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SOME CURRENT CHANGES IN THE CONDITIONS OF RESEARCH

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Abstract. Currently there is debate about the changing conditions of scientific research and appropriate models of knowledge production. Mode 2 and Triple Helix are two of the catchwords used to denote new models of scientific knowledge production. They highlight network characteristics, interplay between research and users, as well as modes of management based on partnering. The present article reviews some of the changes in the research landscape in Western countries that have prompted a rethinking of science policy and the shift from the so-called linear model of innovation to conceptualisation in terms of networks and partnering. This review is framed in a more general discussion of OECD science policy doctrines. In conclusion it is found that the new network models of science policy are deficient in that they tend to exaggerate certain features in limited segments of the current policy-making landscape, but in doing so they at the same time reinforce images and policies dictated by macro-economic forces of globalisation. The present article tries to correct for this lack of critical thinking.

Introduction

In the aftermath of the Second World War the growth of science became a recognized policy objective. The *Frascati Manual* that was developed by OECD ministers of science and higher education in order to keep tabs on and compare funding flows to science in different countries recognized three categories for accounting: basic research, applied research and product development (R&D) (OECD 1989). Encoded in the first science policy doctrine in the early 1960s the definitions of these different types of activity gelled a mind-set, norms and criteria. Basic research was regarded as purely curiosity-oriented and free from attempts to steer it, while applied research and technological development were necessarily subject to external determination, market demands or social policy objectives, later denoted as “sectorial”, e.g. defence energy supplies, housing programmes, health care, and so on.

Simplifying greatly one can say that the first OECD science policy doctrine is characterized by science-push GNP growth. This was followed by a second doctrine in the 1970s, distinguished by a belief in market or societal pull and sectoral steering (with a lot of "science for policy" but not so much "policy for science"); the third OECD doctrine, associated with the 1980s was an orchestration policy with a partial focus on basic research to stimulate new and emerging technologies; and in the 1990s the triggering phrase became, "towards a new social contract for science".[1]

The definitions were normative, and so were the statistical household procedures. The early morphology of the research landscape in many countries displayed concomitant organizational features hinging on a distinction between basic research councils on the one hand and sectoral funding agencies associated with various departments of state on the other. It was taken for granted that such clear-cut distinctions existed, and that norms and rules in the different realms recapitulated stages in a linear model of innovation. This reinforced the belief that new discoveries and ideas rightfully emerged in a free space where they gradually matured, before becoming applied and eventually taken up as new products and processes (i.e. "innovations") in a marketplace. The very definition of "innovation" was thus contextually contingent. In other words it had a specific social epistemology and historical background in which a particular mode of boundary maintenance between science and politics was significant.

By the late 1980s, and especially with the end of the Cold War and the collapse of the former Soviet Union, these boundaries and distinctions were no longer self-evident, and several attempts have been made to redefine what in retrospect has been called the new "social contract for science" (Baldursson 1995, Jenkins 1997, Lubchenko 1998, Guston 1994, Gibbons 1999, Kates et al. 2001). The American science adviser Vannevar Bush, author of an influential report, *Science – The Endless Frontier* (1945) is often credited with drafting the blueprint for the traditional social contract for science that undergirded OECD's first science policy doctrine, but actually he never used the term "social contract" (Bragesjö 2001). It is a retrospective construction in a quest in the 1980s to shape a *reconfiguration*, one that in the eyes of many researchers has narrowed the confines of academic freedom and autonomy, while giving freer play to commodification of research and commercial stakeholder interests (market governance) and other players, including social movements and activists or NGOs.

A number of terms have been introduced to try to capture characteristic features of the "new" situation in order to contrast these with the "old" image(s) of science. The most frequently cited notions are:

– mandated science (Salter)
– postacademic science (Ziman)
– Mode-2 science (Gibbons et al.)
– Triple Helix (Etzkowitz and Leydesdorff)
– academic capitalism (Slaughter and Leslie)

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[1] The history of science policy doctrines is reviewed by Elzinga and Jamison (1995).

