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Understanding Cooperative Research Centers: Learning from Success and Failure

Developing an Applied R&D unit in a small HE Institution

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Abstract: In some countries smaller educational institutes have developed strong contacts with local companies through provision of training and apprenticeship services. Some of these institutions are now attempting to widen their local relevance and service by also developing R&D functions. The perceived national advantage of this is that it builds on established company linkages, and also that many of these institutes are located in areas where there are no alternative sources of R&D services (e.g. universities or RTD institutes). This paper looks at some of the issues experienced in creating successful applied R&D functions in small institutes in Ireland. The Applied Research Enhancement (ARE) programme supports applied R&D centres in Institutes of Technology, which are widely varied in size (3,000 to 13,000 students/institute) and in R&D activity (€1 to €8m spend/annum). The 14 institutes are located in all regions and most now support at least 1 ARE centre. The study was made as a formal evaluation of these centres on behalf of the funding agency Enterprise Ireland. The factors which emerged as most significant in development of successful centres were: (a) **Institutional Support**: there must be a clear indication from institutional leadership that provision of R&D services and technology to local industry is a priority activity of the institute and this must be carried through so that administrative, human resource and other barriers to the successful running of an R&D centre are removed; (b) **Centre Director Expertise**: it is critical that the manager of the R&D centre has significant industry experience. This Director will provide the important mediation function between the needs of industry (both in technology and delivery) and the capabilities of academia; (c) **Technology Sustainability**; the small scale of many institutions is a challenge in ensuring a continuing flow of relevant expertise and technology for industry. This is particularly so in institutions where there is no related basic R&D activity within the same field; (d) **Technology Focus.** A critical difference between centres is how they defined the scope of their expertise or activity. Some chose broad fields of activity (National Design Centre; Marine BioTechnology Centre) while others were highly specific and aimed at solution of one industry problem or development of one technological opportunity. Because of the scale of activity, the latter were better able to focus their activity (both R&D and marketing) in a manner appropriate to their

funding and manpower. The former were always unlikely to be able to deliver on the promise of their title. On the other hand, the narrowly focussed centres were (usually) dependent on a smaller client base and had the potential disadvantage of making itself redundant by its success. The lessons learnt from this evaluation have been used by Enterprise Ireland to define criteria for selection of new ARE centres, and also conditions of funding and management of ARE centres.

Keywords: Industry collaboration; industry-science relations, applied R&D, small institutes, outreach.

1. Introduction

This paper reviews some issues related to the establishment of Applied R&D competence and activity in small education institutes with low R&D activity. This has been attempted in Ireland as part of a wider national programme to develop the Higher Education (HE) sector as a source of new technologies, Innovation, and of technological support for enterprises.

Ireland has historically been a very low funder and performer of R&D. However, in the late 1990's a significant policy change resulted in a major, and continuing, investment in Research, Technology and Development (RTD) infrastructure and competence development. The basic premise was that greater innovative activity would assist the development of new start-ups, and also enhance the technological basis of existing companies, particularly Foreign Direct Investment (FDI) companies on which Ireland is heavily dependent. Government therefore adopted a new proactive approach to stimulating R&D based innovation as a mechanism for both attracting and retaining foreign companies, and enhancing the creation and competitiveness of domestic companies.

The objectives of the new national policy were defined in the National Development Plan (2000-2006) and included*:*

- *To strengthen the capacity of Irish third level institutions and other research establishments to conduct research relevant to the needs of the Irish economy;*
- *To strengthen the capacity of Irish firms to assimilate the results of R&D into their products and processes* (Finance 2000)

The elements of the new national RTD policy were later detailed in the Strategy for Science, Technology & Innovation (SSTI) (DETE 2006) which accompanied the National Development Plan 2007-2013. The SSTI plan provided for a range of funding programmes designed to develop R&D competence and facilities within the HE sector. As a result of this investment, the R&D expenditure of Irish universities more than trebled in less than 10 years, from €169 million in 1998 to €568 million in 2007(Forfás 2008). During the same period, researcher numbers more than doubled from 2,148 (FTEs) in 2000 to 4,689 in 2006 (Forfás 2008).

