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INTRODUCTION

'Mode 2' Revisited: The New Production of Knowledge

Nine years ago, six authors published *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*.[1] Reviews were mixed. Some philosophers, historians, and sociologists of science regarded the argument in the book as either simplistic or banal (or perhaps both), while science policy analysts worried about the empirical evidence for the trends it identified (or argued that these trends were not new). However, the book's broad thesis – that the production of knowledge and the process of research were being radically transformed – struck a chord of recognition among both researchers and policy-makers.

Of course, like all theses that gain a certain popularity (and notoriety), this thesis was radically simplified, and collapsed into a single phrase – 'Mode 2'. The old paradigm of scientific discovery ('Mode 1') – characterized by the hegemony of theoretical or, at any rate, experimental science; by an internally-driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions, the universities – was being superseded by a new paradigm of knowledge production ('Mode 2'), which was socially distributed, application-oriented, trans-disciplinary, and subject to multiple accountabilities.

Those with most to gain from such a thesis espoused it most warmly – politicians and civil servants struggling to create better mechanisms to link science with innovation; researchers in professional disciplines such as management, struggling to wriggle out from under the condescension of more established, and more 'academic', disciplines; and researchers in newer universities, other non-university higher education institutions, or outside the academic, and scientific, systems strictly defined. Those with most to lose were most sceptical – including researchers in established disciplines and institutions, who feared that the quality of science would be eroded if such levelling ideas gained political currency, and who feared that their own autonomy would be imperiled if more explicit links were established between research and innovation.

[1] Michael Gibbons, Camille Limoges, Helga Nowotny, Simon Schwartzman, Peter Scott, and Martin Trow, *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies* (London: Sage, 1994).

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Both reactions were predictable. A generation ago, Thomas Kuhn's *The Structure of Scientific Revolutions* aroused far more interest among social scientists – and humanists, who not only felt a shock of recognition in his account of paradigm shift but also saw that it could enhance the legitimacy of their disciplines – than among natural scientists, who saw Kuhn's companion idea of incommensurability as a threat not only to universal, or 'objective', truth but also to progressive experimentally-based research.[2] His own discipline, physics, was most resistant of all to his ideas.[3]

However, in the case of *The New Production of Knowledge*, there was a new twist. The 'Mode 2' thesis, however simplified, was recognizably derived from the argument presented in the book. So, as authors, we could not object. Our critics may even have seen us as being hoist by our own petard, because inherent in the very notion of 'Mode 2' (or socially distributed knowledge), is the idea that this cannot be authoritatively encoded in traditional forms of scholarly publication. If nurse researchers pounced on 'Mode 2' to reduce their subordination to medical research, or if global accountancy companies placed 'Mode 2' at the heart of newly-established 'Centres for Business Knowledge' – both of which are actual examples – who were we, the authors, to complain? We had fallen into our own postmodern trap.

It was partly to resist this collapse into relativism (and over-simplification of the argument), partly to answer the valid criticisms of that argument, and partly to develop our broader thesis, that the present three authors wrote a second book, *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*.[4] Yet, the difficulty remains – how to describe and defend, in traditional academic discourse ('Mode 1', in our own terminology), ideas that attempt to analyse how that discourse is being transcended ('Mode 2'). 'Mode 2' is not only a concept, inherently open to manipulation or exploitation by others (even in ways of which we may disapprove); it is also a project, an example of the social distribution of knowledge, which it seeks to describe.

This special issue of *Minerva* cannot hope to resolve this difficulty. Instead, we hope it will contribute to the continuing debate about the future of knowledge production. This Introduction is divided into four

[2] Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1970).

[3] Gary Gutting (ed.), *Paradigms and Revolutions: Applications and Appraisals of Thomas Kuhn's Philosophy of Science* (Notre Dame: University of Notre Dame Press, 1980).

[4] Helga Nowotny, Peter Scott, and Michael Gibbons, *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty* (Cambridge: Polity Press, 2001).

sections: (i) a description of trends in science policy and tendencies within the research enterprise, out of which our analysis arose, and which have intensified in the past eight years; (ii) a summary of the arguments first presented in *The New Production of Knowledge*; (iii) an account of how these arguments have been extended and elaborated (and, perhaps, modified) in *Re-Thinking Science*; and (iv) a brief speculation about next steps, because our thesis is highly reflexive and closure of the argument is not possible.

