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Science Policy: Two Views from Two Decades

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ABSTRACT *Science policy, as the theme appears in* Prometheus *over the last 20 years, has been represented by discussions of industrial competitiveness. Many comparative articles have appeared under this theme, as well as evaluations of policies aimed at innovation. By the mid–1980s, articles in* Prometheus *were tracing the emergence of the knowledge economy, with some of its associated issues. The issue of human resources for the knowledge economy has received scant attention, however, but* Prometheus *authors have discussed public participation in science policymaking and setting priorities. Finally, authors have noted and analyzed the closer management of Australian science to direct it toward economic ends. Overall,* Prometheus *has tracked the dominant themes of science policy in other OECD countries well, and also given space to issues that are less prominent but nonetheless important.*

Keywords: science policy, competitiveness, human resources, priorities, management.

Introduction

Science policy—what shall we mean by this phrase? In the old days, the one phrase *science policy* was taken to include both science and technology; yet these days, the production of new knowledge and the production of new products and processes in the private sector are approached from different policy angles—thus the analytical separation between research policy and innovation policy. Some observers have used the phrase *science policy* to refer to the use of technical information in the policymaking process,[1] yet the tensions among 'expert' knowledge, bureaucratic knowledge, elected official knowledge, and the various knowledges that publics bring into the policy process is surely just another dimension of the policy arena we are trying to describe, not the whole thing. Finally, even if we stretch the phrase to *science and technology policies*, have we fully conveyed the crucial role that human resource policies are playing in regional and national policies that involve research and innovation? Indeed, does this phrase adequately capture the economic context in which this policy realm is embedded?

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What has *Prometheus* meant by *science policy* over its 20 years of publication? 'A very wide range of topics' is the answer, with no boundaries marked off between science policy and the other themes. In preparing this essay, I have read the abstracts of 20 years of *Prometheus* issues.[2] As I read, the issues I have addressed in my own 20-plus years in science policy have flashed before my eyes. I have constructed this essay from the two stories intertwined—the issues that appeared in my work, and the themes that appeared in *Prometheus*. Two views, two decades.

As a preface, I should let readers know exactly where I have stood in the world of science policy. A few of the articles in *Prometheus* have featured women in science in Australia, but I did not find one that discussed the changes women might bring to the culture of science, in Australia or elsewhere. One feminist approach to doing science gives permission to all of us to say who we are—where we stand and what we care about. I will accept that permission in this article, especially since it is important in science policy studies to understand where people are coming from—literally.

I have spent my time as a science policy analyst in the United States, so my roots are deep in the policies of the world's largest science and technology nation. The United States has S&T policy luxuries that no other country in the world can afford. The common view in Washington is that we do not really need to set priorities; we are big enough to do a lot of things. What the US federal government does best, in this view, is to provide generic resources—knowledge, technology, and people. Our powerful private sector R&D enterprise can then adopt what it needs to do well in the market. Perhaps Europe will feel big enough to take this bold strategy at some time, but it has not yet done so.

In the US, it is only at state level that policymakers pick industries they want to support and invest in local capabilities to support them. An example is my own home state of Georgia, whose Research Alliance has actually been described in the pages of *Prometheus* (Lambright, 2000).[3] In this sense, US states are more like European countries, or Australia. There is a large generic knowledge pool produced outside the country (or state), and the key policy question is how to draw on it and absorb it for the benefit of the local economy. US federal policies thus do not translate directly into the issues faced by any of these smaller units, and my own policy experience will not always overlap with some of the policies that have occupied a large number of pages in *Prometheus*.

Like *Prometheus*, I have been working on the boundary between science studies and science policy in a variety of ways over my two-decade career. My degree is in the sociology of science, and I went to Washington while I was still working on my dissertation, taking a job as a policy analyst at the National Science Foundation, and running a small program of science policy studies. A first theme I found in the *Prometheus* abstracts takes me back to that time.

Competitiveness

Competitiveness is a dominant theme in *Prometheus*, not surprisingly given its intersection with other keywords in the journal's focus, like change and innovation. When I went to work in Washington the first time, in 1981, the word innovation was just going out, and the word competitiveness was coming in. Japan and Germany were looming as threats to US economic well-being then, and the US federal government wanted to do everything it could (short of 'picking winners') to counter the threat. Authors in *Prometheus* have also noted and commented on

Japan's innovation system over the years. Utick (December 1989) described how Australia could benefit from a Japanese initiative, the Human Frontier Science Programme. Forester[4] (1993) described 'Japan's move up the technology "food chain"', in which he claimed that Japan had overtaken the US in information technology, semiconductors, advanced manufacturing, and office equipment. Fransman[5] (1994) told readers about 'The Japanese innovation system: how it works'. Ray and Buisseret[6] (1995) informed readers about Japan's use of collaborative research to build a computer industry.