The underlying purpose was to dramatically enhance Ireland's innovative skill base. A government minister responsible for economic development noted that "*.. we want to develop excellence in the public research base and a strong pro-commercialisation culture so that we can promote collaboration with enterprise and maximise the commercial exploitation of research outcomes*"

(*Forfás 2005*). Although establishment of Public RTD institutes was considered, it was instead decided to develop university and other HE R&D capabilities on the basis that this would provide the twin advantages of both developing an active body of RTD activity, and also enhancing the output of technologically competent graduates. Availability of such graduates has been a core attraction of Ireland for overseas companies.

Whereas approximately 95% of the R&D investment in the HE sector went to the seven Irish universities (Forfás 2008), efforts were also made to develop R&D competence within 14 'Institutes of Technology' (IOTs). These institutes provide degree and diploma level training for 90,000 students annually, as well as apprentice training and further education. They are strategically located in all parts of the Republic of Ireland so as to provide regional access to third level education and also a local source of training for firms. Many also undertake R&D activity albeit at a relatively small scale. As an indication of their scale, in 2006 they jointly received €25.7 m in R&D funding, which was 5.5 % of total public R&D funding for HE sector in that year (Forfás 2008). These institutions have certain advantages in enterprise development including (a) they tend to have strong links with local industry as a result of a successful history of industrial training at all levels from operatives to degree-holders, and (b) most are located in areas where industrial firms have no other sources of R&D competence (e.g. Universities) nearby. This paper reviews the outcome of one programme – called the Applied Research Enhancement Scheme - established to develop applied R&D competence in these IoT institutions.

2. State of the art about the topic

There is a strong international awareness of the enormous potential for stimulating economic activity by effective dissemination to industry of the new scientific knowledge and technologies developed by national and regional research groups. There are many examples of economic benefits which can arise from those universities which effectively interact with local or national industry so as to enhance the competitiveness of local firms. The factors which determine why some universities are successful in external partnering have been reviewed by Tornatsky *et al* (2002). These factors include: (a) *Leadership* – there must be a champion for partnering within the HE institutional leadership; (b) '*Supportive language'*, i.e. the institutional mission as an economic partner must be clearly stated at all relevant levels both internally and externally; (c) *Organisational policies and structures* must be established which are appropriate to the fulfilment of this mission (i.e. staff and facilities dedicated to the outreach or partnering mission, and suitable administrative procedures) and (d) *Regional policy and political context*, i.e. external to the University, the local region or country must have policies and infrastructures which match and support the institutional policy.

The research which identified these factors was mainly concerned with universities which had significant R&D activity and budgets. Scale of activity could reasonably be expected to be a factor in success. More recently, however, Palmintera *et al* (2007) have demonstrated that even small academic institutions in rural locations of the USA can have substantial local economic impacts if the technology transfer process is well planned and well implemented.

The Irish innovation model is very dependent on getting these factors right, and the relevant S&T agencies have been innovative in the development of programmes designed to create effective

links between the developing expertise within the HE sector and industry. In 2009 an 'Innovation Taskforce' was set up by the Irish Government to consider the issues. Its report, published by the Dept of the Taoiseach (2010) identified 6 principles which are fundamental to the goal of transforming Ireland's Innovation capability. One of these principles states that "*we must sharpen the focus of our national research system to ensure that it is targeted at areas of potential strategic and economic advantage for Ireland. In particular, our research system must be aligned with an effective technology transfer and commercialisation infrastructure to ensure that the significant investment being made yields increasing rewards to economy and society in terms of employment, revenue and solutions to societal challenges*".

Table 1: ARE Centres included in the Evaluation

CENTRE	INSTITUTE
CAMBio: Centre for Applied Marine Biology	Letterkenny IoT
Sligo Design: Design Innovation Centre	Sligo IoT
GMedTech: Galway Medical Technologies Centre	Galway-Mayo IoT
Shelltech: Technologies for the marketing of Live Shellfish	Galway-Mayo IoT
SABC: Shannon Applied Biotechnology Centre	Limerick IoT & Tralee IoT
TEC: Technologies for Embedded Computing Centre	Cork IoT
3CS: Centre for Converged IP Communication Services	Waterford IoT
SEAM: South Eastern Applied Materials Research Centre	Waterford IoT
SUNAT: Seamless Use Thro Network Abstraction Technologies	Athlone IoT
MCA: Micro Sensors for Clinical Analysis	IoT Tallaght