THE CHANGING RESEARCH ENVIRONMENT

The nature of the research process is being transformed, and this transformation has many separate elements. Scholars disagree about their respective novelty and intensity. However, three trends are generally accepted to be significant – (a) the 'steering' of research priorities, (b) the commercialization of research, and (c) the accountability of science. These and other trends, or changes in practice, have given rise to new discourses of science and research.

a) The steering of research priorities

The first element in the transformation of research is the increasing desire to 'steer' priorities. This operates at three levels:

i) The supranational level: The successive European Community Framework programmes are perhaps the best example. These programmes have attempted to shape research priorities and build research capacity to meet identified social and economic needs. On the whole, these efforts have been supported by the research community because the Framework programmes have been broad in their scope (and few areas have been categorically excluded) and because they have provided genuinely additional resources;

ii) The national level: Although highly prescriptive research and development programmes (for example, those funded by ministries of health, defence, or agriculture) have existed for some time, there has been a growing tendency for all ministries to develop dedicated research programmes. These programmes, rather confusingly, attempt both to focus on short-term political agendas and develop long-term research capacities. There has been a tendency for 'Foresight' exercises, which initially attempted to predict future research needs in a relatively open and speculative way, to be succeeded by more directive approaches, as industry and trade

ministries attempt to identify areas of international excellence and of inadequate research within the context of global economic competitiveness; and

iii) The system level: In many countries, Research Councils have increasingly adopted more pro-active (or top-down) research priorities in place of essentially reactive (or bottom-up) policies, whereby the best research proposals, as identified by peer review, are funded. Much greater emphasis is now placed on thematic programmes. Although typically broad in their scope, these programmes are often the product of an awkward – and unstable – compromise between 'political' goals, promising science, and available research capacity. In a similar way, universities have begun to manage their research priorities more aggressively, rather than simply providing a support environment.

b) The commercialization of research

The second element is the commercialization of research, although this label can be misleading; 'engaged research' may be a more accurate description. This has taken two main forms. First, as the public funding of research has become less adequate, researchers have increasingly turned to alternative sources of funding. Second, universities (and similar organizations) have become more aware of the value of the 'intellectual property' generated by their research. More attention, and anxiety, has focused on the first than on the second – perhaps wrongly. The available public funding for research is inevitably outrun by the sheer fecundity of research potential, although this is not an argument for abandoning efforts to increase public funding. The funding of research has always come from a plurality of sources; arguably, this contributes to the diversity – and creativity – of the research system. Of greater concern perhaps is the tendency of governments to define their role in research funding in quasi-commercial, rather than in fiduciary terms. This attempt to align public policy with market priorities in research policy – creating what are, in effect, public-private partnerships – is likely to reduce diversity and creativity.

The second aspect, the determination to exploit 'intellectual property', raises greater concern. The motives of universities and similar organizations are obvious enough. Public expenditure on higher education and research generally has failed to keep pace with costs, and universities have been encouraged to develop alternative sources of income. With the emergence of a Knowledge Society, knowledge 'products', many of which are derived from university research, are increasingly valued, not in terms of their long-term potential, but in terms of immediate

market return. However understandable the motives, seeking to exploit 'intellectual property' has two important consequences.

First, by raising the question of who 'owns' the property (i.e., the individual researcher or research team, the research community, or the institution), and then negotiating respective shares, the exploitation of intellectual property transforms the organizational character of the university. Second, the exploitation of 'intellectual property' challenges the idea (ideal?) of science as a public good. This raises awkward issues. One is commercial confidentiality. If 'intellectual property' is valuable, it cannot be given away 'freely' by open publication in peer-reviewed journals, or at scientific conferences open to all. However, the quality of science is largely determined by its exposure to refutation and counter-argument. This process becomes much more difficult if the circulation of research findings is restricted.

c) The accountability of science

The third element in the transformation of research is the growing emphasis placed upon the management of research – and, in particular, upon efforts to evaluate its effectiveness and assess its quality. One leading example is the Research Assessment Exercise (RAE) conducted by the higher education funding councils of England, Scotland, and Wales, most recently in 2001.[5] In the RAE, no overt attempt is made to influence the kind of research that is done, in terms of its themes, concepts, or methodologies. In practice, of course, the notions of international and national 'significance' upon which the RAE relies as a measurement criterion, are not value-free; in all subjects, there are prestigious themes, preferred concepts, and preferred methodologies. But, as far as possible, the RAE attempts to include – and so to assess – all styles of research by adopting an all-encompassing definition of research. The funding councils also try to make the whole process as transparent as possible by publishing the detailed criteria used by each panel of assessors, and by identifying their members, providing (limited) feedback on the grades awarded by these panels.

