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Connecting Science to the Economic: Accounting Calculation and the Visibility of Research and Development

The Argument

The presence or absence of scientific research in productive organizations is a subject of professional concern to the scientific and engineering community, and of wider interest to political agencies in the United Kingdom. This paper will explore aspects of the economic visibility of scientific practices in productive organizations: how, by whom, and in what contexts research and development practices have been constructed, monitored, and disseminated as economic statistics within and beyond the modern industrial enterprise. The paper will focus on the construction of scientific practices as accounting and economic signifiers within their organizational context: the growth of mechanisms for the connection of scientific practices to economic calculations. How companies account for R&D has been elevated by particular government agencies through the accountancy bodies, as a way of forging a relationship between economic calculation and the scientific practices of U.K. companies.

Introduction

The place of science and technology in modern society may seem both manifest and secure. Even those who profess to lack understanding of science and its methods can acknowledge the importance of the technical results that are present in their everyday lives. It is perhaps this taken-for-grantedness that makes "techno-science" appear as a constant and unchanging force in social life, a force that is linked to improvements in the quality of life.

While acknowledging the technical payoffs of scientific endeavor that have been achieved, certain discourses do not pronounce the status of science and technology in our societies as necessarily secure. Most prominent are those that express

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worries that society is insufficiently appreciative of the *value* of science, or further, that the project of modernity is threatened by the lack of attention to the scientific practices at the base of modern society (e.g., Royal Society 1985).

It is the problem of valuing and promoting science in the United Kingdom that provides the empirical focus for this paper. During the 1980s a new problematization of the value of science and technology emerged in the context of changing governmental discourses and a severe economic recession. Out of these concerns new ways of thinking about the problem of science in the U.K. economy began to address the problematical relationship between the *visibility* and *calculability* of scientific practices; accounting techniques came to be seen as one means of *connecting science* to the national economy by enhancing individual managers' *responsibility* for science and technology through economic calculation.

The structure of the paper is as follows. The next section briefly addresses the question of the varying ways in which the role of science and technology in national contexts has been understood. It is argued that far from being practices whose values and benefits are constant, and in some senses "obvious," scientific research and technological developments have been connected, through particular discourses, to many different questions and issues. This argument is extended in the following section to focus specifically on the linkages that have been forged in the post-World War II era between national indicators of scientific endeavor and measures of national economic strength and future prosperity. To illustrate the changing relationships between scientific practices and economic calculation, the case of the development of "accounting for research and development" in the United Kingdom during the decade of the 1980s is examined. Out of a specific constellation of governmental programs and managerial discourses, the problem of promoting scientific and technological innovations in the United Kingdom was connected to the calculability of such practices and their visibility to those within and outside of the productive *enterprise*. By creating systems of individual and corporate responsibility, new forms of accounting calculation were finally cast as the means for promoting economic growth through the expansion of scientific research.

Valuing Science and Technology

In many of the countries of the industrialized west the degree and status of scientific research has at some time been brought into question (see Williams 1973). It seems perhaps simple to formulate such arguments in terms of the occupational interests of scientists and engineers (e.g., Finniston Report 1980), or in terms of the economic motivations of defense contractors or inventors. One might of course argue that there are those who have a clear stake in promoting an increased allocation of resources to scientific and technological practices, and therefore that such discourses merely reflect the values of the community of scientific practitioners. But this would ignore the specific contexts of such discourses and the attachment of science and technology to different social and political rationales.

While it is true that worrying about science and technology stretches back into the last century and beyond (Hobsbawm 1969; Rose and Rose 1969), the form of these worries has been shaped by a number of different problems, priorities, and rationales. The presence or absence of science and technology has been taken as a signifier of many different questions. For example, Searle (1971) explored the links between the discourse of "national efficiency," British military failures in the Boer War and the economic recession of the last quarter of the nineteenth century (ibid., chap. 2). In relation to these events a specific figuration of concerns emerged linking an apparent decline ("degeneration") in the character and mental capacities of the population with an unscientific military, educational, and productive organization at the national level. The speeches and writings of Liberal and Tory politicians, Fabian socialists, eugenicists, and journalists were constitutive of a particular pattern of discourse through which recent national failures were analyzed in terms of an attitude to science. In contrast, Wilhelmenian Germany was re-presented as an ideal of national efficiency and organization (ibid., 32). Anxieties were also expressed at the absence of scientific advice at the government level (ibid., 84–85). As Gummett (1980, 22) notes, the National Physical Laboratory, founded in 1899, was modeled on the German example.[1]

The key point here is that the character of such discourses displayed a significant break with prior discussions of science. Earlier justifications of scientific and technological endeavor emphasized their importance in terms of "high culture" (Rose and Rose 1969, 188); the legitimation of scientific quests had, previously, seemed to focus on their gentlemanly status and contribution to national "culture."

