Changing patterns of research direction in higher education institutions: Evidence from Australian universities

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Introduction

The relevance of academic research to national objectives and mechanisms for linking academic research to industry applications are widely discussed themes among higher education research policy analysts. In particular, the problem of linking academic knowledge with commercial applications is not a new concern. A recent report of the Task Force established to examine the commercialisation of Australian research noted that linking academic research with commercial partners was crucial to Australia's future economic development (Block, 1991). The Task Force expressed some concerns over the relevance of academic research in relation to commercial innovations but acknowledged the importance of the universities' role in both educating the workforce and in stimulating industrial innovations. The changing role of universities from 'learning institutions' to 'research institutions' with near-market orientations is of great concern to academic researchers. Recent government policies directed toward the restructuring of universities are promoting these changes. The result has been that the university research system is undergoing considerable modification. Not only are these policy changes affecting organisational restructuring but they are also influencing the university research system including evaluation of the performance of academic researchers.

Several policy instruments and mechanisms are now in place to direct and target university research toward specific areas of national interest. The Research Centres Program announced in 1982 by the Department of Employment, Education and Training (DEET) was an important policy instrument designed to strengthen the research capability that exists in universities. This program contributes nearly 20 million dollars per annum to university research and represents about 10 per cent of the total research allocation by the Australian Research Council. In addition to these centres, the Cooperative Research Centres (CRC) Program announced in 1990 aims to fund 50 centres with total Commonwealth funding rising to $100 million by 1995. The CRC scheme aims to strengthen joint-venture research by bringing together the best research teams from university, industry and public research institutions. Since 1982, the Research Centres Program of DEET and the CRC scheme have established 94 research centres with significant university involvement.

This paper analyses the impact of Centres-based collaborative research programs on the university system and outlines broad policy implications for academic researchers. The paper is based on a report by the authors at the Centre for Research Policy and draws on data provided by the Office of the Chief Scientist and DEET.

Research centres programs of Australian universities.

Three types of research centres currently operate in Australian universities. These research centres tackle three major policy concerns associated with the Australian research system:

- To capitalise on existing research capabilities and coordinate widely dispersed elements within the research community.
- To emphasise research activities dealing with near-market research and develop capacities to commercialise research results.
- To develop leading-edge research and technology capabilities by cooperating with the private and public sectors and university researchers.

Under the Special Research Centres (SRCs) program, 26 centres were established by the end of 1990. Funding for these centres was provided on the basis of universities building specific areas of research with a long-term commitment to foster selected areas of strategic basic research. SRCs receive around $600,000 per annum for a six to nine year period. These centres are supported in areas of national importance. They also intend to promote and strengthen existing research excellence in higher education institutions and are primarily involved in the exploration of knowledge (DEET, 1991).

The establishment of Key Centres of Teaching and Research (KCs) in 1985 was originally intended to address industrial training and research needs. The purpose of establishing these centres was to facilitate the transfer of knowledge from research laboratories to end users by means of rapid and targeted dissemination of information. Funds allocated to these centres are relatively small ($200,000 per annum) compared with SRCs. KCs are primarily focused on undergraduate training and link academic teaching with industry demands. They contribute directly to the innovation process by facilitating knowledge transfers and through the provision of trained personnel, particularly the training of postgraduates. A total of 33 Key Centres was established by the end of 1990, one of which won a Cooperative Research Centre in the first round of the CRC program and now functions as a CRC.

The Cooperative Research Centres (CRC) program is the first of its kind in Australia and intends to create the conditions for research collaboration among various research performers and stakeholders. Australian CRCs have been largely influenced by collaborative research models pursued in other industrialised countries, in particular, the Interdisciplinary Research Centres of the UK, and the US National Science Foundation's Industry/University Cooperative Research Centres Program. However they differ in terms of types of collaboration between partners who are not necessarily drawn from industries. Characteristics of Australian CRCs tend to encompass several aspects of research policy including the performance of interdisciplinary leading-edge research; the building of research excellence and leading research groups; the collaboration of research, training and commercial activities; and transferring knowledge to various users. Design of research programs is generally left to CRC participants and the result has been applications consisting of combinations of any of the aforementioned aspects. The CRC program has already established 35 Centres and, when fully operational, the Program will involve up to 50 centres receiving $100 million per annum. The program requires the involvement of at least one university in each CRC.

The potential to benefit from these research centres depends on the ability of universities to adapt their research systems to accommodate the demand side of research policy considerations. These centres draw upon considerable human and financial resources from participating institutions. As a result of their demand side orientation they provide quite different dimensions in the production of research outputs and processes of research evaluation. Although these research centres still consumed only a small proportion of the estimated $1072 million total research budget in 1988/89, their long term implications to higher education research in terms of deployment of intellectual resources and changed research directions arising from their establishment are considerable.

Cooperative research funding

Changing patterns of funding are significantly altering the direction of academic research in Australia. Consequently, universities have responded to these changes by developing institutional and human resource capabilities that allow them to retain a substantial stake in cooperative research. The number of cooperative, collaborative and linkage mechanisms have sharply increased although the exact value of contract research undertaken in universities is unknown.