3. Research Focus

This paper specifically focuses on a review of the progress of the Applied Research Enhancement (ARE) Programme, which was launched by Enterprise Ireland[2] to ensure that the applied expertise within the IoTs is made available to local industry. It funds the establishment of applied R&D centres which engage in R&D of industrial relevance, guided by an industry-representative Steering committee created for each centre. The programme funding years per individual Centre is €5m over 5 with limited possibilities for extension, and funding is conditional on appointment of a Director with strong industrial experience, and the creation of a steering committee with industrial representation to advise on technical direction. No funding from industry is required initially.

In 2008 CIRCA Group evaluated 10 ARE centres for Enterprise Ireland. These 10 Centres were located within 9 separate Institutes of Technology, all of which are small R&D performers. (see Table 1) The largest had an annual R&D spend of ~€9m. The ARE Centres evaluated were all small in size and numbers of staff involved typically in the range 5 – 10. CIRCA's evaluation (unpublished) showed that there was huge variability in the success of the centres and identified

[2] The agency responsible for development of local industry – www.enterprise-ireland.com

several critical issues. This paper presents some of the major findings with an emphasis on those most likely to have lessons for other countries.

4. Methodology

The evaluation involved several phases:

- The authors reviewed the Enterprise Ireland information file on each of the 10 centres (see Table 1) including the original funding application, current objectives; funding and its allocation, formal reports on progress; and other available documentation, websites etc.

- Visits were made to each centre and discussions were held with (a) Centre Directors (b) Institute of Technology management and (c) leaders of projects within the centres. These discussions used a formal template which was circulated in advance.

The major issues in these discussions were:
  - Nature of interactions between the ARE Centres and their parent institutions (major challenges and issues)
  - Nature and extent of communication mechanisms with external partners and stakeholders
  - Nature of collaborations with external partners (consulting, collaborative/contract R&D etc)
  - Metrics for success
  - Management issues (IP Protection, major challenges and constraints)
  - Plans for centre sustainability after Government funding ends.

- A telephone survey of regional companies was conducted regarding their interaction with the centre. These discussions (also using a formal template which was circulated in advance) covered issues of relevance and impact of Centre expertise, communications, responsiveness etc.

Table 2 below illustrates the relatively small size of the Institutes of Technology involved.

Table 2. Host Institutes involved in Study

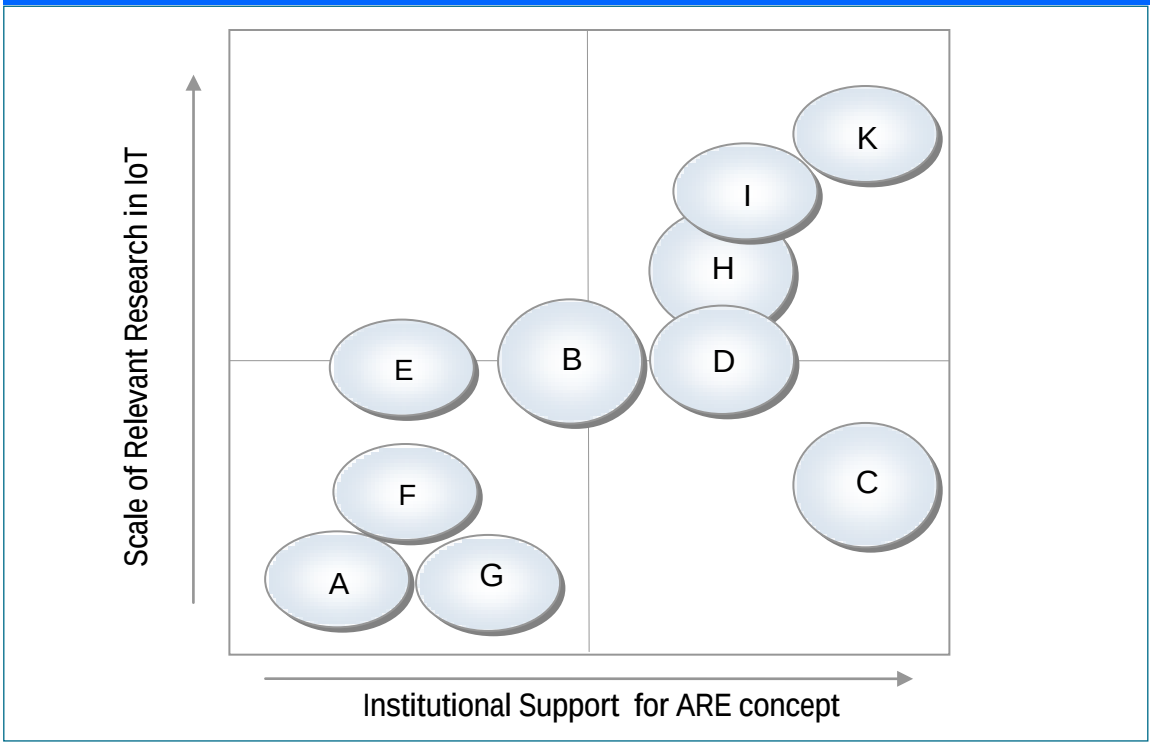
Institute of Technology	Total Students	PhD Students
Waterford	10,000	~ 200
Cork	13,000	~ 50
Galway-Mayo	9,000	~ 50
Limerick	5-6,000	< 10
Athlone	5–6,000	< 10
Sligo	5–6,000	< 10
Tallaght	4,000	~20
Tralee	3,000	< 10
Letterkenny	3,000	< 10