During World War II the success of key scientists such as J. B. S. Haldane, J. D. Bernal, and P. M. S. Blackett in their governmental roles provided a distinctive legitimation for scientific ventures. As Steward and Wield (1984, 196) note, for Haldane and Blackett the contribution of the scientific community to the war effort sealed the case for more national planning of science and technology. The return of the commitment to a liberal economy in the postwar era, coupled with doubts as to the radical political orientation of some of the aforementioned scientists (Gummett 1980, 29–30; Edgerton and Hughes 1989, 421), prevented the realization of this program, but a new and closer relationship between science and government was soon to emerge (see Vig 1968).

In the aftermath of World War II, and partly in connection with the program of Marshall Aid and postwar reconstruction, the formation of the Organization for European Economic Cooperation (OEEC) exemplified a new conception of science and technology as the dominant factors of successful economic production. Origi-

[1] This refers to the Physikalische-Technische Reichanstalt in Charlottenburg, "the State owned research and testing facilities of industrial and commercial significance" (Vig 1968, 11).

nally envisioned as a forum for the discussion of scientific policies and national problems of productivity, the OEEC was reconstituted in 1961 as the Organization for Economic Cooperation and Development (OECD), an association for the advancement of science and technology policies among the industrialized nations.

Whatever the success or failure of the OECD as a supposedly international forum for science policy, its most lasting achievement was in the definition and promotion of *research and development* statistics. Indeed, R&D became inseparable from the rules established by the OECD for its statistical identification and collection. R&D became the measure of science and technology. As the OECD assembled cross-national statistics of R&D expenditure within member states (e.g., OECD 1965, 1968, 1975), so the constitution of R&D activity (as "pure," "applied" or "developmental") in governmental publications followed the guidelines of the OECD-sponsored "Frascati Manual" (OECD 1961). These definitions in turn influenced those of other arenas — such as, for example, accounting policy (e.g., ASC 1978), the U.K. *Annual Review of Government Funded R&D* (Cabinet Office 1986), and the costing of R&D in noncompetitive contracts with the defense department (House of Commons Defence Committee 1982).

The visibility given to science and technology by the standardization of R&D, in terms of definition and collation, facilitated the process of drawing comparisons between the commitments of individual nations to scientific research. Science and technology, principally at the national level, became a *calculable space* (Miller 1992) within which programs and policies could be focused and enacted. As Latour (1987) has emphasized, the inscribing of scientific practices translates them into "stable and combinable mobiles" capable of being aggregated, normalized, and compared. As such, the construction of R&D statistics provided a condition for the calculation of national and international norms and averages for R&D activity. For example, on the basis of the Frascati definitions, OECD and governmental reports "showed" total R&D expenditure in the United Kingdom as relatively significant when set against national gross domestic product (see table 1). The progress of this elementary statistic, the standard measure for national comparative purposes, was indicative of the newly perceived relationship between scientific practices and the problems of the national economy.

Given the assumption of a basic relationship that emerged between science and technology and economic growth, R&D statistics became not merely the "signifier" of scientific and technological activity but also the key indicators of future market competitiveness and long term national prosperity. Once R&D statisitics had been prepared, they could be related to other measures of economic activity to reveal new relationships and facilitate calculation. From the immediate postwar period to the late 1960s, R&D expenditure as a proportion of GDP in major industrialized countries was represented as increasing rapidly, to between 1.5–2.5 percent of gross domestic product. In this way R&D statistics gave a new visibility to science and technology at the level of national economies, and measures of R&D in particular countries have been closely monitored for what their comparison "reveals."

Table 1. Trends in R&D as a Percentage of GDP in Selected Countries

	1963	*1967*	*1971*	*1975*	*1979*	*1983*	*1985*
Canada	1.00	1.20	1.20	1.00	1.10	1.30	1.34
France	1.60	2.29	1.90	1.80	1.80	2.05	2.20
Germany	1.40	1.70	2.10	2.10	2.40	2.45	2.50
Italy	0.60	0.70	0.90	0.90	.0.80	1.00	1.20
Japan	1.30	1.30	1.60	1.70	2.10	2.50	2.80
U.K.	2.30	2.30	2.10	2.10	2.25	2.25	2.30
U.S.A.	2.90	2.90	2.60	2.30	2.35	2.65	2.90

Source: OECD (1965, 1968, 1975, 1986, 1989).