Important questions have been raised by the RAE. No measurement system, however scrupulously used, can fail to affect the behaviour of that which it seeks to measure. The influence of the RAE on the behaviour of individual researchers, research groups, departments, subjects, and institutions has been manifold. Some resumes have amounted to cynical game-playing. But such game-playing – 'star' researchers playing

[5] Peter Scott, 'The Impact of the Research Assessment Exercise on the Quality of British Science and Scholarship', *Anglistik*, 1 (2000), 129–143.

the transfer market like footballers; artificial or unrepresentative 'entries' being contrived, and so on – can be anticipated and, to some extent, discounted, although rule changes tend to lag behind the abuses they are designed to combat (five years behind, in the case of the RAE). A more serious consideration is that distortions are produced and hierarchies are reinforced by the taxonomy of the assessment process itself, notably by the demarcations between units-of-assessment. Interdisciplinary research has to be clumsily disaggregated, while truly creative research in the borderlands between disciplines is devalued. A third criticism is that RAE-type accountability and/or research management mechanisms have encouraged researchers to espouse industry-style production. It is said to be safer to deliver predictable (and second-best?) results on time than ground-breaking research, late.

To focus too closely on the RAE, however, is perhaps unnecessary. The same principles are at work in many other contexts. During the past decade, there has been a remarkable intensification of the associated processes of audit, assessment, and evaluation which has given rise to the suggestion that we now live in an 'Audit Society' (having sinuous but suggestive links with the Knowledge Society).[6] These processes are at work at every level within the research system – within the research team, as it evaluates the contributions of its individual members; in departments, as they seek to maximize their research performance; and in institutions, as they struggle to manage their overall research efforts, as well as in funding councils and government departments.

This is a key point. It is a mistake to imagine that accountability is being forced upon universities and other research institutions by hostile external forces, even if mutual trust, once rooted in the collusion of political, administrative, and academic elites, has been eroded. The processes of assessment and accountability have been deeply internalized – and, at the same time, have moved from the arena of professional (or collegial) responsibility to the domain of organizational (and managerial) competence. Power has theorized these processes as 'rituals of verification'.

A New Discourse of Science?

As a result of these and other trends, the research that is variously described as 'pure', 'blue-skies', fundamental, or disinterested, is now a minority preoccupation – even in universities. In Britain, Research Councils

[6] Michael Power, *The Audit Society: Rituals of Verification* (Oxford: Oxford University Press, 1997).

and RAE panels now include 'user' representatives alongside more traditional scientific peers. Detailed impact studies and lengthy evaluations have become routine. 'Knowledge' is now regarded not as a public good, but rather as 'intellectual property', which is produced, accumulated, and traded like other goods and services in the Knowledge Society. In the process, a new language has been invented – a language of application, relevance, contextualization, reach-out, technology transfer, and knowledge management.

Efforts to develop this new language – by which to describe the transformation of research, to map its new concepts, and to create a new discourse – have produced an extensive body of literature. This includes a literature of 'regret', which treats this transformation as inimical to the production of high-quality research (as well as a potential threat to free thought and the open society). In the United Kingdom, the Campaign for Academic Freedom and Democracy has been articulate, and aggressive, in representing this point of view, but it is a view that is also shared among academic scientists. There is also a new literature of 'modernization', emphasizing the importance of research within the Knowledge Society – and the need to align research priorities more closely with social, economic, and political goals. In Britain, successive White Papers – typically with titles such as *Realising Our Potential* – and the various Foresight exercises, reflect this second point of view. Neither, however, attempt a deeper analysis of changes in how knowledge is produced, validated, and disseminated. Both tend to regard the inner core of the research enterprise as essentially unchanged, and unchanging.