Historically, government has provided research funds to Australian universities and government still plays a dominant role. In real terms, government financial support has increased from $987 to $1082 million during 1990-92. (Budget Papers, 1991). Government funding of university research is further augmented by increased funds through Commonwealth competitive granting schemes which contributed 29% of total direct academic research funding in 1989/90 (DEET, 1990a).

The direction and type of research fostered in the higher education research system is governed by implicit and explicit conditions attached to competitive funding. A number of Commonwealth schemes already direct funds into commercial research. These schemes include the Generic Technology Grants administered by the Department of Industry, Technology and Commerce and the Cooperative Research Centres Program of the Department of the Prime Minister and Cabinet. The CRC Program alone is expected to provide nearly $100 million per annum by 1995, although only a part of CRC funds are earmarked to university research groups. Universities have currently committed $44.3 million/annum and 267 key researchers to 35 new CRCs (Liyanage, Mitchell, Jones, 1991) and have requested and expect to receive an amount equivalent to their financial commitments from the CRC program. In addition to key researchers identified in CRC applications, there are also large numbers of participating scientists who are listed as contributing to future work in the Centres. Overall, collaborative research funding is expected to increase with new funding schemes such as the Australian Research Council's Collaborative Research Grant program which will provide an additional $2 million/annum for collaborative research with this amount expected to rise sharply (DEET, 1991).

The Australian university research system generally contributes to a reservoir of basic knowledge. Nearly 62.5% of research expenditure in the higher education sector has been identified as basic research (DITAC, 1990) and Australia's capability in some areas of the sciences is attributed to basic research undertaken by universities over the years (ASTEC, 1988). Basic research in universities is closely linked to teaching activities with both teaching and research activities contributing to the innovation process. With the advent of cooperative research, this basic academic research component is likely to be affected.

Research funding derived by universities from industry in Australia is low compared with other OECD countries. According to DEET sources, the industry contribution amounted to approximately 4.8% of the total direct research expenditure of universities during 1989/90. The weakness of the industrial base in Australia is cited as a reason for the low level of R&D which in turn results in the low level of industry university collaboration (Industry Research and Development Board, 1990: p.25). Developing university/industry collaboration is not always easy. According to a US study some industries maintained that research collaboration between universities and private industry encountered several problems such as the inconsistency of academics in concentrating of industry problem areas (Government-University-Industry Research Roundtable, 1991).

Traditionally, research in Australian universities has been carried out as part of academic activities. According to DEET sources, an estimated 6.2% or $181 million of the 1990 Operating Grant of $2923 million was devoted to teaching related research in academic institutions (DEET, 1990b). While the validity of the calculation of this amount is arguable, it does point to the extent to which university research is being generated outside established funding sources. Teaching related research can be regarded as relatively free from granting conditions and actually reflects the basic academic research component regarded as vital for maintaining standards of academic excellence. Attaining a balance between teaching related research and commercially oriented research is often argued as important for maintaining the creativity and intellectual scholarship of the nation (Aitkin, 1990).

Support for commercially oriented research primarily originates from competitive granting schemes. Competitive funds have grown together with increasing funds for research and numbers of academic staff. The number of academic researchers increased from 4,902 to 7,481 person years between 1978-1988 (Johnston and Liyanage, 1983) and funding per academic researcher at current prices has increased from $21,500 to $136,500 for the same period (ABS, 1990). While this increase suggests a relative growth in funding in relation to academic researchers, factors such as increases in research expenses for some fields like Physics need to be taken into account.

A proliferation of collaborative research centres and projects with a commercial focus is rapidly becoming a feature of the Australian higher education research system. The foremost example of centre based research collaboration in Australia, the CRC program, is characterised by a comprehensive evaluation and assessment process. The preparatory phase involved the generation of awareness of the program both directly with research institutions and through the media. The actual award of centres followed a complex selection process based on calling for referees reports, shortlisting proposals, negotiating with applicants and drawing up contracts.

Two rounds of applications have now been completed and the 35 CRCs awarded are based on a process of intensive dialogue and appraisal between funding agencies, research stakeholders as well as research performers. The CRC Secretariat also sought discussions with university administrators and university bodies such as the Australian Vice-Chancellors' Committee in creating an awareness of the program. Universities responded by establishing internal quality control processes to ensure that the best proposals were submitted and adequately supported.

The Office of the Chief Scientist did not develop or utilise a structured application form for first round CRC applications. The guidelines provided were general, accommodating all proposals within the area of applied sciences. First round applications were screened by the Secretariat according to their own assessment criteria and nearly 50% were rejected as falling outside the program's objectives. Centres were awarded after selected applications were peer reviewed. Second round applications benefited from more information and explicit directions made available to applicants on the preparation of applications and centre agendas. All second round applications were peer reviewed. Both rounds had only a short space of time in which to prepare applications and find the best groups for collaboration.

Collaborative research undertaken by CRCs is focused more on strategic research which is of direct interest to industry development or national interest. Such research tends to deviate from traditional academic research concerns. In order to accommodate a commercial orientation, the academic research system inevitably has to undergo changes. Such changes need to accompany a transition from academic basic research to a strategic basic research system which is attractive and acceptable to industry partners. Therefore, the establishment of collaborative research centres inevitably results in changes to the organisation, orientation, conduct and support of research within

academic institutions.