R&D statistics have apparently shown that the sources of funds for R&D activities in the United Kingdom have been evenly balanced between governmental and private organizations. Another apparent national trait is that the major proportion of U.K. government-sourced R&D funds going to private business has been devoted to defense procurement (Cabinet Office 1986, chart C1, 36; cf. Williams 1973, 15–16).

The development and growth of R&D expenditure statistics provided new legitimation to a series of discourses that problematized scientific activity in the United Kingdom. The claim that national scientific expenditure is unsatisfactory is dependent on the definition of "unsatisfactory," which is itself contingent on the aims and ideals expressed through these discourses. The rationales for asserting that U.K. R&D expenditure is problematic are varied and inhabit a wide range of professional bodies, pressure groups, and state agencies.

The apparent lack of commitment to science spending has been interpreted as a symptom of an undervaluing of scientists and engineers in U.K. society. As C. P. Snow (1959) declared in his analysis of Britain's "two cultures," in the context of what he saw as the scientific revolution, science and technology were too low on the list of national priorities. A more recent statement of this view suggested that

> Science and Technology play a major role in most aspects of our daily lives both at home and at work. Our industry and thus our national prosperity depend upon them. . . . Improving that understanding is not a luxury: it is a vital investment in the future well-being of our society. (Royal Society 1985)

During the 1960s the widespread belief that large numbers of British scientists were emigrating reflected emergent concerns over the status of science in the modern British economy (Gummett 1980, 41; Williams 1973, chaps. 1 and 2).[2]

[2] This problem of the "brain drain" was associated in particular with the program of the Labour government of 1964–70. Williams (1973, 26) argued that in the United Kingdom the brain drain concern "mounted almost to panic." The belief that the problems of the British economy were associated with the inability to translate scientific advances into new technologies (the "technology gap" — ibid., 21–34) stimulated the founding of the Ministry of Technology and a more directive science policy. At the same time, the funding given to the Research Councils was increased substantially.

Business organizations have queried national levels of R&D expenditure in terms that suggest the priorities of national education are distorted:

> The question whether, if more [R&D] funds were available, there would be bright scientists to use them properly scarcely needs asking since in many fields the present shortage of funds, coupled with the expectations of greater penury to come, has dissuaded some talented youngsters from scientific careers. There must be an assurance that scientific proficiency is crucial to the United Kingdom and publicly rewarded. This must obtain right down to those teaching in junior schools to assure our future. (ICI memorandum, House of Lords 1986, part 3, p. 143)

Other accounts of the apparent U.K. R&D "crisis" have focused on problems of government. The culture and hierarchy of the British Civil Service has been said to lack interest in scientific training and expertise. The publication of the Fulton Committee Report in the late 1960s reinforced contentions that the administrative-generalist civil servant is ignorant of, and undervalues, scientific and technological activity in civil society: "Many scientists, engineers, and members of other specialist classes get neither the full responsibilities and corresponding authority, nor the opportunities they ought to have" (Fulton Committee 1968, 8).

Although there may be varying accounts of the causes of an R&D malaise (poor education; the neglectful state; unscientific culture) and conflicting evidence of its wider symptoms and effects (lack of scientific personnel — "brain drain," deterioration in terms of trade, declining market shares), statements referencing concern with the condition of R&D activity in the U.K. economy do reflect at least one common or overlapping ideal: R&D statistics are located in these discourses in such a way that they signal something more than merely a measure of scientific and technological activity. Scientific activity and R&D have been translated from a measure of techno-science into bench marks of the health of the nation and portents for, or even determinants of (Edgerton and Hughes 1989, 420; cf. Freeman 1987), future economic prosperity: "Advances in science and technology, and the early exploitation of those advances, are essential to national success" (Cabinet Office 1987). R&D statistics, and the scientific practices to which they are presumed to refer, assumed equivalence with competitive position, issues of national productive strength, and long-term market prospects.

