

# **TECHNOPOLIS**



**An International review of Competence Centre Programmes**

**Erik Arnold  
Jasper Deuten  
Jan-Frens van Giessel**

**April 2004**

# **An International Review of Competence Centre Programmes**

**Erik Arnold  
Jasper Deuten  
Jan-Frens van Giessel**

Technopolis Group  
April 2004

<b>1</b>	<b>Introduction</b>	<b>1</b>
<b>2</b>	<b>What are Competence Centres?</b>	<b>2</b>
<b>3</b>	<b>Competence Centres in Theory</b>	<b>4</b>
<b>4</b>	<b>Some Competence Centre Programmes in Practice</b>	<b>6</b>
4.1	Engineering Research Centres, USA	6
4.2	Co-operative Research Centres (CRCs), Australia	8
4.3	<i>Kplus</i> Centres, Austria	10
<b>5</b>	<b>How Competence Centre Programmes Operate</b>	<b>12</b>
5.1	Objectives	12
5.2	Operations	12
5.3	Assessment criteria	14
<b>6</b>	<b>Success Factors</b>	<b>16</b>
<b>7</b>	<b>Effects of Competence Centres: What Does the Taxpayer Get for the Money?</b>	<b>19</b>
<b>8</b>	<b>Conclusions</b>	<b>23</b>

## 1 Introduction

‘Competence centres’ are a comparatively new form of university-industry research alliance that do both fairly fundamental but also more applied, problem-oriented research. Their long-term nature and the comparatively high rates of subsidy involved allow them to have a structuring effect on sub-systems of innovation, educating and generating communities of research practice between research-performing institutions and industry and generating common, use-oriented research agendas with potential to have significant positive socio-economic effects.

RCN is considering how to create ‘centres of innovation excellence’ that can exploit strong academic and institute research capabilities to build clusters of innovation. The Council therefore asked us to make a survey of ‘competence centre’ programmes internationally.

In agreement with RCN, we selected eight competence centre programmes to study. For each, we built a description using secondary sources, which we sent to the responsible programme manager for comment. Obtaining the managers’ comments also allowed us to interview them about some of the more ‘soft’ factors involved in defining and running such programmes. This paper summarises lessons from the revised programme summaries.

There are growing numbers of international examples<sup>1</sup> of competence centre programmes (**Exhibit 1**). All share an intention to change research structures permanently, by providing a long-term – but nonetheless time-limited – financial and organisational impulse.

### Exhibit 1 Competence Centre Programmes

Country	Start Date	Agency	Competence Centre Programme
USA	1985	National Science Foundation	Engineering Research Centres
Ireland	1988	EOLAS/Forfás	Programmes in Advanced Technology
Canada	1989	NSERC, CHIR, SSHRC	Networks of Centres of Excellence
Australia	1990	Ministry of Industry	Co-operative Research Centres
Sweden	1994	NUTEK/STEM/VINNOVA	Competence Centres
Netherlands	1997	Ministries OCW and EZ	Top Technological Institutes
Austria	1999	BMVIT/TiG	Kplus
Austria	1999	BMW/FFF	Kind, Knet
Hungary	2000	Ministry of Education	KKK Co-operative Research Centres
Estonia	2004	Ministry of Industry	Competence Centres

This paper is based on a survey of all of these – except the ones in Ireland and Estonia. We omitted these because the Irish case is rather old, very complex and involves many elements that appear specific to Ireland’s state of development in the early 1990s. The Estonian centres were set up at the same time as we began work on this study, so there is so far no real experience from which to learn. Other important inputs to this paper include work for VINNOVA and STEM over the past year,

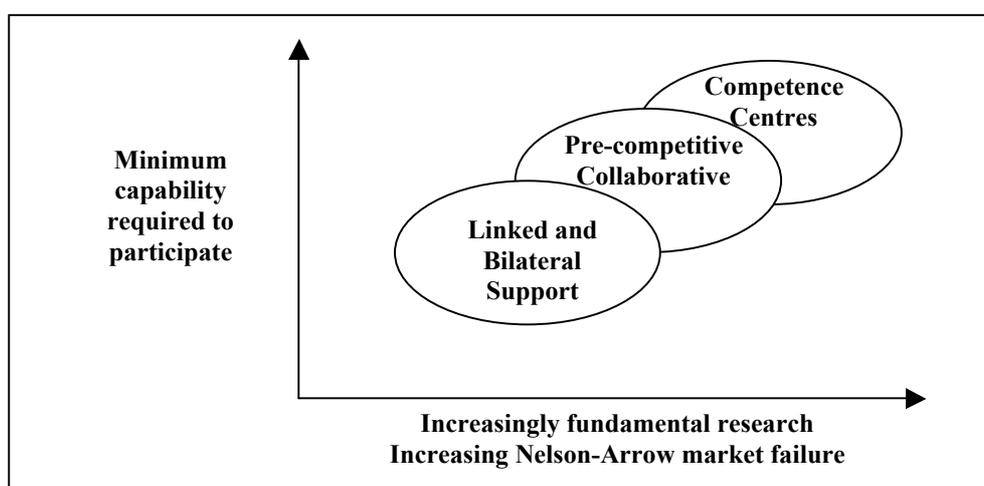
<sup>1</sup> Note that the well-known German Kompetenzzentren concept is a different kind of initiative, involving regional clusters that include a research element together with active ‘network management’, rather than setting up new institutional entities.

aiming to improve our understanding of the impacts of the Swedish competence centres, the work of the MAP networks on complex R&D programme initiatives, and participation in the mid-term evaluation of the Austrian *Kplus* centres over the past three years, as well as a reading of relevant evaluations.

## 2 What are Competence Centres?

Competence centres use a combination of academic excellence with industrial needs and problems to focus joint academic industry R&D on areas of high innovation potential. As policy instruments, they typically focus on comparatively high-capability industrial and academic participants: typically medium-large companies and high-capability SMEs (**Exhibit 2**, which is of course a simplification) – though there is scope for a fair amount of variation.

**Exhibit 2 Focus of Competence Centres**



As one moves North-East in the Exhibit, R&D tackles increasingly fundamental questions and the traditional or ‘Nelson-Arrow’ market failure<sup>2</sup> (that companies under-invest in research) comes more and more into play. Participants need increasing capabilities or ‘absorptive capacity’ in order to make use of the results of R&D. As one moves South-West in the Exhibit, market failure declines, as does the need for internal technological capabilities. This is typically reflected in the levels of subsidy provided in state programmes. Linked and bilateral support (such as *brukerstyrt forskning*) tends to get 25-40%; pre-competitive collaborative work (such as the Framework Programmes) 40 – 50%; while competence centres tend to be in the range 50 – 70%. Each of these instruments serves a somewhat different purpose, not least because it tackles a different **segment** of need.

The idea of fundamental research in the context of industrial innovation can sound paradoxical, because the basic science lobby likes to define ‘basic’ as ‘blue skies’,

<sup>2</sup> Ken Arrow , ‘Economic Welfare and the Allocation of Resources for Invention,’ in Richard Nelson (Ed.) *The Rate and Direction of Inventive Activity*, Princeton University Press, 1962; see also Richard Nelson, ‘The simple economics of basic scientific research,’ *Journal of Political Economy*, 1959, vol 67, pp 297-306

‘curiosity-driven’ or ‘research-driven’ research. But, as Donald Stokes<sup>3</sup> points out in his 1997 book *Pasteur’s Quadrant*, much fundamental science is actually done with considerations of use in mind (**Exhibit 3**). His examples of the curiosity-driven Bohr, of Pasteur (doing fundamental research in order to understand and control disease) and Edison (with his ruthless empiricism, not much interested in underlying mechanisms) give a better sense of how research actually operates. The instruments in **Exhibit 2** operate mostly in Edison’s quadrant. They can have adventures in Pasteur’s quadrant, but competence centres systematically devote more of their resources Pasteur’s Quadrant it than do the other instruments.