Cooperative research arrangements within the university research system

University/industry cooperative research arrangements have been in operation in Australian universities for some time. Both formal and informal arrangements have been made to forge links with university and industry partners. Universities have established technology transfer and development organisations such as the ANUTECH, LUMINUS, UNISEARCH, which represent commercialisation and contract research management organisations on behalf of university researchers. Organisations and establishments like Technology Parks, Technology Centres and Technology Corporations have been directly involved in developing mechanisms for greater participation of academics in industry related issues.

Australian universities have developed two types of special mechanisms to forge links with industries; centre-based and project-based collaborations. Centre-based collaborations have wide applications and long-term impacts while project-based collaborations are directed towards solving specific and short-term problems of identified clients. Beside research collaborations, teaching and graduate fellowship also form important links between academics and industrialists. Such linkages are important for the transfer and diffusion of knowledge. The CRC program, for example, has research, teaching and commercial development components which exploit the potential of academic talent for cross collaborations. Universities have responded quickly to capture a large share of the CRC scheme by participating fully at all levels. A conservative estimate based on figures provided by applicants indicates that universities are committing between $310 million and $354 million over 7 years to the CRC Program. The actual commitment of higher education resources into this program is a reflection of the level of university interest in this area.

The guidelines for the program suggest that large cooperative schemes such as the CRC Program inevitably draw on the best research groups with tested credibility. The core-applicants to the proposal need to have made outstanding contributions to research in their respective fields and be internationally known. Applicants are asked to nominate up to six assessors of which at least two have to be Australian and two international authorities in the research area. The applications represent a sample of the best scientific ideas formulated by active researchers. They are also indicative of existing research capabilities or research groups active in selected research areas.

The proliferation of collaborative research centres is a recent phenomenon noted in many industrialised countries (OECD, 1991). These centres are created to stimulate new ideas as well as concentrate and prioritise research effort. Within the research management context, centres represent a mechanism rather than a structure for innovative ideas. It has been pointed out that 'centres must be considered mechanisms for creating new linkages between university and industry and not just a new structure for old linkages' (Gray et al. 1986: p 185). While CRC applications can be nominally equated to the 'best scientific ideas', the centres granted can be equated to 'innovation processes or systems'. An examination of applications and centres, therefore reveals a great deal of information regarding the best current research ideas nominated and in practice in the Australian research system.

University participation in the CRC program

The amount of research resources drawn into the CRC program from the general pool of university resources is considerable. CRCs are funded initially for 5 years and the involvement of the universities once a centre is awarded continues for at least 5 years. Unlike the US National Science Foundation's research centres there is no separate or initial period of time granted for the conceptualisation of the centre or its research agenda. The extent of university contribution to the CRC program as revealed in applications involved 26 universities (both core and supporting partners). A majority of their contribution was 'in kind' as well as in cash. The number of key researchers involved in the centres announced so far amount to 553 researchers/personnel drawn from all sectors. The dominance of the university sector contribution in CRC staffing is approximately half (267) of the total. Universities also have a high degree of control in 7 of the new centres when weighted on the basis of key personnel and funds committed to these centres.

Success in obtaining a CRC appears to depend on a variety of factors. Although university research may be at the leading edge of international developments for a specific research area, factors such as the absence of candidates for partnership means that good research proposals which were not successful in the first round may have been successful in the second round, provided the conditions for partnerships and management processes were better formulated. Some of the criteria for assessment of applications included; research focus of the Centre in specified natural science and engineering areas; outstanding performance of key researchers; their ability to manage the research program; international standard of the research program proposed; ability to achieve proposed goals and appropriateness of the proposed budget; the effectiveness and workability of the proposed process of management; the ability of the centre to integrate research activities of the participants and the extent of real cooperation between them. Other factors including the existence of linkages among research groups and organisations, commitment of participating organisations, quality and feasibility of proposed programs, ability to manage and perform research, management of teaching and commercial activities, ability to forge links with outside agencies and organisations, application and relevance of outcome of the proposed program to national and international impacts, adequacies of business and research management strategies and plans were also considered.

The selection process followed in the CRC Program also included extensive interviews with nominated Key Personnel of the centre. After an extensive process of peer evaluation, 35 Cooperative Research Centres resulted from 194 applications and 26 universities (out of 32 universities submitting applications) benefited from the program. Only 15 universities or colleges succeeded as major partners in obtaining a CRC with the remainder involved in the program as minor partners.

A total of 32 universities and university colleges participated in submitting applications to the first and second rounds for CRCs. University participation proved to be higher in the first round of applications than in the second round. Important features overall included participation of universities with relatively limited research bases and the significant reduction in numbers of new research areas presented in the second round of applications. In spite of active encouragement by the CRC Secretariat to resubmit unsuccessful applications from the previous round, the number of applications fell from 120 to 74.

Possible reasons for the diminishing numbers of applications can be attributed to the time taken to assemble research groups involving several agencies; effort and time required for the preparation of applications and the level of resources required from institutions. Those universities which gained five or more CRCs as either a major or minor partner included the University of Melbourne (9), the University of New South Wales (7), University of Queensland (6), University of Adelaide (6), Sydney University (5), Australian National University (5) and Monash (5). This group of successful universities are all large established Australian universities supported by substantial resources.