5. Findings

The evaluation showed that the Centres were enormously variable in their activities, success and in the nature of the challenges with which they had to deal. However, a set of inter related core principles was found to be central to the success of ARE centres. These are outlined and discussed below:

Institutional Support. Establishing a successful research centre in an academic institution is difficult, particularly in institutions where there has not been a strong tradition of research. It is very important that the management of the host institute fully supports the centre, and the concept of external partnering which it implies. Institute management must also both articulate this importance internally, and also ensure that appropriate management supports are in place. This is central to the success factors identified by Tornatsky *et al* (2002). Similarly Palmintera et al (2007) found that successful partnering institutions had "*a culture that promotes technology transfer, commercialization and entrepreneurship. That culture is encouraged by academic leaders and fostered by internal incentives that reward and celebrate commercial partnerships and entrepreneurial successes*".

Figure 1: Centres in relation to institutional support for ARE Concept



Although most IoTs have now determined that R&D is a fundamental part of their operations, it is a new activity for many IoTs and there is little experience of research within IoT management staff. It is perhaps unsurprising that there are difficulties in embedding research activity into the administrative practices of an Institute whose systems are designed for an educational role.

Successful applied research centres, which normally have a strong entrepreneurial ethos, present challenges to such systems. They seek rapid responses to issues (hiring, equipment purchase etc) as they arise. Therefore they do not fit comfortably into administrative and managerial systems which have been shaped by other priorities - such as compliance with established educational procedures or legislative requirements, or the perceived need to avoid setting precedents which other staff may wish to follow. Working out a "*modus operandi*" which successfully balances the need for administrative compliance with the need for efficient responses to urgent research issues has been a challenge for many ARE centre Directors. The ability of the central administration to deal with the accounting, human resource and travel needs of an R&D activity proved very challenging in certain centres. Institutional administrators were often unwilling to modify their systems to accommodate a small proportion of staff. In several institutes there was no champion for the ARE centre concept within the leadership of the organisation and the necessary administrative procedures and supports were not put in place.

As a result of this lack of support, some Centre Directors spent an unreasonable amount of their time in dealing with minor administrative issues. In essence, their time is used in coaxing the administrative system of an educational establishment to deal with the needs of research management, with consequent loss of time for marketing, or other client services. If the IoT leadership makes it very clear that the ARE centre is a priority activity of the institute, it ensures that such issues are quickly addressed by administrators. The development of positive, mutually supportive relationships between the ARE centres and their parent Institutes is a key determinant of future prospects for each ARE centre.. Since completion of the study, Enterprise Ireland has included the requirement for full institutional support as one of the terms of the funding for ARE centres.

