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Australian University Research and National Objectives

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The formulation of national objectives in terms specific enough to be of practical use is not an easy task, and indeed the very definition of what we mean by a national objective is far from clear. Certain legitimate objectives are national in character - the health, welfare and happiness of the nation's people, the preservation of the nation's resources alongside the development of its economy, friendly co-existence with the nation's neighbours, combined with an adequate defence force in case of difficulties - while other objectives relate to the nation's obligations to the community of nations, in terms of the environment, resources, energy, food and so on. We might even properly consider as worthy national objectives the contribution of knowledge, truth and beauty to the unfortunately small international stock of those commodities.

University Research in a National Context

In evaluating the role of university research in the Australian scene we are fortunate to have the two volumes of Project Score, which survey Australian activities in research and development in 1973-74. (1) Changes have generally not been rapid enough to alter greatly the pattern shown in that survey, though dollar figures should now be increased by about 30 per cent to allow for inflation. In the analysis that follows I have accepted the information in the Project Score report at face value; to do otherwise would be to introduce personal prejudices into its interpretation.

In 1973-74 the equivalent of 53,300 man-years was devoted to research and development activities in Australia, of which 17,110 (or 32 per cent) was attributed to the tertiary education sector and therefore to universities, since colleges of advanced education accounted for less than 1 per cent of the total. Associated with this work-force was a total expenditure of $651 million, of which $142 million (or 22 per cent) was spent by universities, largely in the form of salaries (72 per cent in 1973-74, but by 1977 a larger percentage). These figures suggest that universities are responsible for roughly one quarter of the research and development activity in Australia - the other two comparable sectors being the Australian Government and business enterprise, with state governments and private non-profit organisations making up the balance. Clearly the contribution of the universities is an important one and, it would seem, either a very economical or a very underfunded one. I shall return to this point later.

The emphasis in university research does, of course, differ from that in industrial research or even in research generally. On a national basis and omitting industrial and commercial sectors, as shown in Table 1, about 50 per cent of the expenditure and manpower is associated with applied science (engineering, agriculture and medicine), about 35 per cent with basic science and only about 15 per cent with social sciences and humanities. In universities, on the other hand, about 40 per cent of research effort goes to the

Table 1. Australian Research Expenditure in Various Fields, 1973-74

	National Total		Universities	
	$ million	(man-years)	$ million	(man-years)
Basic sciences (incl. geology)	147	(12,763)	60	(6,734)
Applied sciences (incl. medicine)	219	(19,028)	40	(4,728)
Social sciences and humanities	56	(6,796)	42	(5,648)
Total (excl. business and industry)	422	(38,587)	142	(17,110)
Business and industry	229	(14,710)		
Total	651	(53,297)		

basic sciences and about 30 per cent each to applied sciences and to social sciences and humanities. Expressed in another way, the universities are responsible for about 40 per cent of Australia's research in the basic sciences, about 20 per cent in the applied sciences, and about 75 per cent in the social sciences and humanities. The details are given in Table 2. Table 1 separates out and Table 2 omits altogether the contributions of business and industrial enterprises, not because they are unimportant but rather because they are different and generally involve development rather than research.

Table 2. University Research Expenditure in Australia as Percentage of National Total, 1973-74 (excluding business and industry)

Physics and maths	47		
Chemistry	50	41*	
Biology	53		
Geology	16		
Engineering	14		
Agriculture	11	18*	34*
Medicine	63		
Social sciences	66	74*	
Humanities	99		

* Note that, when several fields are combined, the individual percentages must be weighted by the total expenditure in the field concerned.

With such an important part to play in the national scene, as judged purely on a quantitative basis, it is obviously important to discuss university research. It turns out, however, that university research is also qualitatively different from many other types of research and this has an important bearing on its special contribution to the nation.

The Nature of University Research

One of the distinguishing features of most university research is the relative freedom from pressure to produce practical results (or, indeed, often any results at all) for some particular deadline. The major input of funds for university research is in the form of staff salaries (a proportion of which is counted against research activities) and this funding continues almost irrespective of research productivity. Indeed, of the $142 million spent on research by universities in 1973-74, only about $19 million was provided from 'outside funds' such as the Australian Research Grants Committee and various industry funds.

