of jobs might be provided. Employment potential appears in information technology producing and using-services (finance, business, professions, engineering and computers) to the extent of 600,000 jobs; personal market services (including distribution) 1,150,000 jobs; and public services (including construction) 850,000 jobs (Table 11.4, p. 234, median figures). The gap between the total above (2,600,000) and the three million is made up of additional places provided in education, training and community projects. Optimistically, the authors conclude "But given a favourable trend in the world economy we would maintain that the type of increase suggested is certainly not unattainable" (p. 235). The readers of this book will hope that the attainable is attained.

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The Ends of Science: An Essay in Scientific Authority *by Barry Redner.* (Westview Press, Boulder, 1987.) pp. xiv + 344, ISBN 0-8133-0452-0

Harry Redner's *The Ends of Science* is a work of enormous scale; it is indeed a *tour de force* on several levels, as the dustcover suggests. Redner undertakes an historical sketch of science, in an encompassing sense that extends through the natural and social sciences into the humanities, which identifies a disjuncture around the time of the two world wars. This disjuncture is identified as, **and** with, a change in the form of the organisation of science. Having established the historical disjuncture in science, and relating the characteristics of the posited modes of science, Redner seeks to identify the extant beginnings of a thoroughgoing scientific reformation in order to suggest parallels and convergences amongst the reforming forces which might permit of their co-operation and co-ordination, and thereby their reformative (revolutionary?) triumph. Indeed the suggestion of both means and avenues of a reformation appears to be the book's *raison d'etre*.

Redner's study is divided into three main parts. Their aims and concerns are first, to establish the existence of, and characterise the transformation of **classical science** into **world science**, second, to establish the interrelationship of knowledge and authority, and third, to trace the development of reformative movements currently at work in the sciences, and to identify their convergences in order to suggest the direction of reform. I shall look at each in turn.

Redner begins (Part I) the task of identifying a disjuncture or transformation in the development of science in the twentieth century by taking a proxy census of participant scientists. Using a series of quotations from practising scientists in a variety of disciplinary fields, a transformation around the time of the two world wars is suggested. The basis of this is the expression of a sense of the end to a golden era of progress. While the disjuncture seems to me to be a real one, I doubt the usefulness of this method of establishing it. Effectively Redner's approach is an attempt to overcome the problem of attribution by employing only the expressive meaning of the participants. I suggest that perhaps a use of Mannheim's 'documentary method' would have been a valuable alternative or supplement. It is all too common for people who have made a major

contribution to a field study to see it as a completion, the end of an era. J.S. Mill, for example, declared political economy (the theory of value) complete in the first half of the nineteenth century.

Redner suggests that the era of **Classical Science** ran from the 'scientific revolution' until approximately the second world war. The mode of science since that time Redner calls **World Science**. Chief amongst the characteristics of the transformation are the following, first, that individuals gave way to task forces in the production of knowledge, such that scientists no longer own or control the means of scientific production. Second, that science and technology are no longer separate. World science is seen to be merging with technology in the organised pursuit of knowledge (p. 22). Third, that changes in socio-political organisation and technique are now more important and effective than changes in cognition (p. 18). Fourth, that there has been a change from the **reductive** classical stage to an **integrative** world stage. In world science there has emerged a discernible shift toward tackling the problem of complexity by means of systemic approaches.

The fact of, and the characteristics of, the transformation in science carry some important implications. The recognition of a transformation implies that in the area of science policy we must work with the idea of world science and not, as is still disquietingly common, with an out of date classical science model. In the history of science most approaches to date have centred upon cognitive changes. They have, in short, been histories of classical science. In the era of world science such notions as Kuhnian paradigm change are no longer relevant; rather we must look to sociology and organisation theory (p. 22). Moreover, the trend in science toward ever greater technification is now such that experimental technique is often much more than a mere extension of observation. Modern techniques are more nearly generative of the objects of knowledge (p. 68). Throughout the sciences it is increasingly the case that the experimenter acts upon, and changes nature. Consequently a philosophy of science based upon observation, such as empiricism, is no longer relevant. The philosophy of science **must** embrace our acting upon nature, and abandon epistemologies based upon mere observation (p. 68).

Redner suggests that *post hoc* it is possible to separate scientific from political issues in past debates, and that sociologists and historians of science should do this (p. 108). I strongly disagree with this. Redner admits that sciences are a vague idea which cannot be defined (p. 61), and clearly states, "[n]or is there any rigorous way of demarcating the boundary between science and non-science" (p. 61). How, then, can the historian of science separate science from non-science in practice? What is seen as 'scientific' relates to our current 'paradigm'; *post hoc* judgements on this score are necessarily cognitive polemic, and commonly also political polemic. Redner's suggestions here leave the history of science in danger of continuing to be what it so often has been to date: little more than competitive pedigree fabrication. What is required of the historian or sociologist of science is to transcend all ideas of science, and to look at **knowledge**. We must give up all preconceptions about what it is that makes scientific knowledge 'scientific'. This not only permits one to transcend polemics and bias, but also, more importantly, opens to study the very constitution of the prefix 'scientific'. It allows one to open out the relation between knowledge and power (authority) more thoroughly than Redner, given these inauspicious methodological pronouncements, is able to do.