Fig 1 shows the variability in support for each centre (mainly determined by the authors' perception of the institutional readiness to deal with internal constraints to its performance). As of Summer 2010 four of the 10 Centres that were evaluated in the 2008 study had withdrawn from the ARE Programme by mutual agreement with the funding agency Enterprise Ireland. The reasons for this were generally related to the requirements and expectations of Enterprise Ireland for increasing levels of industrial interaction by the ARE Centres. It is interesting to note that the four Centers which have withdrawn – designated as A, E, F, G in Fig 1 – were all assessed as having both poor institutional support, and also being in institutions with a low level of R&D activity in their fields (see Technology Sustainability below).

Centre Director Expertise & Experience. A sustainability issue for the centre is retaining their attraction for industry, and critical to this is their ability to retain the services of an industrially-experienced centre manager or Director as they are usually designated. Companies surveyed in the evaluation process emphasised the importance of having a Centre Director who had an understanding of industry needs and practices. The ability of these Directors to act as an interface and interpreter between HE activities and expertise and industry requirements was perceived as a major advantage by companies surveyed. In almost all centres the Directors were industrially experienced and were actively involved in contact with companies. At one Centre there was a considerable start up delay as the academic researchers initially opted to plan a Centre managed internally by themselves without having to recruit an industrially experienced outsider. Eventually this approach was abandoned and the Centre was able to get up and running. An issue for some centres is the retention of such Directors, and this issue is closely related to the financial

sustainability issue above. If Centre Directors must earn their salary by winning R&D funding from a variety of academic funding sources, and also spend a large proportion of their time negotiating minutiae with administrators, they are unlikely to remain interested in the role of centre Director.

Technology Sustainability: Centre viability is strongly determined by the relevance of its technology offering. Centres cannot continually offer novel technology or expertise without a continuing supply of new ideas, expertise and technologies. However, successful fulfilment of their role frequently results in loss of technology and expertise through creation of spin-off companies, or by licensing. This can divest a centre of its technology edge, as will competing expertise from other sources. Centres must therefore have some means of continually regenerating their technology offerings so as to remain relevant to their external partners.

Some ARE centres are what might be called 'Add-on Centres', i.e. they are associated with existing research units which are actively involved in relevant R&D. These centres can operate, at least partially, by further developing and commercialising the output of the existing basic R&D programme. These 'Add-on' centres can also draw on a wider range of expertise and experience within the IoT research community. In addition, they will be more likely to attract quality staff due to the existing track-record of research; and they can benefit from a wider output of technologies and potentially spin-off opportunities.

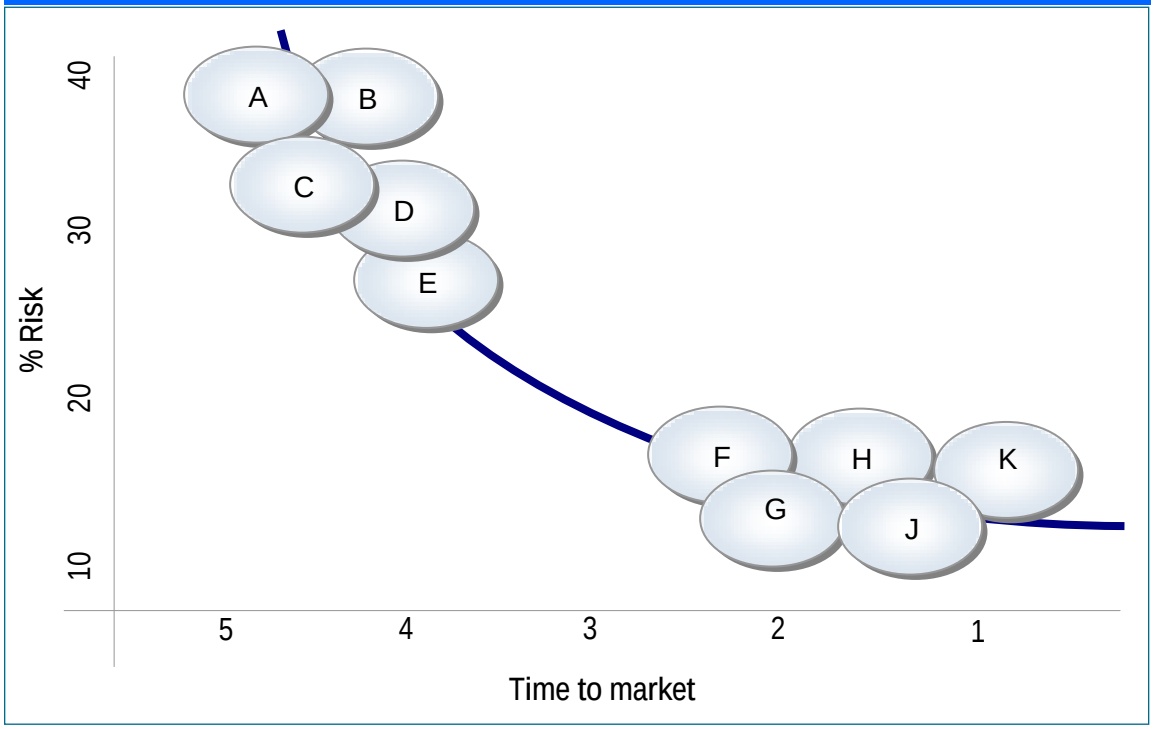
Others ARE centres are 'stand-alone' centres created *ab initio* to address perceived local technology needs, and are the only or main performer of relevant research within the IoT. These centres are in a more difficult situation regarding sustainability as they do not have a flow of ideas and technologies from basic research activities for which they can seek applications and commercialisation.

