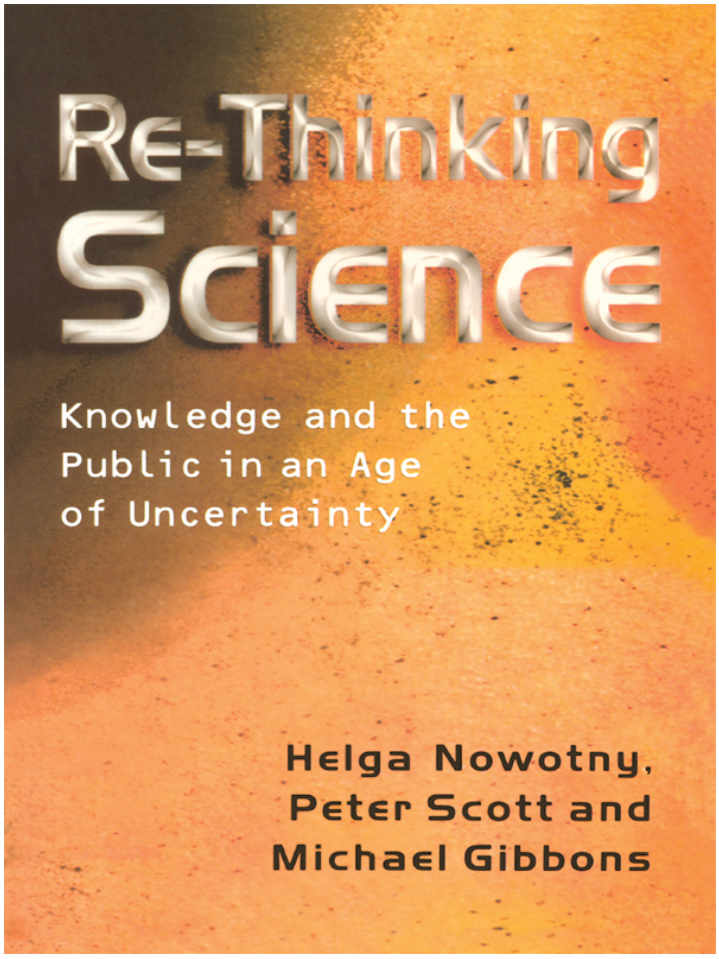
Re-Thinking
Science
Knowledge and the
Public in an Age
of Uncertainty
Helga Nowotny,
Peter Scott and
Michael Gibbons

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For Didja in memoriam

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Preface

The aim of this work is to present an account of a dynamic relationship between society and science. It seemed to us that the current array of arguments intended to persuade society to support science did not take sufficient account of the developments that have taken place, whether in society or in research, which are discussed both in the scholarly and policy literatures and in the popular press. Despite the mounting evidence of a much closer, interactive relationship between society and science, current debate still seems to turn on the need, one way or another, to maintain a 'line' to demarcate them. Often, too, there is a presumption that communication flows one way – from science to society – with scant attention paid to describing the transformative effects of any reverse communication. The development of arguments which bring current social realities and research practices into line, we believe, requires not so much a clearer articulation of the current arguments, useful as that may be, as a revisiting of the foundations on which they are based. To this end, we have developed an open, dynamic framework for re-thinking science. It is based upon four conceptual pillars: the nature of Mode-2 society; the contextualization of knowledge in a new public space, called the *agora;* the development of conditions for the production of socially robust knowledge; and the emergence of socially distributed expertise. Our conclusion, briefly stated, is that the closer interaction of science and society signals the emergence of a new kind of science: contextualized, or context-sensitive, science. Of course, this book builds on our previous work, *The New Production of Knowledge* (Gibbons et al. 1994), particularly in its greater elaboration of the

significance of the ‘social’ in the practice and constitution of science, but familiarity with that work is not essential to understanding the argument developed here.

This volume, as was the last, is the outcome of a collaborative effort, albeit, this time, with a reduced team. Its production has occupied our thoughts for nearly three years and over this period we have had meetings in London, Zurich and Stockholm, during which we read, modified and, not infrequently, discarded drafts that had been prepared in the period between one meeting and another. Following our usual practice we have aimed to produce an integrated text rather than a set of individual essays. Working with this intention in mind renders unfruitful all attempts to identify who has contributed what to the final result. In any event, as we have already indicated, this is not our style. We have decided, in this case, to rotate the authorship from the strict alphabetical listing of our previous writing, but we want to make it clear that the new arrangement reflects nothing more than our decision to do so.

Many individuals have helped us along the way. In particular, we would like to thank: Yehuda Elkana, Camille Limoges, Hans-Jörg Rheinberger, and John Ziman, with whom we have discussed our ideas at various stages of their formulation; Alessandro Maranta and Myriam Spörri, who checked our references and completed the bibliography; and Sarah Cripps, who compiled the index.