The other distinguishing feature of university research on which I shall comment here is the existence of graduate students on whom falls a considerable share of the research burden. The Project Score survey showed that in 1973-74 these graduate students accounted for 43 per cent of the total manpower effort devoted to research in universities, this fraction ranging from about 40 per cent in the basic sciences to 60 per cent in the humanities. The picture may have changed a little since then, with the further decline of graduate student numbers in the physical sciences, but graduate students are still an important feature of the system.

Graduate students are, at the one time, professional researchers and research assistants - and lowly paid ones at that. Only in this way can we explain the survival of university research in the natural sciences with 0.5 support staff and $13,000 per professional worker, compared with the Australian average of 1.2 and $25,000 respectively, and the Australian Government laboratories' figures of 1.9 and $43,000. The figures for the social sciences and humanities are not so revealing because of the concentration of these areas within the universities; on the surface they suggest that the disparity is much less pronounced than in the natural sciences.

Whatever the reason, the figures suggest that, provided the research output per man-year is the same for university workers and those in other environments, university research is, relatively, a very good investment. It is, of course, very difficult to measure research productivity, and one is forced back on to such dubious indices as number of papers in research journals of international standing. There has not been any recent survey of this question, as far as I am aware, but one conducted some ten years ago (2) suggested comparable publication output for scientific workers in CSIRO and in Australian universities. Bearing in mind that university staff are lucky if they can spend half their time on research, while CSIRO staff are full-time, and the balancing feature that much of the effort for university research is contributed by graduate students, there seems no reason not to accept the working hypothesis that university research workers are, on average, little different in their productivity per man-year from research workers in other environments.

The stated objectives of university research are not dissected in the Project

Score report, but tentative conclusions can be drawn from the national averages in each field, as shown in Table 3. I cannot forbear from pointing out the small fraction of the efforts social scientists devote to national objectives, 33 per cent, compared with the 65 per cent from the natural sciences and even the 43 per cent from the basic sciences. Even the 15 per cent of effort that social scientists devote to community welfare is only marginally more than the 13 per cent devoted by workers in the basic sciences. Rather than talking of the social responsibilities of scientists (by which is generally meant natural scientists) we should be expressing concern at the lack of social responsibility among social scientists.

Table 3. Distribution of Objective for Major Fields of Research in Australia: National Average

	National Security	Economic Development	Community Welfare	Advancement of Knowledge
	(percentage of expenditure, excluding business and industry)			
Basic sciences	9	21	13	66
Engineering and agriculture	22	61	2	15
Medicine	0	0	36	64
Social Sciences	1	17	15	67
Humanities	0	0	1	99
Natural sciences	15	41	9	35
Social sciences and humanities	1	13	12	75

It is reasonable to assume that the emphasis in university research is rather more concentrated on the advancement of knowledge than is the national average, though perhaps not to the extreme extent found in the humanities, where 99 per cent of the effort has this avowed purpose - the remaining one per cent being devoted to community welfare. As a rough guess we might expect perhaps 80 per cent of university research in the natural sciences, 90 per cent in the social sciences and 100 per cent in the humanities to be devoted to the advancement of knowledge rather than to more immediate national objectives.

One reason for this lack of concern with clear-cut objectives is the dual purpose of university research. On the one hand, university researchers are concerned to extend the frontiers of knowledge, if this is not too grandiose a phrase; while on the other hand, many of them are involved in research or scholarship largely just to keep abreast of their subject so that they can teach it effectively - and we must not forget that teaching is at least half of the reason for the existence of universities. For the second group, scholarship (which I take to mean the orderly assembly of and commentary upon the work and opinions of others) is often more effective than original research and clearly has, in most cases, no impact upon national objectives except in the field of teaching. I do not intend to belittle scholarship in comparison with research, however, but simply to point out the distinction.

Distribution of Research Expenditure in Universities

As I have already remarked, one of the major features of research expenditure in universities is its egalitarian distribution. The main cost, more than $110 million of the $142 million spent in 1973-74, went towards salaries; and the fraction of that attributed directly to academic salaries is large. Internal pressures towards staffing readjustments now mean that the average humanities lecturer has a larger proportion of time available for research than does the average science lecturer, and the relatively large staffing of humanities departments produces some strange and perhaps indefensible paradoxes.

The general distribution of manpower and research expenditure in universities was shown in Table 1: roughly 40 per cent on basic sciences and 30 per cent each on applied sciences and on social sciences and humanities. Such a distribution seems not unreasonable, though we might note that Australia spends a greater proportion of its total research funds on the humanities and social sciences (9.1 per cent, mostly in universities) than do any other countries except Denmark and Finland.

