COMPANY-COLLEGE R & D LINKS: A SOURCE OF INNOVATION AND ENTERPRISE?

Dorothy M. Barry*

The 1984 White Paper on Industrial Policy placed particular emphasis on a potential source of product and process innovation – the university or third-level college with research links to industry. The notion that the third-level sector, which has traditionally been associated with the training of entrepreneurs, could itself become more directly involved in the entrepreneurial process is an interesting one. It has arisen due to the growth of new technology-based industries, to whom university research findings are of central importance and where the forefront research is barely ahead of the products available in the market place. The U.S. has led the world with the completion of multi-million dollar research agreements between leading corporations and colleges. In the decade since these university-links have become topical, other developments have occurred which point to a role reversal between companies and colleges. Many large companies with global marketing strategies undertake large scale intramural educational programmes. At the same time, universities have welcomed new tenants – "academic entrepreneurs". Somewhere between these extremes lies an acceptance by many companies and colleges that there are great advantages to closer cooperation. The purpose of this article is to review the situation in Ireland to determine whether we can expect university-industry links to become a prevalent feature of the industrial scene in future.

Defining the Link

Cooperation between companies and colleges falls into two major categories [Smith and Karlesky, 1972] – knowledge transfer and collaborative research. At present, the focus of attention internationally is on the various forms of collaborative research, e.g. cost-sharing research programmes, joint company/college laboratories and research groups, which may lead to substantial technological breakthrough. This extensive cooperation occurs within a broader environment in which knowledge transfer is taking place. Familiar aspects of education and training have now been extended to allow college participation in consultancy, licens-

*The author is Public Relations Manager at the National Board for Science and Technology. She conducted the research reported here as part of the research programme of the Enterprise Centre, University College, Dublin, and in fulfillment of the thesis requirement for the MBA degree.

IBAR — Journal of Irish Business and Administrative Research, Volume 7, Number 1, Spring, 1985, pp.46-56.

ing, innovation centres, industrial parks and small business development centres. The research work which forms the background for this paper is confined to the research and development partnership, involving joint participation in a research project or the commissioning of a specific research project from a college.

Cooperation: The Company Viewpoint

Any argument for closer links between companies and colleges must recognise the fundamental differences in their respective roles, functions and methods of operation. There must be sufficient motivation present for both groups to make the investments and adjustments involved in diverting from their main purpose. This suggests that the benefits to both parties are tangible and fairly predictable.

The degree of company involvement in cooperative research links with colleges depends on a number of factors such as company size, industry sector and the company use of technology as a major element in its competitive strategy. Large companies in high-technology sectors are regarded [OECD, 1984] as having the greatest willingness to form R & D partnerships with colleges. As well as 'tapping' the new ideas and information in a particular technology, companies gain access to potential employees who are trained researchers. Where does this leave the large company in a mature industry with highly standardised operations? In such cases, links with colleges can form the basis of a diversification programme, or better equip the company to respond to technological innovation.

However, it must be recognised that the small and medium-sized enterprises (SME'S) which dominate the Irish economy have special problems when it comes to setting up cooperative research links. Many SME's in research intensive sectors experience problems in raising the necessary funds to undertake or subvent research projects. On the other hand, SME's in traditional sectors need the support of industry federations or other interface institutions for their interaction with colleges to make sense. The behaviour and strategy within individual companies has an equally strong influence on cooperative research links.

Cooperation: The College Viewpoint

Joint research projects with industry provide a valuable means of enriching the training of students who are destined to work in industry. There is an immediacy and satisfaction associated with solving problems which are intellectually challenging, and also of particular relevance to society. The motivation for college involvement goes somewhat deeper than that.

As financial problems beset colleges and research and development work becomes more expensive, cooperative projects provide an additional and welcome source of funds. Government-sponsored schemes for collaborative research are a further impetus.

Through cooperative R & D work, colleges may gain access to company facilities. By contrast college equipment may be used to provide services for a number of companies in similar industrial sectors who separately lack the resources to purchase sophisticated and modern equipment. There is a further possibility that potential entrepreneurs among the college staff can use cooperative links as a means of testing their ideas beyond the workbench or laboratory phase.

Cooperation: The Problems

It would be wrong to assume that setting up a research partnership between two sectors with such diverse roles and objectives is an easy matter. Some of the problems frequently cited [Peters and Fusfeld, 1983] relate to the proprietary information associated with the particular research project, patents and licensing arrangements, and restrictions on the publication of research findings. In addition, the timescales of companies and colleges can vary, and many colleges may seek a long-term financial commitment that companies cannot or will not give.

