An Evaluation of the RTDI for Collaboration Programme: Main Report

TECHNOPOLIS

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Main Report

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Summary

This evaluation considers the principal programmes supported under the RTDI (Research, Technological Development and Innovation) for Collaboration component of Ireland's Operational Plan for Industry, 2000 – 2006. These are

- Innovation Partnerships, which aim to build R&D partnerships between industry and the Third Level Institutions
- The Commercialisation Fund, which finances 'technology push' projects within academia, testing and developing their commercial and technical potential
- The Programmes in Advanced Technology, which were set up in the late 1980s as academic / industrial centres of research and innovation competence, but whose role has been successively reduced to focus on commercialisation of academic research and some limited research and innovation support services to industry

The first two schemes are running rather smoothly and to the satisfaction of their beneficiaries, though demand for them is limited by the availability of other attractive R&D funding options for Irish academics and companies. However, they fail adequately to tackle the needs for genuine academic-industry collaboration, networking and the development of appropriate capabilities. The role of the PATs has become unclear, having been slowly eroded via a series of organisational imperatives since 1996.

Taken together, the schemes fall significantly short of the ambitions for partnership and development within the national innovation system implied by the RTDI for Collaboration programme's high-level goals and its role in the Operational Plan. Rather, they embody an out-dated 'linear' perspective on innovation that was explicitly rejected as long ago as 1995 in the White Paper on science and technology. The task of modernising the programme and realigning it with its goals is not made easier by the institutional changes in R&D and innovation funding that have accompanied the current Operational Plan, and which tend to institutionalise the linear model.

The RTDI for Collaboration programme needs radical redesign, to tackle the need for partnerships in R&D and develop academic and industrial capabilities in directions that will develop critical mass over and above the narrow foci currently supported by Science Foundation Ireland, for example in services and manufacturing. Differentiated instruments are needed to tackle the different development needs of different sub-populations. A modified form of the 'competence centre' model used internationally can play a role, but there is also a need for measures that develop more basic capabilities, allowing companies to enter the worlds of R&D and innovation.

The history and performance suggest that Enterprise Ireland has key weaknesses in handling the technological aspects of innovation funding and in programming. Its capabilities should be reviewed, as a basis for deciding whether RTDI programmes would be better handled in a separate agency.

Contents

1 Introduction

This short document reports[1] an evaluation of the RTDI for Collaboration programme. Our brief was to carry out an evaluation of the programme, in order to establish how the component schemes complement each other, how they contribute to meeting the aims of RTDI for Collaboration, identify the ways in which they are developments of earlier programmes and determine whether they can be improved.

We have carried out the brief via a programme of interviews with policy makers, industry and academics, as well as reviewing documentation and conducting questionnaire surveys of programme beneficiaries. A panel of people responsible for running equivalent programmes in Sweden, Austria and Finland attended a workshop with Enterprise Ireland (EI) to review the programme, and has produced a report, which we have used as an input to the overall evaluation. We also studied how certain programmes operate abroad, and exploit this in our conclusions and recommendations.

2 RTDI for Collaboration

RTDI for Collaboration is an important component of the Productive Sector Operational Plan, 2000 – 2006. That plan implemented the very large increase in R&D funding decided by government at the end of the 1990s, and marked a radical change in the importance of research and innovation in Irish policy.

Within the RTDI Industry chapter of the plan there were three major elements

- RTDI for industry, comprising schemes to help companies build R&D capacity, to subsidise in-house R&D and increase companies' innovation management capabilities
- RTDI Infrastructure, which involved both research and training grants for researchers in the Third Level Institutions (TLIs) and the large Technology Foresight Fund, now operated by Science Foundation Ireland (SFI), funding strategic or 'oriented basic' research in biotechnology and ICT
- RTDI for Collaboration between companies and researchers in the TLIs

A major Programme of Research in the Third Level Institutions (PRTLI) was also set up under the plan, to develop both the physical and human research infrastructure needed in the universities in an increasingly knowledge-based economy.

The plan says that under RTDI for Collaboration there will be an emphasis on collaborative research networks, which will

- Build partnerships that enhance company capability and competitiveness in firms, particularly SMEs, through collaboration networks nationally
- Help firms, particularly SMEs, to exploit technology effectively by improving access to appropriate technology available internationally

[1] An accompanying volume provides the various background analyses

RTDI for Collaboration comprises three main schemes - – Innovation Partnerships, the Commercialisation Fund and the Programmes in Advanced Technology – plus four smaller initiatives[2].

EI kindly prepared a short retrospective document for this evaluation, outlining the three main schemes and explaining why they are important. However, it has been unable to supply us with any programming documents that describe *ex ante* the rationales, objectives and strategies of the schemes (or of RTDI for Collaboration as a whole). The aims described below derive from the Operational Programme.

2.1 Innovation Partnerships

The Innovation Partnerships programme was launched in 2000 and is a successor to the Applied Research Grants Scheme, which was aimed at industrially relevant research in the universities. The programme aims to "stimulate new product and process development for industry through collaboration with Third Level Institutions resulting in mutually beneficial co-operation and interaction".

Under the Programme, grants are awarded to researchers to undertake research and development projects in collaboration with one or more industry partners. Projects should be of potential benefit to a company (or group of companies), which demonstrates its (their) confidence by making a significant financial contribution to the project. EI will pay between 35% and 75% of the total eligible costs within Third Level Institution only, subject to a maximum contribution of Euro 190,000. The participating company(ies) will be expected to cover the remainder. Any associated research and development work undertaken by the companies themselves is not eligible for support. Projects are expected to be between 6 and 24 months duration.

The average annual spend on Innovation Partnerships in the period 2000-2003 is about Euro 2.4 million. The number of projects supported each year is around 50, and the average size of a grant is about Euro 50,000. The average level of support provided is 55% of the total project cost.

The Innovation Partnerships scheme is the only of the RTDI for Collaboration support schemes that enables TLIs and Industry to work together on joint projects (though actual collaboration is not a requirement: the TLI can do research **on behalf** of the industrial partner). It is therefore the most obviously 'collaborative' of the RTDI for Collaboration mechanisms. Most of the projects are very applied and very technical in nature. Some are improving existing products and processes within industry by making them faster or more accurate. Others projects are aimed at developing entirely new product lines or technologies that can automate aspects traditionally undertaken by humans.

