

Centres of Excellence

April, 2001

The February 2001 report of New Zealand's Tertiary Education Advisory Commission (Shaping the System; Second Report of the Tertiary Education Advisory Commission, February 2001) has recommended the *establishment or recognition of national centres or networks of excellence within the tertiary education system, with linkages to a national strategy and the international research community.*

The report emphasises the need to produce knowledge, to disseminate it, and to train new researchers in partnership with the wider research and business community. It stresses the building of a world-class research capacity and capability and the importance to New Zealand of achieving this with Maori and Pacific Island peoples. It advocates greater specialisation in tertiary research, increased collaboration across the system, support for research-led teaching, and greater investment in research infrastructure.

This response from the Royal Society of New Zealand expresses our necessarily brief and initial views on the philosophy and purpose of centres of excellence, criteria for their establishment, funding and administration issues.

The Royal Society has considerable experience in nurturing, funding, and putting excellence to use through its stewardship of the \$26 million Marsden Fund since 1994; through its Academy Council, which is devoted to excellence; and through its awards for outstanding science and technology. The Council of the society has committed to consult and volunteer recommendations to TEAC and the government on centres/networks of excellence.

1. EXECUTIVE SUMMARY

The Royal Society has drawn upon a broad range of expertise residing in the tertiary sector, in Crown Research Institutes, in educational research and in the Society's membership to draft this advice on centres and networks of excellence and innovation. In summary we see four goals for research in New Zealand:

- Excellent and effective research for New Zealand's benefit.
- Excellent and effective researchers.
- Effective critical masses and concentrations of researchers.

- Effective use of research to underpin public policy and private sector innovation.

Centres of excellence and innovation must fit into the already crowded field of policy instruments in New Zealand. To achieve the highest possible returns on investment the various parts of the New Zealand innovation system must be closely integrated. Strengthening horizontal links between tertiary institutions, CRIs and the private sector will strengthen the national research network.

We propose five related objectives for centres of excellence and innovation:

1. Focus intellectual effort in fields of endeavour important to New Zealand.
2. Accelerate the development and use of new knowledge, insights and results.
3. Develop teams of sufficient size and concentration to stimulate creative synergies and cross-fertilisation of ideas.
4. Bring appropriate multiple disciplines, institutions, cultural views and sectors to bear on the problem area.
5. Build human capacity by training and providing a future in New Zealand for a new generation of outstanding researchers.

These goals are backed by ten criteria for selection:

1. Excellence of the research, and the researchers.
2. Viable, focussed and creative research teams in fields important to New Zealand.
3. The long-term importance of the research.
4. Appropriate mixes of disciplines, institutions, cultural groups and sectors.
5. Linkages to other programmes and wider issues.
6. Ability to train, develop and retain outstanding researchers.
7. Ability to establish joint relations with those who will use the research.
8. A capable host organisation.
9. Leverage of non-central government funding.
10. Provision of an evaluation plan.

The amount and conditions of funding will be the deciding factor as to whether the objectives for excellence and innovation can be met. We propose that new funding be found, and/or reserved in roughly equal

proportions if necessary from Vote RS&T, Vote Economic Development, and Vote Education. Initial investment of \$20m per year, committed for five years, could be followed by new tranches each year of \$10m, until the total fund reached \$60m per year after five years. At the end of that time, original funds would become available for a new cycle of investment.

A possible mechanism to administer the fund would comprise a steering body reporting to TEC, a secretariat contracted to the steering body, and a series of expert panels for selection advice.

2. PHILOSOPHY AND PURPOSE

This response takes the view that the major purpose of centres of excellence is to enhance and exploit New Zealand's excellence in research and innovation. In a world of accelerating change a high capacity for adjustment is essential. This capacity is commonly called innovation. Throughout this paper, therefore, we will use centres of excellence *and innovation* when referring to our own proposals. This itself is shorthand for centres *and networks* of excellence and innovation, as we will develop a case for centres to be linked in a broad collaborative network.

We note in passing that many of New Zealand's tertiary institutions suffer from another major problem — that of funding levels. Centres of excellence will not alleviate this problem, at least in any immediate sense, and the advice below does not attempt to use centres of excellence as a means of exacerbating or solving general funding issues.