We owe a special debt of gratitude to Dan Brändström, Director of the Tercentenary Fund of the Royal Swedish Bank and to Thorsten Nybøhm, Director of the Swedish Council for Higher Education whose organizations together funded the project. We also want to acknowledge the special contribution of Roger Svensson, Director of the Swedish Foundation for International Co-operation in Research and Higher Education, whose role was, ostensibly, to provide us with administrative back-up. In fact, he made substantive contributions to our discussions, making available to us

insights from his vast store of practical experience, and constantly prodding us to provide concrete instances of our more abstract speculations. Roger has been our colleague now on two intellectual journeys and we hope he will not desert us should we begin to contemplate a third!

As we have indicated, this book was written in intervals carved out of over-busy schedules. This has demanded sacrifices and support from our family and friends. In particular, to Carlo Rizzuto, Cherill Scott and Gillian Gibbons, we simply want to say that we won't do it again, but expect that you know us too well to believe that!

Sadly, in the midst of our writing, Helga Nowotny's brother, Didja, died after an agonizing illness. Working as we do, intensely, in close proximity, over long periods of time, it is to be expected that our thoughts would be affected by his suffering. We would like to recognize his abiding presence in the composition of these pages by dedicating this book to his memory.

Helga Nowotny
Peter Scott
Michael Gibbons

1
The Transformation of Society

Science has spoken, with growing urgency and conviction, to society for more than half a millennium. Not only has it determined technical processes, economic systems and social structures, it has also shaped our everyday experience of the world, our conscious thoughts and even our unconscious feelings. Science and modernity have become inseparable. In the past half-century society has begun to speak back to science, with equal urgency and conviction. Science has become so pervasive, seemingly so central to the generation of wealth and well-being, that the production of knowledge has become, even more than in the past, a social activity, both highly distributed and radically reflexive. Science has had to come to terms with the consequences of its own success, both potentialities and limitations.

In *The New Production of Knowledge,* changes in the constitution of science and in research practice were attributed to the growing contextualization and socialization of knowledge. One of the characteristics of Mode-2 science, we claimed, was that knowledge was now being generated ‘in the context of application’, and our book contained frequent references, appeals even, to the ‘social’. The implication of our argument was that science could no longer be regarded as an autonomous space clearly demarcated from the ‘others’ of society, culture and (more arguably) economy. Instead all these domains had become

so ‘internally’ heterogeneous and ‘externally’ interdependent, even transgressive, that they had ceased to be distinctive and distinguishable (the quotation marks are needed because ‘internal’ and ‘external’ are perhaps no longer valid categories). This was hardly a bold claim. Many other writers have argued that heterogeneity and interdependence have always been characteristic of science, certainly in terms of its social constitution, and that even its epistemological and methodological autonomy had always been precariously, and contingently, maintained and had never gone unchallenged. In a recent essay in *Science,* Bruno Latour wrote about the transition from the culture of ‘science’ to the culture of ‘research’ in the past 150 years:

> Science is certainty; research is uncertainty. Science is supposed to be cold, straight and detached; research is warm, involving, and risky. Science puts an end to the vagaries of human disputes; research creates controversies. Science produces objectivity by escaping as much as possible from the shackles of ideology, passions and emotions; research feeds on all of those to render objects of inquiry familiar. (Latour 1998: 208-9)

Latour goes on to argue that science and society cannot be separated; they depend on the same foundation. What has changed is their relationship. In traditional society science was ‘external’; society was – or could be – hostile to scientific values and methods, and, in turn, scientists saw their task as the benign reconstitution of society according to ‘modern’ principles which they were largely responsible for determining. In contemporary society, in contrast, science is ‘internal’; as a result science and research are no longer terminal or authoritative projects (however distant the terminus of their inquiry or acknowledgement of their authority), but instead, by creating new knowledge, they add fresh elements of uncertainty and instability. A dialectical relationship has been transformed into a collusive one. In the sub-head in another article Latour sums this up

as ‘a science freed from the politics of doing away with politics’ (Latour 1997: 232).

So much is common, and uncontroversial, ground. But, even in this more ‘open’ description, much of the attention remains focused on science rather than society. The latter impinges on the argument only when it touches the former – for example, when controversies about nuclear power or environmental pollution draw in a wider range of actors whose presence and significance cannot be ignored. The perspective is still mainly that of the scientific community(ies) – its composition more heterogeneous, its values more contested, its methods more diverse and its boundaries more ragged, of course, but still distinguishable from other domains such as culture, economy and society. In other words the relationship is viewed principally from one, still dominant, perspective. Indeed, it is possible to read into this more ‘open’ description of science (‘research’ in Latour’s term) a restatement of traditional accounts of the scientification of society. Science’s success has made the world more complicated and scientists must wrestle with the consequences of this complication. But science is still in charge.