Finally, there is a literature of empirical investigation. For example, the Institute for Scientific Information (ISI) in Philadelphia has used large-scale data-sets to generate citation indices which, despite their imperfections, have increased our understanding of the dominant modes of scientific production. Research groups, such as the Science Policy Research Unit (SPRU) at the University of Sussex, have done valuable work on changes in patterns of scientific publication – examining, for example, the trend towards multi-institutional authorship (including many more non-university institutions, notably in the health sector) and the growth of so-called 'grey' literature.[7] Finally, there is a literature of theoretical speculation. Some examples, such as John Ziman's recent book, have attempted to re-justify the traditional autonomy of science.[8] Others,

[7] Diana Hicks and J. Sylvan Katz, 'Science Policy for a Highly Collaborative Science System', *Science and Public Policy*, 23 (1996), 39–44.

[8] John Ziman, *Real Science: What it is, and What it Means* (Cambridge: Cambridge University Press, 2000).

such as Henry Etzkowitz's conceptualization of the science-industry-government relationship as a 'triple helix', have embraced, and sought to explain, a new research paradigm.[9] Others again, such as Karin Knorr-Cetina's work on the dynamics of disciplinary cultures, have adopted an intermediate position.[10]

THE NEW PRODUCTION OF KNOWLEDGE

Both *The New Production of Knowledge* and *Re-Thinking Science* were written as reflective essays rather than as empirical studies. Their purpose was as much to address the need to invent a new language of research, as to offer a detailed analysis of the trends we have just described. In *The New Production of Knowledge*, the notion of 'Mode 2' knowledge production was introduced – and contrasted with 'Mode 1' research. 'Mode 2' knowledge production has a number of characteristics:

> 'Mode 2' knowledge is generated within a context of application. This is different from the process of application by which 'pure' science, generated in theoretical/experimental environments, is 'applied'; any technology is 'transferred'; and knowledge is subsequently 'managed'. The context of application, in contrast, describes the total environment in which scientific problems arise, methodologies are developed, outcomes are disseminated, and uses are defined.
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> The second 'Mode 2' characteristic is 'trans-disciplinarity', by which is meant the mobilization of a range of theoretical perspectives and practical methodologies to solve problems. But, unlike inter- or multi-disciplinarity, it is not necessarily derived from pre-existing disciplines, nor does it always contribute to the formation of new disciplines. The creative act lies just as much in the capacity to mobilize and manage these perspectives and methodologies, their 'external' orchestration, as in the development of new theories or conceptualisations, or the refinement of research methods, the 'internal' dynamics of scientific creativity. In other words, 'Mode 2' knowledge is embodied in the expertise of individual researchers and research teams as much as, or possibly more than, it is encoded in conventional research products such as journal articles or patents.

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[9] Henry Etzkowitz and Loet Leydesdorff (eds.), *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations* (London: Pinter, 1997).

[10] Karin Knorr-Cetina, *Epistemic Cultures: How the Sciences Make Knowledge* (Cambridge, Mass.: Harvard University Press, 1999).

The third characteristic of 'Mode 2' is the much greater diversity of the sites at which knowledge is produced, and in the types of knowledge producted. The first phenomenon, it can be argued, is not especially new. Research communities have always been 'virtual' communities that cross national (and cultural) boundaries. But, in 'Mode 2', their dynamics have been transformed. Once, interaction within these communities was limited by the constraints, both physical (the ability to meet) and technical (letters and telephones); now, as a result of advances in information and communication technologies, interaction is unconstrained – and instantaneous. The orderly hierarchies imposed by these 'old' technologies of interaction are being eroded by this communicative free-for-all. This shift has been intensified by the second phenomenon – the fact that research communities now have open frontiers – which has allowed many new kinds of 'knowledge' organizations, such as think-tanks, management consultants, and activist groups, to join the research game.

The fourth characteristic of 'Mode 2' knowledge is that it is highly reflexive. The research process can no longer be characterized as an 'objective' investigation of the natural (or social) world, or as a cool and reductionist interrogation of arbitrarily defined 'others'. Instead, it has become a dialogic process, an intense (and perhaps endless) 'conversation' between research actors and research subjects – to such an extent that the basic vocabulary of research (who, whom, what, how) is in danger of losing its significance. As a result, traditional notions of 'accountability' have had to be radically revised. The consequences (predictable and unintended) of new knowledge cannot be regarded as being 'outside' the research process because problem-solving environments influence topic-choice and research-design as well as end-uses.

