Divining directions for development: a cooperative industry–government–public sector research approach to establishing R&D priorities

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This paper discusses the limitations of many fiscal and related methods of encouraging increases in R&D as a tool for establishing research priorities. It suggests that any 'national' rather than industry-specific approach is likely to be ineffective in stimulating the R&D needed for the development of all industries. This is particularly the case in countries such as Australia and New Zealand where many decisions about R&D investments are made overseas, in the headquarters of the multinational firms that dominate most sectors of the economy. Instead, the paper suggests that an industry development approach currently being used in Australia, the Action Agenda approach, be modified to include a broader range of players, notably the public sector R&D community and an industry's 'users', to think about and establish R&D priorities which will underpin progress in the industry as a whole rather than being restricted to individual firms. The proposal rests on the results of AEGIS empirical research (surveys and interviews) into the dynamics of innovation in different 'product systems' (broader than sectors) in Australia which indicates the broad range of players that need to be included both in the analysis of innovation and in policies for stimulating the research which can assist innovation.

Introduction

There is now widespread acceptance by governments in OECD countries that innovation plays a key role in economic growth. While innovation involves much more than R&D, legislators are increasingly recognising the importance of the R&D that often underpins product and process innovation and are seeking ways to encourage further knowledge generation. They are re-considering both the design of appropriate policies for encouraging technology development as such and the roles that government can play in stimulating technologically-related research and ensuring the rapid and effective dissemination of new knowledge generated.

Some OECD countries are large enough to invest in new knowledge generation across a very broad range of promising fields, either directly via government or indirectly via incentives to firms. In smaller countries, such as Canada and Australia, and even more so New Zealand, issues of priority and capacity are central to decisions about policy directions and instruments. As de la Mothe has expressed it, '... questions concerning scientific capacity and priority setting are implicit in all discussions about science policy. They are both *difficult* and *inescapable*' (1999, p. 373, emphasis added). That decisions are difficult but also inescapable means that especial attention needs to be paid to getting priorities right and making the best use of public monies invested.

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In Australia, recent public science policy-related discussions have tended to focus on the *amount* of scientific investment by the nation and not on the fields in which investment should have priority (see e.g. Batterham, 2000). Since discussions about priority setting are 'inescapable', however, it is important to put in place policy decision mechanisms which can suggest a way forward in assessment of appropriate directions for as well as levels of public investment in R&D. In addition, and this has proved the most difficult for countries which have attempted priority setting via mechanisms such as technology foresight, mechanisms need to ensure that suggestions made have the commitment of players and are implementable for the benefit of each industry as a whole.

This paper draws on existing Australian research and industry development strategies to suggest a more effective way forward, one which can determine directions for development and ensure industry commitment and user acceptance. It could provide specific guidance on the major R&D issues related to different product systems and allow players to determine both directions for and levels of investment for their own industry – within the limits of public and private expected expenditure on R&D as a whole – through a joint bargaining process which includes both public and private sector players. The major difference with current practice is that industry is not invited to the researchers' table but researchers and regulators are invited to the diverse industry tables. The paper thus uses recent Australian experience with industry Action Agendas to suggest a way forward which puts sectoral industry development at the centre of research priority discussions. The suggestion is not that this be the only way in which national R&D management take place: only that it is useful to have the priority setting discussions where *research is incorporated into particular commonly determined industry development agendas*.

Encouraging improved technology capacity

There has been a good deal of international discussion about different methods and policies for encouraging the conduct of R&D, usually within the private sector. There is still considerable disagreement as to the best approaches. None has universal endorsement. It is useful to summarise some of the major discussion areas before presenting the alternative approach proposed here.

i. The limitations of standard fiscal and other financial interventions

Technology policies adopted by OECD country governments over the last few decades have often involved governments in making investments with public monies to stimulate extra R&D investments by the private sector. A series of articles published in *Research Policy* in 2000 reviewed many such approaches (David *et al*., 2000; Hagedoorn *et al*., 2000; Hall and van Reenen, 2000; Klette *et al*., 2000). The authors of these papers made important distinctions between the kinds of investments made, covering fiscal means such as R&D credits or tax concessions, government R&D contracts and public sector grants to firms to encourage investment in areas selected on the basis of competitive bidding for 'excellent science' and reviewed advantages and disadvantages. Thus, for example, Hall and van Reenen suggested that tax credits perhaps only encouraged a dollar of extra investment by the private sector in return for every dollar invested from public funds (in this case, government tax income foregone). They also pointed to some problems for the justification of such policies because, if the case for public investment depends on the view that spillovers from the investment create high social rates of return, the focus by private companies on investing in areas which have the highest private rates of return may be ineffective or perhaps counterproductive (Hall and van Reenen, 2000, p. 493). Another evaluation, this time by David *et al*., pointed out that tax credits do not leave the composition of national R&D unaffected and may shift firm priorities into less beneficial directions. In that sense, research priorities have indeed been set but not by governments with national interest in mind. David and his colleagues say that:

> As firms expand their R&D activity in response to linked tax offsets against earnings, the incentives are likely to favor projects that will generate greater profits in the short-run. Consequently, projects with high social rates of return, and long-run exploratory projects and 'research infrastructure' investments in particular, may be less favored by the expansion of private funding. In this way, weaker 'spillover' benefits to other firms and industries would be generated by the private response to extensive reliance on this particular form of pro-R&D policy instrument.
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> (2000, p. 502).

Similarly, where governments direct grants to firms or spend the monies directly, which may at first sight seem a better option from a social point of view, distortions may occur, meaning that increased government spending for industrial R&D projects leads to firms reducing their own commitment, especially where R&D activities are heterogeneous rather than homogeneous (David *et al*., 2000, p. 502). OECD (2000) has also reported that government subsidies may crowd out private sector research while others have raised the now familiar arguments about governments' inability to 'pick winners'.