**Exhibit 3      Types of Research, According to Stokes**

<b>Quest for fundamental understanding</b>	Yes	Pure basic research (Bohr)	Use inspired basic research (Pasteur)
	No		Pure applied research (Edison)
		No	Yes
		<b>Considerations of use</b>	

Competence centres have some recognisably special features relating to their role, especially

- They are normally funded by three partners: industry, university and a state agency. They are intended to have an effect on university resource allocation and strategy, in addition to reinforcing university-industry links
- They involve long term contractual arrangements, requiring a much bigger commitment than traditional project by project funding of collaborative R&D
- They create new on-campus structures, and therefore make new organisational and structural demands on the universities
- They are interdisciplinary and generally problem-focused in the research they do, demanding ‘horizontal’ networking across traditional university structures
- Their long-term presence on campus and their engagement with postgraduate education draws them into closer contact and co-operation with universities’ ‘core business’ of education and research than is often the case with linkage actions, which tend to focus more purely on research
- By drawing industry personnel onto campus to join in research, they also extend academics’ networks into the industrial research community

<sup>3</sup> Donald Stokes, *Pasteur’s Quadrant: Basic Science and Technological Innovation*, Washington DC: The Brookings Institution, 1997

The prototype was the US National Science Foundation's Engineering Research Centre programme, launched in 1985. While competence centres are normally categorised as R&D funding instruments that aim to improve academic-industry linkages, they generally also have a less clearly stated ambition to alter the research culture of the universities: moving towards greater interdisciplinarity; and making close co-operation with industry more acceptable. The extent to which competence centres are needed, as change agents within the university system, naturally varies, not least because there are many different kinds of university. Nonetheless, this aim to change university-industry interaction by changing the way the universities work is something that most clearly distinguishes competence centres from other 'linkage' initiatives, which tend to take university norms and culture as 'given'.

### 3 Competence Centres in Theory

Competence centres operate in a context of significant change, not only in the way the knowledge and innovation system works, but especially in our understanding of it.

They conform with our essentially **systemic** understanding of research and innovation, often discussed under the slogan of 'National Innovation Systems'. In part this seems to represent an improvement in theory: a better way to describe what already exists. But there is also some evidence that research and innovation operate in ways that are **increasingly** systemic: that there is also a qualitative change in reality in progress. There is evidence for this, for example, through the increasing citation of academic research results in industrial patents.

A particularly interesting expression of the systemic nature of innovation systems is the emergence of so-called 'Knowledge Value Collectives' (KVCs)<sup>4</sup> – essentially the set of actors which defines, creates and uses related knowledge. Competence centres represent contractual, institutional relations among some of the actors within individual KVCs.

The systems view of innovation<sup>5</sup> is based on ideas in 'evolutionary economics' that have been emerging over the past few decades. These see the firm as constantly challenged to innovate by external and internal changes. There is no economic equilibrium, but a constant search for ways to create advantage. Competence centres respond to this need constantly to search for knowledge that can be used in change.

The balance of knowledge production is shifting towards what Gibbons<sup>6</sup> et al. called 'Mode 2': namely, interdisciplinary, problem-focused and heterogenous in its performance, as opposed to the disciplinary focus of traditional universities. Such interdisciplinary, problem-oriented research is precisely the sphere of the centres.

---

<sup>4</sup> Barry Bozeman and Juan Rogers, 'A churn model of scientific knowledge: Internet researchers as a knowledge value collective,' *Research Policy*, Vol 31, 2002, pp 769 - 794

<sup>5</sup> See Christopher Freeman, *Technology Policy and Economic Performance: Lessons from Japan*, London: Frances Pinter, 1987; Bengt-Åke Lundvall, *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, London: Pinter, 1992; RR Nelson, *National Innovation Systems*, New York: Oxford University Press, 1993

<sup>6</sup> Michael Gibbons, Camilla Limoges, Helga Nowotny, Schwartzman, S., Scott P. and Trow, M., *The New Production of Knowledge*, London: Sage, 1994

One crude indicator of the growth of Mode 2 is the growing proportion of the national R&D effort financed and conducted by the private sector. The emergence of mass education since the mid-20<sup>th</sup> century means not only that there are large numbers of research-capable people working outside the knowledge infrastructure but also that companies have many more options about where to do R&D – and that they increasingly have the capability to do research in partnership with universities. The economically ‘driving’ technologies are increasingly to be found at the boundaries between disciplines (sometimes<sup>7</sup> referred to as the ‘hyphen technologies’), not in what the universities would traditionally see as the disciplinary mainstream of knowledge production.

While there are changes in the mode of knowledge production, people continue to play a central role not only in the generation but also in the movement and exploitation of knowledge. Competence centres tend to have an important role in post-graduate training.

In what looks initially like a paradox, the major parts of industry that depend on, and compete in, technology-intensive products and services, there is a movement away from conducting fundamental research in-house<sup>8</sup>. The reasons appear to be partly the traditional problem that it is hard to appropriate fundamental research results, so the economic incentives to doing it are low. Partly, also, the breadth of the fundamental knowledge needed by industry seems to be growing, so that companies need new strategies for accessing world knowledge. Competence centres provide contexts in which companies can influence the direction and content of research that, in the medium term, they need, but that is more fundamental than they can afford to support.

Globalisation of industry has been accompanied by a willingness to conduct R&D in multiple locations – primarily within the ‘Triad’ of the USA, Japan and Europe. As a result of the growing interaction between large, multinational companies and the research and higher education sector, the shape and quality of the knowledge infrastructure becomes one of the factors influencing industrial R&D location. Competence centres can play important roles in ensuring not only that the research performed in the knowledge infrastructure has, over time, user relevance, but also that it is of high quality. These are necessary, but alone not sufficient, aspects of attracting and retaining industrial R&D activity.

In the context of a changing ‘social contract’ between science and society, many research funders are giving priority to funding ‘relevant’ work. Social goals for both research and education are bringing universities increasingly under pressure to change. At the same time, many of them have weak strategic capabilities and resources, and are strongly ‘locked in’ to existing activities and trajectories by the way they are governed

---

<sup>7</sup> Following Frieder Meyer-Krahmer

<sup>8</sup> Frieder Meyer-Krahmer and Guido Reger, ‘New perspectives on the innovation strategies of multinational enterprises: lessons for technology policy in Europe’, *Research Policy*, Vol. 28, No. 7, 1999

## 4 Some Competence Centre Programmes in Practice

In this section, we sketch three examples of competence centre programmes, including the NSF one that has functioned as a prototype for the competence centres movement and the *Kplus* programme in Austria that applies the model in an economy that is in important respects not very different from that of Norway.

### 4.1 Engineering Research Centres, USA

The US Engineering Research Centres programme that started the competence centres movement predates the emergence of the National Innovation Systems literature, but this new model of creating a common network of companies and academics fits very well with the new way of looking at innovation. With a budget of some \$50m per year, it is still the second-largest competence centres programme, of which we are aware.