The fifth characteristic is seen in novel forms of quality control. First, in 'Mode 2' knowledge, scientific 'peers' can no longer be reliably identified, because there is no longer a stable taxonomy of codified disciplines from which 'peers' can be drawn. Second, reductionist forms of quality control can not easily be applied to much more broadly-framed research questions; the research 'game' is being joined by more and more players – not simply a wider and more eclectic range of 'producers', but also orchestrators, brokers, disseminators, and users. Third, and most disturbingly, clear and unchallengable criteria, by which to determine quality, may no longer be available. Instead, we must learn to live with multiple definitions

> of quality, a fact that seriously complicates (even compromises) the processes of discrimination, prioritization, and selectivity upon which policy-makers and funding agencies have come to rely.

In *The New Production of Knowledge*, the idea of 'Mode 2' knowledge, with these five characteristics, was developed in a number of concrete contexts. The first was the commercialization of research. This provided a more nuanced account than either of the two standard accounts – characterizing commercialization as a threat to scientific autonomy (and so, ultimately, to scientific quality); and as the means by which research is revitalized in both priorities and uses, and in the resources it commands (because public funding of research is inherently both constraining and insufficient).

The second context was the development of mass higher education. The great increase in the number of students over the past half century, and the equally spectacular expansion of research, have often seemed uneasy bedfellows. Between 1945 and the mid 1970s, the former initially enhanced the resource base for the latter, but in recent years, these two elements have become increasingly competitive. More seriously, mass access and high-quality research have come to be driven by, and to address, different value systems. But this may partly be explained by the persistence of traditional – 'Mode 1' – accounts of research. Within the context of 'Mode 2', these tensions are reduced, and new synergies are apparent between the democratization of higher education and the wider social distribution of knowledge production.

The third context was the role of the humanities in the production of knowledge. The conventional view is that the humanities are the most detached disciplines, furthest removed from the turmoil of application and contextualization. Their 'uses' are almost entirely internalized. Our account in *The New Production of Knowledge* challenged that view. Instead we saw the humanities as the most engaged of all disciplines, not simply because they flow through into the culture industry (for example, through novels and popular history), but because they comfortably (and inevitably) embody notions of reflexivity which the natural, and even the social, sciences distrust.

The fourth context was globalization. Not only has 'knowledge', in the form of world brands and massive (and instantaneous) data flows, become the key resource in the global economy, 'scientific' knowledge more narrowly defined has also become more highly integrated and distributed. The idea of 'Mode 2' knowledge, in our view, is a useful tool to unlock some of these apparently contradictory phenomena. For example, the tension between modernity (Enlightenment values and

scientific culture) and modernization (the application of science and technology) becomes much less of a problem if a 'Mode 2' perspective is adopted.

The fifth and sixth contexts to which we attempted to apply the idea of 'Mode 2' were the least well developed. They were, first, the potential re-configuration of institutions that flowed from the wider distribution and greater reflexivity of knowledge production; and, second, the management of 'Mode 2' knowledge. These are key issues. The modern world is populated by expert institutions, which are not only essential for the advancement of social and technical progress and professional careers, but also shape personal and group identities and influence both the constitution and the uses of knowledge. Similarly the production of knowledge, however widely distributed, however trans-disciplinary, however heterogeneous, however reflexive, has to be 'managed'. More choices have to be made more urgently about scientific priorities. Although the explosion of choice may make it more difficult to aggregate them into, or shape them within, the framework of planned programmes, this does not mean that the problem of management has disappeared. Clearly 'Mode 2' knowledge must be managed in new ways. These are themes to which we intend to return in a third book.