The OECD also published a study in 2000 which used a new methodology to evaluate claims made

about the effects of public subsidies to R&D, using the experience of 17 countries over a period of 15 years. The main conclusions that concern us here were somewhat more positive than the reviews in *Research Policy* but nonetheless contained important caveats which must be borne in mind when considering the real world of policy choices.

The principal conclusions of the OECD studies were that:

- direct government funding of R&D performed by firms has a positive effect on business-financed R&D;
- tax incentives have a positive (although short-lived) effect on business-financed R&D;
- direct government funding and R&D tax incentives are substitutes;
- the stimulating effect of government funding varies with respect to its generosity; it increases up to a certain threshold (about 13% of business R&D) and then decreases;
- direct funding and public research are complements: public research becomes more effective when government funding of R&D increases, thereby increasing the capacity of firms to digest the knowledge generated through public research (OECD 2000, pp. 185–186). This last finding is of especial relevance to governments considering broader and more coherent innovation policies.

The policies reviewed by the OECD are derived from government intervention using indirect policy instruments and by their nature tend to be concerned more with a nation's overall business-related scientific capacity than with research direction. The fiscal benefits also go to individual firms who ultimately make the decisions about what to invest in, how much to invest and over what periods of time, not to groups of interconnected firms and/or to networks which include both firms and public sector research agencies.

There are several well-known drawbacks to such schemes. As the OECD study says, 'tax breaks do not discriminate very much, so that firms can use public money for any goal, whatever its social rate of return' (2000, p. 187). The tax breaks are also not available to small or new firms, which may be the most innovative, since there must be an income sufficient to charge the tax reduction against. (In Australia, the latter point has to some extent been addressed by the recent decision to include cash out provisions for small firms but the overall point remains.)

While there is some evidence in Australia that greater investment by firms in R&D was encouraged by the 1985–86 150% tax concession and there is certainly evidence that investment fell when the rate of the concession fell and the rules under which it could be claimed were changed in 1996, this very change suggests that investment in R&D had not become embedded in company strategic planning to any great degree over a period of eleven years. This finding throws doubt on the efficacy of the tax concession approach in the absence of other major industry development policies.

ii. Improved approaches; from firm to technology cluster or sector

One problem with the tax concession approach to encouraging R&D is that it is targeted to individual firms when it may be more effective to target groups of firms who are already collaborating or to a broader group of industry players. This is clear in another in another review in the same volume of *Research Policy* as the articles quoted. Thus, Klette *et al.* found that it could be useful to take a technology cluster approach to evaluating whether financial interventions worked rather than look simply at the effects on individual firms. They suggested that:

> ... in order to estimate the impact of an R&D subsidy program in the presence of knowledge spillovers, we need to look beyond the direct impact on the performance of targeted firms and consider changes in the performance of the industries or 'technological clusters' to which the supported firms belong. This may lead us to a more aggregated, industry-level analysis
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> (2000, p. 493).

A second problem with the tax concession approach is that it is by definition open in the same way to all firms when the needs of different industries may be very diverse. The differences may prevent some major industry steps forward because the needs do not fit the general format. In a related vein, David *et al.* (2000) have suggested the importance of industry-specific targeted policies. They draw on a paper by Levin and Reiss which was carried out in 1984 but not widely followed up. In that study Levin and Reiss used a method that focused on the effect of R&D subsidies using a structure equation system that relates an industry's concentration, R&D and advertising intensities to the industry's structure of demand, technological opportunities, and appropriability conditions. Using this approach, the authors found that government R&D investment has a positive and significant effect on private R&D intensity, such that each additional dollar of public funds stimulates from seven to 74 cents of private R&D investment. In other words, the findings may be interpreted as meaning that taking into account the specific situation of a given industry and relevant aspects of difference with other industries suggests that public sector R&D investment can be beneficial. *The structure of the industry and its opportunities, however, are critical to success.*

Such findings in turn suggest that public policy-making in this field, as in others, needs to develop more sophisticated instruments for understanding the

industrial and service sector environment and the internal dynamics of the sectors before choosing policy approaches. More specifically, David and his colleagues conclude that studies in the field suggest that,

> ... the heterogeneity of experience caused by the application of institutionally different subsidy programs to diverse industries and areas of technology provides strong grounds for doubting the usefulness of searching for 'the' right answer
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> (2000, p. 525).

This paper concurs with that view.

Innovation encouragement: the need for a differently focused policy approach

A number of different trends have been coming together in the understanding of the dynamics of innovation and of policy options for furthering innovation. In recent years, there has been increasing international appreciation of five particularly important elements of the ways in which modern economies and the central players in them operate.

The first element is the (belated) recognition of many firms' need to collaborate in innovation. The second, and related, element to consider is the importance of calling on the skills of a variety of players in innovation, most notably other firms, as users of products or suppliers to the innovating firm. The third, and again related, element of the new situation is the recognition by governments, industry and researchers that they need to build new organisational links which lead to a virtuous 'Triple Helix' in which the performance of all can be upgraded (Leydesdorff and Etzkovitz, 1999). The fourth is that if countries are to be successful in economic development they need to build better functioning national, local and regional systems of innovation. The fifth is the continuing importance of policies in place in the home nation because these are at the basis of the institutional and practical arrangements pertaining in the innovation systems most relevant to firms' activities. Such policies include labour market, intellectual property, education and training, R&D and regulatory arrangements and frameworks and policymaking capacity. In other words, improving innovation performance depends on a broad range of mutually supporting policies, not on one alone.