The apparent need for more science, translated into problems of national competitiveness, may be familiar; but the nature and causes of the problems identified, and the strategies and solutions put forward to counter such problems have taken different patterns in different discourses. During the 1980s conditions have contributed to an intensification of worrying about R&D. And this worrying has taken a particular form, in line with a new way of thinking about the conditions that will boost R&D activities and expenditures and thereby promote growth in the economy.

Responsibility for Science and Technology in the Managerial Society

Since 1979, Conservative governments have pursued the notion — based loosely on a particular economic analysis of the macro economy and a neoliberal political philosophy — that public expenditure had crowded out the private sector in the United Kingdom, to the detriment of the national economy — as made visible, for example, by balance of payments statistics, levels of investment, and especially inflation (Thompson 1984, 1990). Whether this analysis of the problems of the U.K. economy is true or false, expenditure cuts in the public sector were made in its name. The cutbacks in funding for research in higher education are one symptom of this program (ABRC 1987, 27; Scott 1984). Furthermore, the economic recession in the United Kingdom of the early 1980s exacerbated the decline of R&D expenditures in the private sector. Whatever the relative importance of these contingencies, the impact on R&D, as viewed through OECD and governmental statistics, appeared unambiguous. In 1986 a House of Lords Select Committee examining "civil research and development" reported that there was "now growing evidence, very considerable evidence, even on a GDP basis, as well as a per capita basis, that we are falling badly behind our competitors in R&D and in technology and especially development" (House of Lords 1986, part 2).[3]

The reduction in governmental expenditure on R&D (Cabinet Office 1986, chap. 2) was made with a very specific purpose and function. Conservative governments in the United Kingdom throughout the 1980s emphasized the need to free markets, provide the conditions for the entrepreneurial individual, and put back into the private sector those services and industries that had previously been nationalized (Thompson 1986, 1990; Tomlinson 1985). The "privatization" of economic functioning was intended to apply equally to industry's provisioning for new products, technologies, and processes. The political philosophy of neoliberalism was unequivocal in apportioning the *responsibility* for funding of scientific practices. This allocation of responsibility to the "private" sector, or *enterprise,* also rested on the recognition that the most successful and innovating economies (those of Japan and [West] Germany) had had a far greater proportion of their total R&D expenditure funded by industry than had that of the United Kingdom (see table 2). Moreover, the relatively high rates of R&D expenditure in Germany and Japan revealed by such statistics appeared to confirm the perceived association between scientific and technological practices and national long-term strength in industrial competitiveness and production. However, the statistical information generated by such bodies as the OECD through the 1980s seemed to demonstrate that U.K. "private sector" responsibility for R&D investment was not being shouldered.

[3] This assessment was based on the figures for 1984.

Table 2. Business Enterprise R&D Expenditure (BERD): National Trends

	1985		*Compound real growth rates (%)*		
	Million $	*Percentage of total*	*1975–85*	*1975–79*	*1979–85*
U.S.A.	78,208.0	50.4	5.9	4.5	6.7
Japan	26,768.6	17.2	9.8	6.6	12.0
Germany	14,285.7	9.2	5.6	8.2	3.9
France	8,556.5	5.5	4.6	3.8	5.1
Italy	3,994.5	2.6	6.3	2.6	8.9
U.K.	9,065.9	5.8	3.3	5.0	2.1
Canada	2,729.5	1.8	9.0	7.6	10.0

Source: OECD 1989.

The primary thrust of governmental R&D policy was calculated to provide the circumstances within which industry would provide its own adequate level of funding for R&D activity. Some of the changes introduced by the Conservatives had been mooted before the 1979 election (Gummett 1980, 53–57); the government enacted them in a strong program of departmental committees, advisory bodies, parliamentary committees, structural re-organizations, and funding procedures (Cabinet Office 1987). A cabinet committee was formed under the chairmanship of the prime minister, Margaret Thatcher, for the assessment of science and technology policy. Each governmental department was appointed its own departmental chief scientist, and a committee of these chief scientists was created to advise the Cabinet Office. The House of Lords Select Committee on Science and Technology reported on "engineering R&D" in 1982 and "civil research and development" in 1986. The Cabinet Office's *Annual Review of Government Funded R&D* was first published in 1984. And while the dominant political ideology has been neoliberal, aspects of the government's initiatives have been somewhat more *dirigiste* in an effort to spur enterprise (Edgerton and Hughes 1989, 429), particularly in the area of government-funded R&D. For example, the Advisory Body for the Research Councils (ABRC) structured the assessment procedures for funding of university research in terms of strategic, industrial, and economic importance. The LINK programme has attempted to construct closer ties between university research and industrial applications. In 1987 a national Centre for Exploitation of Science and Technology (CEST) was set up, funded jointly by "the City" and industry. As Edgerton and Hughes point out (1989, 422–31), some of these policies are rather loosely coupled with the new-right, free-market philosophy.