RE-THINKING SCIENCE

The New Production of Knowledge provoked a lively debate. The argument presented in the book was criticized on a number of grounds. To some, it amounted to little more than a legitimization of malignant trends – in particular, the subordination of research to market and political agendas on the mistaken assumption that scientific breakthroughs could be predicted and therefore planned.[11] To others, the argument was not underpinned by adequate evidence; critics argued that the characteristics of knowledge production summed up by the 'Mode 2' label were neither as significant nor as novel as we had suggested. Other critics pointed out that, although we made much of the wider social distribution of knowledge and, therefore, of the more intense engagement between science and society, no real attempt was made to discuss the dynamics of society, which were treated as an unproblematic given. Some accepted the accuracy of our account, but insisted that it described social and political epiphenomena; the core of science remained inviolate. Finally, others

[11] John Ziman, 'Is Science Losing its Objectivity?', *Nature*, 382 (1996), 751–754.

saw *The New Production of Knowledge* as offering a postmodern vision of research.[12]

Re-Thinking Science was an attempt both to respond to these critics and, more substantially, to develop the argument. Some of the criticisms were well-founded – in particular the last two. However, the idea of 'Mode 2' was never intended to be a new-fangled label for applied science or programmatic research; by questioning the linearity and predictability of the research process, it called into question definitions of applied as well as pure research. Neither *The New Production of Knowledge* nor *Re-Thinking Science* was intended to be an empirical study. The aim of this second book was not simply to answer critics of the first. Rather, it was to take the two most substantial critiques and, by addressing them, offer a more theoretical account of the argument advanced in *The New Production of Knowledge*. First, the relationships between 'science' and 'society' were articulated more clearly to give substance to the twin notions of 'science speaking to society' and 'society speaking back to science'. The second book attempted to identify the key changes taking place in society. In the 1970s, these were confidently described in the language of industrial society. This assumed a post-industrialism in which knowledge accessible to (almost) all would replace physical, energy, and financial resources rationed to the rich and in which the rough edges of ideological conflict would be smoothed away. Knowledge would create prosperity. In the past quarter century, this optimistic vision has been superseded by dark images of a society in which risks have remorselessly accumulated and new hegemonic 'networks' have emerged.

Re-Thinking Science attempted to steer between optimists and pessimists, arguing instead that the great sub-systems of modernity (State, Market, Culture – and Science), once clearly partitioned, were becoming increasingly transgressive. This fuzziness helped to create the transaction spaces in which 'Mode 2' knowledge developed (and also, perhaps, the new social movements). The second book concentrated on four key characteristics which, it argued, were evident both in society and science. These were (i) the generation of uncertainty/ies, which reduces the possibility of post-positivistic planning – in both arenas; (ii) the trend towards self-organization, which is intimately related to the growth of reflexivity – again in both domains; (iii) the emergence of new forms of 'economic rationality', according to which, as in any 'futures' market, the poten-

[12] Paul David, 'Science Reorganized? Postmodern Visions of Science and the Curse of Success', Proceedings of the 2nd International Symposium on Research Funding, Ottawa (1996), 191–136.

tial of science is measured by its immanent rather than its instrumental value; and (iv) the re-constitution of time/space, of which the revolution in information and communication technology is one aspect.

Second, the assertion in *The New Production of Knowledge* that 'Mode 2' knowledge was produced in a 'context of application', was refined into a more developed argument about different forms of contextualization, so removing any possible doubt about a facile identification between such knowledge and applied research. Three forms of contextualization were examined. The first was 'weak contextualization'. Counter-intuitively, perhaps, national R&D programmes are a good example because, to succeed, they must simplify both. The second was contextualization in the 'middle range', in which the majority of 'Mode 2' knowledge production is clustered. Here, so-called 'trading zones', transaction spaces, and what we labelled 'Mode-2 objects' play a crucial role in determining a form of contextualization in which local contingencies shape synergy and potential. The third was 'strong contextualization', where powerful reflexive articulations between science and society are at work. This may take highly-specific forms, or relate to the interaction between the world of ideas and much wider social movements, such as feminism or environmentalism.