Two of these elements of innovation systems deserve special mention here because they relate directly to the policy prescriptions suggested in this paper. These are the continuing importance of the nation and national policies adopted and the centrality of collaboration in many areas of successful innovation. It is also important to emphasise again the critical need to adopt a range of coherent and related policies to reinforce the systems of innovation targeted.

The importance of the nation

In some senses national systems of encouragement of innovation clearly need to take international trends into account, recognising the increasing internationalisation of much economic activity, including the performance of R&D, and the degree of overseas influence via foreign direct investment. While there has been much discussion in the literature of the internationalisation issue as it relates to national systems of innovation (see e.g. Porter, 1990; Dosi, 1999; Guerrieri, 1999), the current consensus still is that happens *inside* a country is the key to improving innovation and through it to sustainable economic growth in the nation. Thus, Guerrieri, for example, in a 1999 paper, while recognising that the current phase of global competition affects not only firms but also national and regional innovation systems, concludes, with other observers, that:

> In the new environment ... nations have continued to play a significant role in corporate strategies, including those of transnational corporations. Therefore, the structural features of national economies such as production and management organisation, technical infrastructure and other institutional factors, have continued to exert a significant influence on firms' performance ... differences in technological capabilities endure ... the trade specialisation trends of major countries and areas during the past decade can be interpreted in this perspective
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> (1999, p. 155).

Moreover, analysis of trade patterns, although sometimes difficult to interpret with certainty,

> seems to confirm that domestic innovative activities are still a major determinant for specialisation and competitiveness, and that, although technology may have become internationally mobile and cross-boundary, regional and other systems of innovation are increasing in significance, geographical proximity continues to play a very significant role for knowledge flows
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> (Guerrieri, 1999, p. 154).

While these comments apply perhaps especially to *innovation*, rather than R&D per se, they suggest that getting all aspects of innovation policies right at home is of paramount importance.

Collaboration

The importance of inter-organisational collaboration in successful innovation is now well documented internationally. The recent international DISKO surveys of collaboration in innovation in manufacturing, innovation surveys in different countries, studies of networks and their formation, all indicate on an empirical basis the advantages that firms find on

working more or less closely and more or less formally with others (OECD, 1999; Basri, 2001). The benefits to firms of networking are several: they include the opportunity to obtain scale and impact in a market, to enter new markets and to do so rapidly, to share R&D and other costs and risks, to obtain access to specialised and new technological and organisational knowledge and skills, to deal more effectively with the complexity of much new technology and to increase their flexibility and adaptive capacities.

Recent recognition that firms have a much greater propensity to network than was previously realised has led to a focus on networks assuming considerable importance in technology and innovation policy, especially in European countries (OECD, 2000, p. 201). The growth of collaborations has been itself the subject of study and indicators of networking by firms have been developed (see Dodgson and Hinze, 1999). In relation to the adoption of new technologies, Kogut has emphasised that collaboration may assist companies to gain valuable experience, to increase their exposure to related markets and to improve their ability to sense and respond to new opportunities (Kogut, 1991, quoted in Hagedoorn *et al*., 2000, p. 573).

The especial importance of users and suppliers (to a lesser extent) in successful innovation has been well recognised since the work of von Hippel (1988). Many more recent studies in a variety of industries have confirmed his results (for our region, see for example, Marceau (2000) on the medical device industry; Basri (2001) on a range of industries in Australia; AEGIS (1999a–d, 2000) on some more traditional industries such as TCF and furnishings and the health system as a whole. For European countries see reports by a number of OECD countries within the context of the DISKO project on collaboration in innovation in manufacturing). User–producer linkages are a particularly effective form of collaboration. The DISKO studies show such linkages to be very long term and to sometimes involve several partners, thus making user-producer collaboration a close relation of networking more generally. These networks may be strengthened by inclusion in the partnerships of relationships with R&D organisations and the suppliers of critical components, who thus find themselves also in user-producer networks.

Moving ahead

Given the emphasis by firms themselves on collaborative patterns of innovation activity, it may be sensible for policymakers to also take such an approach, collaborating with sectoral participants in devising a program of joint industry-government action. This is the proposal here.

The approach proposed recognises that the most effective way to encourage greater innovation capacity and the R&D that underpins it may be the creation of an agenda developed by the participants in an industry product system themselves via a process of joint negotiations as to what is essential to moving the industry concerned forward. The joint negotiation approach aims to deal with the fact that national systems of production and innovation are extremely slow to change. Over the last few decades the only countries which have made major changes to the structure and nature of their productive systems are the Asian ones known for long as the Asian Tigers. It is clear from input–output data, for example, that these countries have made a transition to a strong manufacturing base from an agricultural base half a century ago. Explanations of how they achieved this transformation range from an emphasis on the nations' institutional arrangements, such as possession of a 'developmental state' (Orru, Woolsey-Bigart and Hamilton, 1997; Weiss, 1988) and its associated institutions through to control of the economy and political institutions by a family-based elite with a developmental focus or a particular form of business organisation which has been summarised by Redding as 'Chinese capitalism' (1990).

In contrast, modern western economies have changed only slowly and only in parts and economists are still arguing about whether convergence or divergence can be expected among them. Thus, even though analysis of France suggests some significant recent changes, this would seem to be the exception among European countries rather than the rule because France has what could be described as a European version of the developmental state and there has been very considerable public investment in the technological shifts made (OECD, 2000). Most OECD countries do not have the political institutions which would allow such radical shifts as have occurred in Asia and many policy advisers are opposed to government intervening actively in the economy by measures often summarised as 'picking winners'. Thus, one reason for the observed long term stability in economic structures is that western political and economic systems find it hard to put in place and legitimise large scale programmes of industrial and economic intervention. Economists indeed have long advocated reductions in existing interventions, such as tariff walls, on the grounds that these distort markets and have supported a move to freer trade in international relations. Their recommendations have been incorporated into the policy outcomes of several rounds of world trade negotiations which as a result have constrained individual nations' policy options by reducing their room to manoeuvre, especially among smaller nations, and seem now irreversible.

