Nurturing National Talent: The Australian Research Council's Fellowship Scheme

JANE MARCEAU & HUGH PRESTON

ABSTRACT *This paper examines the functioning of a Research Fellowship Scheme in Australia and its place in the higher education system. It indicates the educational paths and early career tracks which have led the gifted researchers studied to their elite positions. It indicates how the research strategies of supervisors (Heads of Department and School) affect the placing of Fellows and how the sociological and institutional contexts of the broader education system influence outcomes. It suggests some of the dilemmas faced by policymakers attempting to strengthen the research and higher education systems of small countries with limited resources which want to maintain a national and international science capability.*

Keywords: higher education, research system, science policy, international research links, international technology transfer, public policy.

In recent years there has been considerable debate in both academic and policy-making circles about two critical issues in the research field: the relative weight which a country 'should' give to the basic and applied ends of the research spectrum in making its knowledge-generating investments and the degree to which industry and the higher education system should be contributing to the overall research endeavor. The OECD regularly publishes comparative tables which indicate the relative investments in each Member country in different kinds of research and according to the source of funds. In more recent years, too, there has come to be a greater emphasis on the broader mechanisms which link knowledge production to goods and services production in what has become known as the innovation process. New issues have arisen relating to the ways in which institutions linked de facto into national systems of knowledge production or innovation may work against each other or cohere into more powerful systems than may have been expected without good institutional synergies. These institutions may include business as well as public sector organisations.

While '. . . reliance on R&D data can lead to overemphasis on the research part of the innovation process' as the *Oslo Manual*[1] points out, it is clear that there needs to be emphasis on *both* the research which produces the knowledge in a successful innovation system and the development which is needed for commercial application and on the systems which underlie both processes.

In both cases it is very important to understand the processes by which a country may maximise the value of its innovation-related investments. This involves understanding the processes underlying all aspects of a country's innovation system. These processes at macro-level are difficult to catch. This is because there may well be several systems of knowledge production in operation. Some of these are more institutionalised than are

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others. While we can measure the productivity of research organisations through such indicators as publications in recognised international journals and number of patents granted, it has recently been pointed out by a group of science policy experts that much new knowledge in developed societies is not generated through formal organisations but through transient teams which are called into existence because of a problem recognised in the real world whose solution demands input which cuts across the traditional boundaries of disciplines.[2] In the view of Gibbons and his colleagues there are now two modes of knowledge production, which they call, unsurprisingly, Modes 1 and 2, one being the traditional university research organisation and the other the teams referred to above. The productivity of players in Mode 2 is much harder to measure because the teams disperse after their task is done. Moreover, say Gibbons and his colleagues, it is now clear that much of what is normally considered 'basic' research is now done within the context of Mode 2 operations so that much of a country's basic research escapes the formal system.

In many countries, too, it is becoming increasingly clear, much basic science is being generated by scientists working in companies, especially in the biological sciences where certain firms generate as many papers in ISI journals as do medium-sized universities in the UK or the US.[3] As Hicks also shows, much is also produced via international collaborations between groups of experts.

So where is Australia in the emerging knowledge generation system? The OECD and ABS (Australian Bureau of Statistics) data available make it clear that although business investment in R&D has been rising since the mid-1980s it is still low by international standards. Moreover, much of this increase seems to be due to a set of incentive schemes such as Factor (f) and the 125% R&D tax concesssion[4] and these schemes usually have finite lives, especially in a context where the emphasis of public policy is on a rather narrow view of competition. The great bulk of funding for research in Australia comes from public sources and is performed in public sector institutions. In 1992–1993, the last year for which full figures are available, just under 1% of GDP was spent by Australian Federal and State governments on R&D while only 0.55% of GDP was funded by the private sector, a figure which includes tax revenues foregone.[5] Similarly, the largest proportion of Australia's R&D effort was (and is) performed by public sector institutions. What these organisations do is therefore still critical to the innovation process in Australia and of greater importance than in many other OECD countries which have more home-based multinationals (important since most such organisations conduct their R&D at 'home' as Patel and Pavitt have pointed out)[6] and greater investment by their business community.