It is more unusual to view this changed relationship from the perspective of society. The transformation of society is regarded as predominantly shaped by scientific and technical change. In other words the socialization of science has been contingent on the scientification of society. There are now extended scientific communities and more urgent socio-scientific controversies because society as a whole has been permeated by science, although it is accepted that in the process the culture of science – autonomist, reductive and self-referential – has been transformed into something different: in Latour’s phrase, a culture of research which is more populist, pluralistic and open. The ‘social’ has been absorbed into the ‘scientific’. It follows, therefore, that those other aspects of social transformation that appear initially to

have owed less to scientific and technical change, even if subsequently they have helped to shape Latour's culture of research, must be regarded as inherently less significant. As a result, changes in the affective and aesthetic domains, so dominant in our definitions of modernity, have rarely been given prominence in analyses of the changing science-society relationship – except, perhaps, to be dismissed as irritating irruptions of irrationality.

In *The New Production of Knowledge,* despite the importance of the 'social' in its account of Mode 2, wider social transformations went largely unexplored. This may have been excusable in the light of the interminable academic literature on modernization and modernity (and post-modernity). The book was never intended to be an essay in social theory – any more than it was conceived of as a tract on science policy. Only in the chapter on the humanities, because of the need to engage wider cultural themes which made it essential to acknowledge other dimensions of social transformation, and in that on higher education, because massification and democratization mean that universities are no longer so intimately associated with the production of scientific and professional elites or the dissemination of a scientific culture, was there any attempt to explicate 'society'.

In retrospect this avoidance of any substantial discussion of the 'social' was a weakness – in three senses. First, it allowed the argument to be assessed purely in narrowly empirical terms, as a more or less accurate account of recent trends in scientific production. For example, Diana Hicks and Sylvan Katz (Hicks and Katz 1996) used bibliometric data to test claims about the growth of networking and collaboration made in *The New Production of Knowledge.* Revealingly their tentative explanation was that this trend was probably an 'internal' phenomenon, the consequence of the end of institution building and budget growth during the 1970s, rather than an 'external

phenomenon', the result of the changing dynamics of research itself (in scientific as well as professional and organizational terms), not to say of the emergence of a new relationship between science and society. Second, it made the argument unclear at crucial points. As a result the book was read by some critics as an endorsement of applied science and an apologia for relativism. For example, Paul David characterized our argument as 'a post-modern vision' in which 'mission-oriented R&D is well on its way to displacing discipline-based scientific practice, and becoming an ubiquitous and institutionally decontextualized activity' (David 1995: 14). John Ziman has offered similar criticisms (Ziman 1996). Third, this avoidance of the wider social picture made it difficult to differentiate our argument from those of others like Latour who readily acknowledge the changed relationship between science and society. That difference may lie not simply, or perhaps especially, in more radical notions of the new articulations between them, but in a more radical vision of society. This is important because whether the idea of contextualized science is perceived as substantially different from earlier ideas of science and, consequently, more threatening to the rigour of scientific method and robustness of scientific practice depends on how this 'context', that is, society, is defined. If the evolution of society is defined in terms of benign continuity, the difference and therefore the threat are less. If it is defined in disruptive and disjunctive terms, they are greatly increased. The argument that will be presented here, at its simplest, can be reduced to the assertions that (to borrow the terminology used in *The New Production of Knowledge)* Mode-2 science has developed in the context of a Mode-2 society; that Mode-2 society has moved beyond the categorizations of modernity into discrete domains such as politics, culture, the market – and, of course, science and society; and, consequently, that under Mode-2 conditions,

science and society have become transgressive arenas, co-mingling and subject to the same co-evolutionary trends.

The Growth of Complexity

Certainly there appears to have been a remarkable coincidence between the development of more open systems of knowledge production on the one hand and on the other the growth of complexity in society – and the increase of uncertainty in both. The climax of high modernity with its unshakeable belief in planning (in society) and predictability (in science) is long past, even if the popularity of ‘evidence-based’ research demonstrates the stubborn survival of the residues of this belief. Gone too is the belief in simple cause-effect relationships often embodying implicit assumptions about their underlying linearity; in their place is an acknowledgement that many – perhaps most – relationships are non-linear and subject to ever changing patterns of unpredictability. A good example is the development of chaos theory in the 1970s and its enthusiastic reception by a wider public previously unfamiliar with the phrase and certainly not able fully to understand its technical details or appreciate its scientific significance. For this wider public, chaos theory was a powerful metaphor which vindicated its long-held belief that not everything was predictable – either in science or government or in daily life. The popularization of chaos theory had a double significance, political and scientific. First, because ‘experts’ who previously had pretended to know (almost) everything were shown not to know as much as they claimed, the political distance between governors and governed was reduced; traditional hierarchies of deference were eroded. Second, in epistemological terms chaos theory, in its metaphorical much more than its technical aspects, appeared to suggest that the link between determinism and predictability had been broken.