R & D Partnerships: Contribution to National R & D

It must be stated that college – company R & D links have attracted a degree of attention that is totally disproportionate to their contribution to national R & D. Although the U.S. is the acknowledged leader in the scale and diversity of cooperative links, recent estimates [National Science Foundation, 1982] suggested that direct research links accounted for less than ½% of the national R & D effort.

The research work which forms the basis of this paper began by establishing the position in Ireland. Business enterprise expenditure on R & D in Ireland is very low overall: the latest survey figures available [NBST, 1982] show that of the IR£48m expenditure in 1982, just over £0.5m went directly to the third-level colleges. Funding schemes from State bodies such as IDA and NBST supplemented that figure but not to a major extent. Activity was concentrated in the three sectors – electrical/electronics; food, drink and tobacco; chemicals and drugs – which are the leading R & D performers in Ireland.

The contrast of the Irish and U.S. positions in this regard serves to highlight an important issue regarding the immediate potential for higher

education – industry links. In the U.S. both company and college research groups are large. Here, most companies are small, make little use of R & D, and lack the capability to use external research sources such as the third-level colleges. This may arise because of a very understandable pre-occupation with survival, or because of an unwillingness to expose themselves to risk when market conditions appear reasonable in the short-term. Companies may not be able to define their R & D problems in ways that suit academic researchers.

However, the shift in the structure of Irish economy towards technology-intensive activities suggests that the scope for cooperative R & D will grow in the future. Within the past two years, a new R & D scheme and increased promotional efforts have resulted in growth in the level of cooperative R & D expenditure. In addition, the Government pledged an additional IR£2m in 1985 in the White Paper on Industrial Policy. It did so in the expectation of a very direct contribution from university-industry links to new product and process innovation.

Cooperative R & D: The Irish Experience

With this in mind, 56 joint R & D *projects* undertaken between 1974 and 1982 were examined to determine their objectives, characteristics and outcomes. The projects represented all the *completed* University-Industry R & D projects funded by the National Science Council 1974-77 and by the NBST between 1978-82.

The profile of the participants (Table 1) indicated research effort spread between the Irish private and public sectors and foreign-owned companies. It suggests that cooperative R & D is fairly concentrated among a small number of companies and college research groups who involve themselves in many research projects. The industrial groups involved in 52% of the projects had over 100 employees.

To ascertain the attitudes and perceptions of the business enterprise sector towards cooperative research, further detailed interview research was undertaken with 14 of the 19 companies involved in the projects. These companies were divided into three groups:

— Companies in new and foreign-owned high-technology industries such as chemicals and electronics,

— Irish companies in mature industries such as engineering and dairying,

— Irish companies in new or rapidly-growing industries including food and chemicals.

Table 1: *Profile of Participating Companies and Colleges*

	Company	College
Number of Projects	56	56
Number participating	54	45 (research groups)
Involved in more than one project*	11	5
Status		
• Private Sector	33	
• Foreign owned	12	
• Public sector	7	
• University		42
• National Institute for Higher Education		8
• Colleges of Technology		6
Sectoral Breakdown of Projects:		
Chemicals/Drugs	20%	
Electronics	16%	
Metals/Machinery	14%	
Food, Drink, Tobacco, Agriculture	7%	
Mariculture	6%	
Other	33%	

*4 cooperative partnerships were linked in eight projects.

Turnover levels in these companies ranged from just under IR£1m to just over £200m. In general, less than 10% of the R & D expenditure of the companies was spent in the third-level sector in Ireland. R & D investment was growing substantially in most companies. But many of the companies did not have a high level of formal R & D. Many of those interviewed were European or world-leaders in their particular market segment. In this situation, attention to technical product characteristics was a means of achieving the product differentiation consistent with this leadership position.

Market-related factors had an overriding influence in setting-up of the cooperative research project, as Table 2 demonstrates. However, projects were also undertaken to test the potential of new technology, to meet a demand for a particular technical service or to keep a watching brief on technological developments. In 66% of the projects, the idea originated from the company or from a previous link between the college research group and the company.

Table 2: *Motivation for Cooperative R&D Project*

Motivating Factor	Relative Importance*
Identified Market Opportunity/Demand	168
'Technology Push'	89
Technical Service Requirement	72
Background State-of-the-Art Knowledge	56
Cost Savings	41
Diversification Opportunity	30
Competitor Threats	18

*Weighted Points Scale applied to ratings for 56 projects.