A key feature of this program was that no significant quantities of new government funding were to go directly into R&D activity (Cabinet Office 1987); industrial managers, in accordance with the valorization of the private sector, had to be encouraged to accept their own responsibility for science and technology funding.[4] The Cabinet Office response to the 1986 House of Lords Select Committee Report argued that the "key consideration is effective management. . . . Industry must take the initiative for its R&D programmes" (ibid., 1, 4).

The concept of *management* and the particular abilities and knowledges employed by management may be unclear; but again in line with certain economic and political ideologies, in the 1980s the "manager" emerged as a key figure in the articulation of economic and national achievement (MacIntyre 1984, 26–32; Keat and Abercrombie 1990; Heelas and Morris 1992). Armed with their neutral, expert knowledges and techniques, managers had to be left to manage, as an almost sovereign "right." The Department of Trade and Industry announced in its now famous 1988 paper, *DTI — the Department for Enterprise* that the role of government was not to intervene and direct industry but to provide the conditions within which "open markets" and "enterprise" could flourish.

Yet by 1986 the foresight of management in funding and enabling R&D in their organizations began to be subject to doubt within government — in part because of the evidence of the R&D statistics. Managers had not indicated that they were fulfilling their responsibilities to this area: "The primary problem is the low level of industry's investment in R&D" (Cabinet Office 1987, 1).

Seen in these terms, direct political intervention in the functioning of private organizations offended the ideals of deregulation, free markets, and the encouragement of "entrepreneurial" initiative. There appeared to be an impasse between political concern for the relative decline in U.K. R&D activity, as revealed through government statistical returns (Cabinet Office 1984), and the rationale for creating the entrepreneurial or managerial society. One way of reconciling the two, however, was to extend the domain of economic conceptualization by promoting, within industrial organizations, new or existing modes of economic calculation for scientific practices and so encourage individual or corporate responsibility for R&D by making it visible and calculable (Hopwood 1992).

Connecting Science to the Economy: The Role of Accounting Calculation

The connection forged between R&D, as the measure of science and technology, and accounting, as a form of economic calculation at the level of the organization, arose out of the attempt to reconcile science and technology with the ideals of economic growth and prosperity. Within the specific conditions of possibility that

[4] The possibility of the government providing tax incentives was foreclosed in the Cabinet Office response to the House of Lords Select Committee, although there is some anecdotal evidence that companies supported R&D disclosure as a means of promoting such allowances. For tax allowances to be granted it would be necessary first to "reveal" R&D expenditures and then have them audited. The issue had been revived in 1986 when, in the run up to the 1987 General Election, the opposition Labour Party had declared that they would consider incentives for R&D in their next government.

both enabled and constrained the "problem" of R&D and possible solutions, the management "tool" of accounting for R&D presented one of the interfaces between the problem of industrial management's responsibility for R&D, and science and technology.

The regulation of accounting practices in the United Kingdom was then governed by a combination of company law requirements and the accounting standards (statements of standard accounting practice — SSAPs) that were drawn up by a committee of representatives from the professional accountancy bodies, the Accounting Standards Committee (ASC). Accounting for research and development had been regulated by SSAP 13, drafted in 1977.

As an outcome of lobbying of the ASC by aerospace and defense contractors (Hope and Gray 1982), the first SSAP 13 allowed, but did not require firms to capitalize on the balance sheet categories of "development" expenditure that met a series of stringent criteria.[5] SSAP 13 did not require a company's annual expenditure on R&D to be revealed within company financial reports. The terms of reference of the working party responsible for revising SSAP specified consideration of R&D disclosure.[6]

By not requiring disclosure, SSAP 13 allowed firms for whom capitalization of development expenses was not an option (the majority) to pass R&D expenses through the profit and loss statement as an undisclosed element of cost of sales. In theory, and at the extreme, such firms would not necessarily need to calculate their R&D costs separately to meet the standard. Whether or not this extreme case was realized in practice, the more important issue was that under the 1977 SSAP 13, *internal* scientific and technological practices had no *external* visibility, and hence no calculability, at the level of the individual manager or organization.