Interestingly, the German innovation system received little attention, then or now, in *Prometheus*, but a steady stream of articles has described how other countries were pursuing S&T strategies for economic competitiveness. Some of the other countries and regions discussed are Israel (Teubal, 1986);[7] Korea (Enos, 1986);[8] Western Europe (Aislabie, 1986);[9] Canada (Wilson, 1985, 1987, 1994);[10] Asia (Henry, 1988);[11] Sweden (Bohlin, 1992);[12] New Zealand (Winsley and Hammond, 1997; Engelbrecht and Darroch, 1999);[13] and Thailand and Singapore (Corbitt, 1999).[14]

The shift from innovation to competitiveness in Washington signaled the beginning of an era of strategic innovation, directed toward particular industries that regions or nations felt were important to their economic survival—at least, everywhere except in Washington itself. Clem Tisdell[15] noted this trend among 'developed' countries in the June 1983 issue of *Prometheus*. Australian policies had previously been generic; he called for a re-examination in light of new competitive positions. Joseph,[16] in the June 1984 issue, pinpointed a change in Australia from non-interventionist to economic nationalist strategies to the time of the March 1983 elections. Joseph and Johnston[17] (1985) commented further on this shift, comparing economic theory and political practice with regard to market failure and government support for science. Green[18] (1986) described the 'restructuring' of the Australian R&D system.

The early 1980s in Washington saw the passage of the Bayh–Dole Act, which made it easier for universities to patent their inventions, along with a sudden spurt in industry funding for university research. Although the national government was not 'picking winners', the huge prior investment in life sciences research suddenly began to look commercially important. Venture capital began to pour into biotechnology spin-offs from universities. In Australia, the MIC venture capital program was receiving attention. Ryan[19] (1989) claimed that the program was supported in accordance with political climate. In the June 1992 issue, after the program had been terminated, he evaluated its successes and failures.[20]

Generic policies for stimulating innovation were being developed in many countries in the 1980s. A key question became: what are the economic payoffs from R&D investments? My NSF colleagues were already assessing the effects of the US R&D tax credit in the early 1980s; Dwyer[21] reported on his assessment of the effects of the Australian version in the December 1989 issue of *Prometheus*. Jevons and Saupin[22] (1991) took up the topic of regional appropriability—the factors that help regions capture benefits from local innovations. Martin[23] (1991) analyzed the effectiveness of policies to encourage exploitation of publicly funded R&D, as did Renner[24] (1992). Freed reported on the economic effects of R&D incentives in August 1997.[25]

The 1980s were also a time of change in world trade. Liberalization and the elimination of trade barriers were in the air, both in the United States and in Australia. In the June 1985 issue of *Prometheus*, Gregory[26] reviewed the barriers to

trade liberalization in the Australian economy in the form of tariffs and quotas. Liesch[27] (1986) discussed the Australian offsets program, an older set of policies. Stewart[28] (1991) asked the question that if protectionist policies had worked in Japan, Korea, and Taiwan, why not in Australia? Penrose[29] (June 1993) asked: 'Economic liberalization: openness and integration—but what kind?'

The Knowledge Economy

The question was a good one. We now know that beginning in the mid–1980s, as these industrial strategy discussions were taking place, a new world pattern of globalization was emerging.[30] A drop in communication and transportation costs permitted the manufacturing process to be distributed, and multi-national firms moved operations to the places with competitive (there's that word again) advantage. The countries that had been called 'industrialized' in earlier decades were de-industrializing, and a 'convergence club' of several dozen countries previously labeled 'developing' captured manufacturing jobs. Therefore, unlike the previous eras of growth in trade between nations, which were characterized by the exchange of raw materials from the South for manufactured goods from the North, the period that began in the mid-1980s has been characterized by the exchange of competing goods. National or regional strategies must therefore pay attention both to maintaining or increasing their market share of exported commodities, and to maintaining local industries that could lose market share to imports. Everything must get more competitive at once, for the countries in the exchange pattern. At the same time, a large group of countries have been left out of that pattern. With prices for raw materials dropping in the world economy and no manufactured goods to trade, these countries have faced deepening poverty.