Table 3: *Outcome of R&D Project*

Outcome	No. of Projects
Product Innovation	7 (13%)
Process Innovation	6 (11%)
Product Improvement	4 (7%)
Process Improvement	13 (23%)
Provision of Technical Services	11 (20%)
Access to State-of-the-Art Knowledge	12 (21%)
None available	3 (5%)
Total	56 (100%)

The fact that many of the projects did not set out to achieve a major technical advance in the form of a product or process innovation was reflected in the immediate project outcome (Table 3).

Because the degree of success of an R & D linkage may depend on factors other than the direct outcome of the R & D project itself, the overall result of the partnership was assessed. New enterprise spin-off, new R & D linkages and staff mobility were among the features examined. Table 4 summarises the results of this assessment. It shows that while one-third of the partnerships had above-average results, the remainder just met or failed to meet expectations. The most successful partnerships resulted in

Table 4: *Overall Assessment of R&D Partnerships*

Assessment	
Very successful	7 projects (13%)
Moderately successful	12 projects (21%)
Met Expectations	30 projects (53%)
Below Expectations	7 projects (13%)
Spin-off Company Formation	
— Associated with partnership	6 companies
— Independent of partnership	7 companies
Personnel transfer from college to company	5 projects
Subsequent Level of Cooperation	
— High Level	10 projects (18%)
— Moderate Level	42 projects (75%)
— None	4 projects (7%)

new product or process development or led to new enterprise formation. The assessment of the outcome also identified six cases of company formation by college staff.

Cooperation: Company Attitudes

Companies involved in cooperative R & D work were operating in very different sectors and environments. Despite these differences, there was a high degree of unanimity between them in their initial motivations to establish a research link with a particular college research group. Similarities were also evident in their attitudes to future cooperation.

Table 5 shows that the principal motivating factor for the establishment of a cooperative research project was the company perception of a unique R & D capability among the research group in a particular college. Another important motivating factor was the college access to latest information on the specific technology of interest to both parties. Incentives played a minor role in the establishment of the link. This result has clear implications for the design of public policy instruments to stimulate university-industry linkages further.

Companies are of the view that the opportunity to build on the good partnerships which already exist and to maintain access to developments

Table 5: *Relative Importance of Factors Motivating Initital Linkage with Higher Education Sector*

Factor	Relative Importance*
Unique R&D capability of College	60
Geographical Proximity	54
Access to State-of-the-Art Technology	26
Superiority of College (to all other R&D sources)	24
Company actively seeking linkages	15
College actively seeking linkages	14
Access to College Personnel	12
Government and Incentives	12
Only source of R&D available	9

*Weighted Points score applied to rankings for 56 projects.

in technology are the main reasons to support further cooperation. Table 6 shows that financial support becomes more important once the R & D link has been established. Previous empirical studies and these research findings lay very great emphasis on the role of individual research team leaders in the college and company. Specific evidence for this is seen in Table 7 where barriers to future cooperation perceived by companies are summarised. The high rating for the use of other external sources of R & D suggests that company use of the higher education sector continues only in the absence of better alternatives either within or outside the company.

Table 6: *Relative Importance of Factors Influencing Future Cooperation*

Factor	Relative Importance*
Existing linkages good	48
Access to technology	45
State Support (R&D Schemes)	30
Stated Company Policy — Product Innovation	18
State Incentives (e.g. taxation)	16
Confidentiality	13
Stated Policy of Parent Company	9
Company Ability to Manage Link	4
Quality of College Expertise	3

*Weighted Points Score applied to rankings for 56 projects.

Table 7: *Relative Importance of Perceived Barriers to Cooperation*

Factor	Relative Importance*
Loss of College Research Leader	42
Loss of Company Research Staff	34
Availability of Alternative Sources of R&D	32
Conflict with Primary role of College in Education	30
College R&D Regulations	18
Company Policy—New Products	16
Company Policy—Existing Products	11
Company Policy—Process Innovation	6
Lack of Expertise	4
Parent Company Policy	4
College Reputations	4
Lack of Facilities	4

*Weighted Points score applied to rankings for 56 projects.

Building on the Irish Experience

Cooperative R & D projects are a means of transferring technology from the colleges to the companies. In many cases, this is a two-way process enriching the company and the college R & D groups.