In retrospect the coincidence between the degree of order, control and predictability thought to be found in the physical and in the social and political worlds is remarkable. The search for control and the belief in predictability had guided the project of modernization from the beginning. The Clock, and later the Machine, had become the guiding metaphor and dominant iconography of the political order. At first regarded as the worldly embodiment of a cosmic order, later this political order was reflected in, and also celebrated, the machinelike operation and technocratic efficiency of welfare-state capitalism and liberal democracy. In its smooth and predictable functioning, the process of modernization in the highly industrialized Western countries reached its climax during the quarter century after 1945. Moreover, modernization was no longer attributed to the 'hidden hand' of the market or other apparently impersonal forces; instead it was publicly on display for all to see, a powerful affirmation of man's control over nature and society. Any remaining errors or malfunctioning systems could be rectified by more and better science and more ingenious and detailed social engineering. The future, an open-ended horizon, seemed to promise wealth and health for all who remained true to these underlying principles of order and liberty.

Of course, in its early days at the end of the nineteenth and beginning of the twentieth centuries modernity had been a much more tormented, and ambiguous, phenomenon. In its cultural manifestations, at any rate, it was plagued by doubts about promises of a progress that had yet to materialize for the majority of the population. But with mass consumption succeeding, and complementing, mass production, these fears eased. In Western Europe and North America, at any rate, the years after 1945 produced unprecedented economic growth, full employment and material wealth for a population that quickly became accustomed to its twin role as producers and consumers.

Predictability and control became the hallmarks of an accomplished modernization arrogantly characterized by assertions of universalism, openness, rationality and efficiency. Science and technology also became powerful metaphors for the transformation of politics; the latter came to be seen as potentially as efficient, predictable and orderly as the former. For a brief period in the 1960s the social sciences, in their capacity as advisers to the political 'Princes' of the democracies of the West, were swept up by the same unprecedented euphoria and naively came to believe they could emulate the triumphant progress of the natural sciences. This period coincided with the Cold War – although it was far from actually being a coincidence. The enemy of the open society, like disorder generally, had to –- and could – be kept outside the realm in which control and predictability had been successfully installed. Cartesian dualisms, not only of mind and body, but of right and wrong, of good and evil, of rational and irrational, and of sharp differentiation between modern and pre-modern, were justified by the bipolar configuration of the Cold War world. The reputation and funding of science flourished, as did that of technology, for strategic reasons, partly because scientific and technological success was seen as a key guarantor of national security and partly because the wider scientific and technological enterprise benefited from the spin-off from military uses.

This exceptional conjunction of order and freedom, which produced a fleeting, and misleading, coincidence between the (assumed) regularity of society and the predictability of a progressive science, was destroyed by two great events. The first was the oil crisis of 1973-5. Unexpected and without previous warning, it brought home the vulnerability of a highly industrialized technological civilization to sudden changes in its political and natural environment. It had both political and cognitive consequences. First, a new confrontational discourse was created within Western

societies as the hitherto uncontested primacy of economic growth was questioned in the light of the rapid depletion of natural resources and degradation of the natural environment. An international commission set up through an initiative of Norwegian Prime Minister Brundlandt coined the word ‘sustainability’. Limits suddenly appeared – first to economic growth and then, in the wake of environmental protest movements against nuclear power, to the feasibility of unrestrained scientific-technological developments more generally.

The state, until now seen as the embodiment of political modernity and technocratic efficiency, also began to run up against its own limits. Decentralization in political authority and administration came to be regarded as a requirement of good governance, and citizens ceased to be seen as passive recipients of public goods to be distributed or re-distributed according to expert systems. Consumers became individualized, as did their ability (and right) to maximize their individual preferences, which were now defined according to models of economic rationality and of utilitarian welfare functionality. These developments, of course, were not uniform. National variations and different types of welfare states persisted. Although after the oil shock nearly all post-war welfare states started to evolve in a similar ‘market’ direction, their actual trajectories were determined by their previous histories, and their detailed configurations shaped by specific, and even unique, ‘local’ value conflicts and organizational and professional structures.

At the same time, the sources of scientific and technological knowledge were reshaped by the processes of internationalization and, more radically still, globalization, largely (but not solely) supported and stimulated by the development of new information and communication technologies. Knowledge production ceased to be the nearmonopoly of a handful of Western industrialized

countries. The configuration of scientific and technological knowledge in the context of concrete application became at times as important as its primary production. Control over geographically widely diffused networks of a partly ‘immaterial’ quality inherent to the new technologies became ever more difficult to enforce. Moreover, new materials and new production processes began to affect the production system itself, which now became ‘flexible’, organized ‘just-in-time’ and around principles dictated by ‘lean’ organizations.