The rationale for the scheme is unclear, beyond a general desire to assist companies with product or process improvements. We were told that companies tend to only be supported once through the programme, but there are several large international

[2] The Intellectual Property Assistance Scheme, Networking Initiatives, Technology Transfer and the International Collaboration Programme. These are all described in the background report

companies participating in the programme and many instances where companies are undertaking multiple projects concurrently.

The aims are similarly general in nature. There does not appear to be any focus on specific sectors or particular categories of firm (in terms of size or capabilities). However, the project lists suggest much of the work is going on in the areas of microelectronics and electrical engineering, food and agriculture, mechanical engineering and civil engineering.

This scheme is not competitive. All projects that meet a minimum technical standard tend to be supported.

Internationally, the rationale for this programme, namely the need for tighter linkage between academic and industrial research, is widely recognised and is addressed using a range of funding instruments as well as more structural interventions such as joint R&D centres. In contrast to many of these, the IPs involve companies in paying for R&D but not necessarily in actively participating in the project. In that sense, IPs rely on a rather old-fashioned 'technology push' model of innovation, rather than the current interactive view. At the very least, 'Innovation Partnerships' is a misnomer: in real partnerships, both sides would be active participants on the projects. Since the companies only pay for, rather than participate in, the projects, IPs risk divergence between the goals and expectations of the academics and the company people, who are likely to feel they do not receive what they pay for (even if they pay a discounted price). Unless the companies involved also invest in-house, developing relevant absorptive capacities and doing the parallel R&D work needed to verify and implement the academic findings, this programme is likely to have limited industrial effects. Thus, in order to stimulate academic industrial partnerships, it is necessary to stimulate both partners, rather than to establish a customer-contractor relation.

IPs do not appear to address any particular target group among companies, whose partnership needs and opportunities actually vary by sector and with their technological capabilities. This is reflected in the lack of clear and measurable goals, below the high-level ambition to foster product and process development.

2.2 Commercialisation Fund

The Commercialisation Fund has grown out of Enterprise Ireland's redefinition of its mission at the start of this century. Formerly, it viewed itself as an R&D funder. Now, it focuses on the commercialisation of research results. The Proof of Concept strand within the Commercialisation Fund is new. The Technology Development strand recycles resources that until 2000 were spent via the Programmes in Advanced Technology (PATs). In 2001 and 2002, these funds were opened to wider competition in the Advanced Technologies Research Programme (ATRP). From 2003, they were reclassified to the Commercialisation Fund. In 2004 (outside the scope of this evaluation) a third strand ('CORD' grants) was added to the Commercialisation Fund, which supports business planning.

2.2.1 Commercialisation Fund – Proof of Concept

The Commercialisation Fund (Proof of Concept) was launched in 2003 and is a successor to the Research Innovation Fund, which ran in 2001 and 2002. Prior to this the support was provided through the Strategic Research Grants Scheme (SRGS). The programme aims to "support academic researchers in establishing that a scientific concept, from whatever source, is sufficiently robust, is seen to address a viable market and is not encumbered by intellectual property considerations". The scheme focuses on a proof of concept model where individuals or small groups work on short applied projects to develop a product concept through to a stage where a route to commercialisation is clear, either as a campus company or through licensing.

Under the Programme, grants are awarded to researchers in the Third Level Institutions (TLIs) to develop and examine an idea/concept and to establish the scientific/technical merit and feasibility of the work proposed. Projects eligible for this fund must show a clear route to commercialisation, including where possible the creation of new high potential start up companies or technology licensing agreements. It is anticipated that successful projects will bring a research concept to the stage where a robust prototype will have been developed, a clear idea of the market understood and an understanding of the patents relevant to the area established.

Enterprise Ireland pays 100% of the total eligible costs within Third Level Institution, with projects falling in the region of Euro 50,000 to 90,000. Projects should be undertaken within a 12-month period.

Under the SRGS in 2000, spending on projects totalled just under Euro 5 million. The average annual spend on RIF projects in the period 2001-2002 was ~ Euro 6.6 million. Figures for CF-PoC for 2003 total Euro 0.9 million (but this may not be the final total figure for the year). As such, the scale of the funding appears to vary, suggesting that these different schemes are not direct substitutes, one for the other. Over the past few years the number of projects supported annually was around 60. The average size of a grant was some Euro 70,000 for SRGS and CF-PoC projects, and Euro 125,000 for RIF projects.

Four panels of experts covering Physics & Electronics, Information Technology, Chemistry, Engineering & Materials, Life Sciences assess proposals. The success rate for projects is around 1 in 3.

2.2.2 Commercialisation Fund – Technology Development

The Commercialisation Fund (Technology Development) was launched in 2003 and is a successor to the Advanced Technologies Research Programme, which ran in 2001 and 2002. Prior to this, the support was provided as PAT project funding. The programme aims to "support research in areas of technology of medium term interest to industry in Ireland leading to technologies, products or processes that can provide the basis of new businesses in Ireland or can improve the competitiveness of industry in Ireland". The support is designed to assist researchers in TLIs in accomplishing substantive applied research projects based on a foundation of confidence that the

underlying technologies are sound and that there is a reasonable prospect of serving a worthwhile, identifiable market.

Under the Programme, grants are awarded to researchers in the Third Level Institutions (TLIs) to undertake applied research projects. Projects should lead to technologies that (i) may be of interest to existing companies in Ireland and can be transferred by means of licensing or other arrangements, or (ii) address specific current or emerging opportunities or threats facing individual sectors of Irish industry, or (iii) have the potential to provide the basis of new business ventures. Projects are selected based on their commercial potential, having first achieved an acceptably high standard of technical merit.

Enterprise Ireland pays 100% of the total eligible costs within Third Level Institution, subject to a maximum contribution of Euro 350,000. Projects are expected to be up to 36 months duration.

When branded as 'PAT funding' in 2000, spending on projects totalled just under Euro 20 million. The average annual spend on ATRP projects in the period 2001-2002 was about Euro 14 million. Figures for CF-TD for 2003 total Euro 11.6 million (but this may not be the final total figure for this year). As such, the scale of the funding appears to be in decline, but it may simply reflect changes in how the PATs and associated activities are supported.

Over the past few years the number of projects supported annually was around 60-70, and the average size of a grant was just over Euro 250,000.