– post-normal science (Funtowicz and Ravetz)
– socially robust science, or science in the *agora* (Nowotny et al.)

In addition the term postmodern is sometimes taken over to refer to the new situation, and occasionally reference is made to an image of nomadic knowledge production (Rip & van der Meulen 1996, Rip 2000).

The much-debated book *The New Production of Knowledge* (Gibbons et al. 1994) is only one of many pertinent publications. The work behind it was sponsored by the former Swedish Council for Planning and Coordination of Research (FRN). Three of the authors, in light of the debates generated, have since then come out with a sequel, *Re-Thinking Science. Knowledge and the Public in an Age of Uncertainty* (Nowotny et al. 2001).

The present paper briefly reviews some of the details regarding changes in the academic research landscape and its context that have prompted a re-thinking of research policy models. The post-World War II situation will be highlighted, but concentration is on the past forty years.

Internationalization and globalization

International partnerships around research have been on the increase. They are driven by factors external to science as well as intra-academic ones. First of all it has to be remembered that patterns of interconnectivity between scientific communities across the globe continue to be shaped in the context of centre-periphery relations. The unequal relationships involved introduce skews between pockets of concentration of scientific resources and have-not regions. Historically this situation in the global political economy of science has been over-layered and reinforced by ideological, political and institutional settings, as for example the Cold War after World War II. Today competition between the world's three great trading blocks is an active ingredient of so-called globalization, which is increasingly providing a frame for emerging science and technology.[2]

We see it in the impact of the European Union and its Framework Programs (now into the 6th) for R&D which have a strong slant to the applied side and market governance. EU funding and funding rules, often requiring matching grants in receiving countries, actually have an impact on research cultures that exceed their economic value, introducing new skews of interplay and policy attention. More generally the process of macro-economic globalization and trade agreements aimed at deregulation and privatization aggravates the gap between rich and poor countries in the world, in terms of both relative volumes of research and research agendas. In these agendas it is the problems of the rich that dominate. The end of the Cold War thus marks a shift of focus from East-West to North-South as the fault line of global tensions, mismatch of the profit-nexus and human needs, as well as differing degrees of conflict. This also affects science.

[2] Elsewhere I argue that it is more adequate to speak of a triadization (NAFTA, EU, and Developing Asian Economies plus Japan) (Elzinga 2001 & 2002; cf. Meyer-Krahmer & Reger 1999).

International collaboration is frequently motivated by the need to cut costs, tap into competence and gain intelligence across borders. Companies seek knowledge where they can best access the research they require; adult education and retraining programmes for firms are frequently handled by consultancies but universities are now also making inroads in this branch.

In addition of course some major international research programmes are politically motivated by the simple fact that several urgent problems facing us cut across national boundaries (Elzinga 2001: 13637). Environmental degradation, the loss of biodiversity and global climate change are examples of this.

In OECD circles large-scale projects or efforts needing intergovernmental cooperation, billions of dollars in funding, and new forms of management have come to be called Megascience. This goes way beyond the old image of Big Science, which in turn emerged alongside more traditional disciplinary oriented Little Science. Big Science was characterized by teamwork, large-scale funding, more formal contractual relationships between the state and academe, and the industrialization of modes of research management (Ravetz 1971). Megascience takes this one step further, either in the form of concentrated efforts in one place, as in the case of CERN, or in distributive fashion, as in the Human Genome project (see further Elzinga 1996). Parallel to this there is a proliferation of bilateral agreements between universities in different parts of the world. These agreements are used to enhance the competence and stature of the agreeing parties, which in practice means competition with and exclusion of others on a global arena. In this way industrial modes of behaviour are further replicated in certain (but far from all) realms of science.

Co laboratories encapsulate the idea that promising new areas of R&D can be developed through networking, linking public institutions, local academic units, companies and groups, with calls for greater mobility of advanced knowledge and of those who possess it.