It is significant that almost half of the second round applications to the CRC Program were resubmissions. A high proportion of these emanated from a group which had reached the final stage of assessment in the first round and 60% of this group were short-listed in the second round. A high rate of success in reaching further assessment among those who resubmitted was largely due to better formulation of applications and forging partnerships with new groups. Given the high rate of success for resubmissions, previously unsuccessful applicants would have had a high probability of success if they had reapplied. Another conclusion which can be drawn from the high level of repeated applications is that there may be a threshold to the level of university industry research collaboration which can be achieved under present Australian industrial and economic conditions.

Australia's comparative advantages for support

The impact and influence that the university sector is to have in the CRC Program has been built into the criteria of the program. Every CRC application must have university involvement. CRCs are therefore being developed primarily on the basis of core capacities within the Australian university research system. CRCs are being established in those areas of core capacity which coincide with areas of industry strength.

Michael Porter argues that increasing numbers of firms operating in similar technologies is ultimately advantageous for the long term competitiveness of firms (Porter, 1990). In the context of collaborative research undertaken with firms through the CRC Program it is interesting to note that some research fields were more heavily supported by applications than others. The breakdown of CRC applications by field of science indicates that proposals were largely confined to traditional areas of research. As illustrated in Table 1, the number of applications and their success rate was high in areas such as resource based industries, information technology areas and rural based industry. This suggests that these are the areas which have the potential to realise the best returns in terms of commercial success.

Table 1: Distribution of CRC Applications by Field of Science and Research Aggregations

Field of Science	Total Appl.		Peer review		Succ: Cases	
	1st Round	2nd Round	1st Round	2nd Round	1st Round	2nd Round
1 Mathematical Sciences	1					
2 Physical Sciences	5	2				
(Nuclear and Part. Phy.)	(2)					
3 Chemical Sciences	4	3	2	2		1
(Organic Chemistry)	(4)	(3)	(2)	(2)		(1)
4 Earth Sciences	22	17	12	5	3	2
(Geochemistry)		(1)		(1)		(1)
(Atmospheric Sc.)	(3)		(1)			
(Environmental Sc.)	(9)	(6)	(7)	(1)	(2)	
(Geology)	(4)	(2)			0	
(Oceanography)	(2)	(2)		(1)		
(Hydrology)	(2)	(4)		(2)		1
5 Information, Computers and Communications Tech.	13	7	9	5	2	3
(Information Systems)	(9)	(5)	(6)	(4)	(1)	(2)
(Communications Tech.)	(4)	(2)	(3)	(1)	(1)	(1)
6 Applied Sci. and Tech.	14	11	6	6	1	4
(Manufact. & Proc.)	(2)	(2)	(3)	(1)		
(Ind, Biotech. and Food)	(3)	(2)	(1)	(1)		
(Material Sci. & Tech.)	(5)	(6)	(1)	(4)		(4)
(Aerospace & Tech.)	(1)		(1)		(1)	
7 Engineering	13	5	6	2	2	2
(Mining & Min.Proc.)	(5)	(2)	(3)	(1)	(2)	(1)
(Civil Engineering)	(1)	(1)		(1)		(1)
(Power Engineering)	(3)					
8 Biological Sciences	11	7	4	4	1	2
(Genetics, M. Biol., Biotech.)	(5)	(6)	(3)	(3)	(1)	(2)
(Ecology)	(2)	(1)		(1)		
9 Rural Sciences	19	14	11	6	4	4
(Crop and Pasture Prod.)	(7)	(3)	(4)	(2)	(2)	(2)
(Forestry Sci.)	(5)	(4)	(4)	(1)	(1)	(1)
(Animal Production)	(3)	(4)		(1)		
(Soil science)	(2)					
(Horticulture)	(1)	(1)	(1)	(1)		1
(Fisheries		(1)		(1)		
10 Medical and Health Sci.	18	8	(11)	(2)	(2)	(2)
(Clinical Sci.)	(6)	(4)	(4)	(2)		(2)
(Pharmacology)	(2)					
(Public Health)	(3)					
(Medical Biotech.)	(3)		(3)		(2)	
(Systems Physiology)	(2)		(2)			

Note: Figures within brackets indicate the sub-divisions of major fields which had the highest concentration of applications within fields as well as single applications which resulted in being short listed and peer review.

Table 2: CRC Applications Ranked by Subfield Aggegations (FOS)	
Environmental Management & Rehabilitation (9)	Environmental Management & Rehabilitation (6)
Information Systems(9)	Material Sciences (6)
Crop & Pasture Production (7)	Genetics, mol. biol. & Biotechnology (6)
Clinical Science (6)	Information Systems(5)
Forestry (5)	Clinical Science (4)
Genetics, mol. biol. & Biotechnology (5)	Forestry (4)
Mining & Mineral Processing (5)	Animal Production (4)
Material Sciences (5)	Hydrology (4)
Communication technology (4)	Crop & Pasture Production (3)
Organic Chemistry (4)	Organic Chemistry (3)
Geology (4)	Geology (2)

Notes: Each application is classified to the principal field of science by ascertaining the major research thrust of each application. Some applications may cover more than one field due to the multidisciplinary nature of the research program proposed. The total number of applications is not listed only the largest research aggregations.