The CF-TD projects support applied research with established commercial potential. The aim is for products and processes to have been developed to the point that they are ready for commercial development or licensing. The technological issues should be largely or fully addressed and the projects in a position where they have application within existing industry or are able to be spun out through new commercial ventures. In 2000 the funding was available exclusively to the PAT centres, but from 2001 the ATRP and CF-TD funding has been fully open to all research groups in the TLIs. However, the PAT Directors continue to oversee the funding and the PATs retain a role in helping to ensure commercial application and exploitation of the results of the projects.

The instability of this instrument makes it especially hard to enable its appropriateness and effectiveness to be assessed.

Overall, the CF aims to support the commercialisation of ideas generated in Third Level Institutions. The biggest problem with the rationale is the underlying linear innovation model, according to which technology is developed more or less fully in the universities, after which it is brought to market by a company set up for the purpose or through licensing to existing firms. While such a programme will undoubtedly produce some results, it is important not to exaggerate its importance for industrial development and growth. Especially given the small size and only very recent growth in the knowledge infrastructure in Ireland, it is not clear how many well-developed ideas can actually be delivered by such a 'push' programme at this time.

The Technology Development scheme is of particular concern. It does not seem to us wise to invest in such large innovation projects – on average €250 000 – without involving companies or other users in them. While the scheme uses international expertise to assess proposals, it is very risky to fund projects on the basis of expert opinion alone and in the absence of signals not merely from the market but, in particular, from a stakeholder with strong incentives to follow the project through into the market.

The goals of the Technology Development scheme seem rather unclear: Is this about financing capabilities in the knowledge infrastructure, or about generating industrial innovations? Having only one annual call for proposals is consistent with the former, but not the latter, objective. If the three sub-schemes are meant to be complementary, then it needs to be possible for an idea to move among them – even if this should not, perhaps, be the norm.

2.3 Programmes in Advanced Technology (PATs)

The PATs were launched in 1988 as partnerships between Enterprise Ireland, industry and TLIs. The programmes currently aim to "make Irish industry more competitive through innovation, research and access to technical experts". They undertook applied research and provide contract research, design, development and consultancy services to Irish industry. They provide Irish industry direct access to expertise in the third level sector through technology transfer and specific sectoral networks. There are currently six PATs associated with some 30 centres in universities and colleges. They are

- Informatics Research Initiative
- BioResearch Ireland (BRI)
- Materials Ireland
- AMT Ireland
- PEI Technologies
- Optronics Ireland

In recent years, the AMT and Materials PATs have had a singe director.

The PATs are different to the other mechanisms under RTDI for Collaboration in that they are not a form of support provided to researchers or companies so much as bureaux, which provide certain services and perform certain functions in particular industrial fields. The total budget for the PATs is around Euro 11 million per annum, of which about half is personnel costs and half is distributed to the university centres via Service Level Agreements (SLAs). The PAT funding through the SLAs is described as being a payment for services to be provided by the PAT to industry over the course of the year. These services will include such items as training courses, seminars, R&D and technical services delivered to industry.

Formerly, the PATs had their own research funds and 'owned' research centres within the universities. These have now been handed over to the universities and the financing of the PATs has been in a state of flux for several years. structure and funding structure changes from the 'old' to the 'new' model. PATs no longer have

their own research resources, but are involved in project assessment and monitoring for the Commercialisation Fund.

Making such radical changes in the goals and the rules of the game is a rather classical error in managing programmes with long-term objectives, because it undermines the achievement of those objectives. EI's active involvement as an employer of PAT personnel in the universities was clearly also problematic, undermining the needed distinction between funders and performers in the R&D support system, and has left the PATs with a legacy of personnel and obligations that is not necessarily consistent with innovation funding policy needs. Their effective limitation to 'piggy backing' on the Commercialisation Fund makes them neither technology programmes in their own right nor suitable instruments for building strategies and portfolios that can bridge commercialisation, applied and more fundamental work.

The Service Level Agreement component of the PATs is useful, and fulfils a role that in other countries is played by dedicated company support programmes, often working through applied research institutes. To the extent that some of the PATs encourage industry networking, this is also a useful function.

3 Performance of the Schemes

3.1 Innovation Partnerships

The Innovation Partnerships (IP) scheme is continuously open for proposals, and uses a formal two-stage application process to assess proposals. In parallel, advice is available from EI project officers. Over 90% of applications are accepted, and EI describes the scheme as 'non-competitive'. Applicants are told within 6 weeks whether they have been successful.

Technical appraisal is done by a member of EI's technical appraisal panel (or an assessor nominated by the applicant), while commercial appraisal is done by EI staff. Criterion checklists are used, but these do not link closely to scheme objectives. Commercial criteria are especially 'fuzzy'. The main aim of appraisal is to weed out non-viable projects rather than to select the best. The appraisal process is nonetheless fast and well structured. Applicants receive good levels of feedback about their proposals, and can improve and resubmit failed proposals.

The scheme is used by all sizes of firm, with 43% of questionnaire respondents working in organisations of less than 50 employees. Inspection of the contact data supplied by Enterprise Ireland suggests almost one-third of projects are part-funded by internationally well-known multinationals, mostly not Irish. Many of the remaining firms are specialised, technology-based organisations, but there are also a number of low-medium technology firms in branches such as engineering and foodstuffs.

In order of importance, motives for industrial participation are

- To improve your company's knowledge base (4.06)[3]
- To develop new or improved methods, tools or techniques (3.89)
- To increase the competitiveness of your company (3.71)
- To make improvements to existing products, processes or services (3.69)
- To gain access to skills, knowledge and facilities of academic partner (3.59)

Industrial respondents appear to be less interested in using their participation in the programme to maintain existing relationships with universities or research institutes or improving their ability to recruit trained researchers. Companies were generally optimistic about realising the intended benefits.

The most important motives for academic participation were

- To gain access to research funding through Enterprise Ireland (4.36)
- To maintain or grow existing relationships with industry (4.08)
- To increase the relevance of your research activities to industry (4.06)
- To enhance your department/research group's reputation and image (4.02)
- To assist industry with development of entirely new products, processes or services (3.93)

Other important motives for academic participation include possibility of carrying out and publishing high quality research and working with locally based companies.