The international statistics thus show that Australia relies to a greater degree than do others on the strength of her basic research system to generate new knowledge because of the relatively low proportions of business investment. The implication of this could be argued to be that greater policy attention still should be paid to the functioning of the basic research system. Since the operation of Mode 2 is harder to seize in public policy terms this effectively means that we need to pay more attention to the operations of the organisations working within Mode 1 which in turn means the universities and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). A great deal of policy attention has been paid to the CSIRO over recent years, most of it concerned with the more applied end of CSIRO activities with little attention to its role within the system of generating basic knowledge. Doing so would require a specific study which is outside the bounds of this article but which now needs to be done if Australia's research system is to be considered as a whole.

One further factor needs to be mentioned here before we go on to the central part

of the paper. This is to underline the international nature of scientific research. This is especially important in the context of a country which produces only 2% of the world's scientific output but aims to produce excellent work in many areas and cutting edge work in some fields. In this context clearly international links are vital. Since the technologies of science are moving so fast and so much now depends less on basic discoveries of principles and more on the technologies more broadly defined, keeping up with the technological advances behind success in the basic sciences is as important as the latest findings themselves and much more difficult to achieve. In Australia's case 'being there' is a critical strategy in scientific intelligence gathering. Not everyone can 'be there'—so much depends on the tacit and formal knowledge held by persons. An international traffic in experts is therefore a critical part of Australian strategies for keeping at least close to the forefront of local scientists' fields. The rest of this paper looks at the functioning of a small but important publicly funded scheme for encouraging basic research in Australia. This is the Australian Research Council's (ARC) Fellowships scheme which we reviewed for the ARC in 1994–1995.

A Case Study: The Fellowships Scheme of the Australian Research Council (ARC)[7]

The Fellowships scheme of the ARC is a $20 million scheme which rewards gifted researchers at a number of different levels of experience and achievement with research-only posts for periods of three or five years. The Fellowships are tenable in the Australian university or public sector research institute of each Fellow's choice. The scheme was established in its present form in 1990.

When governments seek to remedy what they see as problems for their nations they often create policies which they see as solving several issues at the same time. Further, in both the detailed writing of the policies and in their implementation, additional, although less explicit, objectives often appear. The case of the ARC Fellowship Scheme is no exception. The Scheme was formally given the twin objectives of strengthening Australia's national R&D capability by providing opportunities for gifted individuals to undertake research of national and international significance or national benefit and strengthening the higher education system. Implied in the policy, however, was a third objective which was the nurturing of a national pool of talent. This paper looks at the way the multiple explicit and implied objectives both worked in practice in the initial years of the Scheme and some of the issues raised for nurturing a national pool of talent. Our study deals only with the initial years of the Scheme; these serve as an exemplar of the broader policy issues concerned.

There are four categories of Fellowships: Post-doctoral Fellow (PDFs), Queen Elizabeth II Fellow (QEIIs), Australian Research Fellow (ARFs) and Senior Research Fellows (SRFs). Around 100 are selected each year, making 420 in the system by 1994–1995, around 15% of all researchers in postdoctoral positions.

The study showed three major factors of importance in the implementation of this policy which were not built into the policy as such but which seemed to work to maximise the benefit of given amounts of basic research funding. Looking at these helps to understand the functioning of the science system in Australia more broadly. The first, and most important, is the strategic use of the Fellowships by the 'supervisor' of the Fellows rather than only by the Fellows themselves. This shows the importance to the system not only of the Fellows' own talents but also of the mix of institutions and strategies into which the Fellowship Scheme fell.

The second is the very narrow but long trail of positions that led to individuals

gaining the Fellowships and perhaps succeeding in research careers beyond. This trail indicates how important it is when designing policies of this kind to take account of the potential impact of the institutional structure and the functioning of the status distinctions which are associated with it on likely outcomes. Policies of the kind discussed here do not operate in a social and organisational vacuum but within a complex system of formal and informal rules and practices. Of the vast number of educational institutions potentially available as training grounds for the Fellows, only a few were actually involved in the first year of the Scheme despite the fact that the trails leading to the positions were often long and complex and usually led out of the country for periods. The narrowness of these trails owes much to the strategic action of research leaders mentioned above.