As has already been pointed out, the popularity of chaos theory in the mid-1970s – the cognitive analogue of the oil shock perhaps – marked the beginning of the end of the dominance of modelling using linear and incremental analytical tools based on a paradigmatic calculus. The use of models, of course, increased and spread into new fields where modelling is less obviously applicable. But modelling no longer provided complete answers; problems eluded its grasp. Many of the insights of chaos theory were made possible by the same impressive advancements in computer technology that encouraged globalization. Non-linearity became the catchword of the day. The enthusiastic reception of chaos theory can be seen as one of the subtle shifts from a culture that valued homogeneity to one that braces itself to live in a world of heterogeneity. Chaos theory captured the imagination of Western intellectuals and, more widely, of an intelligent public. The claim that a butterfly’s wing over the Pacific could give rise to a tornado over Texas appeared to support their instinctive view that dynamics – of all kinds, individual, social, political and scientific – were essentially non-linear. And the once robust epistemological link between determinism and predictability was also undermined.

The second event was the equally unexpected collapse of the Communist regimes and the end of the Cold War fifteen years later in 1989. No political theory had been developed

that could help to explain the rapid, and disorderly but initially peaceful, transition from Communism to free-market capitalism. Few had anticipated the internal contradictions, and consequently erosion from within, of the Communist regimes. Indeed theories that emphasized the contrast between stable totalitarian regimes, which for that reason had to be confronted and contained, and unstable authoritarian regimes, which might be ignored and excused, remained popular through the 1980s. The political repercussions of the collapse of Communism were felt in East and West alike, and were greatly magnified by its unexpectedness. In countries as different as South Africa and Israel their effect was generally positive, opening up new possibilities of political movement and social reform. In the West, and especially in the United States, their effect has been more negative despite shortlived talk of the 'End of History'. The loss of an external enemy and the collapse of mentalities firmly grounded in a bipolar world have produced unexpected internal political fragmentation and contestation. But, in both East and West, the overall impact of the collapse of Communism has underlined the unpredictability of politics.

More fundamental consequences could also be observed. Although the Cold War embrace between scientific and military systems had encouraged some on the Left to demonize science and technology (already suspect on environmental and egalitarian grounds), these links had contributed more powerfully to science's sense of solidity, utility and linearity. Politically contested (but only by a minority), science (despite – or perhaps because of – this contestation) seemed cognitively secure. But with the collapse of Communism this powerful source of support, political and cognitive, was lost. The half-century persistence of a bipolar Manichaean world had also sustained support for the social engineering of the post-war welfare state. However uncongenial to free-market

capitalism and however unpromising as a tool of social-democratic reform, welfare states seemed the price that must be paid to maintain social peace and to ensure the loyalty of the working class. Full-employment policies, therefore, were rooted in Cold War political necessities as well as Keynesian economic theories. The forty-four years of armed peace not only stimulated scientific advance; they also fuelled economic growth. Before the spectre of inflation returned as a result of the oil shock and of the United States' reluctance to raise taxes to finance what was initially seen as a local – and short – war in Vietnam, the economic impact of military expenditure, and its civilian spin-offs, had generally been regarded as a stimulus to growth as well as innovation, rather than as a distortion of the economy. Finally, the frightening certainties of the Cold War perhaps induced a cognitive security that was reflected in the intellectual regularities of that period.

The correspondences between the evolution of social and political contexts on the one hand and intellectual cultures on the other are too suggestive to have been merely accidental. The controlling imperatives of post-war welfare states and of pre-oil-shock economies in the West and the success of science, not only in terms of its political prestige but of its cognitive regularity, are too closely aligned. So the end of the Cold War, even more than the oil shock, represented a radical challenge not only to the political (and social) order that had prevailed in the West since 1945, a period which in retrospect can be seen as an age of equilibrium, although its normative stability was disguised by its technical dynamism. Few people recognized that its contestations at their sharpest, in the 1960s, were in reality contained within stable normative structures – or, indeed, that it was the stability of these structures that had permitted these contestations to emerge. The end of the Cold War was also a challenge to the scientific order which both mirrored this wider socio-political environment and, of

course, contributed so powerfully to its technical dynamism and created its most eloquent discourses of legitimization.

The so-called post-modern condition is as much a reflection of these external circumstances as a manifestation of the internal dynamics of the disciplinary cultures of higher education and of science or of the rise of a febrile new intellectual culture closely associated with the late twentieth-century development of the culture industries and, in particular, of the mass media. The rise of post-modernism, therefore, represents a crisis both of social legitimization and of methodological, epistemological and even normative authority – although some would prefer to talk of opportunity rather than crisis. The post-modern condition's cultural manifestations and expressions have been widely described and explored. Not only has the received canon of knowledge been questioned; increasingly the limits inherent to scientific knowledge and the knowable have also been probed. It is now recognized that what can be observed and analysed today is only a momentary view of a long-term process. The temporal dimension of evolution raises the question about the evolution of evolution, including the sources of our own evolution as biological and social beings and the evolution of societies. It is in this sense that a Mode-2 society and Mode-2 science are inextricably bound together.