By the late 1990s, then, industrial strategy was becoming post-industrial strategy. De-industrialization was well underway in the OECD countries, and the focus shifted in many places to growing a 'knowledge economy'. Rooney and Mandeville[31] (1998) acknowledged Australia's entry into the post-industrial knowledge economy, and questioned a number of commonly accepted strategies for building such an economy. Howells and Roberts[32] (2000) described the transition from innovation systems to knowledge systems. Marceau[33] (2000) introduced a general framework for considering post-industrial innovation.

The quintessential policy issue of the knowledge economy is intellectual property rights (IPR), and accordingly, many authors in *Prometheus* have paid attention to technology transfer and intellectual property issues. Vickery[34] (1986) reviewed the available data on technology transfer. Solomon and Spurling[35] (1987) described patent reform in Australia. Drahos[36] (1995) reported the advantage the US gained in GATT talks. Macdonald and Lefang[37] (1997) explored the relationship between innovation and the role of the patent attorney. Rangnekar[38] (1999) took up the topic of plant breeders' rights in an era of technological restructuring.

The September 1998 issue was entirely devoted to issues of intellectual property, including copyright. Mason[39] introduced that issue on a highly critical note:

> Intellectual property rights run counter to the interests of consumers and the public. They are also exploited in anti-competitive ways. On this account these rights should be qualified or subjected to competition regulation. The globalization of intellectual property exposes the interests of consumers and

> the public to greater risk unless appropriate mechanisms of protection are developed.

This critical tone appears again in the articles I will mention in the next section, on responsiveness.

The information industry lies at the center of the knowledge economy, and many authors in *Prometheus* have described its emergence and growth in Australia. Mandeville and Macdonald[40] (1985) described the growth of the information industry in Queensland. Engelbrecht[41] (1985) raised issues of measurement of the sector, as did Heng and Low[42] (1990). Whiteman[43] (1990) wondered whether strategic trade policy is just a new form of protectionism, in 'Globalisation and strategic trade policy: some implications for the Australian information technology industry'. Nightingale[44] (1990) discusses issues in regulating telecommunications policy. According to Hogkinson[45] (1994), the Australian telecommunications industry had shown marked improvement in international competitiveness since the mid–1980s, and had helped the rest of the Australian corporate sector to stay competitive, but not all the accounts of the information industry in *Prometheus* have been rosy. Preissl[46] (1997) provides a critical perspective on the economic effects of information technology. Lamberton[47] (1997) characterizes the knowledge-based economy with a Sisyphus model. Comor[48] (December 1997) has critical words for the position of the American state in globalization activities in this sector.

Human Resources

It is generally thought that in this highly dynamic, competitive global economy, a country needs all the talent it can get in the R&D system, and also needs a very well trained general workforce who can support and attract value-added manufacturing to the economy. This theme has in fact not been as fully developed in *Prometheus* as I would have expected. The general issues appear in a few articles. Gordon and Kimball[49] (1985) describe the challenges to education in high technology employment, and claim that high quality general education is probably the most important investment to make. Spurling[50] (1987) also describes education as an important part of an overall strategy: 'Educating, manufacturing, exporting'. Mageean[51] (December 1989) traces the implications for tertiary vocational education of the government's emphasis upon skills formation. The suggestion is to learn from Sweden and Japan, but to apply those lessons in context.

Other *Prometheus* authors discuss the situations of particular groups of workers in the knowledge economy. Macadam and Bawden[52] (1985) describe a system for educating more effective agriculturalists. Whyte and Probert[53] (1991) write about young workers in technologically advanced industries. Joseph[54] (2002) advocates raising the standard of management education for electronic commerce professionals. Finally, a few authors address issues of specialized technical talent. Yates[55] (2001) describes the future of professional engineers in the public service. Marceau and Preston[56] (1997) write about nurturing national talent through the Australian Research Council's fellowship scheme.

Throughout my career in science policy analysis, US industrialists have been taking the lead on efforts to recruit more US women and people of color into careers in science and engineering. The reason is clear: demand is growing and supply is short. Their exhortations have had effect. Good programs have been designed to teach science in female-friendly ways, and the numbers are going up in

all categories of concern. Against this background, I was surprised by the paucity and focus of articles about women in science in *Prometheus*. There were a few articles doing reconstructive history (making the invisible visible), including Allen's June 1991 article[57] on the contributions of two Australian women scientists to its wool industry; Allen's in December 1997[58] on a woman plant pathologist; and Moyal's December 1993 article[59] on women in science in Australia, 1830–1950. Even fewer articles deal with women and technology. Moyal[60] (1989) describes the feminine culture of the telephone, and Engelbrecht[61] (2001) takes up the topic of gender and the information work force—but in New Zealand.