2.1 Research, Excellence, and Innovation

There is only science and the application of science – L. Pasteur.

Modern funders of research usually wish to see an ultimate application, while those performing research may seek knowledge for its own sake. This leads to *mission oriented basic* research where there is a motive of utility, as opposed to *free basic* research undertaken solely for its scientific promise. This distinction requires only that the funder select the problem area, and then as far as the researchers are concerned their research is still basic research.

Applied research can be highly fundamental in its character (Brooks) in that it can have an important impact on the conceptual structure or outlook of a field. Brooks' example was drawn from the work of Louis Pasteur who contributed one of the earliest and clearest syntheses of understanding and use. Pasteur's work showed that research changes its nature as science and technology develop. For example, research into group IV elements would be seen as *pure* prior to the development of the germanium transistor, and *applied* immediately thereafter.

2.2 Excellence in New Zealand's Innovation and Tertiary Systems

An *innovation system* is that mix of creators and exploiters of ideas which, when joined in effective partnerships, can combine knowledge from a wide array of disciplines into a new product, service or application.

New Zealand urgently needs a system where flow between understanding and use of research can be connected so that new avenues of excellence can be created. While individual elements of an innovation system exist, New Zealand has offered little encouragement in the past for them to work together. In fact much of what we do still has the side effect of discouraging effective partnerships. Government policy is shifting towards building research linkages which stimulate partnerships in delivering public and private goods and services; and a private sector which values and commissions research because it sees the commercial advantage in delivering value added in the economic, social and environmental spheres.

As a means of characterising the “innovation spectrum”, the Royal Society’s recently published *Manifesto for Science, Technology and Innovation* placed relevant government programmes into a uni-dimensional framework running from *near to application* to *underpinning* research.

Table 1: Government Policy Instruments for Innovation

Place on the Spectrum	<u>Government Goals for RS&T</u>			Gaps/Opportunities
	Economic Goals	Capacity Building	Social, Health, Environmental, Govt Depts’ research	
Near to Application	Trade New Zealand Industry New Zealand BizInfo etc. Venture Capital Seed Capital Incubators	Enterprise Scholarships — eventual \$20M Maori Scholarships – \$0.4M Post Doctoral Fellowships -\$5M,	Research in Government Departments – \$95M Health research HRC – \$48M FRST research Social – \$4.3M Maori – \$2.7M Health – \$1M Environmental – \$84M	<i>Encourage Foreign Direct Investment Tax incentives Help SMEs IP use and protection Public/Private partnerships Target value-added research Long-term policy commitment Specialise in tertiary sector research Review EFTS loans and</i>
Basic/ Underpinning	Grants for Private Sector R&D – \$12M Technology New Zealand – \$25M Research for Industry-\$170M NERF- \$51M	Doctoral Scholarships – eventual – \$10M NERF Science and Innovation Advisory Council		

	Proposed Centres of Excellence
	EFTS-funded research in Universities – \$144M
	Public-Good-orientated Non-Specific Output Funding (NSOF) – \$27M Marsden Fund – \$26M

*Equipment funding
Develop Human Capital.
Rationalise teaching
Develop New Zealand's capacity to absorb overseas research*

The discussion above on research, innovation and excellence suggests that there needs to be a move beyond this one-dimensional approach to basic and applied research, to consider the goals of understanding and use. A two dimensional approach can accommodate a simultaneous desire to *understand* and a desire to *apply* research. Here the extremes of the quest for understanding and of application can be accommodated:

Table 2: Understanding and Application

High Fundamental Understanding Low	“Pure” Basic Research <i>(Bohr)</i>	Use-driven Basic Research <i>(Pasteur)</i>
	“Tinkering”	“Pure” Applied Research <i>(Edison)</i>
	Low	High
	Application	

In the high fundamental understanding, low use quadrant (the *Bohr* Quadrant) lies the pure voyage of discovery for example Neils Bohr’s development of a model atomic structure.

In the high application, low understanding quadrant is narrowly focused research seeking specific solutions to technical problems, for example in *Edison’s* drive to develop a commercial electric light. A great deal of modern industrial research follows this scheme of highly sophisticated, narrowly targeted research with immediately applicable results.

The high-high quadrant can be called the *Pasteur* quadrant in recognition of his drive both to understand microbiology and to apply the knowledge gained. This is the home of strategic research, aimed at developing the understanding of an area that in turn will lead to applications.