While the general directions described above are now almost universally seen as improving competition and providing the underpinnings to recent economic growth, there are some signs that countries may be reconsidering some of their options. As the *Australian*

Science and Technology Budget Statement 2000–2001 points out, for much of the twentieth century Australian science and technology policy was preoccupied with government funding of public sector research [while over more recent years] we have seen a fundamental shift in the emphasis of science and technology policy [towards] a range of policy actions [that] have sought both to increase the level of innovation in industry and to transfer greater benefits from public research and development to the commercial sector (Department of Industry, Science and Resources, 2000, p. 1.3).

The Statement goes on to suggest that:

> The scene is now set for a further shift in policy thinking. More than ever before, it is now widely accepted that the generation *and application* of knowledge is [sic] the key to future prosperity. In recent decades it was widely taken for granted that knowledge developed in universities and research laboratories would be applied in industry as a matter of course. It is now clear that this is not always the case. Application depends on a complex array of interactions between the generators and translators of intellectual capital. It requires a whole host of factors to be present, including for example, understanding industry needs, access to finance, the ability to negotiate intellectual property rights, effective business management, marketing skills and, perhaps most importantly, vision, leadership and drive. Bringing the necessary elements together requires effective cooperation and high levels of communication. This cooperation may occur within a firm, but it is just as likely to involve outside elements, perhaps other firms in complementary, or even like, industries, universities, research organisations, and government granting and regulatory bodies
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> (2000, p. 1.3, emphasis in original).

The range of elements needed to ensure that a nation can maximise the economic return on its investment in R&D indicates that there is no one best solution, no one best way, to mitigate the problems that countries, industries and firms are facing in the innovation field. This then suggests that a *package of policies* needs to be devised to deal with the range of elements and the perceived inter-relationships between them. It also suggests that the complexity of the issues requires more than what one might call 'spot contracting', single and ad hoc, relationships between the public and private sector players involved. Getting the policy packages right, not just for the present but also for the future, suggests that longer term relationships are needed and policies must both bring in a variety of industrial partners and involve them in a long term 'foresight' and scanning process. The policy development arrangements must focus not on the interests of a single firm, or even a small group of leading firms in an industry, but on the collective future of all firms that have innovative capacity in the arena. Indeed, Dosi has recently suggested that:

> ... technological and organisational learning might be a major collective positive sum game whereby, under certain institutional and micro-organisational conditions, knowledge accumulation couples with investment opportunities which couples with labour demand which couples with market growth ... a possible achievable scenario ... is precisely a renewed path of self-sustained income growth characterised, to a major extent, by an increasingly diffused access to information-processing competences, 'intangible investments', and rapid development of the related infrastructures
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> (1999, p. 44).

As emphasised above in this paper, other observers, too, have suggested that, rather than having a whole nation as the policy focus, as is the case with policies focussed on R&D tax concessions, it can be useful to have a technology cluster or sectoral/industry level approach (see Klette *et al.*, 2000, p. 493; David *et al.*, 2000).

The Australian situation

These observations provide the basis for what is proposed in this paper as a potential way forward for Australia and perhaps other small nations with only limited supplies of funds for R&D, whether in the public or private sectors. Before detailing that approach, however, it may be useful to summarise the problems facing Australia in achieving desired results via its major current fiscal approaches. Some issues are general to the approaches adopted and have been discussed in the first section of the paper but others arise from the specific situation in Australia.

In Australia, as elsewhere, governments thinking about their innovation improvement policies constantly return to R&D and investment in R&D. Even though they are usually aware that the linear model which suggests that innovation is directly related to scientific breakthroughs has been criticised as applying to only a very limited range of industries, notably biotechnology, they seem to continue to use the model as the basis for their thinking. The recommendations of recent reviews of science and innovation capability in Australia (the Batterham and Miles reports published in late 2000) have much the same underlying assumption. The linear model is attractive largely because the R&D system is one which the government can control more or less directly, since so much is done in the public sector, can be relatively easily measured in terms of policy impact and is universally seen by scientists and others with a direct interest as appropriate. It also has the important policy characteristic of simplicity of design.

The reach of such policies, however, is extremely limited. The R&D tax concession has only ever been

used by a very small number of companies in Australia (this is not unusual – overseas experience is similar) and therefore has very little impact in many areas. Since there are very few large locally-based firms, the majority of users of fiscal concessions may be induced by the concession to conduct research in Australia but not to commercialise it locally in the absence of other relevant policies. Such users probably also receive the majority of their key technological inputs from elsewhere. International evidence confirms that many innovations occur in small firms who do not have the resources and/or profits to benefit from the concession (see e.g. de la Mothe (1999) on Canada): very few smaller firms claim the concession in Australia. Australia's industrial structure is also very patchy so there is a problem of user-producer linkages (close customer connections) and supply chains lead rapidly out of the country. The major networks of users and producers operating in specific technological systems (Carlsson, 1996) are largely overseas. On the political level, the federal system of government means that each state has different policies and frequently states compete for the industries that may benefit from research conducted. The most obvious present example is biotechnology where several States are competing for the R&D and associated industry benefits, each potentially to the detriment of the others and the emerging industry as a whole. Finally, of course, there is the central concern that the absolute level of resources that a small country such as Australia can pour into research is low.