In specifying and exploring the links between knowledge and authority (Part II) Redner turns his attention to the organisation of world science. The institutionalisation of science is revealed to have had an important influence

over the authorisation of knowledge. There has, in short, been a reversal of the relationship between authorship and authority. In classical science authorship legitimised authority, but now authority commonly legitimises authorship. In the dual pursuit of legitimacy, competition over cognitive commitments is increasingly overlaid by that over institutional (organisational) authority (p. 100). A scientist today must be a manipulator and must establish his/her authority in the institutions of science in order to, and as a prerequisite of, getting his/her work noticed.

One disquieting implication of this state of affairs in world science concerns 'progress'. Authority now lies with the institution rather than with the individual. In classical science 'paradigms' were attached to people, but in world science they are attached to institutions (p. 96). Consequently, a chief element in the 'progressive' paradigm shifts in Kuhnian historiography, the literal dying-off of the old paradigm with the death of its carriers, no longer occurs. The institutions of science live on: world science tends to ossify.

Redner next turns his attention to the 'forms of scientific authority' (p. 123). Using a broadly Weberian approach Redner identifies three ideal-type forms of authority. These are **Formal Professional**, **Collegial Elite**, and **Patronal Authority**. From a broad analysis of the sciences using this basis Redner goes on to reveal a number of 'pathologies' in world science; the chief amongst these being the hypertrophy of knowledge and the corruption of scientific ethics, as control slips beyond the individual (conscience) to the institution.

While Redner's is a most stimulating and insightful analysis, it seems to me to be rather partial for reasons relating to the methodological approach. In focusing on the organisation of the sciences Redner descends immediately to the micro level politicking of the 'scientific community' within the institutionalised multiversity-research complex. Redner's analysis is adequate to the socio-historical study of the sciences (disciplines), but it is not adequate as, nor is it, a study of Science (as a collective enterprise). By descending to the micro level politicking of organised science Redner reveals something of the tussles for authority, and the relation of these to the development of the cognitive content of the sciences. What Redner does not touch upon, or even acknowledge, is the broader capital 'P' politics involved in the very constitution of science as 'science', and the institutionalisation of a given set of practices and organisational forms as 'Science'. Redner does mention the differences between his usage of the concepts of knowledge and authority and the Foucaultian concept of Power-Knowledge, and might with some justification feel that I am accusing him of failing to do what it is no part of his project or intent to do. Nevertheless, in such an encompassing *tour de force* I feel that this divergence (partiality/tactic) should have been more fully explicated.

The third major section of Redner's book brings us to his analysis of the directions of, and prescription for, a reformation of science. In the light of the foregoing analysis it is made clear that reforming science must involve a struggle for authority at the highest level and the broadest scope (p. 207). Identifying reforming forces as either conservative, moderate or radical Redner revealingly pursues the metaphor of the religious Reformation, and outlines extant positions in and on the sciences in those terms. Put simply, Redner suggests that an integrative systemic approach is necessary in all sciences. He subsequently seeks to identify the emergence of such an approach across a range of the sciences in order to establish commonalities in the cause of reform.

Beyond the important integrative and systemic trends in world science Redner highlights a further interesting pointer to the future. He takes notice of the recent proliferation of discontinuities (disjunctures, ruptures, etc.) in the language of

many of the sciences. From Foucault's epistemic ruptures, to Gould's punctuated evolution, to Wolfson's economics of boom and bust, etc. everywhere Redner notes the replacement (or supplementation) of classical equilibrium states by (or with) theories of their catastrophic degeneration (p. 300). In this context Redner identifies the catastrophe theory inaugurated by René Thom as a key avenue of 'progress'.

On the final page Redner makes a rather flippant return to the macro level, which is notably absent in the rest of the work. Redner reveals that he sees the transition from classical science to world science as but one aspect of the wider transition of European civilisation to a world civilisation. He thereby reestablishes the link between science and the wider context. As I have noted, Redner has addressed the micro level scientific community politicking and the sciences' institutional level of authority — as a consequence of (consistent with) his failure either to define or transcend the notion of 'science'. To return in the last paragraph to the macro level institutional constitution of science *qua* science in the notion of civilisation merely highlights the lacuna in his study. Having engaged the semantic quibble of replacing the element of power with that of authority in Foucault's Power-Knowledge, on the implied grounds that power was a concept more applicable to capital 'P' politics than the politicking **within** the sciences, Redner reveals that his usage and his project are no more (or less) than the underlabourer of the broader Foucaultian one in which the notion of power, as in the case of the establishment of the hegemony of European civilisation to which Redner refers, is more applicable than authority. Authority is 'power plus'; power plus legitimacy. Redner's use of authority rather than power has served only to obfuscate the process whereby power is legitimised as, and in, authority. This, of course, returns us to the key question which Redner has left unanswered. Namely, what is it that makes science 'scientific'? What makes it legitimate knowledge?

The omission of the wider level of inquiry, and of any analysis of a wider contextual siting, has allowed Redner to slip back into the rut of conventional approaches to the history of science (knowledge). Having characterised the transformation from classical to world science as, and essentially if not only as, an organisational disjuncture (transformation), Redner seeks to identify the **cognitive** way ahead. He does not even offer an organisation reforming blueprint, as would seem to have been logically implied by his own analysis, let alone an outline of an upper case 'P' political reformation. Redner's characterisation of world science is suggestive of the centrality of organisational reformation, in the absence of the possibility of the cognitive reformation(s) (paradigm changes) of the classical epoch, and yet he appears in the end to outline a cognitive reformation.

Despite these criticisms I recognise that Redner's book is an excellent work of the highest order. It is an extraordinarily ranging and stimulating study which is destined to be controversial. It comes highly recommended to everyone interested in the past, present or future of science (knowledge).

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