External funding and proprietary research

Proprietary research and issues of intellectual property have also gained prominence as the Cold War rationale of national security in leading countries shifted to economic competitiveness (Slaughter & Leslie 1997). In the US the ratio of public funding of scientific research to private funding is today 1/3 government funding and 2/3 private funding, a reversal of the proportions after World War II (Reider 2000).[3] This changing structure of scientific funding is occurring more slowly in Europe, but it is happening. In Sweden, for example faculty funding at universities at the beginning of the 1990s was 60%, today it comprises 40%.[4] An

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[3] Citing Harvard Professor of Business Administration, Joshua Lerner.

[4] *Universitetsläraren* (Stockholm) nr. 15 (11 Oct 2002), where we also learn that the dependence of the strategic foundations' funds on investment in stocks has meant a loss of available capital in the order of well over 1 billion SEK over the past couple of years. This is roughly equal to half of the annual budget of the basic research council, Vetenskapsrådet.

entrepreneurial flavour also permeates images of new role models and management schemes within academe. Knowledge societies are becoming knowledge control societies, as research gets increasingly steered by patents and licensing arrangements.[5] For parts of academe the shift implies greater steering from the outside with an eye on economic productivity, together with sharper competition for external funding and a constant situation of under-financing at our universities. Short-term projects gain favour at the cost of long-term continuity and greater vulnerability to the ups and downs of the stock market.

In the corporate world a corresponding trend is that the pure research side of science is attracting less money. Uncertainty of economic payoff from investment in research prevails, and the possibility of measuring the economic impact of research is highly contested, even if it has its defenders (Malakoff 2000). Technology transfer offices have sprouted up at universities and research institutions, but most discoveries are licensed to a big corporation in one way or another. Over the past decade companies have been focusing more on "D" than on "R", reflecting a sense of greater pressure to get products more rapidly to the market (de Aenelle 2000).[6] Research seems to wane in relative importance, and much of it is seen to move from corporate labs to universities.

Today it is not uncommon either to find universities, at least in the US, using patent counts as a positive factor in comparative ranking lists regarding performance, and some of this thinking has also rubbed off in Europe. Unfortunately it leads to lopsided pictures, since the focus is on lucrative fields while many other areas that promise no economic payback are lost in the scoring. The hard sciences get accentuated, with increasing gaps between them and the instrumentally less useful humanities and social sciences.

Increase of external funding and problem-oriented research in many countries has been at the cost of faculty-funded efforts and relative autonomy in some decision-making. Overall, university personnel also complain of being weighed down more than before by an increasing number of different tasks alongside their traditional core mandates – "task congestion".[7] Demands of greater efficiency have even led to the introduction of new terms, like scientific "deliverables", which are ready-made packages of results that are supposed to emerge from publicly funded R&D. The concept of "value added" (especially prominent in EU rhetoric) also suggests a turn in the way potential output of projects is construed in terms of instrumental utility. In the face of all this the old-fashioned ethos of research "for the good of your soul" is held *both* to be in decline and making a comeback.

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5 In Sweden compare recent statements by researcher on patent law, Ulf Petrusson in Eliasson (2002). Further, Henry et al (2002), Hilgartner (2002), Narin et al. (1997).

6 Citing Shawn Johnson, director of research at State Street Global Advisors.

7 *Universitetsläraren* (Stockholm), no. 14 (2002): 8.

Strategic research and efforts at foresight

Recent studies indicate how many of the large multinational corporations now use a strategy of concentration on worldwide centres of excellence (Meyer-Kramer & Reger 1999). In biotechnology, for example, there are two types of firms, those that try to produce the next drug and those that are trying to create new bio-technological knowledge and selling that knowledge in anticipation of the next wave of products 20–30 years hence. The former are concerned with applied research, while the latter is focusing on strategic research, e.g. relating to chemical molecules and the malfunction of specific genes, and not the more controversial areas of gene or modification. This gives rise to a corresponding division of labour, where most firms maintain their role as product developers and universities, despite many changes, still continue as the home of fundamental research and certifiers of excellence.

