WHICH TYPE OF HIGH-TECHNOLOGY FOR IRISH INDUSTRY?

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At the present time high-technology enjoys high visibility in both industrialised and industrialising countries. Crash programmes to reduce an alleged 'technology gap' are being prepared in several countries and there is widespread interest in mature technological societies in so-called innovation policies. In mid-March 1984 the West German government made 3 billion marks available to the country's high-technology industries "to further research and development during the next four years". At about the same time the U.K. Trade and Industry Secretary added £120 million to the £55 million already allocated "for projects aimed primarily at the development, production and use of microelectronic components". France has been providing direct and indirect subsidies to its high-technology sectors longer than other European countries.

How is Ireland responding to this 'second industrial revolution'? In order to answer that question it is necessary to differentiate between two quite different interpretations of the term high-technology. Under one interpretation high-technology is reserved for companies that are engaged in the design, development and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge [U.S. Congress Office of Technology Assessment, 1982]. The second interpretation of high-technology is where traditional industries adopt the most up-to-date production processes and apply automation to manufacturing technology in order to produce at low unit cost. There is little doubt that Ireland has shown more commitment to, and has made more progress with the latter type of high-technology than with the former. The term 'high-technology' is used most frequently in the context of improving industrial output by employing the most modern production plant aimed at reducing unit costs. It is important to look at the fundamentally different nature of these two concepts of high-technology, to examine their distinguishing characteristics and some of their economic implications.

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Rationalisation Technology

New technology which rationalises traditional industry is a conventional response to international price competition. It is often an attempt to overcome the labour cost advantage enjoyed by producers in low wage countries. It can also be an attempt to match the production efficiency in developed countries. Industries such as textiles, footwear and electronics assembly are affected, but so also are car manufacturing, food processing, steel, man-made fibres and many other industry sectors.

A modern television set can be assembled with one hour of direct labour. A Toyota car plant turns out nine engines per day per employee. Technological development has virtually automated the printed circuit board "stuffing" process. In garment making, computerised cutting techniques have transformed productivity while electronic controlled knitting machines have nearly eliminated time lost on yarn and style changes. The entry barrier to producing traditional products using high-technology is not technology but capital. Very little technology transfer takes place: the equipment suppliers readily send their own technicians and engineers to assist local managers in smoothing out training, quality control or start-up problems. The very best technology is available to, and is currently being deployed by countries in all stages of industrial development.

There are two main difficulties with rationalisation type of technological change. First it leads to very heavy job losses. A recent study on the impact of the European Community's external trade policy on the Irish economy concluded that "job losses from increased productivity have been nearly four times more important than job losses from changes in net trade flows for manufacturing industry as a whole" [Mathews, 1980]. This can be exemplified by the experience of Guinness Ireland which reduced employment from a peak of over 10,000 to the present level of 2,500 and at the same time considerably expanded output. There are indications that further substantial reductions in labour force are necessary.

The second problem is that investment intensive modern technology needs high capacity utilisation to achieve low unit costs. When output volume is perceived as the key to profitability price cutting becomes a feature of the industry particularly in times of reduced aggregate demand. This is now a chronic aspect of many food production and chemical processing businesses.

New Technology Enterprises

The second category of high technology is associated with so-called "new technology-based firms" (NTBFs) who design, develop and introduce new products and innovative manufacturing processes. There are some industries such as micro-electronics, communications equipment and bio-technology which have a high proportion of NTBFs producing similar or related products and hence are classified high-technology industries. These industries compete not on price but on innovation which Schumpeter (1947) described as "competition from the new commodity, the new technology, the new source of supply, the new organisation . . . competition which strikes not at the margin of profits and the output of existing firms, but at their very lives". Companies in high technology industries typically use state-of-the-art techniques and serve small specialised markets.

While new technology companies normally require a heavy capital injection during their initial years the main entry barrier is not capital but technology. There are two measures frequently employed to assess the level of technology in a firm or industry: research and development expenditure as a percentage of industry revenues or value-added and employment of scientists, engineers and technicians as a proportion of the total workforce.

A significant investment in research and development (R & D) is invariably required to achieve a technological breakthrough. Estimates vary on the minimum size of initial R & D effort needed. In discussions with Irish technological entrepreneurs a figure of ten man years or about £300,000 was mentioned. A Swedish venture capital study [Timmons, 1981] puts the figure in the range of £70,000 to £400,000. There is probably no upper limit, however, as illustrated by the Trilogy Corporation experience where a commitment of 500 million dollars proved inadequate to develop a new wafer production process.