Two Accounts of Social Transformation

In both social and scientific systems, therefore, a regularity that was limited (because the less predictable was relegated to the fringes of both systems) but also generalizable (because it was governed apparently by rational rules and universal laws) has decayed. It has been superseded by an unpredictability that is both unconstrained (because the 'social' is no longer confined to the instrumental-rational arena and 'science' too has burst its positivistic bonds) and

particular, even ‘local’ (because the intensity and pervasiveness of social and scientific change have made both highly sensitive, and therefore susceptible, to ‘local’ environments). This shift is reflected in competing accounts of social change because Mode-2 society can be conceptualized in two different ways – either as Knowledge Society or as Risk Society, although both labels are much too simplistic. The Information Society, another label which is also often evoked, occupies a middle ground between the two, but this ‘Third Way’ will not be discussed in detail here; it comprises discourses about the future direction of socioeconomic development derived from the political economy of information and communication technologies. While the socialtransformation account leading towards the Knowledge Society privileges the changing modes of production, the ‘story’ of the Risk Society concentrates on those who are affected – consumers and citizens, patients and clients, in short, lay people as well as ‘experts’ (and, to some extent, dissolves the differences between the ‘lay’ and the ‘expert’). The ‘Third Way’, or Information Society account of social transformation, seeks to analyse the implications of information and communication technologies for services related to final users (who, by this definition, are already drawn in and, hence, part of the system and its evolving infrastructure).

These competing accounts are based on two different analytical axes. The first, apparently more relevant to definitions of Mode-2 knowledge production, is the scientific-technical-economic, with a heavy emphasis on production. A convenient label, perhaps, is postindustrialism. The second is the socio-cultural, for which terms like post-modernism, or post-Fordism with its more radical and disruptive undertones, may be a better shorthand description. To the extent that writers on the development of science, and on science and technology policies, have thought seriously about the future shape of society they have tended to

emphasize the first axis. New technologies, grounded in the achievements of ‘basic’ science or seen as its correlate, have transformed the conditions for material production. One result has been unprecedented advances in productivity. Another has been the ‘customization’ of production which has replaced mass manufacture, although it can be argued that this ‘customization’ is confined to superficial attributes of increasingly homogeneous products and brands. A third perhaps has been the development of ‘virtual’ products traded in novel ways, for example, on the Internet. New markets, shaped by these technological possibilities, enabled by affluence and shaped by education, have transformed the conditions for social reproduction. The market, in which materialization seems to open the way to individualization, has become as powerful a social signifier as the collectivities of class, race and gender. Again it can be argued that individualization is produced by the eradication of social ‘difference’ rather than by the liberation of individuality and that, in any case, these older categories still shape, perhaps decisively, access to these markets in material – and symbolic – goods. Finally, society itself, and the institutions and organizations it comprises, are now organized around the availability and manipulation of ‘knowledge’ (although this ‘knowledge’ may be imprecisely defined). A grand chain of being is established, beginning with a new science and proceeding by way of technology and markets to a new society. The resemblance to the regularities of traditional research, which we characterized as Mode-1 science, is clear.

The second axis, the socio-cultural, suggests a different account of Mode-2 society. The impact of new technologies, to which it is argued ‘basic’ science has often made a surprisingly small contribution, is seen as undermining not only industrial-age patterns of employment but also the meaningfulness of their social constructions – personal, in terms of families and perhaps the notions of intimacy and

affection that nuclear ‘Western’ families reflect and promote, and of communities, whether spatial, in terms of urban and rural ‘spaces’; social, in terms of shared experience and collective action; political, in terms of economic planning or welfare states; or national, in terms of distinctive ‘histories’. New markets are seen as perverse contrivances, the tantalizing source of ephemeral and volatile identities (whether individual, family or community) which must be reinforced by ceaseless but meaningless consumption. Finally the ‘Knowledge Society’ is regarded as a dystopia – in four separate senses. First, it promotes inequality by reinforcing distinctions between the knowledge-rich and the knowledge-poor. Second, its ‘knowledge’ is not wisdom or even science but data, the organization of which is technically (and commercially?) rather than culturally determined. Third, through its pervasive knowledge-data it dissolves traditional canons of art, ideas and artefact and also compromises rational discourse. Fourth, and last, it proliferates risks – environmental, ethical and intellectual – without hope of reconciliation. Clearly such a de-stabilizing account of society cannot be reconciled with the cool rationality characteristic of Mode-1 science. It may even be difficult to combine with the eclecticism of Mode-2 knowledge production.