The ERC programme was set up in 1985 to develop a government-industry-university partnership to strengthen the competitive position of U.S. firms in world trade. More specifically, the ERC programme grew out of concern expressed in the early 1980s by the National Academy of Engineering (NAE) and NSF that: (1) rapid technological advances were occurring at the intersection of engineering and other disciplines, requiring a cross-disciplinary approach to engineering that had not been incorporated into engineering research or practice; and (2) a mismatch had developed between the way engineering was carried out in industry and the way students were being trained. The ERC mission has three main elements<sup>9</sup>

- Cross-disciplinary and Systems-oriented Research
- Education and Outreach
- Industrial Collaboration and Technology Transfer

Individual ERCs are required to have the following features

- A strategic vision guiding both the production of advances in a complex, next-generation engineered system and the creation of a new generation of engineers needed to strengthen the competitive position of U.S. industry in a global economy
- A dynamic, evolutionary strategic research plan to focus the ERC on achieving its vision
- A cross-disciplinary research programme promoting the synthesis of engineering, science and other disciplines that spans the continuum from discovery to proof-of-concept in test beds and involves undergraduate and graduate students in research teams
- An active, long-term partnership with industry and practitioners in planning, research, and education to achieve a more effective flow of knowledge into innovation and the education of a new breed of engineers

---

<sup>9</sup> [www.eng.nsf.gov](http://www.eng.nsf.gov)

- An education program for undergraduate and graduate students that produces an integrative, systems-oriented intellectual environment and corresponding curriculum innovations
- Outreach to other institutions to enhance the capacity of the ERC to achieve its goals and broaden the impact of the ERC culture in academe and society

NSF's support across all ERCs ranges from \$1.0 M to \$3.6 M per year and per centre; the average ERC award was \$2.5 M per year in 2002. The actual funding level in any given year will depend upon a detailed analysis of proposed work, progress to date, financial need, and the availability of funds. In 2002, NSF was supporting 19 ERCs, pursuing research foci in: bioengineering; design and manufacturing; earthquake engineering; and microelectronic systems and information technology. As of January 2002, 13 ERCs were said to be self-sustaining after the conclusion of NSF support.

Currently there are some 20 centres. Each involves several tens of faculty and an industrial consortium. Generally, the companies are big and have high technological capabilities. **Exhibit 4** gives two examples of industrial participations in ERC centres.

#### **Exhibit 4      Examples of ERC Industrial Consortia**

<b>Centre for Neuromorphic Systems Engineering at CalTech</b>	<b>Centre for Subsurface Sensing and Imaging Systems, NorthEastern University</b>
Boeing	Raytheon
Digital Persona	Air Force Office of Scientific Research (AFOSR)
General Motors	CardioMag Imaging
Honeywell	Hewlett-Packard Company
Intel	Lockheed Martin
IRIS (International Remote Imaging Systems, Inc.)	Mercury Computer Systems
Rockwell Intl.	The MathWorks
	MicroBrightField
	Jamie Whitten National Centre for Physical Acoustics
	National Geospatial-Intelligence Agency.
	Textron Systems
	TransTech Systems, Inc
	Zomega Technology Corporation

**Source:** Centre web sites

The industrial consortia comprise a mixture of very large companies and small to medium sized technology-based firms. In European terms, many of these 'small' firms are rather big, reflecting the fact that in the USA it is possible to grow a new technology-based company very quickly indeed, compared with our normal European experience.

A competition for new ERCs is now held periodically, usually every two years. ERCs are established by NSF as a result of peer-reviewed competitions preceded by programme announcements

Each new centre receives a five-year cooperative agreement stipulating that a

formal review (including by external site visitors) be conducted in the third year for renewal of support. Centres passing the third-year review receive a new five-year cooperative agreement requiring a formal review in each centre's sixth year. The full term of an ERC is 11 years. As a centre begins its seventh year, if not before, it should begin to generate even higher levels of non-NSF funding to lay down a pathway to self-sufficiency after year 11. Funding is phased down in an ERC's ninth and tenth years. The centre is expected to preserve the ERC culture as it moves into self-sufficiency. Sub-groups within an ERC may choose to regroup with others to compete to form a new ERC in the final two years of the ERC's award.

#### 4.2 Co-operative Research Centres (CRCs), Australia

The Australian Cooperative Research centre scheme is the largest competence centre programme considered here in terms both of overall budget (about \$120m per year) and number of centres (71). The individual centres can therefore be comparatively small.

The programme was set up in 1990 in response to perceived weaknesses in the national Innovation System<sup>10</sup>

- Australia's combined S&T resources were dispersed both geographically and institutionally. This separation made it difficult to build strong research teams and led to unnecessary duplication of facilities, and difficulty in ensuring that they were world class. There was a lack of critical mass due to this dispersion
- In addition, there were 'challenges' of effective international links for a country isolated from the international centres of research and innovation
- Existing funding arrangements were not suited to build large integrated multidisciplinary research. (Most research funding in Australia was from institutional sources and was distributed through administrative channels to operational units and individual researchers)
- Links between research organisations and users were weak. In fact, there were disincentives to collaboration among research providers and Australian businesses
- The "absorptive capacity" of Australian industry was limited
- There was a lack of mobility of personnel between government research, academia and industry
- Graduate programmes in Australian Universities did not prepare students well for jobs outside the academic world as well as denying students access to the skills and experience of many of Australia's best researchers, and researchers the stimulus of interaction with students

The (official) objectives (in 2002) for the CRC Programme are

- To enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development
- To enhance the transfer of research outputs into commercial or other outcomes of economic, environmental or social benefit to Australia
- To enhance the value to Australia of graduate researchers

---

<sup>10</sup> Howard Partners, *Evaluation of the Co-operative Research Centres Programme*, Canberra: Department of Education, Science and Training, 2003

- To enhance collaboration among researchers, between researchers and industry or other users, and to improve efficiency in the use of intellectual and other research resources

In addition to the official objectives, the CRC Programme also addressed the “unofficial goal” of changing Australia’s research and innovation culture. Unofficially, CRC also stands for “changing research culture”. Indeed, the emergence of public-private research partnerships reflects a fundamental change in the way in which knowledge is generated and applied as well as changes in approaches to the management of industrial R&D. Research commercialisation has come into prominence. The CRC Programme has been an important contributor to building the required capacity to carry out partnership-based research and innovation, business development based on research commercialisation, and for scientists to engage in public programme design and delivery.

As **Exhibit 5** illustrates, there is a wide diversity of types of company involved, from large and highly capable companies through small, technology-based firms to farmers’ co-operatives, which traditionally have only modest technological capabilities. Clearly, the threshold for entry into this scheme is much lower than in the US case.

#### **Exhibit 5      Examples of CRC Industrial Membership**

<b>CRC for Advanced Composite Structures</b>	<b>CRC for Innovative Dairy Products</b>
Core Members:	Industry members:
Hawker de Havilland Aerospace P/L	Australian Dairy Farmers Ltd
	Dairy Australia
Supporting Members:	
GKN Aerospace Engineering Services Pty Ltd	Commercial members:
MSC Software Australia Pty Ltd	Dairy Farmers Cooperative
Pacific Engineering Systems International Pty Ltd	Genetics Australia
	Probio Inc
Associate Members:	Tatura Milk Industries Ltd
Australian Urethane & Styrene Pty. Ltd	
Pacific Composites Pty Ltd	
Structural Monitoring Systems Ltd.	
International Collaborators:	
Office of Naval Research, USA	
Airbus, Deutschland GmbH	
Airbus UK Ltd	

**Source:** Centre web sites

The CRC programme operates with a series of calls for proposals – altogether 8 Calls have been issued in the period 1990 to 2002. Centre contracts are normally for 7 years, though an eighth may be granted in order to wind up a centre. There is a performance review after 3 years, on which the balance of the funding depends. At the latest during the 6<sup>th</sup> year of operations, each centre must have developed a plan wind up its activities. Participants may apply again in a new CRC, but the old one will not be extended.