The third is the importance of the international experience of the Fellows, especially the QEIIs. This experience is a function of the national and international science education systems as well as of the choices made by the Fellows themselves. Again, the outcomes owe much to the strategic decisions of science leaders. The Fellows selected act as international technology transfer agents in that they bring leading edge information and (tacit and formal) expertise in the selection and operation of some of the most advanced equipment available to laboratories in Australia. They further bring either new networks to their host departments or deepen the existing ones through the constant activation which ensures the networks' continuing existence. The ways in which they do this, however, are only partly determined by the Scheme itself. A glance at the data gathered in the course of the study reported will illustrate the three points.

First, who are the 1991 Fellows and where did they go? Of the 103 Fellows in the 1991 cohort, 12% were aged under 30, 37% 30–34 years, 21% 35–39, 17% 40–49 and 13% 50 or older. The median age was 35 for males and 36 for females. While the ages varied among different types of Fellows, even the most 'junior' group, the PDFs were mostly over 30.

Table 1 shows the institutions where Fellows elected to hold their Fellowships and Table 2 shows the fields of research in which they were active. Table 1 shows the pre-eminent position of the Institute of Advanced Studies at the Australian National University (ANU IAS) as the preferred location for holding the Fellowship, except among ARFs. The overall proportion selecting the ANU IAS was 20% (21 persons) but reached 57% among the QEIIs. The Universities of Queensland and Adelaide were selected by 10 Fellows each and were followed by Sydney, Melbourne, New South Wales and Tasmania, representing 50% of the Fellows. Only seven universities thus accounted for 72% of Fellows' choices.

Similarly, there was a good deal of concentration in the fields of research which won in the initial competition. Table 2 shows the overwhelming predominance of Biological Sciences (29 out of 103 Fellows), followed by Earth Sciences (15 Fellows) and Physics (11 Fellows). The other areas received each less than 10 Fellows, with Computing Science and Engineering receiving respectively only 1 and 2 Fellows. While the Humanities and Social Sciences had improved their score by 1994, Biological Sciences still maintained its position as the single biggest field and was still followed by Physics.

As was indicated above, the trail leading to the Fellowships was both long and narrow. Analysing those trails reveals the importance to future research careers of the universities selected for both first degrees and doctorates. Nearly three-quarters of the 103 Fellows selected in 1990 had obtained their first degree in Australia; of those who had studied in Australia, 42% had studied at one of only three institutions—the Universities of Queensland and Melbourne and the Australian National University (ANU). At doctoral level there was already some movement overseas; more than one-third (37%) of all Fellows had received doctoral training at an institution outside

Table 1. 1991 Cohort by type of fellowship and institution

Type	ANU-IAS	Queensland	Adelaide	Sydney	Melbourne	NSW	Tasmania	Monash	Other HE	Non HE	Total
P	9	3	4	1	2	3	3	2	13	2	42
Q	8	2	0	0	0	2	0	1	1	0	14
R	0	2	4	2	3	1	4	1	5	5	27
S	4	3	2	5	3	1	0	0	2	0	20
Total	**21**	**10**	**10**	**8**	**8**	**7**	**7**	**4**	**21**	**7**	**103**

Source: Ref. 7, p. 35.

Table 2. 1991 Cohort by field of research and type of fellowship

Type	Maths	Physics	Chem	Earth	Comp	App Sci	Engin	Biol	Rural	Med/Hlth	Soc Sci	Humanities	Total
P	2	4	2	7	0	2	1	15	2	1	3	3	42
Q	0	1	1	3	0	4	0	4	0	1	0	0	14
R	0	4	4	3	0	0	1	8	2	2	1	2	27
S	5	2	1	2	1	0	0	2	0	2	1	4	20
Total	**7**	**11**	**8**	**15**	**1**	**6**	**2**	**29**	**4**	**4**	**5**	**9**	**103**

Source: Ref. 7, p. 33.