In these circumstances then, how should one divine development directions? How can Australia's productive structure be moved forward? And in that context, how should one develop priorities for R&D, whether in the private or the public sectors, as well as improve the absolute levels of investment?

A new way forward: collective industry development using the Action Agenda approach

Recent studies of the dynamics of a wide range of industries in Australia conducted by my research centre, the Australian Expert Group in Industry Studies (AEGIS), have suggested the critical importance of key players working together to improve information flows in their arena as a collective contribution to developing the knowledge and skills needed for enhanced innovation. The 'product systems' (a term we prefer to the more usual 'sector' since more players can be included) and their subsets studied include both high and low technology areas, project-based firms and industries where manufacturing and services are mixed as well as manufacturing alone. The AEGIS studies focus on innovation and have involved empirical investigation of the functioning of building and construction (five studies), toolmaking, health services, furnishings, textiles, clothing, footwear and leather, and processed food as well as a more general study of innovation linkages between a broad range of manufacturing firms.

The product system approach, developed initially by Gann and colleagues (Gann, 1996, 1998; Gann and Salter, 1998) and subsequently through AEGIS where it is associated with a conceptual view of industries as 'complexes' of activity linking four major sets of players – users, producers, public sector research and training institutions and regulators – enables us to illuminate the functioning of information flows between the key players. The approach is designed to highlight strengths and weaknesses in flows of information related to innovation. The two sets of figures illustrate the method.

The first figure allows us to indicate clearly which areas are potentially strong as sources of innovation

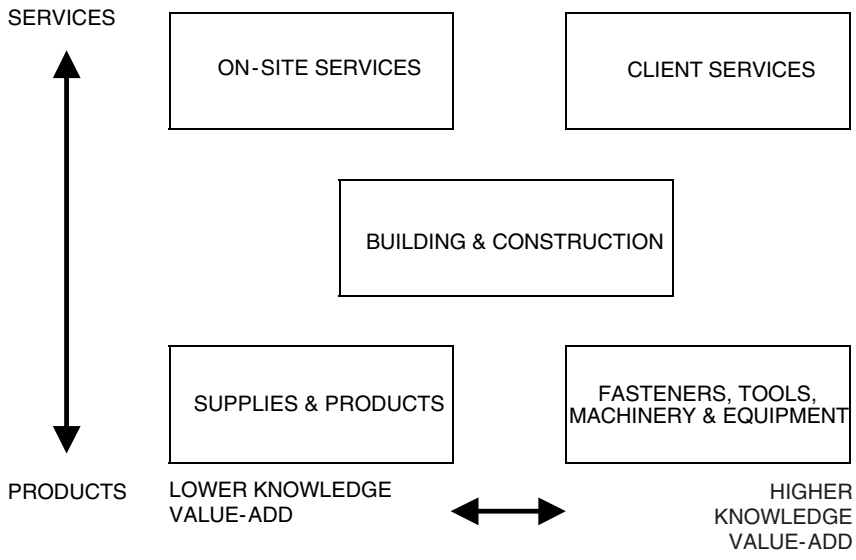

Figure 1. B&C product system.

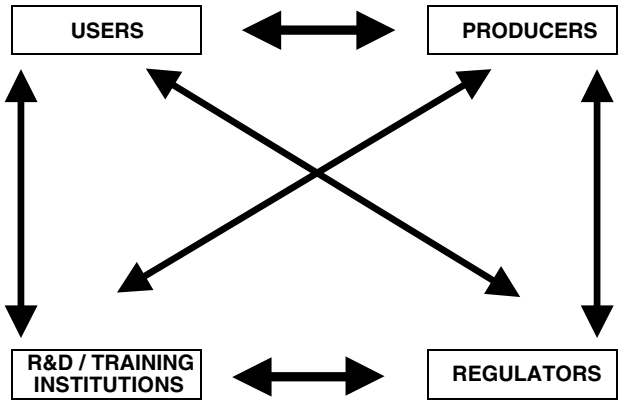

Figure 2. A well-functioning complex.

while the second models ideal information flows between key players. The third figure illustrates the situation in the most high tech subset of building and construction, the engineering construction field, and shows the poor and patchy flows of information between the four key sets of players. It shows where there are weaknesses in knowledge generation and transmission as well as where regulatory systems may be hampering progress or may indeed be insufficiently used to encourage innovative activities.

A second study of building and construction by AEGIS, this time of the research funded by companies in the field but carried out in public sector research institutions, revealed that there was quite a bit of investment, especially in the materials area. The study also revealed, however, that the investments were made in an ad hoc manner, with few or no systematic programmes of investigation and very little joint research in related technology fields such as building-related industrial ceramics. (There were some exceptions to this rule, notably in solar energy, but this investment was made not by building-related companies but by the power utilities). The study also showed that, understandably, while individual firms made the investments that most suited them at the time, these were often not in areas most useful for the industry as a whole and there were often few spillovers since the results were confidential.

Working further on improving links in such product systems or complexes of activity is clearly one way to strengthen innovative capacity and leverage up the capabilities of the whole complex, including both large and smaller firms as well as the R&D agencies and regulators concerned.

The AEGIS studies were conducted as part of the inputs needed to the Action Agenda policy process adopted by the federal government in 1998 as an important component of its industry-related strategies. The approach partially replicates that taken from the early 1990s by the government of Quebec in Canada and incorporates some of the 'complexes' approach taken by my own earlier research (Marceau, 1994).

