

ECONOMIC PERSPECTIVE

THE JAPANISATION OF SILICON GLEN: IMPLICATIONS FOR SPIN-OFF AND SUPPLIER LINKAGES

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Introduction

The incidence of management buy-outs, subsidiary spin-offs and the level of local supplier linkages in the Scottish electronics industry has always been both a cause for concern and a source of great disappointment. For too many years now the cry of wasted opportunity has been heard amongst analysts of the Silicon Glen phenomenon as the industry itself has spectacularly failed in its attempt to become Scottish in an ownership sense. The December 1990 issue of this commentary notes that in the electronics industry in Scotland, "...the actual record of MBOs in this sector is disappointing, with only two of any note in the last couple of years."(1) One of these was subsequently sold to a Korean company. The evidence suggests that the nature of the industry itself has prevented the development of a more prominent indigenous representation and that the large American domination has had a negative influence in generating start-ups, developing the immediate local supplier infrastructure or leading to a significant growth in management buy-outs.

The Scottish correspondent of the Financial Times wrote in 1989 that, "Another disappointment has been the failure of the multinationals to breed many offshoots in Scotland through the process - well known in the US - whereby teams of executives spin out to set up on their own."(2) What we have is largely what we consciously set out to develop: an American-derived industry comprising production-oriented subsidiary operations. The Locate in Scotland Bureau and the Scottish Development Agency's electronics division have managed, since the mid-1970s to attract a significant number of American electronics companies into the Scottish economy, and the subsequent effect on employment has been welcomed. Both these agencies would be the first to admit that this American base brings limited benefits other than those associated with direct employment. The foreign-owned sector is predominantly American, and consists of subsidiary operations which have, over time, evolved limited research and development and marketing capabilities. However, the level of this R&D capability is confusing. A survey by Young, Hood and Dunlop in 1988 found that 53 per cent of subsidiaries claimed to undertake some significant R&D work and only 15 per cent undertook no R&D at all.

There is also a question mark over whether the R&D work is linked to product design or is simply modification to suit local conditions. One of the significant issues is that given the R&D propensity apparently present in the foreign electronics sector why have such firms not generated significant spin-offs or localised supplier networks? (3:4)

There has, over the last few years, been a change in emphasis. Again as the December 1990 issue of this commentary notes, "...we may now be seeing some success from the SDA's policy of increasingly targeting the Far East as a source of inward investment."(5) This paper looks at some of the likely implications of sustained inward investment in the Scottish electronics industry from Japan and looks at three areas - the internal organisation of Japanese subsidiaries, the implications for spin-off generation, and the development of supplier linkages within the indigenous population. The paper is inspired by the recent comparative work of Florida and Kennedy into organisational factors in technology intensive-industry which compares the developmental processes undertaken by both American and Japanese firms in high technology industry(6). This drew attention to the subsequent effects of these differing approaches on a number of issues such as, the organisation of production, inter-firm and inter-organisational linkages. Their work suggests that the Japanese model of organisation represents a best-practice system which has the greater likelihood of success in the global economy, and is the one likely to be diffused and imitated by other nations. If this is the case, and the arguments made here suggest that the Japanese model is currently being utilised within Scottish electronics by several American subsidiaries, then does the attraction of Japanese and other Far East electronics firms offer another opportunity which indigenous industry could benefit from?

The paper is divided into four sections. The first analyses the differences in approach between American and Japanese high technology firms. Second, the organisational issues for management and workforce are discussed. Third, there is an analysis of the likely implications for the generation of new start-ups. Finally, there is a commentary on the indigenous industry's capability to deal with opportunities that come its way and circumstances which might assist this process.

1. A comparative analysis of US-Japanese high technology firms

The basis of Florida and Kennedy's argument is that the structural make-up, organisational patterns, product development processes and supplier linkages between American and Japanese firms differ, and that the latter offers a model of best-practice. The differences are in places limited but in specific areas, such as supplier linkages and organisation they vary to such an extent that it is perhaps worthwhile considering that Japanese firms may offer greater opportunities for spin-off generation and enhanced local supplier linkages than have hitherto been present in the American-dominated Scottish electronics industry. Recent evidence suggests that the number of spin-off start-ups from American subsidiaries operating in Scotland have not reached the hoped for levels that "critical mass" proponents of inward investment in the early 1980s optimistically espoused.(7) Indeed the Strathclyde Institute indicated in 1990 that as many as 25,000 jobs could have been created in new start-up and enhanced supplier linkages had these opportunities been taken. There are several reasons for this failure to capitalise on the presence of such a large foreign-owned sector in the Scottish electronics industry. Many of these are related to the indigenous community itself, however, there are also a number of issues related to the structure of American electronics subsidiaries present in the Scottish economy which hindered indigenous growth. These can be linked to what Florida and Kennedy term the US model of high technology development.(8)