The review of the Irish experience suggests that Ireland does not differ greatly from the U.S. in the motivations for college-company links. In both cases, the company needs to tap the source of technology in the college and adapt it to its own needs. Industry looks to colleges for new technology and personnel rather than directly as a source of product or process innovations. The most obvious difference between U.S. and Ireland is that the scale of our economic and research activity will not allow us to replicate the substantial research partnerships that exist in the U.S. Multi-million dollar research agreements between large corporations and centres of specialised expertise are not an avenue we can explore yet.

Cooperation with colleges is confined to a small number of companies who maintain links for one or other of the following reasons:

1. Companies with high levels of R & D and substantial in-house expertise use colleges to complement or supplement their own resources. Their relationship with Irish colleges is part of their network of research relationships maintained worldwide.

2. Companies who do not have a high level of R & D, but who have identified diversification opportunities, require a technical contribution which is available only from the college research team.

In neither case does the college play a central strategic role. In the projects examined, colleges contributed to process improvement rather than directly to new product development. Companies themselves have to take responsibility for implementing the results. R & D is only the first step in a four-part process of R & D, transition to industrial process, production design and start-up, and market penetration (Kamin, 1982).

A successful product innovation means ensuring that the company gets all these phases right. This is one reason why a 'technical entrepreneur' within the company was seen to play such a crucial role in linking market and technology requirements. During discussions companies frequently emphasised their responsibility for linkage 'management' particularly the setting and monitoring of clear targets for the research project.

The research work also demonstrated the importance of a versatile college research leader with an understanding of company needs, a flair for building up a specialist research team and the managerial competence necessary to balance external and internal demands on the research groups. Leaders of the more successful groups reflected these qualities through work experience or study overseas, regular contact with industry and internationally recognised research work.

Overall Conclusions

A company which sets out to acquire technology must ensure that such a move is rooted firmly in overall company strategy. Successful R & D partnerships are rarely built quickly. But effective technology transfer can be accelerated if the company has detailed targets for the R & D projects, monitors these and keeps in regular contact with the college. Informal links with researchers will provide Irish-based companies with an important means of access to latest technological development.

The college has an important role in forming graduates with technical-entrepreneurial qualities which are such a necessary component of successful research links. As unique research expertise within a college attracts industrial links, colleges must retain sufficient academic staff with the capability to build up specialised research teams in key technologies. Only by having expertise in the latest "appropriate technology" can colleges expect to maintain applied research and development partnerships with industry.

On the basis of the research work outlined here, the hopes of substantial

product and process innovation resulting from college-company partnerships as expressed in the White Paper are misplaced. If the State wishes to foster improved research and development partnerships, its primary responsibility is to ensure that the scientific and technical facilities which attract company R & D projects are in place. Distinct competence in new technologies, particularly in the form of specialised centres of expertise, provide the most appropriate mechanism to achieve this.

A by-product of the research work carried out in 1984 was the clear indication that the general taxation environment was not conducive to building up research and technical expertise on a large scale. Companies reported difficulty in retaining researchers who were attracted by better salary conditions outside Ireland. It is to be hoped that the situation can be reversed, so that Ireland can consolidate its small but valuable base of college-company R & D partnerships.

REFERENCES

BARRY, D. M. 1984. *Companies and Colleges: Factors Determining Successful R and D Paretnerships in Ireland.* Dublin: University College. Unpublished MBA dissertation.

KAMIN, J. Y., I. BIJAROUI and R. HORESH. 1982. "Some Determinants of Cost Distributions in the Process of Technological Innovation", *Research Policy.* Vol. II. pp.83-94.

NATIONAL BOARD FOR SCIENCE AND TECHNOLOGY. 1982. *R & D Survey of Business Enterprise Sector.* Dublin (unpublished).

NATIONAL SCIENCE FOUNDATION: 1982. *University-Industry Research Relationships: Myths, Realities and Potentials.* Washington: Fourteenth Annual Report of the National Science Board.

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT. 1984. *New forms of Cooperation and communications between Industry and the Universities.* Paris: Analytical Report, DST/SPR/83.82.

PETERS, L. and FUSFELD, H. 1983. *Current U.S. University-Industry Research Connections* in *University-Industry Research Relationships: Selected Studies.* Washington: National Science Foundation / National Science Board.

SMITH, B. L. R. and KARLESKY, J. J. 1977. *The State of Academic Science – The Universities in the Nation's Research Effort.* New York: Change Magazine Press.