Projects tend to be in core business and technology areas for participating firms, and to be of some strategic significance, but were not seen as especially high- or low-risk. Bigger firms tended to see their projects as more risky than smaller ones. In contrast to pre-competitive collaborative schemes, where the most important outputs tend to be various kinds of intermediate knowledge for later use in the R&D function, industrial partners' IP projects were strongly focused on the production of new products and processes. While industry sees the scheme as rather close to market, the academics prioritise publications and more traditional measures of academic output. It appears that companies in IPs see themselves more as **customers** than as partners (perhaps because they part-fund but do not have to play an active part in performing the projects), and their priorities are clearly at odds with those of the academics.

Reported additionality in the scheme is moderate. Just under half (47%) of the industrial respondents stated that their project would not have gone ahead had it not received Enterprise Ireland funding. The remainder stated that the project probably would have proceeded, but typically over a longer time frame (69%), reduced scope (50%) or a reduced financial scale 25%).

The majority of academic respondents (79%) stated that their project would not have gone ahead had it not received Enterprise Ireland funding. This suggests that the funding is more critical to the academics than to industry. The remaining academic

[3] Average importance to the firm on a 1 – 5 scale, where 5 is high

respondents stated that the project probably would have proceeded, but typically at a reduced scale (68%), with reduced scope (37%%) or over a longer timeframe (32%). Respondents tended to know their way around the funding system in Ireland. The long list of alternative funding sources given by the respondents suggests that apparent additionality is limited by opportunities to obtain alternative subsidy elsewhere. Outcomes were mixed. Projects were seen as creating academic-industry links and as focusing R&D activity. But commercially useful outcomes such as new product or process developments were expected late in, or often after, the projects.

Questionnaire respondents were complimentary about the efficiency of EI programme management, though they would like more help in handling IPR questions. The companies tended to regard EI as a positive influence on their level of technology and their business.

While our survey provides a lot of positive feedback from the beneficiaries, limited demand for the scheme also suggests there are more interesting funding opportunities available for many. Interviews confirm that the RTI scheme, in particular, which subsidises company R&D, is especially attractive in comparison with the IP 'offer' of subsidised academic (usually postgraduate) research for the company's benefit.

Interview evidence supports what most R&D programme managers know: that active industrial participation in project definition and performance in such partnerships with academia is a prerequisite for obtaining industrial benefits from this type of scheme. Companies with high technological capability worked in a genuine division of labour with the academics, themselves handling the links between the research and the market. This points the way towards a more effective scheme for the more capable companies. Less capable firms needed turnkey delivery of new products and processes – something not always within the capabilities of academic partners. Their needs for a 'first-time' partnership scheme in order to develop networks and experience could be separately addressed, while it is not clear that universities are the best deliverers of ready-to-produce product and process innovations.

3.2 Commercialisation Fund

The Commercialisation Fund (CF) operates one call for proposals per year for its main activity – Technology Development projects – but has a continuously open call for its other, smaller schemes. Applicants are academics, and – especially in the Technology Development phase – projects are closely tied to postgraduate training. Project performers complained, in both the survey and interviews, that project funding decisions came too late in the academic year, at a point were the best potential postgraduate students were already being lost to other institutions.

PAT personnel and other EI staff are available to give advice, but the proposal process is formalised. Proposals are allocated to one of three 'programme' areas relating to the PATs, and the PATs play a central role in organising the appraisal process. Four national or international assessors are used per project application: two with commercial and two with technical expertise. Assessment criteria are clear and correspond to the goals of the scheme. The PATs appoint assessment panels of

three academics and three industrialists, which make a final prioritisation and submit lists to the National Research Support Fund Board for approval. In the latest round, the proportion of proposals funded was about 45%. Issues in the appraisal process are

- Individual assessors see few proposals, and therefore have difficulty in making comparable assessments
- Commercial and technical assessors do both commercial and technical assessments, which appear to be given equal weight
- It is not clear what value the involvement of the PATs adds, given their lack of technical strategy, lack of influence over the call (which is 'bottom-up' and accepts proposals on any subject), represent only a partial coverage of potential themes and appear to be on an unsustainable path and in need of direction

In order to obtain a usable sample and explore changes, our survey of beneficiaries had to cover the current CF scheme (2003) and its two predecessors, ATRP (2001-2) and the RIF (in 2000), which had previously provided research funding more tightly linked to the PATs. One quarter of the responses we obtained were from proof of concept projects, the remainder from the Technology Development scheme or its predecessors (ATRP and RIF). None of the Technology Development respondents had previously carried out a Proof of Concept project, though they mostly claimed to have taken other steps to explore commercial viability.

The most important objectives, or project performers, those rated as of high or medium importance by more than 90% of respondents were

- To gain access to research funding through Enterprise Ireland (highly important to 62%)
- To develop a new piece of technology to the point where it can be commercialised (highly important to 48%)
- To improve your department/group's research capabilities in an existing area (highly important to 41%)
- To increase the relevance of your research activities to industry (highly important to 36%)
- To establish the market potential of an idea/concept (highly important to 33%)
- To enhance your department/research group's reputation and image (highly important to 28%)

Notable differences among the three schemes were

- The higher value attributed to the development of *new products*, *new technologies* and *new processes* (to the point where they can be commercialised) by CF respondents compared to ATRP and RIF respondents
- The higher value attributed to *establishing the market potential* of an idea or concept by RIF respondents compared to CF respondents

- The higher value attributed to *training* by RIF respondents compared to ATRP respondents

In all three schemes (on average 82% of the time), the researchers were the main source of the project idea. The schemes do not involve industry partners. At the same time, it was clear that the technical results of the projects would tend to need commercialisation efforts after the end of the projects, in order to complete the development of new products and processes (but, rarely, services). Overall, the respondents saw the most important project outputs as publications in refereed journals or books, but there is a shift in ranked priorities between the RIF, ATRP and CF schemes in favour of patenting and new products. EI is therefore succeeding in shifting the focus of activity from applied research towards more commercially oriented activities. Additionality seems to be declining, but this appears to be because there are a growing number of alternative ways to fund this type of research within the Irish national funding system. These schemes are but one set of ways in which academics may realise their research ambitions.