Australia, principally at Oxford, Cambridge and London. Within Australia, 21% had received doctorates from the ANU, followed by 15% from Queensland and 11% from Adelaide. Those from ANU were predominantly in the biological sciences.

From a Ph.D. in Australia the Fellowship trail, especially for the most prestigious appointments, the QEIIs, led overseas. Between two-thirds and three-quarters (71%) of Fellows selected in 1990 had had overseas experience at postdoctoral level before applying to the ARC while a quarter were still overseas before taking up their Fellowships. Almost all QEIIs (93%), half the PDFs, two-thirds of the ARFs and three-quarters of the SRFs had gained postdoctoral experience outside Australia. Most had held these overseas positions in one or more of a small group of highly prestigious institutions. These international connections are probably very important for the candidates' success, given the selective nature of the experience and choice of overseas institutions which revealed itself through the background data and interviews conducted for the evaluation.

The choice of institution at which to hold the award was no matter of chance in most cases, again especially among the QEIIs. Eight of the QEIIs interviewed out of the 15 QEII Fellows held their Fellowships in the Institute of Advanced Studies at the ANU. Of these three had done their first degrees there; two had also done their Ph.D.s there while the third had gone to California to prepare his doctorate. Another had a Sydney first degree but an ANU Ph.D. while the others had gone to Cambridge, Oxford and London for their doctoral work. Of the whole group of QEIIs *no* person with either an ANU first degree or an ANU doctorate took his Fellowship to another university. Similar patterns were also shown in relation to the University of Queensland.

This narrow path is evidence of the importance of particular research networks and helps show why some universities are able to maintain their lead in given disciplines for what may be quite long periods.[8] In other words, just like companies which seldom innovate in product areas totally new to them because of the need for complementary scientific assets and which, when they do move, remain in related fields, so universities may decide to specialise and maintain their lead in the same areas rather than move into unrelated ones and use the Fellows' special expertise to do so.

Despite the strategic nature of the selection decisions by the host institutions and the narrow paths which had led to the Fellowship position in terms of place of earlier training institutions, trails leading to the ARC Fellowships were long in many cases. Even among the most 'junior' group, the PDFs, more than half had already held post-doctoral positions, and 4 had had two. Among the QEIIs, 14 out of 15 had held post-doctoral posts, including 8 who had held two or more while among the ARFs the proportion is even higher: only 1 out of 27 had held no post-doctoral post while 9 had held two, and 11 three or more, including 4 who had held more than four such posts.

The overseas experience they had obtained was also of great importance. The same number of PDFs who had no postdoctoral experience also had no overseas experience but even there, among the most 'junior', more than half had worked overseas. From there up the scale the proportions with overseas experience were overwhelming. Thus 13 of the 14 QEIIs from whom we have the information had worked overseas (93%), as had 17 of the 27 ARFs and 16 of the 20 SRFs. Nearly half the QEIIs were overseas at the time of appliction to the ARC in 1990 as were almost a third of the PDFs.

The interviews undertaken with the Heads of the Departments in which the Fellows were working indicate why these appreciated the Fellows' presence. These persons used the resources at their disposal in a strategic manner, whether these resources were persons, knowledge or positions available. The following examples illustrate the ways in which the ARC Fellowship Scheme was incorporated into broader research development

strategies and shows the mechanisms by which canny departmental leaders fought to maintain their units at the leading edge of the field, to move resources into promising areas and to ensure the national and international visibility of their units through a steady stream of prestigious publications and international visitors and collaborators. This set of inputs and outputs in turn makes it easier to attract good people and extra funds through grants and collaborations with industry or other outside organisations. In these departments the ARC Scheme takes a respected place alongside a range of positions funded by other authorities such as the National Health and Medical Research Council and internal funds. Some of these entrepreneurial departments develop links with the more apparently 'applied' Special and Key research Centres and Co-operative Research Centres (CRCs).