The tendency to follow traditional areas of research is largely a reflection of the historical development of a 'value-added philosophy' for mining and primary products. Unlike the case of cooperative centres in the UK and Europe which concentrate in new technology areas, the CRC Program did not exclusively support research in similar areas. Traditional Australian research areas such as mining, forestry, and rural based industry have been significantly supported in the program. In comparison, collaborative research centres established overseas have normally tended to support leading edge technology with high technology applications.

The distribution of applications by the CSIRO's Field of Research by Purpose indicates that despite total first round applications spreading across a wide range of fields by research purpose, they also tended to concentrate into a select number of categories such as manufacturing industry, information and communications industry, environmental aspects of economic development and health. The pattern of concentration of applications into research areas in the second round had a similar distribution but with a marked decrease in numbers of applications submitted for the categories of energy supply and the environmental aspects of economic development. With the completion of the second round, research programs oriented to value-added primary products and the manufacturing industry contain the largest group of CRCs.

CRC applications exhibit a number of interesting features when analysed by Field of Science. While some areas attracted large numbers of applications, other did not and were still successful. Although the subfields listed in Table 1 contained the highest concentrations of submitted applications as well as those selected for peer review, some high technology fields such as Aerospace Technology, did not contain high numbers of applications. For example, RMIT submitted only one application in the first round and was able to win a CRC in aerospace technology.

Greater numbers of applications in heavily supported research areas does not always necessarily mean that these areas will enjoy a high rate of success. Some research areas with low numbers of applications had a high rate of success. For example, Horticulture, Fisheries, Civil Engineering, Ecology and Geochemistry all represent research areas in the second round where only one application was submitted and each application was selected for peer review. In the first round only one centre resulted from a research subfield which contained no other applications: Aerospace Technologies. On the other hand, high numbers of applications in a particular field does indicate the existence of substantial numbers of researchers/research groups working in that field.

Geographical advantages

The distribution of research groups indicated by applications shows some links to State of origin. Universities in some states have obviously developed areas of research which are applicable to their local economies. In general, the states with highest populations (NSW and Victoria) have more centres in new technology areas like biotechnology, genetics and new materials. Resource rich states like Queensland, Western Australia and Tasmania have more centres in the rural and earth sciences areas of geology and geochemistry, crop and pasture production and environmental sciences.

A majority of awarded CRCs are multi-nodal, that is, research teams are geographically separated. A total of 23 centres are multi-nodal with the remainder (12) operating from single facilities that are existing or newly created. There is an obvious opportunity to develop new networks and communication strategies for inter-state cooperation in joint research ventures, however, the implications for management of such research arrangements have yet to be explored.

The breakdown of applications by the CSIRO's Field of Research by Purpose or socioeconomic objectives shows that the majority of CRC applications from NSW and Victoria concentrated in common areas: health; manufacturing; and the information and communication industry. Applications from the ACT concentrated in environmentally based research. Queensland submitted more applications in animal production and primary products and the environmental aspects of economic development. Western Australia's applications occurred in research areas involving plant production and primary products and the mineral industry. Applications put forward by South Australia tended to aggregate in areas like the information and communications industry, economic development and health.

Preferential fields of support

Academic units are generally organised according to disciplines and research is supported within the disciplinary boundaries. Cooperative research is invariably bound by its interdisciplinary character. Involvement of several disciplines makes it difficult to categorise a given collaborative research proposal into a discrete discipline. On the basis of the central theme of proposed research and the involvement of key researchers, a proposal can be categorised into a particular field of science using the Australian Bureau of Statistics Field of Science Classification.

Fields of science, in which the highest number of applications were presented is given in Table 2. The distribution of applications indicates that research areas supported by universities in the first round were primarily in Earth Sciences (18%) indicating a high research capacity in this area. Rural and Medical sciences were responsible for 16% and 15% of the applications respectively. Applied sciences and technology (12%), Information science (11%) and Engineering sciences (10%) were the next to follow. Major concentrations within a field were confined to a few sub-fields.

Second round applications basically continued the pattern established in the first round although there were some changes in ranking and emphasis of subfields. Applications in the Medical and Health Sciences areas declined, while the Applied Sciences and Technologies increased in the second round. Both Earth Sciences (geological research) and Rural Sciences (animal and crop research) continued to feature strongly in numbers of applications for both rounds.

Highest rates of success in obtaining CRCs occurred in selected areas like crop and pasture production; material sciences; mining and mineral processing and the information and communications industry. The CRC Program has exhibited a strong tendency to support traditional areas within the national research system. These areas have been previously recognised as engineering, applied sciences and agricultural sciences. (DITAC, 1992)

It is significant that the total number of applications diminished in the second round. The actual number of completely new applications (other than those re-submitted from the first round) was 38. A decline in the total numbers of applications for this round suggests that organisational limitations exist which limit support for new innovative ideas through major collaborative programs.

Table 3: Distribution of Research Centres by University Size			
	SRC	KC	CRC
Large	15 (57%)	12 (36%)	22 (63%)
Medium	8 (31%)	18 (55%)	10 (29%)
Small	3 (12%)	3 (9%)	3 (8%)
Total	26	33	35

Note: For classification purposes only the major or primary partner was considered

Large universities include: Sydney, melbourne, Monash, Australian National University, New South Wales, Queensland.