Accounting calculations, and the visibility they would create, were perceived as a way of influencing managers' awareness of and responsibilities toward corporate R&D. For example, the 1986 *Report of the House of Lords Committee on Science and Technology* argued strongly for the disclosure of R&D in company accounts: "The Committee continues to believe that companies should declare their R&D expenditure in their annual reports.... It would bring home to *management* their shortcomings in relation to similar firms" (House of Lords 1986, part 1, para. 6.84; emphasis added).[7] The aspiration to have industrial organizations represent R&D expenditure in their annual *external* financial accounts was not directly associated with external "information," or *ex post,* effects. The House of Lords Select Committee, among others, viewed the disclosure of R&D as a mechanism for the

[5] The ASC had originally wanted all forms of R&D expenditure to be expensed in the profit and loss account as incurred. As this would have influenced adversely the prices paid to aerospace, electronics, and other defense-related government contractors under the regulations for the definition of capital employed governing the prices on such contracts, the ASC was the target of strong lobbying by these industries to allow some form of capitalization of R&D costs. See Hope and Gray 1982.

[6] The DTI did favor R&D disclosure in its submission on the first R&D exposure draft to the ASC (Hope and Gray 1982).

[7] An earlier committee report had made the same recommendation (House of Lords 1982).

promotion of R&D practices *within* private sector organizations in accordance with the needs of the national economy. By exposing R&D for external reporting purposes, managers would create for themselves a space for appraising their R&D activities. In accordance with the mores of the liberal economy, managers would then be free to choose their R&D strategies, by relating their current actions to industry norms and national or international averages, to calculate their firm's long-term competitive position, and to assert their role as responsible and autonomous decision makers. The calculation of R&D expenditure by management and the disclosure of R&D in company accounts were seen to supply a means of intervening in the management of research and development activities, but in a way that preserved a distance between the agencies wishing to promote R&D and the managers whose behavior they wished to guide: accounting for R&D was a mechanism through which to "act at a distance" upon the issue of science and technology and its role in national economic growth (Latour 1987; Miller 1991; Miller and Rose 1990; Robson 1991, 1992; Rose and Miller 1992).

Evidence of the concern with the economic visibility and calculability of science and technology is given in the oral reports submitted by the Department of Trade and Industry (DTI) and the Treasury to the House of Lords Select Committee on Science and Technology:

> (Mr Roith) [DTI Civil Servant] The DTI is in favour of the declaration of R&D in company statements. This was a recommendation made in one of your Lordship's earlier reports.
> (Baroness White) Has anything happened? Are there any movements?
> (Lord Gregson) They put a voluntary clause in the Companies Act which nobody takes any notice of.
> (Mr Roith) The Committee will be aware that the Accounting Standards Committee has been considering the possibility of reporting R&D expenditure and revising their advice accordingly. It has not yet come to any conclusions. Behind the scenes the Department is encouraging the Accounting Standards Committee very strongly to introduce some proposals in this area. (House of Lords 1986, part 2, p. 72).

Accounting for R&D expenditure would allow the initiation of other forms of "good conduct" for management of R&D to be advanced. For example, good management of R&D also required the utilization of appropriate methods of economic calculation for R&D appraisal. Starting with the public sector, the Treasury throughout the 1980s attempted to reintroduce management to best practice in investment appraisal and policy analysis (HM Treasury 1984, 1988). Although it was felt that "the underlying principles for [science and technology] evaluation are broadly the same as those for other policy evaluation" (HM Treasury 1988, 17), this program carried over into the economic calculation of R&D with the publication in 1989 of *R&D Assessment: A Guide for Customers and Managers of Research and Development* by the Science and Technology

Assessment Office of the Cabinet Office. This guide to managers outlined the main managerial techniques for monitoring and appraisal (e.g., peer review, cost-benefit analysis, investment appraisal [net present value techniques], program evaluation and review technique [PERT], and rationale, objectives, appraisal, monitoring, and evaluation [ROAME]) of corporate R&D projects.