The final quadrant covers regions where there is little understanding generated and no desire to apply the finding – the curiosity about a

particular thing, without wanting to understand more general phenomena or consideration of applying the results found. This research can be important if it provides the precursor information that can be used to build a broad understanding. It is also the area where research skills can be built.

All three high level quadrants are significant in an analysis of a major advance in science and technology, with fundamental, strategic and applied research all being necessary to ensure the success of a major breakthrough. But the link between the desire for understanding and the drive to apply the research is through the strategic quadrant where there is the drive to both understand and use the knowledge produced.

In a large economy such as the United States, much of the *Bohr* research will be used to underpin and lead *Pasteur* research that in turn will be exploited in Applied Research. In a small economy, such as New Zealand, no such assurance can be given, and it is most unlikely that any *Bohr* research carried out in New Zealand will be captured and be applied to the benefit of the society that funded it.

2.3 New Zealand's Goals for Research

The Government has set out four goals for research, science and technology, which aim to develop human capital, and to enhance our knowledge of the economic, environmental, social and health determinants of our well-being. The Royal Society also believes, and has stated in its *Manifesto for Science, Technology and Innovation* that there are four "behavioural" goals for research:

- Excellent and effective research for New Zealand's benefit – encouraging focus and producing excellent research outputs for New Zealand, and particularly intellectual property capable of generating significant export earnings.
- Excellent and effective researchers – developing, and retaining excellent researchers / innovation workers for New Zealand's needs, and using them effectively across the full spectrum of activity from basic to applied research, from wealth generation to policy application.
- Effective critical masses and concentrations of researchers – developing and maintaining an excellent research capability / infrastructure based upon networks, collaboration and co-operation across the public and private sectors.
- Effective use of research to underpin public policy and private sector innovation – developing a cadre of New Zealanders who are S&T-literate, and are intelligently able to commission needed research, interpret its results, and embody their findings in public policy and the private sector.

Centres of excellence *and innovation* can be designed in such a way as to contribute significantly to these goals. Experience in OECD countries has

suggested that centres of excellence also act as magnets for talented researchers, and help New Zealand to absorb international knowledge.

2.4 Goals for the Tertiary System

The essence of recent TEAC proposals for reform of the tertiary system is to encourage tertiary institutions to specialise in areas of strength, by a system of "profiling." A *Tertiary Education Commission* is proposed to give more active and integrated leadership to the sector as a whole. TEAC's report contains 97 recommendations, many of which remain to be fleshed out in two subsequent reports on the "what" and the "how." Centres and networks of excellence and innovation must work to support these policies, and work in harmony with other policy aims in the tertiary sector.

3. ESTABLISHING CENTRES AND NETWORKS OF EXCELLENCE AND INNOVATION

Centres and networks of excellence and innovation must fit into the already crowded field of policy instruments shown in Table 1. Their near neighbours are the Marsden Fund (\$26m), the New Economy Research Fund (NERF, \$51m), and other university research funding (\$144m?). Marsden funding is available to all comers, and has been won mostly by universities. Universities have also won most new NERF funding, while some \$36m was re-orientated from former Public Good Science funding within CRIs. Doctoral, Post-Doctoral, Maori and Enterprise scholarships will also have a strong role to play in centres of excellence and innovation.

The innovation system itself must change if tertiary institutions are to grasp a new way of working. New knowledge is often produced at the interface where disciplines meet, rather than at their core. The knowledge needed to solve a particular problem may reside in many places, not just a tertiary institution. It could be distributed among non-government organizations, industry, government, and research institutions in every field. Funding programmes must favour and reward multi-disciplinary teamwork.

TEAC's recommendation for centres of excellence sees them as centres of *research excellence, within* New Zealand's tertiary system. Centres of excellence are not necessarily (and perhaps rarely) created by administrative fiat. Funding is usually a necessary, but not sufficient, condition of excellence. Centres of existing excellence can be strengthened by increased support, as witnessed by the UK research assessment exercise, which essentially concentrates funding towards excellence, but increased funding alone will not encourage multi-disciplinarity. It will be important to recognise that centres of excellence and innovation may find a base in existing expertise. Where such capabilities do not exist in an area of strategic importance to New Zealand

it will be necessary build new centres by combining our own resources with external input of leadership and expertise. New foci of excellence will continually arise and must have access to the means for their development into world-class centres.