A somewhat different picture emerges from examination of the support provided to university workers by the Australian Research Grants Committee (ARGC). The charter of this committee charges it with the support of research (primarily in universities) exclusively on the basis of merit, and again with no necessary regard to explicit national objectives. In the recently announced grants of this committee for 1978 (1300 projects at a total cost of about $10 million) nearly 70 per cent of funds were allocated to the basic sciences, with the remaining 30 per cent nearly equally shared between the engineering sciences and the social sciences and humanities. One might reasonably feel that this distribution was simply the result of the larger sums of money needed by workers in the basic sciences, but in fact the number of projects supported in each area shows a rather similar distribution.

It is perhaps significant to note that ARGC funds, being a supplement to the already large basic investment made by universities in academic salaries and physical facilities, play a disproportionately large part in fostering university research. The same is, of course, true for research grants from other sources. At present ARGC is able to fund only about 60 per cent of the applications it receives, and even those funded receive on average little more than half the amounts requested. It is therefore clear that research in universities could be considerably expanded in its effectiveness by a relatively modest extra input of funds through competitive granting bodies such as ARGC and the National Health and Medical Research Council.

One of the best ways such funds might be deployed is in the provision of modest salaries and facilities for post-doctoral research workers within existing university research groups, or even through the creation of specialised institutes within a limited number of universities, where visiting workers from other universities or research laboratories might congregate to develop their special fields. Initiatives from the Universities Council in Australia, which might have led in this direction, have unfortunately been shelved, while the decreasing opportunities for advanced graduates and the stringent conditions within universities are eroding the valuable marginal opportunities that contribute so much to research possibilities.

University Research and National Objectives

As I have indicated in this discussion, most university research is relatively uncommitted in objective; workers might therefore be rather easily influenced by the availability of opportunity and inducement to apply their efforts to the pursuit of particular objectives. Left to themselves, the majority of academic researchers will probably direct most of their energies towards the solution of medium-range basic problems in their discipline, for it is in this area that reasonable success is most likely to be achieved, bringing the greatest academic return in terms of promotion and respect of colleagues. Most academics are perhaps not as calculating in their plans as this statement would imply, but simply tend to follow the sensible and well-established paths of tradition to reach the same result.

I shall return presently to a consideration of the contribution that universities might make towards analysing and defining national objectives. Let us suppose for the moment that some such objective has been decided upon. The next thing is to determine whether it is an objective towards the attainment of which the universities might make a significant contribution. This will be appropriate, in general, in two different situations: the first is that of a short-range problem, where appropriate skills and facilities are known to be available within the universities; the second is that of a long-range and many-faceted programme, for which new approaches will be developed as work progresses and for which there is no obvious completion deadline. (To give concrete examples, the problem of the Crown of Thorns starfish and its damage to the Great Barrier Reef belongs to the first category, while the development of systems for the efficient conversion of solar energy to electricity belongs to the second.)

For a short-term problem the best procedure would seem to be to offer research contracts to selected university departments, research groups or individuals, in the way these things are done in the United States. The agency offering the contracts must be well informed from a scientific viewpoint, and its operations must be carefully supervised to ensure that the right problems are being attacked.

Such a contract system, if developed on a large scale, presents considerable dangers to universities. Because academic staff have teaching in the broad sense as their prime responsibility, their contribution to research contracts is limited in extent and should come largely from their scientific or technical skills. However, it almost inevitably happens that the most senior academic staff members are also responsible for administration of the project and for ensuring continuity of employment for the special staff involved. Unless the universities themselves are properly organised, through research companies like Unisearch, these peripheral tasks effectively become the major preoccupation of academic staff members, to the detriment of both their teaching and their research.

The experience of ARGC is perhaps a useful guide here. (3) As I have said, ARGC now allocates about $10 million each year to research projects, judged solely on the merit of the proposed research programme. An analysis of the extent of support given to funded projects and of the relative merit of the projects that could not be funded suggests that funding at nearly twice the present level would be justified, but not funding at three times the present level. (Funds requested in the 1973-75 triennium were 2.3 times the amount available.) There is no evidence that ARGC research support has had other

than a beneficial effect on all aspects of university life, and an increase in funding by a factor of two would seem to be assimilable without causing academic indigestion. A similar influx of funds for long-term mission-oriented research would similarly seem unlikely to present great problems, though this would certainly not be true of even a rather smaller sum invested in strict contract research.