#### 4.3 *Kplus* Centres, Austria

Austria has many important similarities with Norway, including an industry structure that is not especially R&D-intensive, a weak tradition of university-industry co-operation and a rather strong applied research institute sector.

In order to reach the Lisbon/Barcelona target (3% of GDP allocated to RTD) increasing the investment in R&D alone is not sufficient. Additional public and private investments in R&D need to generate sufficient high returns. This requires enhancing the overall efficiency of the Austrian National Innovation System by

- Encouraging existing firms to engage in more radical types of innovation.
- Promoting technology based start-ups
- Increasing the role of the higher education sector in providing a research base which can be utilised co-operatively with industry

The main reason to launch the *Kplus* programme was the low level of science-industry co-operation in Austria. *Kplus* aims at bridging the gap between fundamental research carried out by universities and industrial R&D. Other reasons to launch the *Kplus* programme were the following deficiencies in the Austrian innovation system

- Short term R&D planning in industry
- Dominance of SMEs in R&D in Austria
- Lack of critical mass within the knowledge infrastructure, especially the universities
- Low international visibility of many Austrian R&D capabilities

The main goal of the programme is to perform research that is highly relevant for both the academic world and industry and to develop human capital in areas that are either multi-disciplinary or which are relevant for a number of sectors/companies in Austria. Other goals are to

- Improve long-term co-operation between science and industry
- Improve transfer of know-how
- Define new areas of research through bottom-up approaches
- Reaching focus and critical mass in research.
- Use public funding to trigger additional private/industrial expenditures
- Ensure internationally competitive quality of *K plus*-centres through a strict selection process and periodic evaluation.
- Create examples of good practice in research management

As in Australia, an important 'hidden agenda' of the programme was to change the research culture and attitudes of both the industrial and the scientific actors. The *Kplus* programme was designed on the basis of extensive research into possible foreign exemplars

There are currently 18 *Kplus* centres in Austria, which have been launched in groups of 6 following three calls for proposals starting in 1998. The annual central

government spend on the programme is about Euro 10m. Some Austrian Länder co-finance centres

As **Exhibit 6** shows, in the Austrian context there is a range of industrial participation, from multinationals through major Austrian companies to medium-sized forms and some start-ups – in some cases as small as one-person operations. A minority of the centres is multi-site.

**Exhibit 6 Examples of *Kplus* Centre Industrial Membership**

<b>Light Metals Research Centre, Ranshofen</b>	<b>Competence Centre for Wood Composites and Wood Chemistry, Linz &amp; St Veit</b>
AluLight	Agrolinz Melamin International
Eckhart Granules	Dynea Austria
Fronius	Fritz Egger GmbH
Foseco	Funder Industrie
Hütte-Klein-Reichenbach	Kooperationsabommen Forst Platte Papier
Linde	Lenzig AG
Magna Steyr	
Rauch	
Stolfig	
SAG	
UBE	
TCG Unitech	

Source: *Kplus* centres

*Kplus* centres have a planned life of 7 years. Many were evaluated by a small peer committee after 2 years, to ensure that conditions laid down at the time of original funding were being fulfilled. In their 4<sup>th</sup> year, the centres are evaluated again by a visiting panel, to decide whether they should be funded for the second half of their planned lives. One of the 12 to be evaluated so far at mid-term, one has been wound down (over a period of time, to protect the post-graduates). The major uncertainty is the viability of the centres in year 8 and onwards, at which point they need to find alternatives to the *Kplus* core funding. In several cases, the Land has stepped in to take over part of this responsibility. There is growing consensus that the centres will not survive in their current role of doing a mixture of applied and more fundamental work without continued public subsidy. This contrasts with the ability of some of the US ERCs to survive beyond the end of their NSF grants (though there is presumably an element of public funding involved here, too). Generally, the size of firms involved in the Austrian centres and their more technological capabilities compared with those in the ERCs are more limited. While *Kplus* centre participants may reapply to the programme in new configurations, the policy is that the Federal government will not finance existing centres beyond 7 years.

An important conclusion from these descriptions is that the competence centre idea can function at a number of different ambition levels, not least in relation to the levels of technological capability of participating firms but also in terms of their scale.

## 5 How Competence Centre Programmes Operate

In this section, we sketch the characteristics of what we can think of as a ‘composite competence centres programme,’ based on the eight examples reviewed. Where there is significant ‘bandwidth,’ we try to give an impression of the variation.

### 5.1 Objectives

Competence centre programmes aim to tackle both ends of the academic-industry link. They encourage firms to undertake more radical kinds of innovation based on more fundamental understanding of the technologies with which they work. They aim to re-focus some of the activities in the knowledge infrastructure (universities plus research institutes, though more often the first than the second) towards interdisciplinary problem areas of importance to industry. They work primarily with established firms that have some absorptive capability. Often, they play a role in making the knowledge infrastructure attractive and supportive for multinational companies with R&D facilities in the country. Sometimes even companies located outside the country may participate, but it seems that the physical distance is an important obstacle to being deeply engaged. In many cases, they also contain a proportion of new technology-based firms (NTBFs), which may include spin-offs. They do not work with low-capability SMEs. Competitors are not often present within the same centre. Where this happens, they tend to tackle different topics within the same centre, or to handle long-term questions of common interest, such as how to tackle environmental requirements.

Centres normally include a significant proportion of PhD education, producing PhDs who are more used to and interested in working with industrial problems than many, and who are more quickly and easily absorbed into industrial companies. Most countries operate one or more separate, academically-oriented centres of excellence programmes, but there is little contact with these, which tend to be seen as ‘complementary’ rather than competing.

Competence centres work with a cluster of industrial partners, whose activities share a common ‘knowledge base’. They build networks and communities of knowledge with value that goes beyond R&D. In some cases, they have a regional focus (Canada, some Austrian and Australian centres); in others they are national. In many cases, they have a small international participation.

Most competence centres programmes have been set up in the belief that industry will take over the funding role of the state at the end of the subsidy period. While thirteen of the NSF Engineering Research Centres have been able to carry on without core funding after their NSF grants ran out, there is little evidence to suggest that industry is more generally able to ignore Nelson-Arrow market failure and step into the role of funding fundamental but industry-oriented R&D. This is creating an interesting puzzle in some funding systems: whose job is it to fund Pasteur’s Quadrant?

### 5.2 Operations

Stakeholders have rarely been involved in the design of competence centres **programmes**. However, their active participation in the planning and execution for individual centres is always effectively a precondition for funding.

Competence centre programmes are run by ministries, innovation agencies, research councils or a dedicated organisation (Australia) – all models are practised. Budgets are often large (Euro 10 – 60m per year), because the centres themselves tend to be rather big and because programmes commit to fund centres for long periods. The duration of centre funding varies from 4 years (Kind in Austria, which is unusually short) through 7 years (Kplus, Austria) to 11 years (US ERCs) and 7 + 7 years (Canadian NCEs). The centres are funded for long periods in order to build reputations and capabilities, and to provide a context in which more long-term and fundamental work can be done. Industry normally commits itself for multi-year periods, too. Centres are evaluated periodically and poorly performing ones will be phased out (usually over a couple of years, in order to protect the postgraduates).