The sharp contrast between these two accounts can be explained in a number of ways. The most obvious is that the former, the scientifictechnical-economic, was first generated in the 1970s under more benign economic and stable cultural conditions long before the collapse of Communism and even before the oil shock. Daniel Bell first offered his account of post-industrialism as long ago as 1973 (Bell 1973). This account has not been substantially modified by successive interpretations of scientific-technological and socio-industrial change, although a slight tendency can be observed for more recent accounts to emphasize its radical

and disruptive consequences as the impact of new technologies and markets has been more clearly felt (see, for example, Reich 1992 and Kennedy 1993). Bell's account, as modified by Reich or Kennedy, has stood the test of time in the important sense that it offers a discourse still recognizable in many policy pronouncements and futurological predictions. It has also proved to be a resilient account in a second sense; it has survived the shift from welfare-state bureaucracy to enterprise-state markets without radical modification. Hard technological determinism is never far away. But this account now presents a number of difficulties. It still assumes clear demarcations between the spheres of the state, market and culture (and science and technology), and assumes that they are distinctive formations within society represented by clearly differentiated sub-systems.

This first account, therefore, emphasizes the central role played by technology in reshaping industrial processes, employment practices and social patterns. 'Knowledge', defined both as human capital, in terms of highly skilled work-forces, and as theoretical concepts (or, at any rate, systematized data), has become the key resource in determining competitive success in global markets. The socio-cultural consequences of these changes are typically treated as secondary phenomena – to be optimistically or perhaps naively glossed as 'post-materialism', or tolerated as playful consumerism, or (for the 'losers' in the great game of post-industrial restructuring) managed by benign social policies. Bell's second book, half the length of the original, was merely a footnote, even if the worry-word 'contradictions' was used in the title and Bell had already spotted that 'culture' displayed a clear tendency towards syncretism, rather than following the pathways of further functional differentiation (Bell 1976). The first account reflects the spirit of its age, the third quarter of the twentieth century – its dynamism, in the economic and

technological arenas; its social stability and ideological predictability (the two apparently warring blocs of the Cold War era had common roots in rational Enlightenment). As such, it is unreflexively married to a technocratic and presumably also a neo-conservative view of history, social change and transformation.

The second account, the socio-cultural, was generated more recently and reflects the anxiety of its era. The social effects of technology, and of the industrial restructuring its advance allows, are no longer mediated by welfare states and other progressive social policies, because globalization has raised the cost of such mediation, in terms of reduced competitiveness, to an unacceptable – or less acceptable – level. The categories within which such mediation could take place, notably nation-states and cultures, have also been compromised by globalization of arenas and hybridization of environments. The environmental impact of technology and the relentlessly ongoing process of industrialization is also causing increasing concern. This impact is no longer a local phenomenon in the sense of ugly coal mines and belching steel works, urban sprawl and increased traffic, but is now perceived as a general or global phenomenon induced by the creation of polluting mono-cultures to satisfy consumerist cravings and the inability to contain the cumulative effects of otherwise local conditions. Thus, phenomena like global warming and nuclear proliferation exemplify the metamorphosis from local to global and the threats that go with their increasing uncontrollability. The success of science and technology has drawn them into highly contested arenas. Not only has the success of science led to radical modifications of social behaviour (for example, advances in reproductive technology have modified sexual habits and so challenged traditional constructions of intimacy); it now appears to compromise the integrity and uniquencess of human life (as in the examples of gene sequencing and, more recently, cloning). Finally, the end of

the Cold War, instead of ushering in an era of ideological stability, as Francis Fukuyama and others triumphantly predicted, has increased the disorder of the world.

Ulrich Beck's argument in *Risk Society* is typical of this second, more disturbing account of future society (Beck 1992). He argues that 'just as modernisation dissolved the structure of feudal society in the nineteenth century and produced the industrial society, modernisation today is dissolving industrial society and another modernity is coming into being' – in other words, industrial society and modernity have become antagonistic in a way that Bell and his successors do not accept, or even recognize (Beck 1992: 10). In his scenario of the 'normalisation of the abnormal' – that is, the self-made production and uncontrollable diffusion of risks – the dominant logic of the industrial age, namely that it can control the risks it produces, is breaking down in an irreversible way. As a result, our 'social mapping' no longer works because we can only conceive of modernity in the context of industrial society. But Beck is not very interested in Bell-type socio-economic analysis. To the extent that he is interested, he offers pessimistic interpretations – for example, by arguing that mass unemployment has been integrated into the occupational structure as 'pluralised underemployment'.