The responses to our project leader questionnaires indicated that academic outputs such as publications and theses would be produced. CF projects were each also expected to produce an average of 1.85 product innovations, but the route to commercialisation was generally unclear. Both the questionnaire survey and interviews underscore that academics rarely intend themselves to commercialise project results. While it would be attractive to make financial gains from the early life of a campus company, academics in the scheme do research because they are academics, not because they want to become industrialists. There was general satisfaction with programme management, but a desire for more support in tackling IPR issues, which academics appear to see as increasingly important.

PAT personnel in the colleges say they play an important role in project monitoring and in helping forge a link between CF projects and potential industrial partners as well as securing IPR through patenting. Academics interviewed were struggling to achieve this link to commercialisation: the element of 'collaboration' implicit in the title and goals of the RTDI for Collaboration programme as a whole is largely absent at the project level. The CF Technology Development projects nonetheless represent quite significant investments(a quarter of a million Euro on average). Given both the experience of participants and the well known difficulties of commercialising 'technology push' projects, projects in the scheme should establish clearer links to the market already at the proposal stage.

3.3 Programmes in Advanced Technology (PATs)

The PATs were originally conceived as three-way partnerships between the universities, industry and EOLAS. Each PAT comprised a small network of university centres, together with a national manager to provide overall co-ordination in marketing and policy. The individual centres had two parts: one, run by an academic, doing research; and the other, run by a centre manager, focusing on technology transfer and services to industry.

In their original form, the PATs can be considered as precursors of the later 'competence centres' movement, with which they share many features. The PAT

concept was developed by NBST and EOLAS and implemented under the Programme for Industrial Development 1989-93. At that time, they had a combined budget of about Euro 12m. They aimed 'to develop new technology in selected niche areas and transfer it to industry. By correctly targeting these niche areas, the cost competitiveness of traditional industries would be improved and new technology-based firms would be fostered.'[4]

By 1992, this initial, rather linear conception that the PATs would generate and transfer new technology had been articulated into a wide-ranging set of aims

- To establish a research agenda strongly influenced by the current and future needs of Irish industry and thus the ability to identify and to create new industrial opportunities and exploit existing ones
- To undertake industrially oriented R&D, with a progressively increasing content of projects funded on a contract basis by both domestic and overseas companies
- To generate intellectual property with commercial potential
- To assist industry in Ireland in identifying and sourcing their technology needs
- To provide expertise to industry in Ireland and, through its interaction with industry, to encourage firms to engage in R&D activity
- To develop skilled and experienced technologists for transfer into Irish industry
- To stimulate the start-up of indigenous technology-based companies
- To contribute to attracting mobile international investment to Ireland
- Through its establishment, development and marketing of its capability, to become a major resource in the national research and development infrastructure and to maintain a reputation for excellence
- By its research activities, to contribute to the enhancement of the Universities' capabilities and reputation

These aims were continued almost verbatim into the Operational Programme for Industrial Development 1994-1999, and the various PATs were required both to cover a substantial proportion of their costs through fee income and to deliver against a list of academic and industrial performance indicators.

An (un-stated) assumption of the original PAT concept was that PATs would be built upon areas of strength in the University sector. Thus there would be a pre-existing source of research, technology and ideas to which the PAT resources would add value. The Strategic Research Programme and the HEIC scheme were put in place to fund capability-creating research in these areas of strength. Acting as a vector for these ideas, the PAT could turn science into innovations. Since the PATs' costs were generated by their role as vectors, not by the costs of doing science, it was felt reasonable to expect industrial income to rise quite quickly, making a target of financial self-sufficiency on operating account after 5 years of operation appear viable. During 1992, this financial target was relaxed to 50% after 5 years, rising to

[4] *Programmes in Advanced Technology: Policy Statement* (Rev 4), Dublin: Department of Industry and Commerce, 1992

80% after 7 years. A consequence of these stringent financial objectives was that the PATs began to orient themselves away from strategic research for industry and towards short-term research and technical services.

The Operational Plan for the period 2000 – 2006 has only one mention of the PATs. During the current period, the PATs appear to have faded from the strategic level of Irish RTDI policy.

The PATs were originally organised under EOLAS[5] but passed to Forbairt when this was created in 1994. From the outset, each PAT was governed by its own Board, comprising a mixture of people from the relevant industries, academics and government officials. This provided a way to link the centres to their stakeholders' needs and the Boards apparently made a large contribution to the development of the PATs. (In other competence centres, equivalent boards or reference groups are normally crucial to good centre performance.) Nonetheless, concerns about the complexity of the governance structure and the apparent lack of accountability of the PAT Boards to Forbairt, led to their abolition in the mid-1990. The PATs then reported to a single manager within Forbairt. and from 1997 within its successor, Enterprise Ireland. From 1999 the PATs were allocated to the sectoral departments within Enterprise Ireland (while maintaining a 'dotted line' report to the science division).

The PATs were all evaluated in the first half of the 1990s. The general picture from the evaluations is of a series of positive and useful activities, to some degree marred by weaknesses of organisation and management – weaknesses, which all the evaluations addressed. A meta-evaluation[6] published in 1997 focused strongly on issues of governance, finance and the extent to which the PATs had adopted the recommendations of earlier evaluators. There is no good record, here or elsewhere, of the PATs' collective achievements during this first period in other than financial terms.

In 1999, the Enterprise Ireland Board changed the form of the PATs. The PATs had by then collectively amassed about 35 university-based centres in the universities, staffed by EI personnel and university employees effectively acting as sub-contract EI personnel. EI transferred ownership of the centres to the universities at that point, and withdrew from their day-to-day management.

Following the change of direction initiated by the Board, the PATs put a number of 'service level agreements' in place with university-based centres. These involved the universities in continuing to provide subsidised advice, consulting and technology transfer services to companies. However, they are seen as transitional arrangements, are expected to be reduced in scale and may eventually be discontinued. University-based PAT personnel not needed to deliver the service level agreements have been assigned to the universities' Industrial Liaison Officers, to assist with their commercialisation activities.

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5 With the exception of the Software PAT, which was run by the IDA

6 Siobhan Philips, *Meta-Evaluation of Programmes in Advanced Technology*, Dublin: Industry Evaluation Group, Department of Trade and Enterprise, 1997

Until 1999, the PATs were each provided with a research budget. Their failure to set up scientific quality-control processes and complaints from the academic community that this funding represented unfair treatment may have been factors encouraging Enterprise Ireland to withdraw these funds. In 2000, the 'PATs Research Programme' – namely, the money the PATs were previously granted to do research – was partly opened to competition. After 2000, the PATs' research component has been funded through national schemes, open to all non-profit research performers: the ATRP in 2001 and 2002, and the Technology Development phase of the Commercialisation Fund from 2003.