Competence centres are rather intensively evaluated, generally through modified peer review, though as programmes age there is rising interest in impact studies. Active evaluation is often used in programme management – notably in the early stages, to test whether individual centres are ‘on track’ or need to change course; and at later stages in order to support decisions about whether individual centres should continue to receive funding.

Typically, a central agency plus the universities involved together contributes over half the cost. In some cases, regional governments also make a contribution.

Most programmes work with a rather formal two-step call for proposal. Outline plans are assessed and a short list of applicants is invited to submit a full proposal. Application / acceptance ratios vary dramatically, from 10:1 down to almost 1:1. In most cases, scientific quality is a key assessment criterion, and is secured using international peers. Applications are therefore generally written in English, since this is the scientific *lingua franca*(!) The majority of programmes have an additional and separate appraisal process focusing on relevance, though some take the position that industrial funding is itself a guarantee of relevance. Technologies supported tend to emerge ‘bottom up,’ though sometimes people are encouraged to apply if there are evident gaps in the programme. Since the centres last for a long time, it is best to launch calls for proposals in waves. Otherwise, the programme becomes a ‘snapshot’ of needs at a particular point in time that may become many years out of date before the programme can be renewed.

Since centres span academic and industrial needs and need to have scientific critical mass, they tend to be fairly large: 20 to 100 or more people. At the minimum, they need a director able to tackle the scientific and commercial issues involved. Often these aspects are split between two people. In some cases, training and handbooks are provided for centre managers and others involved with the programme. Very large centres (the US ERCs) have more people involved in management. Normally, each centre has a board comprising a mixture of industrial and academic interests, and often a separate scientific advisory group. Centres usually have a great deal of autonomy to set and vary their work programmes, and to recruit additional industrial partners (especially as some partners always drop out over time).

Centres vary as to whether they have a clear, single location or as to whether they are ‘virtual’ centres functioning across campuses or universities. Our participation in

centre evaluations suggests there are clear – and obvious – advantaged to a physical centralisation model. Legal forms vary, adopting whatever form is convenient under national law. Some programmes even leave the legal form of centres up to the participants to decide.

Many programmes use a standardised or model contract for the centres and their relations with their partners. Most programmes set Intellectual Property Rights (IPR) rules, but there are often variations within the individual programme. IPR regimes also differ among countries, based on prevailing law and practice. A specifically Norwegian model will be needed here. Centres normally publish through academic and industrial channels. A key aspect of the centres is that industrial participants should work actively in projects – preferably on more fundamental projects as well as industrially focused projects.

Agreements specify governance structures in some detail, because it is important to maintain a balance of power between industrial and academic participants. Normally, there is some kind of Board where the stakeholders sit, and the centre director reports to this Board. Experience is (as one would expect) that excessive industrial influence tends to make the research agenda rather short term, so that – in effect – the companies are able to use the high level of subsidy as economic rent. If the academics are too powerful, the companies become mystified or lose interest. An external scientific committee can be a useful way to ensure that centres stay in the research mainstream and understand where the technological frontiers lie.

Competence centres are now old enough that serious ex post evaluation is beginning. This immediately runs into a severe problem, because of the long lives of the centres: namely, that most of the data needed about the earlier lives of the centres have been lost or forgotten. NSF operates a secure web site for recording key data, including a record of who has been involved. Since people are key to the operation of the centres, keeping such records is vital to understanding them.

### 5.3 Assessment criteria

Each programme has developed its own assessment criteria. Many also track a number of performance indicators, such as numbers of publications, patents, and so on, but none seems to know how or whether these actually measure their success, since programme goals are set at a much higher level.

Assessment criteria normally fall into two categories: technical; and economic / relevance. Often, these are assessed by different experts.

Technical criteria tend to include

- Scientific quality and novelty of the proposed work
- Likely effects on postgraduate training and production of PhDs
- Problem orientation and interdisciplinarity
- Track record of the researchers and participating industry
- Technological capabilities of industry involved

Economic criteria tend to include

- Conformity with the rules of the programme
- The apparent viability and likely longevity of the partnership
- Likely effectiveness of technology transfer mechanisms
- Likely economic impacts
- Likely externalities through networking, publication, raising participants' capabilities
- Active involvement of industry In the work programme
- Viable management and governance

These criteria can be specified at various levels of detail. The *Kplus* programme lists about 50 criteria. Others tackle them in a more aggregated way. The NSF criteria provide a good model, as follows.

- **What is the intellectual merit of the proposed activity?** How important is the proposed activity to advancing knowledge and understanding within its own field or across different fields? How well qualified is the proposer (individual or team) to conduct the project? (If appropriate, the reviewer will comment on the quality of the prior work.) To what extent does the proposed activity suggest and explore creative and original concepts? How well conceived and organized is the proposed activity? Is there sufficient access to resources?
- **What are the broader impacts of the proposed activity?** How well does the activity advance discovery and understanding while promoting teaching, training, and learning? How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)? To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships? Will the results be disseminated broadly to enhance scientific and technological understanding? What may be the benefits of the proposed activity to society?

#### **Additional Review Criteria**

- Proposal defines an emerging engineered system with strong potential to spawn new industries, transform our current industrial base, service delivery system or infrastructure, and have a broad societal impact;
- Research plan targets critical systems goals, identifies challenging scientific and technical barriers to be overcome and proposes research projects and proof-of-concept test-beds to address these barriers;
- Proposal demonstrates a clear knowledge of the state-of-knowledge and the state-of-the-art and presents a persuasive strategy for advancing them;
- Education plan integrates the ERC's research activities and results into curricula at all levels, achieves a team-based, cross-disciplinary culture for undergraduate and graduate students, and incorporates effective plans for implementation, assessment and dissemination of curricular materials;
- Outreach will expose a broad spectrum of faculty, teachers and students to the ERC's research culture, impact pre-college curricula and motivate students to study engineering;

- Proposal provides a convincing rationale for the selection of industrial/use partners and engages these partners in planning, research, education, and technology transfer.
- Institutional configuration is appropriate to the goals of the ERC and, for multiuniversity ERCs, collaboration is integrated across the participating universities;
- ERC has expertise in all disciplines required to attain its goals, a capable leadership team, and leadership, faculty and student teams diverse in gender, race, and ethnicity;
- Organizational structure and management plan effectively organize and integrate the resources of the ERC to achieve its goals and include strong advisory and project selection/evaluation systems. In a multi-university proposal, the resources of all institutions must be effectively integrated;
- Experimental, computational, and other required equipment, facilities, and laboratory space are in place or proposed to support the research of the Center;
- The participating institutions have committed to encourage, support and facilitate the dissemination of the interdisciplinary research, educational and diversity programs of the ERC.

**For full proposals only**

- Headquarters space proposed for the Center will effectively encourage and facilitate interdisciplinary collaboration and house the management functions of the ERC.
- Commitments from firms to be fee-paying members of the ERC, if an award is made.
- Proposed terms of the industrial membership agreement will structured a centerwide program of industrial collaboration to support overall ERC goals, as opposed to a collection of individual sponsored projects; proposed terms of the intellectual property policy will facilitate technology transfer.

**6 Success Factors**

Competence centres are complex creatures. There is a lot to get right, and there is not complete agreement among all programme or centre managers about what the success criteria are.