The US model

Four factors characterise the American model of development in the electronics industry. These are its Fordist heritage, the functional specialism which separates research and development from manufacturing, the framework which failure to fully exploit and commercially capitalise on innovations creates for new start-up generation, and neglect of manufacturing as a source of innovative potential given the correct organisational climate.

The starting point for the US model is recognition of the traditional manufacturing styles adopted by American business in the early part of this century. This model, which emphasises the development of Fordist manufacturing principles is manifested in the traditional principles of scientific management and the continuous flow assembly line. This system, although highly profitable throughout most of this century, contains weaknesses for a dynamic industry. The specialisation of jobs and rigid job classifications, the level of de-skilling of the workforce, and the establishment of management hierarchies based on functional specialism are not acceptable forms of organisation of work in an industry which requires to be both global in nature and flexible enough to deal with change as an on-going issue. One example of this functional specialism which created

difficulties for the US model is the linkage, or lack of linkage between research and development and production.

By separating R&D into specialised centres of excellence, the US model of electronics development focused attention towards small-scale, high technology entrepreneurship, which was characterised by the proliferation of small firm generation in the US domestic economy. The difficulty with this is that such small firms lack global scale capability. The reasons for the large number of spin offs in Silicon valley and the Boston Route 128 area was the ability of large hi-tech firms to generate but not take full commercial advantage of innovations. Examples include Digital in the Boston Route 128 area which has parented more than thirty spin-off companies including Data General, Wang, Prime and Apollo.(9)

The generation of a large number of new start-ups can be viewed in a highly positive sense. New firm formation strengthens the critical mass arguments for industry development. However, it also creates a large number of relatively small-scale enterprises which are wide open for take-over and lack the scale to become global players. It also weakens the market base of larger organisations. Added to this is the US model's systematic neglect of the manufacturing processes linked to success in high technology industries and the separation of innovation from production sites. Florida and Kennedy cite the semiconductor industry as a case in point in which, "The neglect of manufacturing recreates the separation of innovation from production found in Fordist industry, making it extremely difficult to turn new breakthrough innovations into a continuous stream of high technology products. The end result is that although the US model continues to generate important new breakthroughs, it is particularly inept at technological follow-through."(10)

At firm level, there is a recognition that new start ups have been operated in a different manner from their parent organisations, the large multinational semiconductor and computer multinationals. For a start, R&D was organised into team-based environments with devolved decision making authority and alternative organisational and remuneration deals for innovative staff. This level of organisational innovation to match product innovation has only been achieved on the shop-floor by a few companies, such as, Hewlett Packard, Digital, and latterly Compaq.(11) The impact of such decisions are apparent when one considers the need for flexibility in production terms, improved set-up times, the innovative capacity of the workforce, and the need for speed of response from a committed workforce. These are all factors which are apparent in the Japanese model below.

From a Scottish perspective the impact is one of limited innovative capability within production-dominated subsidiary operations. Over time several Scottish operations of American Multinational Enterprises (MNEs) have displayed limited research and development

capability. However, there is also evidence to suggest that 39 per cent of American subsidiaries maintain their branch-plant status. Nevertheless, a sizeable minority exhibit the trappings of independent status, such as significant R&D operations, marketing functions present at plant level or, product and/or process development for European and/or world markets.(12) For example, NCR and Unisys have world product mandate charters and R&D capability whilst IBM and Digital have product specific R&D responsibility. The emphasis here is on limited nature rather than the acquisition of capability. Not enough significant R&D capability is generated at subsidiary level because the US model propounded here keeps R&D centres separate from manufacturing operations. Hence, there is limited potential for spin-off generation. There is reason to believe that some of the other managerial issues associated with subsidiaries also act to discourage spin-offs.(13)