Today, therefore, the PATs represent a specialised way of supporting specific branches of industry, within the context of EI departments staffed largely by commercial generalists. There is no identifiable technology-based strategy – indeed, the PATs have been unable to supply us with any meaningful strategic documentation at all. In effect, the PATs have all but ceased to exist as strategic or research-performing entities separate from their host universities and EI's routine sector-based operations.

Overall, we can summarise that transition from the original to the new PAT model as movement from **capability building** in the universities and in companies to one of more directly trying to achieve socio-economic results, through commercialisation of the results of research.

The context of this transition was the total reorientation of the Irish research and innovation funding system that took place from 1999 when, following a national Technology Foresight exercise, the government was persuaded to make a drastic change in its innovation and research policy and to allocate some Euro 3 billion to research in the national development plan 2000 – 2006. This entailed large investments in university infrastructure and the creation of two research councils, under the Higher Education Authority. In the sphere of the Department of Enterprise and Employment, Science Foundation Ireland was set up as a specialised research council funding 'strategic' basic research in biotechnology and ICT, with an annual budget many times that of the PATs. (Four of the current six PATs are in these areas.) Previously, Enterprise Ireland and its predecessors had acted on a small scale as research funders, as well as company developers, through the Basic Research Grants Scheme, the Strategic and Applied Research Grants Programmes.

Following the major restructuring of R&D support in the 2000 – 2006 Operational Plan, there is less obvious need than in the past for a business development and innovation agency also to fund basic, researcher-initiated research, and Enterprise Ireland has therefore reoriented itself towards **commercialisation** of results, as its main focus in innovation policy. This has been reflected in a narrowing of the innovation policy instruments used by Enterprise Ireland in two respects

- Withdrawal from programmes of research funding aiming at developing and sustaining the knowledge infrastructure (universities, research institutes and the educated people they produce)
- Withdrawal from the wide range of programmes formerly aimed at developing technological capabilities or 'absorptive capacity' among less-capable firms, such as TechStart and the technology audit programme

Some of the PATs are still constrained by the requirement that they focus their work on 'EI companies,' at the cost of serving the needs of the multinationals. This was especially seen by our interviewees as a problem where PAT centres resided within fairly small departments or groups. Large and strong groups could use other mechanisms in parallel with the PAT to address the multinationals. It was seen as important to serve the multinationals to underpin learning in the centres, to find industrial partners for more fundamental research and to support industrial development. Long term work with some multinational plant had helped them establish R&D in Ireland. Even where foreign companies subsequently disinvested, they left behind them their personnel and a large pool of capability, which tended to spawn new indigenous firms.

The PATs, therefore, were originally conceived as a tripartite arrangement between industry, universities and the state innovation agency for generating and exploiting technology. Through their lives, first industry and then academia have effectively been disconnected from their governance. The PATs are now in the process of being absorbed into the body of Enterprise Ireland, an organisation with a narrower innovation remit than that of its predecessors. These changes appear unsupported by any kind of needs analysis, and to be largely driven by the organisational logic and missions of a succession of innovation and business development agencies, whose willingness and ability to tackle 'hard' aspects of innovation has been declining, in sharp contrast to equivalent agencies elsewhere, such as TEKES in Finland or the other members of the TAFTIE network of innovation agencies, to which it belongs.

Originally, the PATs were enthusiastically received by a university system that was acutely starved of research funds, because any money was better than no money. In some cases, the PAT funds helped build strong university capabilities. More generally, the inclusive nature of the programmes meant that too many, under-critical university-based activities were supported. Subsequent experience from other countries' 'competence centre' programmes underscores the importance of critical mass and of using competition to ensure quality in the allocation of resources to university centres.

Despite these objections, the PATs appear to have served a useful purpose for much of the 1990s. The dramatic change in research funding that followed the Technology Foresight exercise at the end of the decade made it inevitable that the structure and role of the PATs needed to be reviewed. Such a review has not taken place. However, it seems that – rather than being the subject of new thinking about the role of university-industry competence centres in economic and scientific development – they have fallen victim to organisationally-driven changes. Since their disconnection from research in 1999 (and in the absence of any explicit decision to do so), the PATs appear to be in the process of being absorbed into the body of EI. (Indeed, EI's web site no longer describes them as PATs but as "initiatives in specific advanced technologies".) Company interviews confirm that their visibility is declining and that the centres are no longer distinguishable from the universities that host them.

Today, a single PAT model is being applied across fields where the inherent relationships between academic research and its users are very different. PATs

operating in non-SFI areas (AMT, Materials) have different research support needs from those in SFI-funded disciplines. The new PAT model is not useful beyond 'push' commercialisation: its results will therefore be stochastic. It needs to be replaced or supplemented by a mechanism that links the research sector with active research performers in industry.

The accounts given by the PATs and beneficiary companies suggest that the SLA activities are broadly useful, and continue the more sophisticated aspects of the services provided by the PATs during the 1990s. The non-SLA cost of the PATs is of the order of €5m per year, doing activities that are hard to measure but focus on monitoring and brokerage activities. Important parts of the PATs' directorate costs are devoted to supporting generic, national schemes (notably the Commercialisation Fund) while other costs should properly be borne by university ILO functions. Value for money and accountability are not clear.

The PATs' original mission to co-develop industry and university capabilities is not replaced by SFI or other new funding, which tend to focus on 'strategic' or 'oriented basic' research. There is something of a funding vacuum; also, for technologies outside SFI's focal disciplines. Other countries devote increasing efforts to co-developing university and industry capabilities through technology programmes or 'competence centres.' There appears to be both need and opportunity in Ireland to follow suit.

The original mission of the PATs no longer clearly falls within the responsibilities of a single organisation. EI's interpretation of its mission within the current division of labour among agencies forces it to use the vestiges of the PATs as vehicles for 'push' commercialisation. This is clearly producing some results, and such activity can usefully be continued. However, it addresses only a small part of the innovation process, and does so using the ('linear') model of innovation that was abandoned long before the PATs were established.