The notion of strategic research privileges certain kinds of basic research. This may be in an attempt to bridge divides created by disciplinary specialization, with an eye to tackling societal problems like sustainable development, but more often commercially interesting areas are privileged. The advent of long-term motivated basic or so-called strategic research reflects intensification of relevance and accountability pressures compared to the broad approach with which research was funded in the 1960s. In Sweden the notion of "public understanding of science" or active dissemination of results to the public was originally defined and outlined in university charters in a general way as the "Third Task" of academe (alongside undergraduate education as well as research and research training – the two traditional core tasks). Today it has been given a new twist that prioritizes collaboration with industry and other commercial users. This reflects a further imposition of non-academic values, once again rendering commoditization of scientific knowledge a contested issue.

Research foresight exercises are now used to identify new and emerging technologies with an eye on future competitiveness in the global marketplace, both industrial and academic (Martin & Irvine 1993, Office of Science and Technology 1993, Rappert, 1999). The aim is to stimulate the science base for economic growth with the help of some kind of anticipatory intelligence, involving as expert advisers researchers and planners from academe, government agencies, and industrial enterprises as well as an ever increasing number of consulting firms. Foresight is a social process of bringing the key actors involved in innovation together around consensual goals. Hitherto focus has mostly been on high tech innovation and a technocratic slant, but voices have been raised to bring in social dimensions and environmental objectives, as well as citizens and so-called "end-user" groups. In response to this in the 1990s there were several attempts to broaden stakeholder participation by including more representatives of NGOs such as consumer groups and environmental organizations and civic society users of knowledge. Consensus conferences and other forms of public consultation are also used (Joss & Durant 1995, Stein 2002, Irwin & Wynne 1996).

In practice, however, the foresight process still mainly revolves around complex patterns of partnering between various actors at universities, government agencies and industrial concerns. By extension it becomes a question of building up consortia with partners in diverse realms of endeavour and across national borders. The over-layering of traditional academic norms by norms of the market place is expected to have long-term repercussions on the daily lives of researchers. Some opinion polls tend to confirm this, but more serious empirical studies are scarce, and among these some fail to find the deep-going transformations that are claimed. The heat of the action is mainly restricted to the life sciences and biotechnology, but similar trends were visible even earlier in microelectronics and more recently in the area of advanced industrial materials or nanotechnology. These three domains, microelectronics or IT, biotechnology and new materials research and development were already the core generic high tech areas of the 1980s. They are key ingredients in what is sometimes called a new scientific-technological revolution that not only transforms our lives in society but also challenges us to rethink what it means to be human. Existential, ethical and legal issues emerge and call for research collaboration also across faculty boundaries, between humanities and social sciences on the one hand, and fields in the natural sciences, biomedicine and engineering sciences on the other.

Linking science with commercial interest, and conflicting norms

The rapid changes taking place in the life sciences, microelectronics and nanotechnology tend to receive a disproportionate amount of attention, colouring science policy vocabularies with images and models extracted from a limited realm. Against this background, fusion of R&D processes with commercial utilization of knowledge is commonly portrayed as both an opportunity and a threat. The conscious and planned fostering of cooperation between academia and industry is however diverse.

After technology transfer offices and science parks as parts of regional development strategies came national investments in strategic research centres involving university-government-industrial partnerships. The rationale has been to create new internationally competitive research environments with interdisciplinary foci and strategic import for industry. An earlier form in the US was that of the National Science Foundation funded engineering research centres.

On the less applied side there is the notion of centres of excellence, also meant to enhance scientific performance as seen in the mirror of globalization and competitiveness. During the past decade too there has been an increase in the numbers of institutes of advanced studies. The latter may be understood as new forms for immunizing fundamental scholarship from the pressures plying the mainstream academic scene, a compensation for loss of concentration on the basics in university settings. Thereby such institutes reflect the continuing robustness of traditional academic values and practices.

Summing up

Summing up thus far, salient features that have stood out during the past twenty-five years relate to at least three cross-cutting dimensions:

First there are the new and emerging or generic technologies, each with its clusters of basic research specialities on which they are more immediately based compared to earlier generations of technological systems in their day.