To achieve the highest possible returns on investment the various parts of the New Zealand innovation system must be closely integrated. Strengthening horizontal links between CRIs, universities and industry will strengthen the national research network. The providers of knowledge, skills, human resources and capabilities must work closely together, and with those who benefit from them.

3.1 Objectives for Excellence and Innovation

We propose five related objectives for centres of excellence and innovation. The objectives apply to all areas of endeavour, including social, environmental and economic dimensions:

1. To focus the intellect in New Zealand and overseas at the cutting edge of new discovery in fields of endeavour important to New Zealand.
2. To accelerate the development and use of new knowledge, insights and results.
3. To develop viable research teams of sufficient size and concentration to stimulate creative synergies and cross-fertilisation of ideas.
4. To bring appropriate mixes of disciplines, institutions, cultural views and sectors to bear on the problem area.
5. To build human capacity by training, developing and providing opportunities for a rewarding future in New Zealand for a new generation of outstanding researchers drawn from all sections of the community.

3.2 Criteria for Selection

Sample criteria for selection relate closely to the objectives set out above, but must also include the capacity of the applicants to deliver results. While each of the criteria would be regarded as essential, with no order of priority implied in the list below, the list should not be regarded as exclusive, and could be expanded where appropriate in response to feedback/the views of the key players:

1. Excellence of the research, and the researchers, as assessed against international standards.

Excellence in absolute terms means the highest levels of performance in a given area by an individual or an institution. This performance can only be benchmarked against best performance worldwide.

2. The ability to build viable, focussed and creative research teams in fields important to New Zealand.
3. The long-term importance of the research for New Zealand (social, environmental, economic).

Areas, in which a society chooses to be excellent and innovative, are influenced by its values. For example, for those values which include economic growth or success, centres and networks of excellence and innovation will include areas of highest potential economic benefit.

4. Bringing appropriate mixes of disciplines, institutions, cultural groups and sectors to bear on the research programme.

Centres and networks of excellence and innovation are unlikely to be formed exclusively from components presently available in the New Zealand tertiary research sector. They must include the best performing components available to a selected area wherever they can be accessed nationally or internationally.

5. Linkages between the research programme, other programmes, and wider social, ethical and environmental issues in New Zealand.

Centres and networks should be established in these areas with best performing components from tertiary institutions, Crown Research Institutes, overseas and other institutions. Linkages will focus on developing capability both on individual researchers and in areas that are considered to be essential for the development of NZ.

6. Ability to train, develop and retain outstanding researchers, skilled in multi-disciplinary and multi-sectoral approaches, and drawn from all sections of New Zealand's community.

Even if the majority of the components of a centre of excellence and innovation were not to come from universities, such centres and networks should be preferred environments for the education of graduate students and should contribute to the research education of undergraduate students.

7. Ability to establish joint relationships with those who will use the research to develop a clear path for its use, including the effective management and use of intellectual property.
8. A host organisation capable of providing the necessary financial, administrative and research leadership.
9. Ability to attract and retain non-central government funding.

Provision of an acceptable plan to evaluate medium-term overall performance of the centre.

4. INVESTMENT IN THE SYSTEM:

The amount and administration of funding will be the deciding factor as to whether the objectives for excellence and innovation can be met. Investment targeted exclusively to tertiary institutions will not permit the collaborations necessary for success. Government funds for research, excellence and innovation are currently associated with three Votes (Education, RS&T, and Economic Development), and ways must be found for funds under these Votes to work in harmony, synergy, and support for each other.

4.1 Sources of Funding

For the immediate future, the Royal Society proposes no change in Vote structure, but the appearance on the scene of centres of excellence and innovation will require complementary arrangements in other votes. We propose that new funding be found, and/or reserved in roughly equal proportions if necessary from Vote RS&T, Vote Economic Development, and Vote Education. The funds from these sources could remain within their Votes, and be available on first call to CRIs, private sector and tertiary institutions respectively if they formed part of a centre of excellence and innovation. In this manner, no single partner would be required to pay for the participation of partners from other parts of the innovation system, each would receive their own assistance. Unused funds would revert to original uses in their Votes.