The third way in which we developed a more theoretical account of 'Mode 2' was in arguing that this new knowledge form was not merely a secondary phenomenon, contingent on 'Mode 1' science, as some critics had suggested. Three pieces of evidence were offered in support of this claim. The first was that 'Mode 2', especially in its trans-disciplinary dimension, could make a fundamental contribution to the development not only of new methodologies but also of new concepts and theories. The failure to recognize this contribution probably arose from the fact that it was not encoded in disciplinary frameworks or embodied in familiar research products, such as journal articles. The second piece of evidence was that the epistemological core of science, the values in which it is ultimately rooted, may be a mirage; *often* it is empty (as, for example, when scientific ideas are absorbed by non-host cultures, predominantly as technical artefacts without regard to their original normative significance) or, more usually, when it is crowded with competing epistemologies. The third was that reliable knowledge, the traditional goal of scientific inquiry, is no longer (self?) sufficient in the more open knowledge environments that are now emerging; knowledge also needs to be 'socially robust', because its validity is no longer determined solely, or predominantly, by narrowly circumscribed scientific communities, but by much wider communities of

engagement comprising knowledge producers, disseminators, traders, and users.

Finally, two new ideas were introduced. The first, related to the fuller explication of contextualization, is the concept of the *agora*. This archaism was deliberately chosen to embrace the political arena and the market place – and to go beyond both. The *agora* is the problem-generating and problem-solving environment in which the contextualization of knowledge production takes place. It is populated not only by arrays of competing 'experts', and the organizations and institutions through which knowledge is generated and traded, but also by variously jostling 'publics'. It is not simply a political or commercial arena in which research priorities are identified and funded, nor an arena in which research findings are disseminated, traded, and used. The *agora* is a domain of primary knowledge production – through which people enter the research process, and where 'Mode 2' knowledge is embodied in people and projects. The role of controversies in realizing scientific potential is also played out in the *agora*.

The second new idea introduced in *Re-Thinking Science* is that of the context of application. This was taken to be one of the key characteristics of 'Mode 2' in *The New Production of Knowledge*. But to the extent that the context of application seems silently to reinforce notions of hierarchy and linearity, and to suggest that positivistic predictions of applicability are possible, it could be regarded as dangerously misleading. Instead, against a background of inherent uncertainty about the future state of knowledge, from which scientific potential was derived, it is necessary to reach beyond the knowable context of application, towards the unknowable context of implication. Here knowledge-seekers have to reach out and anticipate reflexively the implications of research processes.

Re-Thinking Science attempted to fill some of the gaps in the argument in *The New Production of Knowledge* – notably, the absence of an adequate social theory, and the lack of a convincing refutation of the claim that 'Mode 2' knowledge is a secondary activity. However, there is need to systematically explore the implications of these ideas for systems and institutions in general, which will be the focus of the authors' next work. Closure of the 'Mode 2' debate is neither possible nor desirable. The project has many of the characteristics of the much more open knowledge production systems that it is attempting to analyse – wide social distribution, trans-disciplinarity, the need for social robustness, and the creative potential of controversies.

This special issue of *Minerva* is its own *agora*, containing five articles that address themes emerging from both books (and other interventions and contributions to the wider debate). In the first, John de la Mothe discusses the impact of more subtle readings of the process of innovation on policy organizations and policy behaviour, and therefore addresses one of the shortcomings in our analysis. Next, Olle Edqvist describes the layers of Swedish research policy laid down in the 1940s, 1960s, and 1990s as embodying three different models of science – as the motor of progress; problem-solver; and strategic opportunity. In his view, 'Mode 2', or distributed knowledge production, has been the historical norm; it is 'Mode 1', or academic science, that is the recent interloper. In the third article, Sheila Jasanoff argues that it is necessary to increase civic participation in the governance of science to compensate for the erosion of the authority of technical experts, and urges the adoption of what she calls 'technologies of humility', which engage the human subject as both active agent and source of knowledge and insight. Her argument is a more eloquent extension of our account of the *agora* as a site of knowledge production.

In the fourth article, Dominique Pestre asserts that the arguments in *The New Production of Knowledge* and *Re-Thinking Science* do not stress sufficiently the extent to which the evolution science and society, analysed in these two books, are the result of political and social choices. He is particularly interested in alternatives to what he regards as over-deterministic accounts. The neglect of power relationships we acknowledge to be one of the most significant weaknesses in both our books, and Pestre's account helps to remedy this weakness. Marilyn Strathern extends these arguments into new, anthropological territory by discussing to what extent 'society' can be described in sufficiently robust terms so that it can become a reference point, or counter-point, for 'science'. Although in *Re-Thinking Science* we attempted to offer a more subtle account of 'society', Strathern's article demonstrates the scale and scope of the work that remains to be done.

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