Like *Prometheus* articles on gender issues in science and technology, the US literature on African Americans and American Indians in science and engineering has been exceedingly sparse. *Prometheus*, however, has published only one article in its 20 years on any issue linking Aboriginal Australians to science or technology, the interesting 'Digital songlines: the use of modern communication technology by an Aboriginal community in remote Australia' (Buchtmann, 2000).[62] I sense here a research area waiting to be explored.

Responsiveness

Back from the Aboriginal to the biographical. My time as a conventional science policy analyst came to an abrupt halt in an unexpected way. In December 1990, I attended a workshop in the last bastion of believers in democracy, Moscow. The topic was science policy in the new Soviet Union (and one of the attendees became a minister soon afterwards in the new Russian Federation). In the midst of a region of democratic revolutions, I decided to provide perspective on what we had learned in 50 years of science policy in the United States about democracy. I surprised myself with the answer: not much. Thus I began a five-year intellectual journey into democratic and bureaucratic theory to try to discover why not. Why did the US public have so little say in US science policy? My view of science policymaking has never been the same.

Some of the themes in *Prometheus* shed light on the relationship between post-industrial science policy and representative democracy. The articles dealing with the employment effects of changing workplace technologies are illustrative, since unions emerge over time as a relevant actor in technological decision-making here. Some of the articles are descriptive, like Dunford's[63] (1983), which describes the contingent nature of technology's impact in the workplace. Corina[64] (1983), however, explicitly links trade unions, new technology, and incomes policy. Schmoranz,[65] Bessant,[66] and Newton[67] (1984), writing on the employment implications of information technology, note the inadequacies of conventional economic modeling and point to the political problems of policy implementation. Willis[68] (1985) returns to the topic of trade union reactions, and Markey[69] (1987) links trade unions and new technology to industrial democracy in Australia. He says that the country shifted from the free hand of market forces to tripartite consultative planning because of the strategy of particular unions. Hedman[70] (1989), in 'Luddites, hippies and robots: automation and the possibility of resistance', discusses how to resist problematic uses of automation. Badham[71] (1992) compares Australian with European approaches to incorporating skill-based automation in the workplace.

The voices of the public also appear in the treatment of biotechnology in the pages of *Prometheus*. In the June 1985 issue, Johnston, Wonder and Gerardi

discuss the implications of biotechnology for agriculture and technology policy in Australia.[72] Saxonhouse complains in the December 1985 issue that Japan was acquiring an unfair advantage in this crucial field.[73] So far, standard technology policy. Then Bartels in December 1986 proposes a new risk assessment paradigm for this field.[74] Hindmarsh, Burch and Hulsman[75] (1991) claim that past discussion of biotechnology in Australia has focused on commercialization, and neglected social, political, and environmental issues. Love[76] (1992) raises issues of the public perception of risk in GMO organisms, and finally the farmer representatives enter the picture, with growing concerns (excuse the pun) about environmental and social impacts (Lawrence, McKenzie and Vanclay, 1993).[77]

Priorities

Any consideration of democracy with regard to science policy always comes back to issues of setting priorities, and these have received a fair amount of attention in the pages of *Prometheus*. When *priority setting* refers only to choosing areas with the greatest economic growth potential, the crucial tradeoffs are hidden under the promise of broad public benefits. In fact, the economic ends of science are always in creative tension with the public-goods ends, in areas like uneven regional economic development, health, and the environment. Some early discussions in *Prometheus* indicated that the process of priority setting could be used for democratic ends. Badham[78] (1986), for example, discusses possibilities of technological choice in this strategic environment. Franklin[79] (1988) calls for an evaluation culture and explains the implications of priority-setting for the concept of accountability. Perhaps there was too much democracy in the Australian process in the end. Aitkin[80] (1997) writes on 'The vexed question of research priorities: an Australian example', saying that by 1996–97, the possibility of setting national priorities seemed remote.

In fact, the public goods which R&D could help address have received relatively little attention in *Prometheus*. A few articles deal with rural development, for example, Anderson and Parton's[81] (1983) on the allocation of resources among rural research projects, and Tisdell's[82] (1997) on public funding of agricultural research: competitive vs. non-competitive mechanisms. Information services for rural communities, also receive attention, in an article on the 'telecottage project'[83] (Harrison and Qvortrup, 1989), and one on the rural/urban digital divide in New Zealand[84] (Howell, 2001).