It is, however, one thing to indicate an appropriate financial estimate and quite another to suggest how the whole programme might be initiated. ARGC experience with specially ear-marked funds for research on the upper atmosphere and in marine science suggests that funding for a three-year period is inadequately long-term to induce many new workers to enter an unfamiliar field, though established researchers could probably have made good use of about $1-2 million annually in each area. A ten-year commitment to general support of research in a particular area thus seems the policy most likely to bring results.

University workers are unlikely, as a whole, to take kindly to any pressure to direct their research along particular channels; and I am convinced it would be a very bad mistake on many grounds simply to ear-mark a proportion of ARGC funds on a long-term basis for specific research areas. What is needed is an entirely different set of grants for specific purposes, such as those offered at present by the Meat Research Council and the Wool Board, but perhaps with even more specific terms of reference. The funds provided should be for research grants in the real sense, with publication in the open literature, and perhaps patents as well, being the end product rather than contract reports. Each grant should be awarded in open competition with other projects in the same area and on the basis of an external assessment system such as that employed by ARGC, and the funds provided should extend over a reasonably long period (say three years) rather than the shorter commitment that ARGC is able to give. If the whole programme is designed to run for about ten years, this should allow each productive project to seek one or two renewals of its initial grant.

A freely funded, competitive grant system such as this would provide the incentive for university workers to enter the field concerned; it would go a good way towards selection of the most promising projects; and it would avoid any charge that the government agency awarding the grants was unduly influencing university research. The committee awarding the grants might well be made up, as is the case with ARGC, of members drawn almost exclusively from universities and CSIRO, though in some fields there could be good agreement for inclusion of members with appropriate qualifications drawn from industry or from relevant government departments.

Objectives and Their Analysis

The participation of universities in work towards specific national goals, in the way I have described, assumes that these goals have been identified, at least in some broad manner, and that the impediments to their immediate achievement have been appropriately analysed. Universities are perhaps uniquely well situated to help with this preliminary analysis. An example will help to show what I mean.

Consider the problem of energy supply after the year 2000, and the attractive possibilities offered by conversion of radiant solar energy to electricity,

especially in a country like Australia. Preliminary analysis shows the problem to be a real one and identifies the obstacles as arising from the fact that generation of electricity from sunlight using present technology is too expensive to compete with alternatives, such as nuclear fission reactors, that for one reason or another we may not wish to adopt. Further analysis now shows that there are at least three independent methods of achieving the objective:

1. Develop new technology that will decrease the capital cost of solar conversion until it is a competitive process under present economic and social conditions.
2. Develop new economic strategies that will allow society to finance the increased energy costs associated with solar power generation.
3. Develop new social attitudes that will decrease energy consumption per capita to such an extent that the extra costs of solar energy will not be significant.

These three approaches are in a technical sense orthogonal, and we should expect an optimum solution to involve contributions from each area, technological, economic and social. Of course this does not mean that we should necessarily invest equal research effort in each area, for judgements must be based on estimates of the relative likelihood of success by the physical, economic and social scientists tackling the problem. The attention given almost exclusively to technological solutions may reflect a realistic view of the abilities of economists and social scientists or it may simply reflect the tendency on the part of the social scientists, as noted before, to remain aloof from the real problems of society. The technological scientists may, of course, be so successful that their economic and social counterparts are let off the hook, as has happened often in the past, but we cannot continue to count on this happening every time.

Suppose then that we choose to seek a purely technological solution to this particular problem and adopt a target date somewhere in the 1990s, which seems reasonable. We must also recognise that Australia is not alone in the world in confronting this particular problem, so that as well as having an obligation to other countries we may expect considerable help from them. It may be that in this case there are particular features of the problem unique to Australia and perhaps some of these should be tackled in government laboratories such as CSIRO; but there is probably a large and not very well defined residuum of work to be done, in which the most valuable commodity will be new ideas. It is in this work that universities are probably best qualified to help.

I have considered this problem in a little detail to show that a broad analysis is needed even before a technological problem is attacked. I believe that university workers from differing disciplines might usefully come together to help with such an analysis, when national objectives are being defined as anything more than political generalities. Their analysis will not always be correct but it should at least be many-sided.

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