The ways in which the system functions were described by one Head of Department as follows:

> Yes, I certainly do encourage people to apply for Fellowships and to hold them in my School. I have one on my desk at the moment from a person wanting to return to Australia. . . . The School is interested in the experience the Fellows have had; we especially look for those that are overseas. We set out to bring back talented Australians and with them the research excellence they bring back from overseas. They are important for developing and maintaining international links in different fields. *We look around for Australians who are overseas or for others in our competitor institutions and we try to bring that expertise back here.* We use our own research people to do the same [i.e. send overseas to gain information and experience]. Targeting ARC is part of a broader strategy . . . (emphasis added).

Further, the same strategy may be used to attract funds for needed equipment:

> This kind of strategy is important because it may enable [us] to move into areas at a high level and the expertise thus made available allows us to take up new initiatives funded by government. It has enabled us to build links with a key client in industry which provides greater funding. Equipment bought for basic research can be used for applied work.

In this way, too, we were told, it is possible to build on the more applied strengths of other departments in Australia. Some universities have concentrated on building industry links but 'need the more basic as well'. These links allow the basic researcher funds 'to add strength to the system' and lead to collaborative work of benefit to both. The outcome in the School in question is a mix of staff funded from a great variety of sources—'12 out of 47 from ARC funds, five and a half from assorted outside funds and the rest from internal positions'.

A second example pushes the point a little further.

> I encourage people to apply . . . The Fellowship Scheme is an integral and fundamental part of this program. It gives us an extra dimension in two ways. We no longer have enough core money—most of our fundamental research is now funded from outside. We have two ARC Fellows and a DITAC GIRD one but have had many others and are involved in the largest CRC. ARC Fellows are crucial because they are pure untouchable researchers . . . [they] work in tandem with the others. [They] justify the leading edge . . . They give a measure of autonomy since they are pursuing their own lines of interest which ride above the notion of the Centre and give greater breadth.

The Heads of Department in question then clearly sit like spiders at the centre of

worldwide webs, keeping tabs on who at which centres is doing what leading edge research in fields of interest to their units. They place their Ph.D. candidates and graduates and even early postdoctoral students in these positions, keep in touch and advise on next career moves. When an opportunity arises they bring the person(s) back. The Fellows in turn transfer not only knowledge of who is doing what but also the tacit knowledge of how they are doing it, of what works well and less well, and expertise in the construction and use of new equipment, a point explicitly mentioned by one interviewee who had used the Fellow to update the software used in the host unit and to teach its use to others. The Fellows thus contribute to strengthening all the elements of STI mentioned by Faulkner and Senker—skills, artifacts, knowledge and information—in their study of university industry links in three advanced technologies.[9]

Conclusions: Careers, Contacts and Issues for the Future

The case study indicated the ways in which links to world science can be maintained by a small country with a strong science base but relatively few resources. These links can be the basis for continuing the collaborations across national boundaries which have characterised the Australian science system since its inception.[10] It is undoubtedly important that these continue and that they be extended to new arenas. In the past, Australia developed close relations with the scientists of the USA and the UK, as well as with continental Europe to a much lesser extent. These were the major scientific production countries. Now, however, two developments have shifted the patterns of collaboration. On the one hand, there has been a vast increase in the internationalisation of European research.[11] On the other hand, there has been a considerable increase in the proportion of world science produced by the countries of Asia, notably Japan, as Bourke and Butler have recently pointed out.[12]

The ARC Fellowship scheme makes an important contribution to the maintenance of Australia's strong international reputation in the natural sciences. It allows a cadre of well-trained people to practice their craft in the fields of their choice and although the number of Fellows in the Scheme is small, the group is a significant proportion of the total pool of research-only personnel in Australia's universities. We calculated that in 1991 there were around 1940 post-doctoral research-only staff in Australian universities. This figure included 640 or so who were supported by the ANU IAS which also had around 250 research-only staff supported from external funds. The ARC Fellowship scheme supported around 14% of the total PDR population of the time, although the Council also supported a number of other research-only staff through ARC-funded Centres of various kinds.