Medium universities include: Vic. U of Technology, La Trobe, Adelaide, Qld. U of Technology, South Australia, Western Australia, Curtin, U Technology Sydney, New England, Newcastle, Macquarie, Tasmania, Western Sydney, RMIT.

Small universities include: Flinders, Wollongong, James Cook, Murdoch, Swinburne, Canberra, Charles Sturt, Northern Territory, Griffith, U College of Central Qld, UCollege of Southern Qld, Deakin, Ballarat, Victoria College, Phillip Inst. of Technology, Edith Cowen and Bond Uni.

Limiting factors on cooperative research

The number of applications presented to the CRC program have tended to be dominated by institutions with strong research bases. As one would expect, a strong correlation exists between research base size, both measured in terms of total R&D staff and university research funds, and the number of CRC applications (Correlation coefficient of R=0.83 and 0.82 respectively). Those institutions which could afford to spend more research funds and employ more research staff had a distinct advantage in their ability to draw research groups together to submit research proposals. The availability of research funds, academic research staff and other research facilities contributes to the ability of organisations to present new research ideas and be involved in major research programs.

Universities with established research systems are more likely to have developed a large range of supported research fields based on their ability to organise several research nodes within their organisations. Consequently, size of university was an important factor in determining the final number of applications submitted. On the basis of Operating Grant, universities which applied for CRC applications can be identified according to three size categories (see note under Table 3 for details):

a) Large - Over $150 million (6 universities)

b) Medium-Between $75-$150 million (14 universities)

c) Small-Under $75 million (17 universities)

The analysis of applications according to size of the university indicated that the six largest Australian universities exerted a dominant influence on the total number of applications submitted in both the first and second rounds. These six universities were involved as either a major or minor partner in a total of 96 out of 120 applications in the first round, accounting for 80% involvement in total applications. This group of universities also dominated as major partners in 48 applications (40%) in the first round. The second round increased the participation of the six universities to 91% involvement as either a major or minor partner. More than half of the applications in the second round (39) also had one of these six universities as a major partner.

Relatively small universities with a lack of research facilities and equipment are unlikely to benefit from various research centre programs. For example, 17 universities where the Operating Grant is under $75 million, participated as major partners in only 12 applications in the first CRC round (total of 120 applications) falling to 7 in the second round (total of 74 applications) of the program. Obviously, the operating grant is only one measure of the size of the universities and other parameters such as number of academic researchers, total academic staff can also be taken into account. Large universities obviously have a higher concentration of research resources and staff and therefore have the ability to form collaborations. As a result they tend to attract more research funding.

The criteria of the CRC Program can also act as limiting factors on the research ideas that can be formulated and presented to a large funding scheme such as the CRC program. Criteria like the ability to assemble credible research groups; maintain a research system without jeopardising existing research; the ability to allocate sufficient funds, infrastructure and human resources and, finally, retain a balance between commercial research and academic research are among these limitations. As noted previously there was a decline in numbers of applications to the second round. This can be linked to organisational limitations which determine whether universities will be able to conduct collaborative research without having to redirect a substantial amount of their available resources.

The impact of cooperative research centres

Different levels of collaborative research are performed in three types of nationally funded university research centres: Special Research Centres; Key Centres of Teaching and Research and Cooperative Research Centres. While these centres are all significant change agents within the university research system, CRCs have the added role of stimulating specialised research and educational institutions and are promoting linkages which are directing university involvement into related commercial areas.

Government support to research in newly created cooperative research centres is expected to diminish in the long term as centres become self-reliant in funding. It is difficult to predict, at this stage, how many of these centres will survive. These centres do, however, represent an ongoing and substantial commitment on the part of government funding agencies, university administrations and industries, the implications of which have yet to be analysed. The way in which new collaborative centres will fit into the existing fabric of Special Research Centres and Key Centres is another issue which needs to be evaluated.

The involvement of established SRCs and KCs active in scientific research reveals a pattern of concentration in the following areas: geochemistry; genetics, molecular biology & biotechnology; material sciences; computer software; manufacturing and process technologies; and clinical sciences. CRCs have substantially strengthened some of these previously supported areas of research. The impact of the CRC Program is particularly strong in the new technology areas. The addition of three CRCs to the genetics, molecular biology and biotechnology areas increases the number of national centres to seven in this area. Similarly, after the addition of four CRCs a total of eight national centres now operate within material sciences. The CRC for Optical Fibre and Photonic Technology has a substantial involvement in new materials and was awarded $4.3 million, the largest amount awarded to a CRC. Other research areas like geochemistry, mining and mineral processing and the clinical sciences have also been strengthened with the addition of new cooperative centres.

Two major implications of this gradual transformation of the university research system immediately became apparent. First, research in specific areas will be more heavily focused within the parameters of centre programs rather than individual priorities. Second, that all other researchers in those fields which are currently

heavily supported will need to rethink and modify their research and grant getting strategies.

The effect of the CRC Program has been to concentrate research activity within certain research areas resulting in their predominance within the university research system. With the addition of CRCs, the Australian Research Centres Program is predominately focused on the natural and applied sciences and technologies. This development establishes the CRC Program as an integral force in the reorientation of the Australian research system and confirms the argument that research centres are shaping the nature of Australian research.