Political rationales for the disclosure of R&D were not confined, however, to the problem of management responsibility for the economic assessment of science and technology. Disclosure of R&D also presented the possibility of enhancing the long-term economic prospects of industrial firms as viewed through financial calculations of scientific and technological practices. Investors' calculations of company financial performance could be viewed as seriously incomplete if they failed to take account of the long-term nature of annual expenditures such as R&D. Paul Channon, then Secretary of State for Trade and Industry, suggested: "There is clearly with some companies a very considerable communications problem: they do not allow the City to know what their long-term aims are and what their research is for and how much they are spending and why" (ibid., 564). Here the disclosure of R&D was attached to the problem of "short termism" in the centers of investment calculation. On the one hand, undisclosed R&D expenditures would pass through the profit and loss account and thereby reduce reported earnings by an unknown amount. On the other hand, if disclosed, investment analysts could potentially allow for the reduction of earnings that is an outcome of investment in science and technology, and also reward the individual firm's potential for long-term product innovation and growth in market share. Calculations that are believed to influence share dealers behavior, such as earnings per share and price/earnings ratios, could be "corrected," with a related improvement in the market valuations placed on a company's shares.

Channon's comment laid the responsibility for the R&D problem on management, but others argued that the investment problem was centered in the "short termism" of the City's financial institutions. Managers' actions were constrained by the short-term, earnings orientation of stock market investors, portfolio managers, and analysts. The House of Lords Committee reported:

> If, as many have argued, risk capital is available to British firms only on less favourable terms than those open to many of their competitors abroad, then underlining through the annual accounts the importance of R&D strength might be expected gradually to change this shortsighted view. . . . This may lead to only a gradual change in the outlook of shareholders and management; but an appreciation of the value of R&D and a more far sighted outlook must somehow be brought about. (House of Lords, 1986, part 1, para. 6.84)

Nevertheless, wherever lay the "blame" for underinvestment in R&D and to whatever the failure of the economy could be attributed, the disclosure of R&D was seen as a common solution. Those who viewed the decline of expenditure on science and technology as a management problem and those who viewed it as an investor problem could agree on the value of R&D disclosures. And the promotion of R&D disclosure enabled a form of industrial encouragement by a government concerned to avoid the ideological contradictions inherent in direct political intervention or government subsidy. The government responded to the Lords Committee on Science and Technology recommendation and accepted that "there is a need to emphasise to shareholders and managers the value of R&D. It is for companies to ensure that their bankers and major shareholders understand the advantages of investment in R&D. *The reporting of R&D expenditure in annual accounts will promote this understanding*" (Cabinet Office 1987, 6; emphasis added).

The discourses and rationales of the DTI and other state agencies therefore seemed clear. At the same time, however, there remained the requirement to enrol the support of the accounting profession, a process that was lengthy and contested. The ASC working party first met in September 1982; SSAP 13 (Revised) was issued in January 1989. The ASC working party were made aware of government views from a number of sources. Both reports of the House of Lords Select Committee on Science and Technology (House of Lords 1982, 1986) were brought to the attention of the working party through their secretariat. Views of government departments were thereby also apparently disclosed. Further, the working party met with the division of the DTI responsible for the sponsorship of the profession.[8] Government representatives from the DTI and the Head of the Governmental Accountancy Service (HOTGAS) were also present as nonvoting observers of the ASC; and at several of the meetings where accounting for R&D was discussed, the DTI representatives spoke up in favor of disclosure. In addition, a number of ministerial statements on the public record signaled support for R&D disclosure. For example, Michael Howard, the minister for Corporate Affairs, stated that legislation would be considered to compel companies to reveal R&D expenditures (*Accountancy Age,* 24 October 1985). Other statements, however, were more in line with the argument that the government wished the ASC to deal with this disclosure issue.[9] The desire for the accounting profession to produce the necessary regulation accorded with the government's apparent noninterventionist ideology.

The chairman of the ASC argued initially that disclosure of R&D was a Companies Act problem. The DTI observers on the ASC, however, strongly supported a new standard requiring R&D disclosure. It was important that the accountancy profession be perceived as the body responsible for developing and promoting the regulation on accounting for R&D. The Secretary of State for

[8] This meeting occurred subsequent to the rejection of the working party's recommendation for disclosure by the ASC (30 October 1985).

[9] A Civil Servant interviewed at the Companies Division of the DTI commented: "In common with our general sort of approach to these matters we would prefer to see the profession and the users representatives at the ASC to agree on [disclosure] and promulgate it. And we encourage that process. But if they can't agree or don't want to and don't think it should be imposed then we will have to face up to the question 'should government require it?'. . . That is a live issue at the moment."