Success factors identified in the Networks of Centres of Excellence evaluation<sup>11</sup> in Canada included

- World class scientific leadership
- Strong administrative support, including having a strong network manager and board of directors
- A strong and active role for partner organisations throughout the network planning and research process (not just a role in ‘name only’)
- True collaboration among researchers (not ‘collaborations of convenience’), who represent the best people in the field

---

<sup>11</sup> Dennis Rank, *Evaluation of the Networks of Centres of Excellence: Final Report*, Ottawa: KPMG, 2002

- An integrated research programme, in which the themes are mutually self-supporting
- A multidisciplinary approach, in which ‘peripheral disciplines’ are well integrated into the network strategy

This is at least a partial list of success factors, emerging from our overview of centre programmes.

Centre managers are very important. They have to be seen as legitimate by both the research community and the industrial participants. Often, this is taken to mean that a centre manager has to have a track record as a researcher. In some cases, the role is split between a scientific director and a commercial manager, since the job is a demanding one. This overcomes the problem experienced in the Swedish competences centres programme by some centre managers, who found that they lost momentum in their research careers.

Managers obviously need to be perceived as good leaders and managers, and this has consequences for the kinds of personalities that are appropriate for the job. This means in part that they have to be supported by a governance structure that balances academic and industrial power in the centre, and which also delegates authority adequately to the manager.

Research co-operation only works if researchers actually co-operate. This assertion is trivial but also important. Academic and industrial participants need to be physically together and working on the same or related problems for some of their time, otherwise there is no real subject for co-operation and there is little learning. For this reason, and in order to create an esprit de corps, it is important for a centre to have a physical existence, and preferably to be clearly labelled. In some cases, competence centres are seen by academics as ‘simply another source of money’ and by industry as a source of subsidy or cheap (subsidised) R&D labour. Centres where these attitudes are reflected in practice never become viable.

Centres and commitments need to be long term. It takes time to build up trust among the participants in a competence centre. One of the most successful of the Swedish centre managers argues that ‘It takes 5 years to become famous,’ and if there is to be a period of harvesting as well as of growing, this tends to argue for centre lives of the order of 10 years. A consequence of this for the state funder is that there needs to be a way to deliver multi-annual funding, and not to have to get a new funding decision for the programme or for each centre every year. Another consequence is that assessment and selection procedures need to be transparent as well as fair. The allocation of large, long-term funding quickly causes envy within the academic system.

Intellectual property issues are a source of major conflicts. Partly inspired by the US Bay-Dole Act, universities are increasingly trying to control and exploit intellectual property. At the same time, participating companies will try to control as much as they can. A compromise seems to be that, where more fundamental work is done and where it is not part of a relationship between the centre and a single company, the IPR belongs to the centre. In cases where a company is paying a high proportion of the cost of the work, it tends also to get the IPR. Problems of background IPR

feeding through successive projects can arise, and need management. Academics often also need training in good laboratory notebook practice and disclosure routines.

In order to keep the academics interested and to quality-assure the operations of the centre, it is important that it participate in normal conference and publication activities.

Some programmes have created handbooks and training courses for centre managers. These appear to be widely appreciated.

Funding a centre after the programme money runs out is a big and difficult issue. Centres tend to think about this too late, and then to ask funders for more core money. This kind of longer-range planning needs to be built into the centre life cycle as a requirement for funding. Almost no-one involved with the NCE programme believed the centres could carry on unchanged, once the period of network funding (up to 14 years) was over. The eight networks that had been terminated early significantly decreased total funding, and their activity emphasis changed significantly. Only one was able to find longer-term research funding.

An experience with the Swedish programme, which launched 28 centres at the same time, then had no money to do another call for nearly a decade, is that the result is a ‘snapshot’ of national needs at one point in time. It is better to launch smaller, more frequent calls, so that the programme continually adjusts to needs.

In principle, there is a design choice between having a life cycle at the level of the programme or of the individual centre. In a number of cases, individual centres have been problem oriented, and have moved from an early phase of strong focus on rather fundamental research to a greater emphasis on technology transfer and commercialisation later in their lives, as important parts of the problems they were set up to address have been solved. The implication is that these centres may move into a still more commercial mode after centre funding expires – or that they need to reinvent themselves so as to find and tackle new problems in a more fundamental way. Bunching the Swedish investment, as was done, opens the door to having a life cycle at the level of the programme as a whole. It is less obvious that this is sensible. After all, is it likely that all a country’s important industrially relevant problem areas for academic – industrial research can be identified and solved in phase? Yet this is what the latest evaluation<sup>12</sup> of the Australian CRCs effectively proposes.

To date, as far as we are able to determine, there has been only one systematic attempt<sup>13</sup> to compare competence centres programmes: between the Austrian *Kplus* of the BMVIT ministry and the *Kind/net* programmes of the BMWA ministry. It concludes that the much more stringent and formal approach of *Kplus* has paid dividends in terms of having greater influence on changing research and industrial

---

<sup>12</sup> Howard Partners, *Evaluation of the Cooperative Research Centres Programme*, Manuka, ACT: 2003

<sup>13</sup> Jakob Edler, Susanne Bühner, Vivien Lo, Claudia Rainfurth and Stefan Kuhlmann, *Assessment ‘Zukunft der Kompetenzzentrenprogramme Kplus, und Kind/net und Zukunft der Kompetenzzentren,’* Karlsruhe: FhG-ISI, 2004

cultures. Given the high level of public support provided, it is especially important to ensure that the funding is used to support longer-term research rather than to support the type of shorter-term activity that often characterises university-industry co-operation. Another key distinguishing feature of the *Kplus* programme is the complete separation of the ministry responsible from the operational implementation of the programme.

## 7 **Effects of Competence Centres: What Does the Taxpayer Get for her Money?**

Some of the competence centre programmes discussed have been evaluated, with a view to understanding their effects. This section is based upon the available evaluation material.

Competence centres occupy a distinctive position in the research and innovation system. Our own impact study of the Swedish competence centres<sup>14</sup> indicates that they provide

- A long-term linkage between university and academic research, which tackles more fundamental questions than are handled in normal bilateral research relationships or than are available from conventional network or cluster programmes
- Longer term research than is typically provided by research institutes, focusing especially on ‘Pasteur’s Quadrant’ of use-oriented fundamental research
- A mechanism to build (permanent or temporary) critical mass in subjects directly relevant to industry but within the university research system
- A large supply of research-trained people, who are already used to working for industry and who are highly sought-after by industry
- Enhanced networks or collectives among people working with distinct bodies of industrially relevant knowledge, leading to increased co-operation and personnel mobility within the relevant clusters or sub-systems of innovation
- A supply of innovations and company spin-offs, with considerable economic value. There are big methodological problems in making sensible estimates about this kind of value, but it is clear at least that the value of the economic activity generated by the programme in the fairly short term already exceeds its cost
- A mechanism to increase the attractiveness of the national knowledge infrastructure to existing companies, new start-ups and foreign investors. In Sweden, for example, competence centres have played a significant role in retaining in Sweden parts of the R&D capability of major firms

The 2002 Canadian NCE evaluation found that the programme has transformed the way research is conducted. Most of those involved believed the processes involved were the same, better or much better than in normal granting agency support. Advantages of working through the NCEs included collaboration, multidisciplinary, cross-disciplinary student training, partnerships with users, knowledge and technology transfer, intellectual property protection and development of critical mass. 88% of postgraduates emerging from NCE centres in 2000-2001 found employment, over half of them in industry. 56 patents were granted from

---

<sup>14</sup> Erik Arnold, John Clark and Sophie Bussillet, *Impacts of the Swedish Competence Centres*, report to STEM and VINNOVA, Brighton: Technopolis, 2004

among 170 patent applications in the same period. Up to 2001, the programme spanned off at least 97 start-up firms.