Conclusion

The cooperative research effort has now become a growth industry with CRCs contributing a large proportion of funds. Although the precise amount of funds and human resources are difficult to quantify, the estimates provided by the applicants indicate that universities alone will be responsible for 38 per cent of the contribution by the partners to the program (based on a conservative estimate of the total contribution by partners of $817 million for the next 5 to 7 years). There is no clear indication in the applications whether this large amount of university funding for cooperative research will be generated as new funds or redirected research funds. However, a large proportion of high quality human resources will be drawn into collaborative research over the next 7 years. Another implication is that relatively small collaborative research projects, for example those funded under DITAC's Generic Technology Grants Program, may find it difficult to maintain their momentum within the university research system.

An implication of the increase in the number of collaborative research centres is the extent to which academics will be compelled to adopt a greater commercial orientation to research. Traditional means of conducting research within disciplinary boundaries may not be appropriate for a new research culture influenced by commercial interests. The current focus in research areas is associated with new technology based industries. These types of industries need a high level of scientific content for technological innovations. Within this context, types of scientific disciplines that qualify for targeted research funding tend to be confined within a narrow band of disciplines, hence other areas of science and technology suffer from lack of support. It is important that a balance be achieved between basic and commercial research within the university research community which is not jeopardised by policies and programs which emphasise one type of research over others.

The concentration of research fields as well as institutional barriers to undertaking cooperative research is evident with only established research groups and organisations able to take advantage of large scale collaborative research schemes. The tendency to support existing groups is generally a disadvantage for newcomers to the research arena. The established research credibility of large groups and their linkages with other groups is a parameter which decides the level of participation in collaborative programs.

The distribution of research capacity across research centres among different fields suggests that universities have a large array of research capacities across several fields of sciences and that the CRC scheme provides one outlet for research collaboration in selected areas. Although the distribution of CRC applications is widespread throughout the fields of science, some research areas were not able to assemble the required research groups. This suggests that other schemes like the project based Generic Technology Grants could be more effectively managed in these areas. Within the context of the growing influence of the Research Centres Program the real challenge for academic research planners as well as active researchers is how to effectively manage cooperative research.

References

Aitkin Don (1990), 'How research came to dominate higher education and what ought to be done about it', *Australian Universities' Review*, No 1 & 2, p 8.

ASTEC (1991), *Research and Technology: Future Directions*, September, p 21.

Australian Bureau of Statistics (1990), *1988-89 Research and Experimental Development All-Sector Summary Australia*, Catalogue No 81109.0, AGPS, Canberra.

Block Ray (1991), *Bringing The Market to Bear on Research*, Report of the Task Force on the Commercialisation of Research, November, AGPS, Canberra.

Budget Related Papers (1991), *Science and Technology Budget Statement 1991-92*, Minister for Science and Technology, No 6, p 87, AGPS, Canberra.

DEET (1990a) *Competitive Grant Index*, DEET, Canberra.

DEET (1990b) *Relative Funding Model - A Draft Proposal*, National Board of Employment, Education and Training, Canberra.

DEET (1991), *Information Sheet-Research Centres Program*, DEET, Canberra.

DITAC (1990) *Australia's Science and Technology System*, DITAC, Canberra.

DITAC (1992) *Australian Science and Innovation Resources Brief*, Working Draft, Canberra, 1992, p 5.

Gray, Denis, Hertzner, William, Eveland, J D & Gidley, Teresa (1986), 'NSF's Industry-University Cooperative Research Centres Program and the Innovation Process: Evaluation-Based Lessons' in Gary D O, Solomon, T and Hertzner (eds) *Technological Innovation: Strategies for a New Partnership*, Elsevier Science Publishers BV, North Holland.

Government-University-Industry Research Roundtable (1991), *Industrial Perspectives on Innovation and Interactions with Universities*, Washington D C, National Academy Press.

Industry Research and Development Board (1990), *Industrial Research in Australia*, Vol 1, Canberra, The Board.

Johnston, R and Liyanage, S (1983), *Australian Science and Technology Indicators-Final Report*, Department of Science and Technology, DITAC, Canberra.

Liyanage, S, Mitchell, H & Jones. A J (1991), *Australian Research Centres Program: Research Concentration in Australian Higher Education Institutions* A report of the Special Research Centre for Research Policy, University of Wollongong, December 1991. (The data for this report is based on CRC material from the Department of the Prime Minister and Cabinet, Office of the Chief Scientist).

OECD (1991) *Science and Technology Policy Outlook*, OECD, Paris

Porter, Michael (1990), 'Don't collaborate, compete', *The Economist*, June 9, pp 19-23

Reviews

Autonomy under threat?

Accounting for the Humanities: The Language of Culture and the Logic of Government, Ian Hunter, Denise Meredyth, Bruce Smith & Geoff Stokes, Institute for Cultural Policy Studies, Griffith University, Brisbane 1991.

In the post-Green and White paper climate, the question of the autonomy of the universities has been a major theme in discussions on the direction of higher education. The accepted truth is that independence from government intervention is imperative if we are to maintain a socially critical vantage point, a position from which we can assess and interpret the goals of government and formulate alternative analyses and practices.