The evaluation of the ARC scheme for Fellows also suggests, however, that there may be some problems in the future which should concern policymakers. These relate in particular to the careers available to these high-flying research-only staff after they finish their Fellowships. Few of the first cohort of Fellows had finished their Fellowships at the time of the study because many had five year contracts which had not expired. The only career data available which indicate whether there is life after the ARC contracts concern the first post-ARC positions held by the PDFs and some QEIIs. The ARC scheme was intended to provide a career track for research-only staff along the model established by the NH&MRC. It quickly ran into problems in that respect, however, because of the size of the Scheme which meant that there were fewer positions at each level and many uncertainties about the future of the Scheme.

Some ex-Fellows did, nonetheless, manage to obtain research-only positions, including some within the ARC Scheme itself, after the expiration of their first appointments.

Of the PDFs, for instance, nine of the 13 whose Fellowships had expired at the time of the study had obtained research-only positions, five within the Scheme and four within the ANU IAS. Of the 12 QEIIs moving on and whose destination is known, half remained in the ARC Scheme as SRFs (which they took up in the ANU Faculties) or remained in or went to the ANU IAS as Research Fellows. Few entered or remained for long in other ARC-funded Centres or CRCs (three QEIIs, two PDFs), suggesting that there is little contact between the different worlds despite the fact that there are several CRCs and Centres in the fields of work in which the Fellows were apparently directly involved. There is even less contact with the world of teaching in the universities.

Analysis of the more junior Fellowship population's career paths suggests that in many cases a period at the ANU between a doctoral position overseas and obtaining a QEII seems to be valuable in gaining the experience and publications which improve a candidate's chances in the strong competition for ARC Fellowships. The Fellowship in turn improves the chances of obtaining a more senior ANU Fellowship. Thus a period as an ARC-funded PDF may be followed by an ANU research Fellowship which in turn will lead on to a QEII or an ARF. Before the change of eligibility rules, a QEII may have been followed by a period on the ANU payroll and then an ARC SRF position.

There are two sets of problems which may arise in relation to this pattern of career. The first is the insecurity of career offered. The career paths described for the Fellows are essentially composed of a series of relatively short-term contracts. The paths followed before the Fellowships were both long and insecure and those afterwards were similar, despite the fact that by then the incumbents had reached near middle age and were highly experienced and qualified academic professionals. In these circumstances it may be difficult to maintain the motivation which had driven the Fellows in the past and cause some drift to other positions. More important perhaps, such insecurity makes it hard for the Fellows to plan their careers in any but the broadest terms. To some degree they have to take what they can get and the research they undertake becomes a function of the opportunities available. The positions which they get may not be wholly within their fields of expertise and may cause them ultimately to lose the leading edge which they had justified. The skills so expensively acquired both by the Fellows themselves and by the host departments may lose some of their power as their research specialisations become diluted by the demands of new positions.

To some degree this danger may be mitigated by the existence of the ANU IAS which provides the contracts in special areas which complement or support those of the Fellows and where they can exercise and improve their special expertise and skills. This rather closed environment may present its own danger, however. The narrow education and career paths followed by the Fellows, winding as they do through very few institutions in Australia, may mean that their expertise is to some extent 'captured' by the institutions which both educated them and hosted them and provide a post at the end of the Fellowships.

This brings us to the second problem and that is where the multiplicity of goals of the Scheme may need rethinking. We saw above that at least in the initial post-Fellowship careers there was little movement into teaching positions and indeed that most Fellows not remaining within the ARC Scheme had taken positions in research-only centres even within teaching universities. If indeed the Fellows are at the leading edge of their fields and bring with them both valuable international contacts and new technologies, it could be argued that, considered from the viewpoint of strengthening the higher education system *as a whole*, they should be spread more thinly around departments. This is because many departments find it hard to upgrade their research output, or indeed their equipment, without such high-level assistance even though they are good

departments, perhaps even among the country's best. It may even mean that input to teaching at top levels is not enriched.