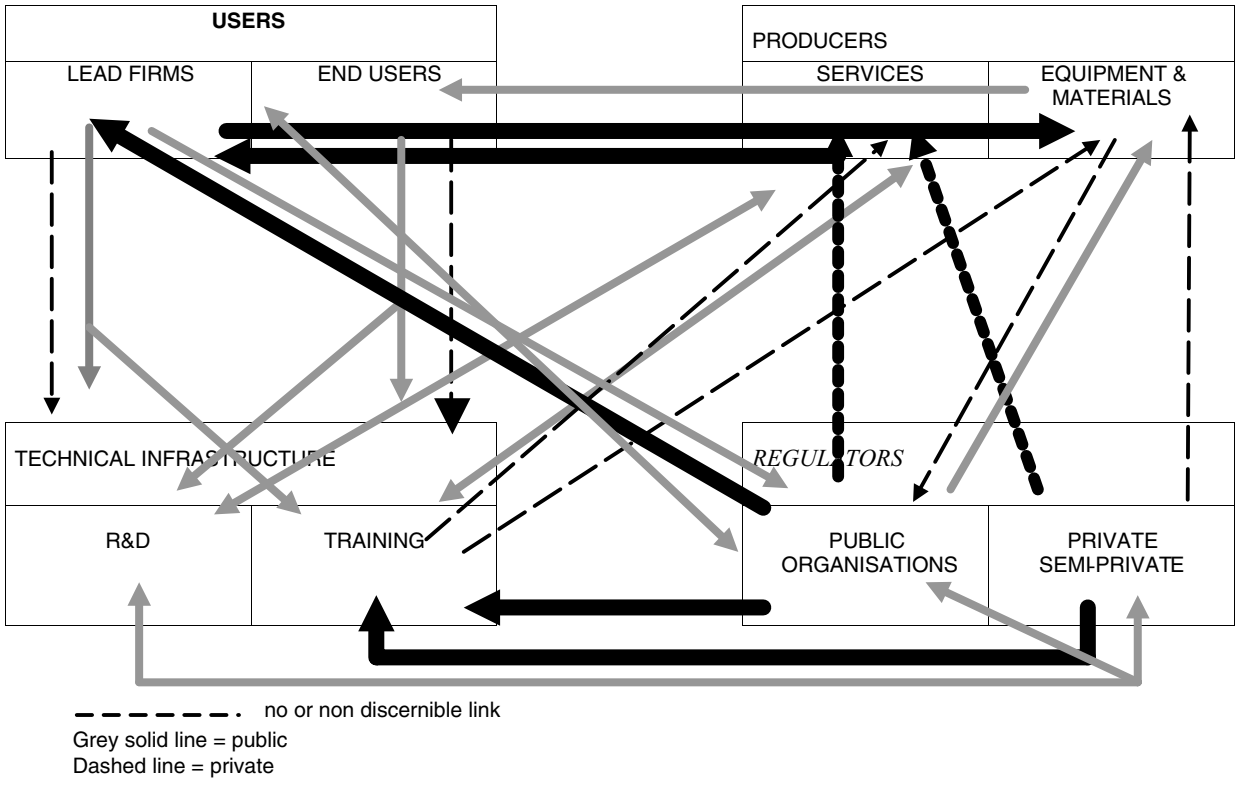

Figure 3. Information flows: engineering construction.

As the Guidelines indicate, the primary focus of the Action Agendas is:

> ... to lift the growth prospects of important industry sectors. They offer an opportunity to create long term sustainable competitive advantage by identifying the actions necessary to lift our innovative and knowledge creating capacity at the sector level ... High level industry commitment is a prerequisite ... The Government's role is that of a catalyst providing the logistical framework for the process and actions and some direct involvement where necessary ... Because it is intended that the Action Agendas take a whole of government approach, they will provide a framework for more effective co-ordination and integration of government policies as they impact on particular industries ... They will also be an invaluable tool for informing the broader policy development process
>
> (Department of Industry, Science and Resources, 1998).

The Action Agendas as currently constituted bring together government and industry players in a range of sectors to examine collectively what is needed to improve the competitiveness of the industry concerned. The core groups involved have usually been nominated by industry associations or are known to the federal department concerned as leaders in the field. The approach is aimed explicitly at recognising the differences between industry sectors. As the Guidelines say, each sector has 'unique characteristics and challenges. Some industry sectors are dependent on large one-off capital-intensive projects while others are best suited to small innovative firms. Some are heavily dependent on science and technology while in others efficiency may be maximised through innovative management and work practices ...' The Action Agenda approach also explicitly recognises that better knowledge in a variety of areas is essential to competitive strength.

Each Action Agenda process undertaken has varied somewhat but commonly includes research into the basic parameters of the industry. The parameters include technological capability, skill levels, and R&D infrastructure and the trade and industry structure (number and size of firms etc.) of the area as well as its productivity. The research undertaken by AEGIS for the different Action Agenda industries reshaped the available statistics to describe the contours of each industry seen as a 'product system' so as to include key players excluded in studies that take the more usual sectoral approach. Thus, for example, in the furnishings study we included not only the furniture producing firms but also the retailers and office designers and architects who act as the drivers of innovation. Similarly, in TCF&L the retailers had a key place and in toolmaking the major clients. This is the approach which enables the analyst to understand the *dynamics* of the arena, not just to build a static picture.

Research of this kind is the basis for discussions between officials of the federal Department of Industry, Science and Resources and the firms involved in the Action Agenda process. The discussions focus on what is needed for the strategic development of the whole industry, not just the leading firms. The Department arranges a series of industry forums and taskforces that are charged with devising a concrete set of recommendations as to how best to take the industry forward. Unfortunately, the government has not yet provided any long term commitment to implementing the recommendations but the process does provide a model for the future when governments may have a greater interest in such developmental strategies. At present the Building and Construction Action Agenda process is perhaps one of the best funded and developed. It has included considerable research into the different aspects of the functioning of the industry in Australia, studies of trends in the international context in which it works, a large scale international benchmarking exercise and an innovation survey. The Department also encouraged the creation of the recently-approved Cooperative Research Centre in Construction Innovation.