A critical differentiation between centres was therefore between those linked to a basic research activity within the host IoT, and those which were created as stand-alone applied centres. In several of these cases, there was little or no existing R&D activity within the host IoT before these centres were established. These centres found it difficult to survive as predicted in Fig 1.

Technology Focus. A further critical difference between centres is in their definition of the scope of their expertise or activity. Some chose broad fields of activity (National Design Centre; Marine BioTechnology Centre etc) while others were highly specific (Technologies for the marketing of Live Shellfish, Micro Sensors for Clinical Analysis). The latter centres had the significant advantage, for a small unit, of being able to focus both their R&D, and their marketing on a narrow field. It also allowed the industry steering group to be more effective, and reduced internal 'political' difficulties in defining which IoT researchers should benefit from the equipment available within the centre.

Those centres with a widely-defined scope were, in practice, only active in a small part of their defined field. By their own design, they had made themselves small fish in a big pond. On the other hand, the disadvantage of a narrow focus is that a centre can make itself redundant by its success. One Centre achieved their original objective of providing a solution to a technical issues affecting local companies. However, in doing so it reduced its own relevance because its technology was spun out of the centre as a separate company which resulted in the loss of staff and technology.

Figure 2: ARE Centres in relation to market readiness



Closeness to Market-readiness: Another important distinction was between Centres which focused on "market led R&D" and those focused on "S&T driven R&D". Some centres were formed to further develop internally-generated technology or expertise which was perceived to have commercial relevance. Others had identified problems or opportunities among potential external partners and worked on solutions to these issues. The former were quicker to attract early industry interest and interaction, but industry attraction diminished when the market-relevant aspects of the centre's expertise were either commercialized or were shown to be non-viable. Gray & Walters (1998) review of Industry-University Cooperative Research centres highlighted the importance of providing useful outputs to industry partners, and state "*the best predictor of whether a company will remain in a cooperative R&D relationship is whether they perceive benefits of knowledge and technology transfer. Everything else pales by comparison*". Those ARE centres which were market-led and offered problem-based services were dramatically more effective, but the rigors of delivery were sometimes not attractive to academic staff. It remains to be seen if there is a difference between these two categories in terms of longer term sustainability. Five of the ten Centres are engaged in "early impact" work which is strongly market led. The work programmes of the other 5 centres are more "S&T driven". These also may have future market relevance but the market pull is weaker, the time scales to commercial impact longer, and the failure risks higher. Figure 2 illustrates our assessment of the nature of the work at each centre in relation to the time scale to achieve market applications. It is interesting to note that of the 4 Centres that have withdrawn from the ARE programme by Summer 2010, two were located within the "close to market" cluster and two in the "S&T driven" cluster in Figure 2.