Trade and Industry made this clear to the House of Lords Committee:

> The *voluntary disclosure* of R&D in their accounts I think is a very good idea. As I said I would prefer for it to be voluntary rather than for them to be compelled to do so by statute. No doubt there will be another Companies Bill one day. I am perfectly certain that, if there is, someone will table an amendment to that effect and, if it is carried, I am not going to cry all night, but I think it would be better if it could be done by agreement. (Paul Channon in oral evidence to House of Lords Select Committee on Science and Technology, House of Lords 1986, part 2, para. 1581; emphasis added)

The evidence of Treasury officials to the House of Lords Committee corroborates the apparent importance attached to the origination of the R&D disclosure requirement from the "knowledge experts" of the accountancy bodies:

> (Lord Butterworth) Have the Treasury or the departments come up with any interesting ideas about *how industry could be persuaded to invest more in research and development?*
> (Mr Burgner) [Treasury civil servant] This is a very important and, we think, difficult topic. It is one that we give quite a lot of thought to and have had discussions with the DTI.
> (Lord Butterworth) I am sure you do but what are the results?
> (Mr Burgner) I do not think we have, as yet, a list of results. As to the sort of thing we would like to see, we think there is a *long process of education*. The question really is what levers we can pull to speed up that process of education. The one positive idea that is under discussion at present is whether anything can and should be done to give more disclosure of R&D by companies, and I am sure you know the Accounting Standards Committee have that under discussion currently. (Ibid., 306; emphasis added)

This strategy was confirmed by other Treasury officials:

> The Committee will be aware that the Accounting Standards Committee has been considering the possibility of reporting R&D expenditure and revising their advice accordingly. It has not yet come to any conclusions. Behind the scenes the Department is encouraging the Accounting Standards Committee very strongly to introduce some proposals in this area. (Oral evidence of Mr Roith, Treasury civil servant, to House of Lords Select Committee, ibid., 72)

Although it was clear that accounting expertise was being drawn upon to legitimate the disclosure of R&D, the ASC resisted the disclosure of R&D for four years; some ASC members objected to the "fashionable" demands for R&D disclosure that were put upon them. Other commentators (ASC 1988) expressed concern about the possible commercial secrecy implications or the problem of defining the relevant costs of R&D departments. But in 1987 the ASC approved a new draft standard that would demand one-line disclosure in the profit statement of companies. In January 1989 the SSAP 13 (Revised) requiring disclosure of annual R&D expenditures was published.

Conclusion

It is unlikely that the new R&D standard will produce the types of consequences that government agencies have calculated. Companies that disclose high levels of R&D expenditures could experience the "marking down" of their share valuations by financial analysts and speculators — in accordance with the effects that high levels of R&D expenditure would have on dividend returns in the short term. Further, the mere fact of expenditure on R&D says little in itself about the nature and caliber of the R&D undertaken. The U.K. accounting profession has also expressed reservations on the practicalities of apportioning organizational costs to the category of "R&D," as if such activities were wholly discrete.

Whether the desired effects are realized or not, this review portrays the central problematization of science and technology in relation to the U.K. national economy that emerged in the post-World War II era and particularly in the mid-1980s. And it is worth noting that the failure of such programs of "managing science by numbers" often become the starting point for further policies of responsibilization and calculation. Nevertheless the strategies and mechanisms for drawing science closer to the "market," recently reaffirmed by the government's White Paper *Realising our Potential* (Chancellor of the Duchy of Lancaster 1993), can be interpreted only against the backcloth of the discourses and rationales of U.K. government institutions in the 1980s. Science and technology came to be perceived as a private sector problem, and the solutions proposed aimed at the *self-regulation* or *responsibilization* (Foucault 1982, 1988) of managers by "revealing" and rendering calculable R&D practices at the level of the organization.

Out of the recent problematization of science and technology a multiplicity of mechanisms have emerged for connecting science to the economic. Accounting knowledges, investment techniques, and governmental statistics have gradually put in place a series of linkages for drawing together perceived problems in national scientific activity. In association with the promotion of other forms of economic calculation that would be enabled by rendering science and technology visible to internal and external agencies, accounting calculation has become a way of acting at a distance upon R&D. Chains of calculation have gradually surrounded the practices of science and technology in the attempt to make them calculable and ultimately programable. The development of "stable and combinable mobiles" representing R&D has created the space within organizations for the calculation of science and technology, and given or created a visibility to such practices within the organization. Financial institutions, productive organizations, government agencies, and other centers of calculation have, through accounting numbers, gradually become linked to the twin problems of science and the economy.

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