4.2 Programme and Centres Funding

Centres and networks of excellence and innovation need a new set of incentives, performance expectations and rules to allow them to be established in areas of highest potential benefit, or to be moved to such areas with great flexibility. Funding should allow such centres and networks to be built from best performing components across the national research sector, and would enable the creation of centres where no suitable capability exists to date.

While several concentrations of excellence can currently be found in New Zealand, few or none of these meet in full the criteria for centres laid out above.

Arrangements must be made for start up of the fund, room for new centres over time, and eventual exit, both for individual centres, and for the fund as a whole, in the event that it should terminate. An important consideration in the development of new centres will be to ensure the on-going development of capability within Maori and PI communities.

While no typical level of funding is likely to exist for a centre, an aggregate of \$20m per year might reasonably support three to five centres. Twelve years of Canadian experience with centres of excellence show annual budgets in the range of NZ\$5m, with 40% coming from government sources. While New Zealand criteria should encourage private sector and local government co-investment, such contributions will need to grow over time. A condition of government investment should, however, be that some (increasing) level of co-investment is found from other sources. Australian Co-operative Research Centre (CRC) experience here has been quite successful, with 50% to 80% coming from non-government funds, and Centre budgets running at some NZ\$8m per year.

Centres will need sustained support over several years. Finland and Australia commit six or seven years in advance, while Canada has just introduced permanent funding, and currently supports 22 centres. New Zealand might aspire over time to eight or ten, with government funding committed in principle over six years, renewable, on presentation of an exit strategy to allow government to use its funding to start new centres. Those centres most successful in attracting other funding will likely present the best exit strategies, but centres mainly engaged in “public good” environmental or social research might find that matching funds can only be found from other government or local government sources.

In some cases, government may wish to continue funding a centre because, for instance, a creative and inspiring personality is at its helm. In such cases, the departure of the person may signal the beginning of a phased exit if no similar replacement can be found.

Initial investment of, say, \$20m per year, committed for five years, could be followed by new tranches each year of \$10m (\$50m per five-year period), until the total fund reached \$60m per year after five years. At the end of that time, original funds would become available for a new cycle of investment. In any one year, funds would not be allocated unless applications of sufficient excellence were received.

5. ADMINISTRATION

Several models exist in New Zealand and other countries for the administration of centres of excellence and innovation. None is fully suitable for use in New Zealand, as each has been developed for a slightly different purpose or different circumstance. Below is one possible process for creating and administering centres of excellence and innovation.

5.1 Selection Process

It is expected that the new Tertiary Education Commission will oversee the policy intent of centres of excellence and innovation. It will need to appoint a small *steering body* to deal with strategic and coordination

questions surrounding centres. The steering body could be drawn from the ministries of Economic Development, RS&T, and Education, chaired by TEC. The steering body would have the power to call on outside resource people for advice as necessary, and may choose to set up a “consumers’ group”. The steering body will need the support of a *secretariat* which develops selection processes, implements them according to policy and strategy guidelines, administers contracts and audits, commissions evaluations, and provides feedback to the steering body.

The secretariat should be contracted to an agency demonstrating experience in funding excellent research, and showing understanding of how to develop excellent people with innovative ideas.

The steering body would be responsible for any instructions as to fields of endeavour where centres of excellence and innovation would be sought in each investment round. It might for instance announce competitions for specific areas, and open competitions for part of the year’s investment, with the onus on the applicant to show benefit to New Zealand.

Applications would be judged against criteria by a set of *expert panels* assembled by the secretariat. Panel chairs would then meet with the steering body to reach final decisions.

Centres would be required to prepare annual public reports, and the steering body would prepare an annual report for submission via TEC to parliament.

5.2 Applications

To minimise unnecessary effort, applicants and their prospective partners would submit a *letter of intent* for first screening, addressing the aim of the centre, the research programme, leveraged funding, and each of the selection criteria in brief, together with the names of leading researchers and a preliminary budget.

Short listed applicants would submit a more detailed proposal, amplifying their letter of intent and including the context of the programme, a strategic plan, research plan, partnership management plan, results exploitation plan, and government exit options. The processes used in Canada and Australia should be examined for adaptation and applicability in New Zealand.