The Internet as a tool in research must also be mentioned here, as well as the establishment of huge databases in electronic form. Both of these facilitate rapid exchange and reconfiguration of information which after appropriation in local sites and with the application of appropriate skills and competence gets translated into knowledge.

Secondly, generated both from outside (globalization) and within there is the intensification of competition. This occurs around scientific fields that have potential as an economic market resource, and within science it occurs between teams of researchers working at different sites. Collaboration and competition go hand in glove, with the formation of coalitions for mutual benefit which imply exclusion of competitors and those less well endowed. As a corollary to this, networking and partnering have become new buzzwords. The realities behind them again imply the sharpening of mechanisms of inclusion and exclusion.

Thirdly, related to the foregoing we find a steady increase of researchers collaborating across both epistemic and geographic boundaries. The former is manifested in the call for new forms of interdisciplinarity, while the latter is usually referred to as international collaboration which is unevenly dispersed across the globe with a display of centre-periphery relations that to some extent replicate the world's economic and social inequities. Foresight exercises used for priority setting in science and technology policy represent attempts at reflexivity in the bringing together of diverse actors to hone harmony in networks and research agendas.

Concluding remarks

As a counterpoint today to the mainstream image of autonomous science traditionally celebrated in the epistemological lens of the analytic philosophy of science, sociologists and policy analysts have come up with the notion of Mode 2 and university-industry-government triple-helix complexes. Likewise, interdisciplinarity is played up in retrospective contrast to so-called Mode 1 monodisciplinary academic science, which in the polemics of the situation is highly schematized, thus paradoxically lending force to the earlier particularism that is to be rejected. It has been pointed out that the new images of scientific knowledge production have a social epistemology that is rather limited in scope (Rip 2003). They are ideologically coloured totalizations of another segment of the knowledge production landscape. In the new metaphors, contexts of application tend to merge with domains of privatization and commoditization, even if in the face of criticism some latter-day advocates of the newer images have retreated to a position of wanting to give recognition to non-commercial users, NGOs and representatives of civil society.

Earlier policy models, like the linear model of innovation, Don Price's image of "Truth speaks to Power", or Robert Merton's CUDOS norms-model all had clear boundaries between science and society and were predicated on powerful metaphors that assumed clear-cut boundaries between science and society. They can be seen as the product of a post-World war II social epistemology, and once commonly accepted they came to function as social facts despite an anaemic picture of the states of affairs they were supposed to portray. In present-day discussions regarding the "new production of knowledge" or a "new social contract for science" the earlier images and metaphors are being replaced by new ones, this time predicated on a social epistemology informed by globalization and the alleged fusion of different stakeholder interests.

Supranational institutions like NAFTA and GATT (followed by the WTO) are mentioned by Gibbons et al. as laying down the rules for such nesting relationships. At times the authors appear ambivalent about the "model's" embedding in globalization. They condone it on the one hand, but on the other hand they express moral and political concerns, wanting to see stronger controls on behalf of civic societies. One comes to think of a brokerage relation, with collaboration to achieve greater competitiveness at another level. Neo-liberal technocratic and social democratic corporatist interpretations of the metaphor form two poles in a tension still requiring historically informed alternative visions that take up the missing dimensions.

The new models and metaphors are no less reductionist than their predecessors, but given the new context they serve to reinforce and legitimate new organizational arrangements where the accent is on hybridity and porosity. In the wake of a continuous stream of workshops and conferences with policy-makers and research administrators they have become a social fact (self-fulfilling prophecies) in some policy circles. The Triple Helix conferences, for example, are actively used to propagate the message in connection with technology diffusion to third world regions. Also transmitted are organizational forms and guidelines for a new mode of knowledge production and concomitant methodologies for assessing related landscapes. In this respect, just as in the early 1960s when the first science policy doctrine and its linear model were enunciated, the OECD offices in Paris now joined by the EC in Brussels, also continue to play an important role.

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