The PATs were an early example of what are now being described as 'competence centres' and implemented in a growing number of countries, beginning with the USA in 1985 but now including Canada, Australia, Sweden, Austria, Netherlands Hungary and Estonia. This type of scheme tackles many of the systemic problems addressed by the RTDI for Collaboration programme but in a more coherent way. The Appendix to this report describes competence centres in more detail.

4 Conclusions and Recommendations

In this final section, we draw conclusions about the RTDI for Collaboration programme, place it in its wider R&D and innovation funding context (which has serious structural defects) and make recommendations.

4.1 The RTDI for Collaboration Schemes

Our review of the Innovation Partnerships and the Commercialisation Fund indicates that these schemes are fairly well operated, produce come useful results and are widely appreciated by their beneficiaries. For the beneficiaries, EI is the funder of choice – in part because it is undemanding compared with other funders, both in terms of bureaucracy and the degree of competition to which proposals are exposed.

But there are also attractive alternatives, especially among EI's own schemes, and we found some evidence that – given their current scope and roles – these schemes may be over-funded. In its current manifestation the IP activity may be useful for stimulating initial contacts between industry and the TLIs, but is inadequate to build further upon these contacts. The Commercialisation Fund is undoubtedly useful, even if its ambitions may be exaggerated, but it is hard to see why this forms part of an RTDI for Collaboration programme: it is technology push. The role of the PATs is hard to understand. Certainly, their less active and less strategic role sacrifices the opportunities to build academic-industrial partnerships and networks that they originally represented.

According to the terms of reference for this evaluation, "RTDI for Collaboration places the emphasis on **collaborative research networks** between industry and the higher education sector, which will **build partnerships** that enhance company capability and competitiveness in firms, particularly SMEs, through **collaboration networks** etc" (our emphases). In our view, the three programmes considered fail by quite a wide margin to live up to these ambitions.

- Most of what is going on appears to be traditional bilateral co-operation and technology push projects
- There are overlaps among programmes, in so far as each does not have clear objectives or target groups
- Gaps include the comparative absence of network-focused funding, and instruments that foster critical mass of industrial relevance. These gaps are not filled by the rather different types of activity funded under the PRTLI or by SFI.
- Another important gap is the absence of any measures aimed specifically at the special needs of service sectors, which are of great economic importance in Ireland as elsewhere

We were particularly concerned about the non-role into which the PATs have drifted. Their goals and mechanisms are diffuse, the instruments at their disposal are lop-sided and their role in the larger support system is inadequately thought through. Some of the things they implicitly tackle – increasing firms' technological capabilities, building critical mass in the knowledge infrastructure, improving academic-industrial partnership, identifying and channelling resources towards important technologies and clusters – are vital functions of the R&D and innovation support system. But a great deal more clarity of function and purpose is needed in order to deliver these functions in a sustainable way.

The overlaps between PAT and SFI priorities need to be thought through, and opportunities created for building critical masses should be identified and taken. In some cases, a technology funding programme approach is likely to work. In others, something close to competence centres could be more useful.

Key to the lack of correspondence between individual scheme activities and the overall goals for RTDI for Collaboration may be the lack of programming documents that articulate the rationale, objectives and arrangements for the schemes and link these to overall objectives. There was little evidence of a structured programming process. Rather, the high rate of change in the programmes and

organisational arrangements suggested a rather ad hoc change process, leading to intransparency and to drift away from higher-level goals.

4.2 The Context

The rapid change in R&D and innovation funding policy in 1999, when the government committed to invest some €3 billion over 7 years, represented a welcome end to the famine from which the system had suffered previously. It resulted in large investments in the Third Levels Institutions' capabilities and infrastructure and improved funding for researcher-initiated work via the research councils, but also in big investments in 'strategic' or 'oriented basic' research in biotechnology and ICT through SFI. Enterprise Ireland responded by continuing the trend in its history (and that of its predecessor) towards becoming purely a funding agency and to focusing on financing company R&D capabilities and the commercialisation of knowledge produced in the academic sector. It also dropped its schemes (such as TechStart and the audit schemes) aimed at tackling the technological capability deficits of companies not yet sophisticated enough to undertake R&D. Meanwhile, the R&D and innovation system as a whole has failed to find a governance mechanism (such as that, for example, used in Finland: the National Science and Technology Policy Council) that would encourage the development of 'joined up' policies across the various ministerial fiefdoms. While a great fuss was made in the 1995 White Paper on Science and Technology of the need to think and work in terms of National Systems of Innovation, the Irish system has in fact, in important respects, institutionalised the long-discredited 'linear model'. This problem needs to be tackled both at the level of national institutions and by adopting a more systemic view within EI.

4.3 Recommendations

At the level of EI and the RTDI for Collaboration programme – as well as at the national level – we therefore see needs for significant changes. Some of these require recognition of important systemic aspects

- Since externally-performed R&D has little or no effect on the capabilities of low-capability companies, separate schemes are needed to help firms develop to the point where they can undertake innovation and R&D projects
- Multinationals are crucial components of the Irish National Innovation System and cannot coherently be excluded from R&D and innovation supports. On the contrary, since the Irish subsidiaries tend to be in competition with locations abroad for both R&D and operational functions, increasing their capabilities will have rather direct benefits for Irish competitiveness. Multinationals are also vital training schools for Irish entrepreneurs and managers, who will generally tend to stay in the country even if their multinational employers prove to be footloose
- Since R&D project funding tends to focus on knowledge production and use, it is easy to overlook the vital role thatit plays in training the research-capable people needed in the economy – both in companies and in the knowledge infrastructure. Funding that increases the supply of people able to research and innovate is itself of great value, irrespective of whether it is provided through Education or Industry Ministry funding. Modern instruments such as

technology programmes and competence centres necessarily intermingle research, innovation and education (especially post-graduate training)

The RTDI for Collaboration programme, and EI's support to innovation more broadly, needs major restructuring, to encompass both support to 'first time collaborators' and more ambitious activities to enhance innovation-related networking within and between the higher education and business sectors.

