95.

Worm in the Bud, by David Wade Chambers (on pesticides)
242 pp, ISBN 0 86828 296 0, (550g), A$6.50.

Science, Non-science and Pseudo-science, by Max Charlesworth
47 pp, ISBN 0 949823 05 8, (200g), A$5.95.

The Night of the Dolphins, by Gavin Daws
53 pp, ISBN 0 86828 156 5, (250g), A$5.95.

Nature and Social Power, by Lyndsay Farrall
35 pp, ISBN 0 86828 124 7, (200g), A$5.95.

Unwritten Knowledge, by Lyndsay Farrall
66 pp, ISBN 0 86828 288, (250g), A$5.50.

Whither Technology?, by Lyndsay Farrall
135 pp, ISBN 0 86828 137 9, (550g), A$9.50.

Science at Work, by Richard Gillespie
47 pp, ISBN 0 86828 148 4, (200g), A$5.95.

On the Philosophical Analysis of Science, by Struan Jacobs
72 pp, ISBN 0 86828 360 6, (350g), A$6.95.

Puzzles and Revolutions, by Fred Jevons
70 pp, ISBN 0 86828 368 1, (250g), A$5.95.

Winner Take All, by Fred Jevons and Terry Stokes
52 pp, ISBN 0 86828 376 2, (250g), A$5.95.

Racism in America by Allan Johnston
66 pp, ISBN 0 86828 164 6, (250g), A$6.95.

Darwin and Social Darwinism, by Rosaleen Love
69 pp ISBN 0 86828 132 8, (250g), A$6.95.

Phrenology: The First Science of Man?, by David Turnbull
44 pp, ISBN 0 86828 140 9, (200g), A$5.95.

Orders and enquiries to: Deakin University Press, Deakin University, Victoria 3217, Australia. Telephone: (052) 47 1156; Telex: AA35625

Not Currently Available for Purchase

Imagining Knowledge, David Wade Chambers (ed.)
In preparation, available: 1990.

Science Worlds, by David Wade Chambers, Struan Jacobs and David Turnbull
In preparation, available: late 1990.

Medicine and Society, by Richard Gillespie
Copyright under negotiation.

Postage and Handling Charges North America and UK/Europe

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Over 500g–1 kg	6.35		10.85	11.60	15.85	18.15
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Introduction to the Sociology of Scientific Knowledge, by David Turnbull
Out of print

Knowledge Making, by David Turnbull
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Maps are Territories: Science is an Atlas, by David Turnbull
In press, available: May 1989.

Singing the Land, Signing the Land, by Helen Watson and David Wade Chambers
In press, available: May 1989.

Enquiries about books not available for purchase should be directed to: Wade Chambers, School of Humanities, Deakin University, Victoria 3217, Australia.

David Wade Chambers, Associate Professor in Social Studies of Science, is Founding Chairman of the Deakin University Social Studies of Science Unit. His books *Imagining Nature* and *Liberation and Control* won Australian national book awards for university textbooks in 1979 and 1984. He has published articles on science education and the history of science in the 'colonial context', especially Latin America and Australia.

David Turnbull, Lecturer in Social Studies of Science at Deakin University, is currently Visiting Research Fellow at Princeton University Gas Dynamics Laboratory. He is coauthor of *Life Among the Scientists: An Anthropological Study of a Scientific Community* (Oxford University Press, 1989). His research interests include the nature of scientific and technological practice, problems of relativism and reflexivity, and the relationship between traditional and Western knowledge systems.

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