High-technology industries are synonymous with short life-cycle products. The R & D effort has therefore, to be maintained even after the initial breakthrough. Comprehensive U.S. data available from the annual Business Week survey show that high technology companies spend nearly twenty per cent of revenues on R & D during their first four years and that R & D expenditure stabilises at about ten per cent of sales after the high growth phase.

The second characteristic of high-technology businesses is a high proportion of technically and professionally qualified manpower. Scientific and technical workers are defined as engineers, life and physical scientists,

mathematical specialists, engineering and science technicians and computer specialists. A recent U.S. study [Riche *et al.*, 1983] set the cut-off point for a high-technology enterprise as ten per cent in high technology occupations. The definition of high technology occupations used in the study required "in-depth knowledge of theories and principles of science, engineering and mathematics underlying technology – a knowledge which distinguishes them from computer operators, computer service technicians and other high-technology machinery repairers or workers in a wide range of occupations who use word processing machines, computers or other high technology products but rarely have – or need – such in-depth knowledge". A comparative study of technical manpower in the electronics industry in selected countries using a less restrictive definition of high-technology occupations, found that proportions of technical workers between twenty and thirty per cent were not uncommon [Cogan and O'Brien, 1983].

High-technology businesses also require professionally qualified manpower outside the narrow technical definition just referred to. The customised nature and the short life cycles of their products place a premium on marketing expertise. High-technology businesses also require sophisticated financial direction to optimise financial structure and to plan and manage difficult cash flow requirements. The quality of strategic management is also critical to the success of new technology enterprises.

Which Type of High Technology Industry?

There is no doubt that higher economic returns can be obtained from innovation as opposed to rationalisation type technological change. The high proportion of technical and professionally qualified workers in NTBFs ensures high value-added per employee and hence has a favourable impact on per capita domestic product. On the other hand, the more automated processes in traditional industries frequently lead to a reduced need for operator and management skills. Most analysts argue that NTBFs are prolific creators of new jobs. There are numerous examples of new high-technology computer companies in the U.S. which became very big enterprises during the decade of the seventies. High technology industries have increased their employment even when overall manufacturing employment has declined.

A U.S. study [Riche *et al., op. cit.* 1983] of the period 1972-82 found that under one definition high technology employment increased by 39.8 per cent, nearly twice as fast as the 20.1 per cent increase in total wage and salary employment. This study predicted that high-technology employment growth was likely to continue through 1995. The propor-

tion of service sector jobs generated by high-technology enterprises is expected to exceed that from mature industries.

New technology-based firms, however, can only contribute a proportion of industrial jobs and this proportion is unlikely to exceed twenty per cent. Ireland will continue to depend heavily on traditional sectors such as food, clothing, textiles, chemicals and general engineering. In some situations there may be no alternative to defensive investment in large scale new technology production facilities to meet competition from other industrial countries. This is probably true for segments of the food, drink and chemical sectors where output volume is large and products relatively homogenous.

Many opportunities exist, however, even in traditional sectors to identify market segments and to pursue an innovation strategy which has parallels with the operations of NTBFs. The objective would be to introduce a sophistication factor into a firm or industry by means of product or process technology and to remove industrial output from the arena of low unit cost competition. There are opportunities, for example, in the food sector to move from producing basic commodities to the manufacture of branded food products.

Conclusion

The practice of equating capital-intensive automated production processes with high technology industry is misleading. Even countries at an early stage of industrialisation can purchase and operate automated productive systems to produce commodities and traditional products. This strategy exposes a country to international price competition and places a high premium on labour productivity. The appellation high-technology is more correctly applied to businesses which achieve competitive advantage through product or process innovation. Industrial sophistication is achieved by systematic application of scientific and technical knowledge. Competition comes from high-income industrialised countries and product quality and performance is more important than price.

Ireland's industrial policy places undue emphasis on cost competitiveness. Low wage countries account for less than three per cent of our manufactured imports and are the market for more than twice that proportion of our manufactured exports. On the other hand adverse trade balances with Japan and other industrial countries are increasing rapidly. The trend in trade flows at the end of the seventies suggests that Japan will supply 32 per cent of our manufactured imports by 1990 but will take less than one per cent of our manufactured exports [Mathews, 1980].

The entry barriers to high-technology industry are formidable: technological innovation compounds commercial risk with technological risk. The evidence from Europe and Japan indicates that the state must intervene to make some difficult technological choices and to put in place a long-term innovation policy for industry. Such a policy will only have authority and legitimacy if it is the outcome of close collaboration between government, industry and infrastructural agencies.

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