The nature of the postgraduate training provided was different from normal, in that it allowed much greater access to networks of scientists, conferences, workshops etc, and gave a much better grounding in the ‘business of business’ through exposure to the R&D concerns of network partners and active participation in knowledge transfer activities. The portfolio character of centres’ research meant that it was possible for both academics and industrialists to include riskier projects than could normally be handled.

The US Engineering Research Centres (ERCs) “discover new industry-relevant knowledge at the intersections of the traditional disciplines and transfer that knowledge to industry, while preparing a new generation of engineering leaders who are capable of leading in industry by engaging successfully in team-based, cross-disciplinary engineering to advance technology.”<sup>15</sup>

Interaction with ERCs provides 90% of ERC companies with a wide range of benefits (**Exhibit 7**). Some 60% said that the ERC had influenced their own R&D agenda.

**Exhibit 7      Examples Of Significant Benefits Received By Firms in ERCs**

<b>Benefit</b>	<b>Percent of Firms</b>
Access to new ideas, know-how, or technologies	84
Receiving technical assistance	63
Interaction with other firms participating in the ERC	50
Access to ERC equipment and facilities	40
Hiring ERC students and graduates	40

**Source:** Linda Parker, *The Engineering Research Centres (ERC) Programme: An Assessment of Benefits and Outcomes*, Arlington, Virginia: National Science Foundation, 1997

Nearly a quarter of all firms reported having developed a new product or process as a result of their interaction with an ERC. The impacts on the firms derived from these benefits are threefold: A majority of the respondents indicated that their ERC involvement had influenced their firm's research agenda. Two-thirds of the corporate representatives reported that their firm's competitiveness had increased as a result of benefits received and the level reached 80% for firms involved with an ERC for eight to ten years. Finally, corporate personnel in firms hiring ERC students or graduates rated these employees as more productive and effective engineers than peers in the same firms.

Three factors in particular are strongly related to the realization of positive outcomes for companies from their interactions with an ERC: the existence of a "champion" for the ERC within the company, the receptivity of company technical staff to ERC ideas and/or results, and management support for the ERC partnership within the company.

<sup>15</sup> Linda Parker, *The Engineering Research Centres (ERC) Programme: An Assessment of Benefits and Outcomes*, Arlington, Virginia: National Science Foundation, 1997

A key objective of the ERCs was from the outset was to create a ‘new breed of engineer’, who could act as a change agent in both academic and industrial R&D. Crucially, companies appreciated not only PhDs in this way, but also the MSc’s produced by certain of the centres. ERC graduates continue working in ways they learned in ERCs, e.g., in interdisciplinary teams and by engaging in industry-university collaboration to advance technology. ERC firms employing ERC students and graduates value this benefit of ERC interaction more than any other type of benefit. Supervisors and other industry representatives of firms employing ERC graduates judged the ERC-trained employees to be superior to non-ERC employees on a number of key performance dimensions (**Exhibit 8**).

**Exhibit 8 ERC Supervisors' and Representatives' Rating of ERC Graduates As Superior to Peers**

<b>Dimension</b>	<b>Supervisors</b>	<b>Representatives</b>
Overall preparedness	89.4%	80.2%
Contribution to technical work	84.8	77.3
Depth of technical understanding	85.0	80.2
Ability to work in interdisciplinary teams	80.3	64.3
Breadth of technical understanding	80.7	74.3
Ability to apply knowledge and use technology	69.9	72.3

SCALE: 1 = "much worse"; 2 = "somewhat worse"; 3 = about the same"; 4 = "somewhat better"; 5 = "much better"

NOTE: Values shown in table are percent responding at level 4 or 5

Source: Parker, 1997

The 2003 evaluation<sup>16</sup> of the Australian Co-operative Research Programme provides a long list of innovations associated with the various centres (see **Exhibit 9**, at the end of this paper). It argues (though without much evidence) that during the period of the CRC programme, three important changes in Australia’s research and innovation culture have occurred, and that the CRCs have contributed to these changes

- A widespread recognition of the role of public-private research partnerships, based on the generation and utilisation of “applicable knowledge”, in industrial innovation
- In the context of the “knowledge economy”, an acceptance of a role for the public sector in supporting new business development through the commercialisation of publicly funded research
- A greater understanding of the contribution of science to the design and implementation of public programmes, particularly relating to the environment and public health

According to the evaluators, the CRCs have developed into three types: those that provide national benefits (for example, in environmental research), primarily aimed at government research users; those that provide collective industry benefits through collaborative research (following the ‘mainstream’ competence centres model, as we describe it in this paper); and those focusing on commercialisation through new

<sup>16</sup> Howard Partners, *Evaluation of the Cooperative Research Centres Programme*, Manuka, ACT: 2003

businesses and technology transfer. Inspection of **Exhibit 9** suggests that an important difference between the ‘mainstream’ and the ‘commercialisation’ centres is the maturity of the industries involved. In the ‘mainstream’ case, there are well-established industries in Australia, with which the centres co-operate. In the ‘commercialisation’ centres, industry itself is nascent: there is little industrial capacity with which to co-operate, so the natural way to make use of results is through company formation and supporting early-stage companies with technology transfer.

The major impacts of the CRCs have, according to the evaluators, been

- Contributing to Australia’s economic growth, social well-being and environmental outcomes
- Developing Australia’s public and private research capacity in the areas of national need or global opportunity
- Producing research of an excellent standard that would not have been undertaken otherwise
- Enhancing collaboration among public and private researchers, and between public researchers and commercial or community interest
- Increasing the proportion of public researchers who are commercially oriented
- Upgrading the innovative capacities of Australian business enterprises

The effect on skills seen in other evaluations is also echoed here

A major contribution of the CRC programme has been to create a cohort of highly skilled industrial research managers who are able to deliver results under complex partnership arrangements ... One of the most positive aspects of the programme has been the contribution to the training of PhD students. CRC based training of PhD students has an advantage in that these students develop a tacit knowledge of the importance of application and adaptation of research and how to interact with industry. This positive externality will greatly assist in developing a culture of adoption and application within Australian industry and government. Unfortunately, it is effectively impossible to measure its impact.

While it points to some important impacts, in a number of ways, we find the Howard Partners evaluation of the CRCs to be problematic. In particular, its central discussion is about finding the right balance between technology push and demand pull – an argument that was settled in theory in 1978<sup>17</sup> – and it fails to take on the innovation systems perspective central to the way competence centres operate, or to pay attention to the **kind** of research done in the centres. Its conclusion that CRCs in future should do less research and more commercialisation seems to involve a failure to understand what ‘mainstream’ competence centres do, which is to raise academic and industrial capabilities in areas where industry already exists. As the evaluators observe, “New technology-based companies have ... been generated as a result of CRC research. This covers not only the transfer of technology into new businesses; it also covers new businesses created by graduates when they leave the CRC. This applies particularly in those industries where there is opportunity for the application

---

<sup>17</sup> Mowery, D.C. and Rosenberg, N., ‘The Influence of Market Demand upon Innovation: A Critical Review of Some Recent Empirical Studies’, *Research Policy*, April 1978

of ‘disruptive technologies’ and a comparatively low requirement for investment in ‘complementary assets’ (machinery, buildings, other Intellectual Property, etc).”

The proper conclusion to draw would seem to be that the competence centre form always relies to some degree on the existence of industrial capacity, but that the nature of the impacts (and probably, therefore, of the required programme rules and infrastructure) depend upon whether centres operate in areas of established or nascent industry.