Building such a collaboration depends not only upon building links but upon the two sides – industry and academia – having the capacity to link. The Stockholm Technology Bridge Foundation (TBS-S), which has this mission in the Stockholm region, amusingly talks about a bridge needing a foundation at each end. It follows that RTDI for Collaboration can only be effective if there are measures in place to ensure that industry has technological capability and that the universities and research institutes have both the capacity to link and what TBS-S calls the appropriate 'culture'. Thus the aims for a programme like RTDI for Collaboration and supporting schemes need to include

- Fostering effective networking and collaboration among companies and institutions in the knowledge infrastructure
- Ensuring that industry has the technological capabilities (including the absorptive capacity) needed in order to participate in such innovation networks
- Changing the research culture and capacities within the TLIs and other institutions in the knowledge infrastructure, to facilitate 'third stream' activities such as commercialisation, networking and other ways to serve social needs beyond traditional education and research

Exhibit 1 illustrates the idea. Today, RTDI for Industry partly tackles the foundation on the left – though it does not help much in creating the human resources needed to bring companies into the club of R&D performers. The foundation on the right is problematic in most countries, including Ireland, because funding the universities tends to be done by education ministries and research councils, who normally regard the 'third stream' as beyond their scope. RTDI for Collaboration tackles commercialisation support, and adds some human resources to the ILO functions through the PATs. Help to the universities in tackling the third stream is otherwise provided in a fragmented way.

Exhibit 1 Components of a Scheme Portfolio to Support Collaboration

<table>
<tr><td colspan="3">Collaborative schemes
• Major network schemes: technology programmes/competence centres
• Focused / bilateral schemes
• ‘First time user’ linkage schemes
• Innovation supports for non-R&D performers</td></tr>
<tr><td>Within industry
• Funding R&D projects to combat market failures
• Building R&D capabilities (people, skills, etc)
• Building R&D capacities (labs, etc)</td><td></td><td>Within academia
• Commercialisation / ‘third stream’ project support
• Building ‘third stream’ culture, organisation and skills
• Building capacities (ILOs, IPR management etc)</td></tr>
</table>

As we indicate, RTDI for Collaboration tackles only a small part of the ‘Collaborative schemes’ area, and needs to become much more ambitious. Existing instruments that address the blocks shown in the Exhibit do not involve any real technology focus or co-ordination. In other countries, especially in the Nordic area (which in many respects serves as a model, especially for smaller countries), these blocks are increasingly being brought together in innovation agencies such as TEKES or VINNOVA, allowing wider strategies and coordination to be developed. Many instruments – and again technology programmes and competence centres exemplify this – tackle multiple needs within the three blocks of the Exhibit. For example, RTI-like industrial R&D projects tend to have a linkage component, while commercialisation projects are linked to users. Networking schemes aim to change university research culture and organisation (often to enable increased interdisciplinarity), and so on. Overlaid on these blocks, too, is normally a technology strategy: a choice about where to focus funding (though usually without at the same time forbidding the funding of other technologies entirely).

The ‘space’ currently occupied by RTDI for Collaboration can usefully be tackled by the following schemes

- A scheme for industry-academia strategic collaborative R&D programmes based on selected technologies, industrial problems, emerging or existing clusters, etc. There are several models based on which this can be built, e.g. a competence centre model core with a second layer of more applied projects for transferring the technologies to a wider group of companies and other actors or a model based on Tekes technology programmes. This should be by far the largest scheme EI has for providing money for HEIs. These selected programmes should target both manufacturing and service industries. They should aim to build and reinforce matching areas of strength within both industry and the academic sphere, and ensure that these are highly networked to each other

- Sub-schemes should tackle the special cases of 'first-time' collaborators across the academic-industrial boundary, and more mature bilateral co-operations, such as a revised form of Innovation Partnership in which industrial partners are also required to be active
- A scheme for improving the availability and quality of innovation services for key target groups (less advanced companies, spin-off/campus companies, entrepreneurs, HEI researchers). This should be implemented in a way that would simultaneously aim at building a strong network of service providers as opposed to building competing centres at HEIs. The network could also include private actors. This could grow from the new SLAs with HEIs
- Scope remains for a scheme for commercialising potential innovations, much like the Commercialisation Fund today, but with appropriate modifications to improve linkages to companies, which should have access to the scheme at earlier stages. Funding should be open both to HEIs and companies

It will continue to be important to provide measures to help companies develop technological capabilities, and this aspect should not be neglected in the portfolio of R&D and innovation support instruments employed in Ireland. However, it is also necessary to provide measures that create genuine partnerships among and between companies and HEIs, involving active engagement from multiple participants. These should include mechanisms to foster networking between multinational and indigenous companies as well as encouraging the development of strong, inter-disciplinary environments in the HEIs. A competence centres programme may be a useful way to achieve this, remembering that this is an instrument that can be adapted to work both at very high levels of technological ambition (Sweden, USA) and at lower ones (Estonia, Hungary). Competence centres are distinct from the CSETs currently funded by SFI, in that they are long-term, involve industry actively in research projects, tackle a range of company capabilities and have goals set by the consortium, rather than being academically led. Technology programmes provide an alternative approach. The main criterion for choosing between the two is the extent to which the university and research institute system already has strong clusters of critical mass in relevant technologies. Competence centres aim to build such mass, which technology programmes are better suited to exploiting them.

The history and performance suggest that Enterprise Ireland has key weaknesses in handling the technological aspects of innovation funding and in programming. It is not clear that it is organised or resourced in a way that would allow it to manage all three blocks shown in the **Exhibit** – especially when the dimension of technology strategy is added. Its capabilities should be reviewed, as a basis for deciding whether RTDI programmes would be better handled in a separate agency.

Appendix A Competence Centres

Competence centres have some recognisably special features

- 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

The prototype was the US National Science Foundation's Engineering Research Centre programme, launched in 1985. 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 inter-disciplinary 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. 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.

Success factors identified in the Networks of Centres of Excellence evaluation[7] in Canada are typical, and included

- World class scientific leadership
- Strong administrative support, including having a strong network manager and board of directors

[7] Dennis Rank, *Evaluation of the Networks of Centres of Excellence: Final Report*, Ottawa: KPMG, 2002

- 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 nest people in the field
- 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

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.

Our recent impact study of the Swedish competence centres[8] is consistent with evidence from other countries and indicates that they provide

- A long-term linkage between industrial 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

[8] Erik Arnold, John Clark and Sophie Bussillet, *Impacts of the Swedish Competence Centres*, report to STEM and VINNOVA, Brighton: Technopolis, 2004

- 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

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. 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.