What Beck is more interested in are the social effects of Risk Society. He argues that the modernization of gender roles – more women at work, higher divorce rates and so on – has undermined notions of family, parenthood, sexuality and love which were characteristic of industrial society. As a result, 'The system of co-ordinates in which life and thinking are fastened in industrial modernity – the axes of gender, family and occupation, the belief in science and progress – begins to shake, and a new twilight of opportunities and hazards comes into existence – the contours of the risk society' (p. 27). He then considers the intellectual implications of Risk Society. 'On the one hand, science and

thus methodical scepticism are institutionalised in industrial society. On the other hand, this scepticism is (at first) limited to the external, the objects of research, while the foundations and consequences of scientific work remain shielded against internally fomented scepticism.... Reflexive modernisation here means that scepticism is extended to the foundations and hazards of scientific work and science is thus both *generalised* and *demystified'* (p. 163). He applies a similar argument to political democracy. Subpolitical systems thrive at the expense of grand political structures. Progress and innovation now flow through the channels of business or technology (neither of which are 'democratic' arenas), while democratic institutions atrophy. Anthony Giddens has offered a similar, although less gloom-ridden, analysis of social and cultural change (Giddens 1992).

The contrast between the two accounts of future society is suggestive of both their arguments and the ages in which they were first developed. The first is schematic, linear, confident, while the second is discursive, diffuse and gloomy. The former describes the culmination of past and present trends; the latter their radical subversion. The first emphasizes the primary role of production; the latter, by suggesting that uncontrollable risks have become an integral part of any production process, challenges such a primacy. Consumers, patients and ordinary citizens at the mercy of such a runaway production process are cast into the heroic role of having to resist the self-proclaimed authority of those who still make believe that they know and are in control. The Risk Society is therefore a latent political society, oscillating between public hysteria, tension-ridden indifference and attempts at reform.

Social Change and Knowledge Production

Both accounts of future society can be linked to our account of the transition from Mode-1 science to Mode-2 knowledge

production, but in radically different ways. The first suggests a number of phenomena that are consistent with Mode 2. The growth of the ‘knowledge’ industries has not only led to an increase in ‘knowledge’ workers and a proliferation of sites of ‘knowledge’ production, but has also tended to erode the demarcation between traditional ‘knowledge’ institutions such as universities and research institutes and other kinds of organization. Novel ‘knowledge’ institutions are arising – in small and medium-sized high-technology companies, for example, or management consultancies and think-tanks (which, arguably, are merely extensions or modifications of traditional institutions; the growth of corporate universities may be a good example). But even more radical change is under way; many, perhaps most, organizations in a Knowledge Society have to become learning organizations, in order to develop their human and intellectual capital, and have also to become increasingly dependent on the ‘knowledge’ systems to operate efficiently – or at all. In simplistic terms it is even possible to equate the transition from Mode 1 to Mode 2 to the successive step-changes in productivity that have characterized the industrial age and have been produced by the coming together of new technologies, new methods of production (and patterns of consumption) and new energy sources. Why not a fourth – new forms of knowledge production?

However, in some other respects, this first account of social transformation is less congenial to our account of Mode-2 knowledge production. Labour-market statistics do not suggest that the number of ‘knowledge’ workers is inexorably increasing, certainly not if such workers are narrowly defined as scientific researchers (Sennett 1998). The great growth has instead been in ‘data’ workers. The ease and instantaneity of communications may even have undermined the need for local sites of knowledge production, even if cost pressures have encouraged out-sourcing of routine ‘knowledge’ work on a global basis.

Global brands, and systems, have flourished – and their proliferation has increased rather than diminished the power of these primary knowledge producers. Nor is there much evidence that the development of a Knowledge Society has weakened the hegemony of traditional 'knowledge' institutions such as universities, although it can be argued that their values and practices have been radically modified by closer encounters with other 'knowledge' organizations not just in government and industry but also in culture (because of the explosive growth of the cultural industries, notably the mass media) and the wider community. The socially distributive and diffusive dimensions of Mode-2 knowledge production are absent. Its potentially transgressive and subversive aspects are limited to cultural syncretism or otherwise ignored. So, although in this first account there are suggestive indicators that support the emergence of Mode 2, there are also counter-trends. The balance-sheet is mixed. Although this account endorses the argument that radical changes have taken place in the organizational structures within which knowledge is produced and its social (and professional) practices, it offers little support for the assertion that core epistemologies and methodologies are also changing.

The second, more radical, account of future society presents other difficulties. Its emphasis on contradictions is difficult to reconcile with the evident continuities implied by the transition from Mode-1 science to Mode-2 knowledge production. As it has been understood, Mode 2 implies an enlargement of the number of participants in research and the widening of what is defined as research. It also implies a multiplication and social diffusion of the sites at which knowledge is produced (rather than the 'abolition' of knowledge – at any rate, knowledge derived from research and embodied in scientific-technical expertise – or its incorporation within the larger categories of data-information and cultural symbols, as this second account