The federal government's apparent increase in intervention in the running of higher education has been regarded as damaging to the historical independence of the universities and, with the feared loss of a critical speaking position, threatening to bring about new forms of political quietism.

In the introduction to *Accounting for the Humanities*, Ian Hunter and Geoff Stokes argue that responses to the recent reforms continue to draw on the ultimately unhelpful oppositions of institutional autonomy versus social utility and of liberalism versus vocationalism. This is especially clear in debates about the role and purpose of the humanities. Academics and commentators lament the passing of an age when knowledge could be pursued for its own sake and where a solid liberal education in the Arts was regarded as essential for the formation of well-rounded individuals who, by virtue of this education, could become valued citizens and professionals. By contrast, the new era, spear-headed by Dawkins et al., is seen as attacking this 'true' nature of the humanities by demanding that it be made accountable, that it, too, serve the national economic interest and that objectives such as efficiency, productivity and externally set (by the federal government) national priorities be applied to assess the value of the humanities.

For those of us working in education it has seemed that there was no way through this impasse: that the best we could do was to defend more strongly and staunchly the autonomy and value of the humanities. After all, many of us have been initiated into and formed by such a curriculum and our employment - as teachers, administrators, policy advisers, researchers - has been tied up with the successful acquisition and transmission of the knowledge and values of the liberal arts curriculum. Yet, there has nevertheless been an increasing sense of frustration with the usual terms of debate which have been unable either to defend properly the humanities or to take us much further in understanding its current status and meanings. The strength of *Accounting for the Humanities* lies in its elaboration of an alternative way to see the relation between the humanities and the sphere of government. Rather than drawing on the familiar rhetoric of autonomy/intervention, the authors argue that there have always been degrees and forms of interdependence and interaction between the two spheres:

> *These polarities [instrumental/intrinsic value etc.] and the oppositional ethic they give rise to are...untrue to both the inner logic of the humanities and the history of their relation to the governmental sphere. The history is not one in which the humanities as custodians of our full humanity have fought, successfully or unsuccessfully, to maintain their autonomy against the state. Rather, it is a history of contingent and unpredictable interaction - of a whole series of bridges, exchanges and translations - that have attached the disciplines of the humanities to the objectives of government* (p3).

The articles flesh out this claim by examining specific instances where the interests and activities of the two domains have converged, such as the establishment of universities in colonial Australia (Ch. 2) or the interconnections between arts faculty pedagogy and the training of personnel for social and public administration (Ch. 3).

One of the underlying arguments of the collection is that we cannot hope to formulate an adequate, let alone oppositional, response to the current changes taking place in higher education if we continue to mythologise the role of the humanities in the past and to insist upon a former golden era when this 'special' faculty operated independently of government influence and determination. It is only when we abandon such generalising and historically suspect view points and attend to the specific that 'we can begin to locate more limited, intelligible and useful grounds on which to assess the social role of the humanities...' (pp. 188-189).

The book is concerned, then, primarily with drawing the lines of debate differently. Its project is to suggest other ways of assessing relations between the governmental sphere and the humanities: it is not to specify a political practice or a formula for a strategic response.

In some ways, the collection is as much about the writing of history as it is about the critique of current common-sense attitudes. A major influence on the authors' work has been the genealogical investigations of Foucault and his concept of 'governmentality'. An understanding of governmentality is important because it is the pivotal concept on which the claims concerning the interdependence of the two spheres rest and around which the interpretation of the vast amount of research material is organised. 'Governmental' here does not just denote federal and state elected parliaments. It refers to the range of social institutions, practices and discourses which act upon, regulate, monitor and 'govern' the population. The operation of power is intrinsic to this Foucauldian concept of governmentality. For Foucault:

> *...power is less a confrontation between two adversaries or the linking of one to the other than a question of government. This word must be allowed the very broad meaning which it had in the sixteenth century. "Government" did not refer only to political structures or to the management of states; rather it designated the way in which the conduct of individuals or of groups might be directed: the government of children, ...of communities, of families, of the sick. It did not only cover the legitimately constituted forms of political or economic subjection, but also modes of action, more or less considered and calculated, which were destined to act upon the possibilities of action of other people. To govern, in this sense, is to structure the possible field of action of others.* [1]

Throughout *Accounting for the Humanities* the authors employ this meaning of governmental to develop their critiques of traditional defences of the humanities. I suspect, though, that the 'defenders of autonomy of the humanities' have been using the term government in the more usual way to refer to the policies and activities of elected governments (the narrow sense). At one level the critique in *Accounting for the Humanities* is also directed at prevailing limited understandings of 'government', the state and of the operation of power. While there is a need for this type of fundamental re-questioning, I nevertheless wonder whether because the terms of analysis are in some sense different for the 'defenders of autonomy' that they and the authors reviewed here are defending and criticising two slightly but significantly different things.

As well, at times the use and mixing of these two meanings of 'government' can be a little confusing. The authors seem to collapse the strategies of state and federal governments and of other institutions of social administration - health, welfare, mass schooling - into the same category so that any specificity about the government (narrow sense) - or of other governmentalised processes such as mass schooling - and the particular effects and character of its interven-