Addressing present limitations: the next steps

The brief of the Action Agenda participants is, as I have emphasised, to come up with *collective* suggestions as to how to take their industries forward with an eye on the achievement of specific outcomes. It is also to consider especially both the technological strength of the sector and gaps in its technological capability and whether sufficient investment is available for innovative but high risk R&D projects.

There are two problems with the current Action Agenda framework from the point of view of discussions of technological strength and the need for more or different R&D. Both relate to the narrow sectoral view often taken and hence the narrow range of players included in discussions. The first problem derives from the fact that, unless the product system approach is systematically used as the framework for analysis, the Action Agenda process may well leave out useful input from the real drivers of innovation who are outside the usual sectoral boundaries as described above.

The second problem is that, while the process brings together officials and industry leaders, it leaves out some other key players, in particular, key public sector researchers. It also neglects input by the 'users' of the sector's products – for example in building and construction, the users of key constructed items – or by some of the relevant regulator-users, the city planners who have critical interests in the outcomes of new designs, construction techniques and technologies, or

the transport planners who may have to use new technologies to cope with major shifts in population geographies.

If the Action Agenda processes were to be adjusted in a second stage to include key driver areas, R&D personnel and users of different kinds they could provide a much more powerful mechanism for allowing players to pool their knowledge so as to agree both on immediate priorities for research and on the directions for and development of long term, systematic programmes of R&D. These programmes could be financed jointly by industry and government, in whatever proportions were agreed.

Taking building and construction as the exemplar area again (but other industries would have similar lists), such long term R&D programmes would have six major goals:

- the development and use of new materials and components (already the area of most R&D-intensity but not necessarily focused on considerations broader than those of the small handful of individual firms involved and their immediate clients);
- the development of new and improved process technologies (including some with the social objectives of improving health and safety in the industry);
- improving the environmental performance of the industry, including improving embodied energy levels in materials and process as well as energy in use, and the development and use of new energy-related technologies;
- the rapid and effective diffusion of awareness of new technologies to architects, developers, and users/planners as they are tested and become available;
- the development of the skills to use the new technologies;
- the development of the business-related skills needed for more cooperative forms of organisation, including relational contracting and other mechanisms for getting the scale and competencies necessary for international competition and local success.

The programmes of R&D thus developed would have the support of industry because they would reflect the priorities selected after analysis of the functioning of the product system as a whole, both at home and in international context, and may encourage firms to invest their own resources to a greater extent. The mix of public and private funding would increase the scale and hence the impact of the knowledge generated and improve its chances of acceptance by the industry concerned. The research could be seen as public good research, because it is not generating proprietary knowledge and hence fits well within the usual justifications for public funding and would have the support of industry because they would be the key stakeholders. It would be future-oriented and enable companies to scan the horizon for technological changes, shifts in the bases of competition and new sources of profitability. It would also enable the industry *as a collectivity* to find areas of local investment, whether in basic or applied research, possibly in collaboration with new partners who enter the product system as technologies and regulatory systems change.

Recent research has indicated that firms can no longer work in isolation. They need to scan the international environment for trends and for this they need to collaborate. Similarly, they need to scan the technological horizon. Several OECD countries, including Australia, have undertaken Foresight exercises. While of potentially great value, many such exercises, however, do not focus on the development of sectors as such and do not usually involve mechanisms for implementing conclusions. The research foresight process often also tends to deal with major priorities, such as the place of life sciences, IT or new materials on the national agenda. In contrast, the Action Agenda process is designed to be a continuous, low key negotiating process. It could easily be redesigned so as to focus more on proposing specific priority programmes of research to be undertaken by existing institutions and, unlike the major reviews recently undertaken or underway by OECD countries (OECD, 2000, pp. 67–72), to be focused on science and technology for the specific industrial and technological collectivities concerned over a five or ten year period.

The Action Agenda programme should not, of course, be the sole priority setting process for industrial research. In Australia, governments and national research councils and the CSIRO will rightly continue to determine further priorities. The key to the Action Agenda success is the on-going involvement of key participants in the different product systems as they work their way forward on a number of fronts. The aims may be relatively modest, at least at first, building trust and strength by small successes, and the research agenda developed will probably be more applied than basic, although it may lead back into more basic science through the iterative process indicated in the work of Senker, Faulkner and Velho (1998). Other research organisations have their own mechanisms for involving industry in their own funding decisions. The difference with the one proposed is that in other arenas the research organisations bring industry to the research table: the Action Agendas bring researchers to the industry's table as part of a much broader development strategy.

The process of selection of research directions and decisions to fund particular projects and programmes would be difficult in that it would involve companies deciding to share some competitive knowledge as well as pre-competitive research and to agree to investments in a common cause. Doubtless not all players in any industry would agree to participate. But some at least of those that did join would be better able to use the

common core, public research to leverage better value from their own R&D investments and thus add individual value to their collaborative efforts. Ownership of the resulting common core IP could be vested in the government or a specialised institute which combined industry and broader interests and was open to all players.