## **8 Conclusions**

We distinguish here between two broad categories of conclusions. Those which are general, and those which apply specifically to RCN at this time.

### **8.1 General Conclusions**

‘Competence centres’ are a comparatively new form of university-industry research alliance. They can do both fairly fundamental but also more applied, problem-oriented research. Their long-term nature and the comparatively high rates of subsidy involved allow them to have a structuring effect on sub-systems of innovation by educating and generating communities of research practice between research-performing institutions and industry and by generating common, use-oriented research agendas with potential to have significant positive socio-economic effects.

As instruments of research and innovation policy, competence centres are peculiarly well suited to intervening to strengthening the systemic aspects of innovation communities, as well as tackling market failure in respect of fundamental but problem- or use-oriented research. The competence centre instrument can be used at different scales to tackle a range of industries and technologies, but is applicable only where there is a degree of (actual or nascent) industrial research capability. Other funding instruments are appropriate for other situations.

High quality research is a necessary condition for competence centres to be effective. As comparatively complex forms of intervention, competence centres require skilful management and good governance. Genuine commitment to the centres from both academia and industry is a crucial precondition for success. ‘Passengers’ or free riders derive few benefits.

The effects of competence centre programmes span short-term promotion of innovation to the longer-term generation of fundamental knowledge. A vital effect is the production of research manpower trained in industrially relevant problems and able to network across the academic and industrial communities.

### **8.2 Conclusions for RCN**

The competence centres model is relevant for encouraging the development of the Norwegian higher education sector, existing large Norwegian industry, and the considerable population of technology-based firms, including potential spin-offs. It is not appropriate for most lower-capability SMEs, which require different innovation instruments. Nor does it substitute for the existing infrastructure of

supports aimed at commercialising the results of knowledge produced bottom up, like science parks, mentoring and venture capital services. However, it **does** offer a new model for meeting the Council's objective of increasing research-based innovation. An evolving population of competence centres is consistent with the idea of an evolving set of themes funded by the Council, that connect socially important problems with research. The model may require minor modification to include participation by research institutes, which are key in the Norwegian knowledge infrastructure.

Needed next steps involve

- Better understanding of potential concentrations of interest in competence centres, especially within industry
- Dialogue with key interests in industry and the knowledge infrastructure
- Programme design and design review (ex ante evaluation)

## Exhibit 9 Examples of Successes Referred to in CRC Publications and Promotional Material

### *National Benefit CRCs*

**CRC for Aboriginal and Tropical Health** - Discovered a new rapid test for detecting streptococcal B infections. The test is fast, non-invasive and easy to perform. This is a critical health issue for newborn infants.

**CRC for Catchment Hydrology**: Developed a short-term detailed forecasting system that enables more accurate predictions to be made of the precise level and location of rainfall during storms. Estimated to save Sydney Water around \$20 million over the next 20 years.

**CRC for Coastal Zone, Estuary and Waterway Management** - Development of a regular comprehensive 'report card' for the Moreton Bay area to more accurately check the environmental health of the area.

**CRC for Conservation and Management of Marsupials** - Development of a contraceptive vaccine to control populations of possums and wallabies

**CRC for the Great Barrier Reef World Heritage Area** - Use of computer models to simulate cyclones on the reef to help engineers construct 'smarter' lighter tourist pontoons that minimise environmental impact and the chance of cyclone damage to the reef.

**CRC for Weed Management** - Successfully engaged the community to overcome an aggressive creeper introduced into Australia 150 years ago that was smothering Australian bushland.

### *Industrial Research Collaboration CRCs*

**Australian Telecommunications CRC** - Patented a technology for real-time signal transfer over the Internet.

**CRC for Advanced Composite Structures** - Developed a patented process for the application of a thermoplastic skin to the surface of thermoset composite materials. The process attracted the interest of the major aerospace companies, Boeing and Airbus.

**CRC for Clean Power from Lignite** - Development of a laser plasma spectrometer; strategies for coal de-watering through Mechanical Thermal Expression.

**CRC for Enterprise Distributed Systems Technology** - Development of **GuideBeam**, a unique search tool designed to improve information access by helping the user formulate a precise description of their information need.

**CRC for Mining Technology and Equipment** - BHP Billiton has retrofitted a production dragline at the Peak Downs mine with the CRC's Universal Dig & Dump Technology (UDD). This innovation in open cut mining technology has increased productivity of the dragline by more than 25 percent.

**CRC for Molecular Plant Breeding** - The CRC's patents represent real innovation in the field of molecular plant breeding in the cereals and pastures areas; the patents are in various stages of certification for licensing, but are expected to deliver substantial commercial returns.

**CRC for Quality Wheat** - Development of WheatRite®, a test to determine the level of potential weather damage to wheat crops; expectations of sales of \$4m by 2004.

**CRC for Sensor Signal and Information Processing** - Development of surface wave radar for coastal surveillance; development of an ultra wideband low frequency ground penetration radar.

**CRC for Sustainable Rice Production** - Developed models and software for understanding the movement of water and salt in relation to irrigation farming at both farm and irrigation-district levels.

**CRC for Sustainable Sugar Production** - Developed decision support models for onfarm water storage to maximise returns from supplementary irrigation.

**CRC for Tropical Plant Protection** - Contributed to the development of a test for disease in tropical fruits which is expected to save the industry over \$21 million a year in managing this problem

**CRC for Waste Management and Pollution Control** - Development of a method for increasing the solid content of sewage sludge

**CRC for Water Quality and Treatment** - Developed a method of rapidly distinguishing toxic blue-green algae species from non-toxic species. The CRC has patented a test that uses genetic technology to identify two of the most toxic species within hours. This enables water resource managers to react more quickly to the potential health threats of algal blooms.

### *Business Development CRCs*

**Australian Photonics CRC** - Creation of companies that: develop, make and sell applications specific optical fibres to component manufacturers; incorporates optical fibres in devices and components; developing optical circuits on a chip; incorporating new products into new wavelength management systems.

**CRC for Cochlear Implant and Hearing Aid Innovation** - Developed software for the tele-commerce sector that recognises and blocks 'acoustic shrieks' in phone lines. Expectations of earning around \$5m a year, including a substantial export market; development of software to allow audiologists to vary the amplification at different frequencies by hearing devices.

**CRC for Diagnostic Technologies** - Developed and patented a technology (FNC) that allows rapid identification of variants of a specific gene at a molecular level; combination of FNC with gene chip technologies to make possible the speedy analysis of thousands of genes; technology has been acquired by US biotechnology company Affymetrix generating a royalty stream.

**CRC for Eye Research and Technology** - Developed continuous wear contact lenses. More than 400,000 people in over 40 countries now have contact lenses they can wear continuously for 30 days and nights.

**CRC for International Food Manufacture and Packaging Science** - Found ways of using plastics manufacturing systems to produce packaging materials that are biodegradable.

**CRC for Satellite Systems** - Development of the first all-Australian satellite in 30 years.

**CRC for Tissue Growth and Repair** - Developed Tendotrophin® for the treatment of horse tendon injuries, which is marketed by PrimeGRO Pty Ltd, a CRC start-up company established in 1999. Another CRC start-up is GroPep Ltd which achieved sales of \$9.6 million in 2000-01.

**CRC for Vaccine Technology** - Developing a vaccine against glandular fever to stage of clinical testing. Potential market of 2.5 million vaccinations per annum

**Source:** Howard Partners, *Evaluation of the Cooperative Research Centres Programme*, Manuka, ACT: 2003