This consideration leads us back to the very difficult issues which surround questions of targeting and concentration of scarce resources. The ARC Scheme itself is driven by individual demand, not institutional requirements. This may be entirely appropriate for the Fellows and for their research supervisors and they clearly contribute to maintaining the country at the forefront of particular areas of science. Unless one can argue that the research undertaken by the Fellows and the contacts that they bring are needed and shared by their teaching colleagues whose own activities thus directly benefit it may be harder to see the contribution which the Scheme makes to the strengthening of the higher education system as a whole in Australia except in the most general way. This is not a criticism of the Scheme but an indication that the very general objectives of the kind allocated to such a Scheme so small in the system as a whole may need to be rethought. Public policymakers, it could be argued, generate excessive expectations by allocating such broad benefits to a Scheme which has quite legitimate particular aims.

There are some further issues for the Australian science base which relate more especially to the nature of the Scheme. Selection of Fellows on current criteria may mean that while the Fellows assist strong departments to continue along lines of inquiry selected some time earlier they may contribute to the overlooking of promising new areas—and indeed promising new institutions[13]—which have a less attractive current profile. In this case much depends on the strategic activities of the Fellows' hosts. It may be that in more recent years the problem of capture by existing strengths has been resolved by a greater variety in the selection of institutions by successful Fellows, although the most recent figures do not indicate that there has been significant change.

This issue is important because of the very qualities and advantages which the Fellows bring to their host departments, at least as they themselves see them and their views were largely confirmed by interviews with heads of departments and senior university administrators. Thus for instance:

> [The Scheme] is important for the Department. It gives something important that would not otherwise be available, an additional dimension . . . [The presence of the Fellows] can have a research stimulus effect on the whole Department, it's not just that they publish or acquire a machine. The Fellow is in an area which I would like the School to have. This Fellow brings *Australian* researchers and contacts to the Department but I've seen other places where the Fellows have brought international visitors and contacts as the group has become a close collaborator with them.

Similarly, another host department Head said:

> The Fellows certainly add; our [1991 Fellow] is a world authority . . . he enhances the profile of the Department; no-one else works in the area and the other staff don't have his stature. He attracts visitors and has run a summer program.

And another:

> It is a real *plus* for the Department to have someone free of charge and who contributes to the Department in ways local staff cannot. They also give students a different perspective on the world.

And a Fellow himself summarised his value:

> It means they [the Department] have a high profile in research, therefore the Department attracts high quality students from all over the world and all over

> Australia, including Ph.D.s and post-docs. It breeds a further three, four or five students and post-docs to work with them and the research gets stronger. The School benefits from someone who has time to organise workshops, seminars, editorial work, etc., all increasing profile. They get all the patent rights to what I have done . . . and supervision of students at a really high level. The [presence of a Fellow] in a Program allows the Head to do other things while the program goes ahead.

We leave it to readers to judge as between the competing values of critical mass and spreading expertise as a form of technology transfer and scientific development.

There also remain issues of relationships with teaching and research colleagues and the use of the now often very limited research time which is available to many staff who are equally motivated and perhaps equally gifted researchers but who did not start their careers in ways which led them in research-only directions. Some such staff may have lacked the mentoring which sent the researchers into post-doctoral positions. In many cases, their early career decisions led them into teaching and research positions after completion of their doctoral work which would have been the 'normal' route in the periods when they graduated or in the institutions they graduated from but which make it hard for them to compete in the research-only field. A Fellowship Scheme as competitive as the one we examined makes it hard for teaching staff to gain research-only positions.

This paper cannot deal with these issues; it can only raise them in the context of the continuing dependence for progress in research in Australia on the efforts of the universities and other areas of the public sector. Upgrading and investing in the whole research system is vital to Australia's industrial future given the close relationships and heavy reliance on the science system for the basic research which sustains the innovative activities of Australia's companies, a dependence found by observers such as Turpin and his colleagues[14] and which the work by Faulkner and Senker in the UK mentioned above suggests is especially important in certain critical technologies such as biotechnology and parallel computing.[9] Programs such as the ARC Fellowship Scheme discussed here make important contributions to assisting Australia's scientists to stay close to the leading edge at least in certain fields; they cannot do everything alone, however. High levels of support must come from elsewhere.

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