Conclusion: six major advantages of the Action Agenda approach

There are six major advantages to the Action Agenda approach to deciding on industry-specific R&D programmes as a mechanism for encouraging greater and more effective national investment in both public and private sector R&D and to link industry interests and public sector research through co-determination of priorities. The advantages are:

- the process leads to major long term programmes of coherent research oriented to shorter term use or to basic investigation as required, recognising the interaction and feedback loops of much R&D and its use, without the public sector 'picking winners';
- players in the product system develop new ways of interacting for the good of the *industry* and not just individual firms and can develop longer term priorities for investment in knowledge-generation;
- greater responsibility is given to industry participants to lift the performance of their industry as a whole and not to wait for government to act (end of the 'government oughta' approach, still very common);
- all benefits are social and spill over to players which tax-related R&D concessions or credits to individual companies do not permit;
- research programmes selected improve both the general level of knowledge-generation in the product system and, equally important, the capacity to absorb and use knowledge by firms in the industry and the more organised transmission of knowledge along supply chains;
- the Action Agenda process makes it possible *to link R&D and other development programmes together into packages of policies and programmes* rather than simply encouraging R&D as the tax-related policies do. Thus, for example, training and skills development programmes can be developed in concert with the creation and use of the new knowledge generated. These programmes too can benefit the whole industry.

The six advantages flow because the process proposed takes account of some of the key insights provided by studies of innovation. In particular, it recognises that industry development involves both competition and collaboration and the effective interaction of users and producers along supply chains at all levels. The model proposed is a way of guiding users and producers to work together for the common future of their industry. It raises the capacity of all firms to adopt new technologies as they emerge or to make the alliances that will enable them to compete in the new circumstances by indicating in a practical manner the advantages of collaboration where scale is of the essence. It involves small as well as large players. Existing R&D institutions together become a more central part of the debate about directions and funding for research and can make better decisions about areas in which to specialise and build strength. Regulators are involved which facilitates the task of effective regulation, regulation with a developmental as well as a standards and public welfare focus. Above all perhaps, the approach involves flows of information about a variety of issues affecting the industry and helps build the trust which research everywhere indicates is central to the creation and functioning of the networks that firms need to share risks and knowledge as well as production and distribution activities (OECD, 2000).

The process also recognises the insights provided by research into the functioning of different industries. The most important insight in this present context is that indeed all industries are different and have different priorities and needs as well as some similarities. Thus, the process can, for example, take account of the conclusions of recent work by Whitley (1999, 2000) which shows how institutional arrangements, governance structures and other elements of sectoral business systems affect industries' capacity to innovate and of work by Unger (2000) that analyses the difference between innovation systems which involve 'voice' rather than 'exit'. Such differences mean that industry development strategies themselves need to differ to reflect these or they will be doomed to failure. Most important of all, the system goes a long way towards overcoming the problems of targeting, scale and participation by a full range of players detailed in the studies discussed at the beginning of this paper.

Perhaps there are some disadvantages to the approach proposed but it is hard to see them as clearly as the advantages. Doubtless, there would have to be special arrangements to ensure participation by smaller firms and to ensure that sufficient attention was paid to public interests as well as private benefits in decisions about directions of research and what to fund as a priority. Since the government would hold at least some of the purse-strings, however, regulators would have leverage to ensure acceptable outcomes on this score. Many firms, especially those more powerful, would need convincing that this is a better way than private lobbying and that the new approach would indeed benefit them in the longer term. However, the Quebec government, using a similar approach, has found that, provided the government makes clear that this is the policy operating and that it will operate for the long term, most come round, even to the extent of opposing changes to the system when proposed. In

general then, the approaches described and suggested seem to be worth trying. The innovation literature is richer in suggestions about what does not work and what to avoid or in proposing general solutions such as reducing barriers to competition (see e.g. Carlsson, 1996; OECD, 2000) when discussing policies for increased investment in research and development than it is in proposing broader and more positive policies for industry development which includes R&D as an element. A sectoral system of priority-setting by government alone is usually equally unacceptable to both industry and researchers.

So far no other set of policies for industry development and national R&D priority setting suggested seems to recognise and meet the insights of the literature to the same extent or to offer the same potential for the coordination of policies across different government departments because there have been no guiding lines for such activities in any but the short term. The inadequacies of our present system ensure that most policymaking in Australia focuses on the shorter term and that in most cases different areas of government do not systematically share enough information or devise common policies, even in closely related areas such as industry, research and training and the environment. The system described and proposed overcomes many present limitations while leaving the way open for policy improvements in every arena. Governments need guidelines for action which can be cumulative and lead to tangible benefits within a relatively short timeframe. This proposal does not entirely overcome the time difficulty because of the nature of R&D but it does provide a framework which can be used in every area for the relevant discussions and a template which can be used for testing policy suggestions and assessing the impact of proposals made in one arena on others.

Experience with the Action Agenda process as it currently stands seems positive: it seems at least worth trying to extend its reach to the setting of priorities for industry-specific R&D investment and management, to deal with the selection issues which, as de la Mothe remarked in the article quoted at the beginning of this paper, are essential but so hard for small countries.

Finally, as de la Mothe also said, it is important to understand that science policy

> cannot be treated as standing outside of the body and practice of public policymaking. In and of itself it does not hold a special place in government circles ... *unless* it is directly tied to the national interest. Even, or especially, at a time when the production of knowledge itself is being transformed, to miss this point is to risk arriving at a distorted assessment of the science-government relationship (1999, p. 375).

The proposal made in this paper brings science policy and the associated priority setting for national R&D management fully into the general arena of government policymaking and gives it the place it deserves in collective industry development strategies which involve active participation by all major stakeholders.

In summary, then, the proposal made in the paper comes to grips with the difficulties now recognised by many to be facing R&D encouragement policies which do not take into account the differences in structure and opportunities which characterise different industries. It also helps overcome the limitations on the development of long term policies for R&D priorities where many critical stakeholders do not participate in funding decisions and are not committed to outcomes or collaborative processes of industry development. It uses a new research tool – the product system approach – to indicate the broader range of players who need to be included and proposes a way in which those players can be involved in the decisions taken.

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