Energy and environmental issues also get a modest amount of attention. Chambers[85] (1985) describes a possible process of technology assessment for the petroleum transition era. B. and A. Henderson-Sellers[86] (1990) say that government planning strategies need better management information to prepare for the enhanced greenhouse effect. Tisdell[87] (2000) addresses technology transfer from publicly funded research for improved natural resource management.

Studies of service industries provide an opportunity to show how innovation touches people's lives. Although Shaw[88] (1986) describes consumer adoption of new retail services technologies, most *Prometheus* articles on the service industries focus on medicine. Sampford[89] (1984) studied diffusion of technology in coronary care medicine. Doessel and Sams[90] (1984) reported on a study of innovation in gastroenterological management. Harman[91] (2000) claimed that priority-setting in Australian biomedical research was doing just fine: 'Muddling with some skill', but

innovation in this area is a two-edged process, with costs that sometimes outstrip the benefits. Richardson[92] (1986) proposed a system of technology assessment in medicine. Doessel[93] (1987) provided evidence (added to an international literature on the topic) that medical innovations contribute to rising health expenditures. Brown and Rappert[94] (2000) analyze the contested meanings of private and public in a new area, bioinformatics.

Managing for Results

A final theme that jumped out at me from *Prometheus* is management. The word itself brings shivers to many in the research community—yet it is here to stay. Let me be biographical again. I went to work in Washington the second time just after major accountability legislation had been passed, in the form of the Government Performance and Results Act (GPRA); indeed I was hired to help the National Science Foundation respond to this new law. The subtitle for the effort was 'managing for results'. Similar legislation was already in place in Canada, New Zealand, the UK, and several Nordic countries. France has adopted something like it since. The G7 (now G8) Working Group on Research Assessment, of which I was a founding member, was called into being because of the common concern among G7 science ministers about responding to the demands they were hearing to demonstrate the value of government science and technology investments to the public.

The aspect of this change that is visible in the pages of *Prometheus* is the growing pains of the research community, especially the university research community, during the transition into this newly managed world. True to the central thrust of Australian research policy, accountability is primarily to the economy. The articles on this theme begin in the 1980s, when Flood[95] (1984) describes the advent of strategic management in CSIRO, which was for the first time taking responsibility for Australia's strategic civilian research. Management remained a key word through the 1980s: Dwyer[96] (1988) described R&D project assessment as an information and communication process; Pederson[97] (1988) called for a coordinated effort in the Pacific region for science policy management.

In the 1990s, the trend hit Australian universities. Leslie and Harrold[98] (1993) described the 'Commercialization of scholarship in Australian universities'. Earl[99] (1994) mused over 'The economic rationale of universities: a reconsideration'. The market spirit caught on by December 1994, when Young, Garrett and Walsh[100] asked 'Pricing of research: what will the market bear?' They claimed that the commercialization thrust associated with changes in management of the university system had given the issue of research pricing greater priority. Reviewing recent CSIRO experience and the results of a working party, they make the case for government to bear the full costs of research that end up benefiting the private sector.

Turpin and Deville[101] (1995) saw business practices being adopted, and transformation in organizational cultures, in 'Research management and commercial markets: cultural change in Australian research institutions'. In August 1997, Turpin[102] again considered the theme of cultural change, in an article on 'CRCs and transdisciplinary research: what are the implications for science?' Randle[103] (1997) observed signs of convergence between business and university cultures, in the use of images of the university in the management of R&D in the pharmaceutical industry.

While some Australians were neutral observers of change, others focused on the downside of the new managerialism. Hanson, Steen and O'Donohue[104] (1999) claimed that one of the lessons from management of basic R&D was that a 'quantitative approach to research management is counter-productive to innovation'; and Harman[105] (2002) reported withholding behavior associated with Australian university–industry links.

Conclusions and Congratulations

To summarize across the themes, *Prometheus* over 20 years has published articles that are solidly centered in the dominant theme of science policy during the period, competitiveness. It has provided enlightenment for the policy process, with historical and critical articles, and it has contributed to the mainstream discussion as well. In addition, it has published a significant body of literature on the soft-underbelly issues of the field, like the participation of marginalized social groups and responsiveness to public priorities. The achievement is substantial, and I congratulate those who have contributed. The way lies open in the future for the journal to contribute even more to the give and take of science policy discussions.

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