6. Conclusions and Implications.

In summary, there were significant variations in the design and method of operation of these 10 publicly funded small applied research Centres located within various Institutes of Technology geographically spread throughout Ireland. This public funding is being scaled down to lower levels as each Centre grows and matures. Already there is evidence that some of these Centres were not able to survive the increasing expectations for industrial funding and relevant alternative sources of funding as time has passed. Valuable lessons about the factors influencing the effectiveness and long term sustainability of these centres have been learned and these are being used by Enterprise Ireland to develop new centres. These include:

Institutional Support is critical to the success of such centres. In several institutes it became clear that the original proposal to develop a centre was the brainchild of an individual researcher. These centres had the tacit support of their institute simply because they represented an additional source of funding, rather than as manifestations of an institutional ambition to reach out to regional industry or other local partners. The lack of institutional support was most obvious in relation to providing administrative procedures to meet particular centres' need for rapid hiring, purchasing etc. Several centres found themselves fighting an uphill battle against administrators intent on maintaining procedures which were designed for entirely other purposes. A champion of outreach at a high level within certain institute could have easily addressed such issues, but no such champion existed in some cases. This finding closely echoes those of Tornatsky et al (2002) who noted that some academic institutional leaders have become '*strong and visible champions of partnering activities*' whose activities both create an '*intellectual argument and language system around the new activities'*, and also build and maintain '*organisational structures and policies that will sustain the work of partnering*'. Greater indication of institutional support for the principle of ARE centres was a recommendation made to EI as a result of this study.

Technology Focus and Technology Re-juvenation is another critical and complex issue which requires careful consideration, particularly in smaller institutions. An IoT which decides to become regionally relevant in its research activities has many choices. One possibility is to find local application for its existing R&D expertise through licensing, consulting or spin-offs. At the other extreme, it can assess local sectoral needs and attempt to develop a competence and activity which can address these needs. The former option will appeal to academic researchers and the latter to local industry, and generally some compromise will be found. If not, the centre will probably fail in its goal to maintain industry partners. ".

Even when a broad field of activity has been decided, they must also decide on the specific focus of their activity in the knowledge that the scale of research activity within an IoT is likely to be relatively small. A very wide focus is unrealistic because the centre competence and activity can never address all of the topics contained within such a wide field. A very narrow focus (e.g. finding a solution to a specific industry problem) has other disadvantages in that technical success can result in the centre's redundancy. On the other hand it has advantages in allowing the centre to develop specialised expertise which should also assist the centre in winning both client funding and also public funding to further enhance its expertise and technologies. The narrow focus will also assist in marketing of this expertise to relevant external partners. The development of niche

areas was also a funding of Palmintera et al (2007) who state "*it is especially important for modestly funded institutions to focus on building niche research areas*" .

Regular re-juvenation of the knowledge and technology available for dissemination is also a key issue. This is best achieved by having the Applied Research Centre located close to an existing R&D Centre which is a source of a regular flow of new knowledge and technology.

Availability of useful expertise and technology is a major determinant of success and as Gray and Walters (1998) have stated *"these programmes are always at risk unless there is a constant flow of technology to their sponsors*

Appointing an Industry-experienced Centre Director is also an essential issue, particularly in the minds of potential industry partners. Other CIRCA research has outlined some difficulties in relations between Irish industry and academics (Ryan et al 2008). A centre Director with an understanding of industry needs and practices fulfils a highly effective role as intermediary in marrying academic potential and industrial acceptability. Such a Director is essential in developing an effective centre.

Sustainability: Total financial self-sufficiency within a fixed time-frame is not a metric by which the Centres are assessed by Enterprise Ireland. ARE funding was initially provided on a 5-year non-renewable basis and the principle was that each centre should strive to become self-sustaining within that period by developing good regional contacts, and by developing the expertise necessary to remain relevant to these partners. In practice, some centres did develop a useful client base, but it was never likely that the small companies which dominate the regional industrial sector in Ireland could be a source of adequate fee income to fully support even a small public sector applied R&D centre. The model developed by Enterprise Ireland for this programme has evolved and full financial self-sufficiency is no longer a requirement. Currently the practice is that if an ARE Centre can demonstrate a significant level of industrial interaction, public funding will continue. Industrial interaction should be evidenced by some direct industrial funding, some indirect or partial industrial funding, positive feedback from the industrial client base, and some funding from other competitive research funding sources nationally or internationally. If these expectations are met within certain timescales Enterprise Ireland will continue to provide such funding as is required to "bridge the sustainability gap" for the foreseeable future.

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