One example of this is head-hunting. In the United States, high technology labour mobility combines with sizeable venture capital availability and potential R&D spin-off ideas leading to a proliferation of new start-ups. In Scotland, the sources of venture capital remain restricted and difficult to obtain, and potential spin-off ideas are also limited. This leaves a small number of highly qualified managers who could act as the start-up base working the merry-go-round of computer and semiconductor subsidiaries, systematically enhancing their personal wealth and authority but adding little to the overall advancement of the indigenous sector. The newer American entrants have brought with them the penchant for innovative forms of remuneration, equity and ownership shares which allow managers of Scottish subsidiaries to share in the profits. This is intended to act as a means of reducing managerial mobility but it does not assist the process of new firm formation. Similarly, some would argue that the challenges faced in subsidiaries may be equally challenging. Jim Manderson, Corporate Communications Manager of Digital in Ayr is quoted as saying, "The multinationals have a lot of good people but they have found the challenges working within the companies. The work is exciting and rewarding. The entrepreneurs do not feel the need to get out there." On a cynical note, one could perhaps argue that, they lack entrepreneurial flair and spirit.(14:15)

The essence of the US model is characterised by the separation of R&D from manufacturing, high degrees of industrial fragmentation which limit 'hybrid' innovations such as, high definition television, neglect of manufacturing processes which leads to the maintenance of traditional assembly line techniques when market and economic circumstances call out for alternatives, and spot market supplier relationships which work on global supply chains and hinder local linkages. This may be an exaggerated analysis of US manufacturers in the electronics industry and several will cry loudly that their organisation is different, but the evidence does not bear this out. There are a few US MNEs present in the Scottish economy that do not fit this pattern, however,

the vast majority do. This is apparent in the lack of local input purchases and by persistence with manufacturing techniques pioneered by the Ford Motor Company in the 1920s but hardly relevant to current manufacturing and market demands. However, the US model has not been transferred wholesale to Scotland. One of its key elements are the high levels of new firm formation, a feature that has been spectacular by its absence in Scotland.

Other symptoms of the US model are apparent in the Scottish electronics industry. One of these is the nature of supplier linkages. American firms purchased 77 per cent of total inputs to the Scottish electronics industry in 1988, the last year for which Scottish Development Agency figures are available. Of this, 85 per cent of inputs were purchased outside Scotland. The remaining 15 per cent included purchases of gas, electricity, and maintenance. What appears odd is that the USA itself accounts for only 9 per cent of sourced inputs. Japanese firms in Scotland accounted for 3 per cent of total purchases yet Japan itself is the highest source country with 30 per cent of total inputs purchased there. Either the small number of Japanese firms are buying an awful lot of material from home, or, as is the more likely scenario, the American contingent has a global supply network which incorporates Japan and the Far East. This would confirm Florida and Kennedy's contention that American electronics firms do not develop long term supply linkages but instead are involved, "...in the constant breaking and re-forming of supplier relations and (an) increasingly general trend of US firms using foreign (eg. Japanese) component suppliers and outside contract manufacturers located in Asia and the US sunbelt rather than local ones."(16) If this is true of the domestic US electronics industry then it is equally applicable to Scotland. The evidence is also brought out in terms of classification. For most American MNEs present in the Scottish electronics industry, local supply means Europe. To regard purchases of material inputs from a Japanese MNE subsidiary in Italy or a fellow American located in Germany as being local would be, in comparative terms, the equivalent of an American computer manufacturer based in Palo Alto, California sourcing components in the Boston area.

In manufacturing techniques, with a few exceptions, traditional assembly line operations still persist in US electronics firms. This is in stark contrast to the processes operated in Japanese electronics firms which lay emphasis on partnership with the workforce. Yet we live in supposedly enlightened times where firms espouse the need to utilise labour as an asset rather than a cost. One would be tempted here to argue that firms talk a better game than they play. There are exceptions. Digital in Ayr and Compaq at Erskine are two American examples where the traditional assembly line techniques have been replaced by team working conditions which offer greater responsibility to the shopfloor worker, and lead to greater levels of flexibility and response to changing product demand conditions.(17) In this sense these firms are

related closer to the Japanese model of manufacturing techniques, born out of the need to fully utilise a fully tenured workforce and which led to the elimination of elements such as, downtime and waste. In Japan the use of self managing teams allowed firms to devolve managerial responsibility in areas such as, day-to-day operational decisions and supervision, leaving managers free to do other things whilst gaining more from shopfloor workers.

The Japanese model

The model for development of the Japanese electronics industry is markedly different from that of the US and does appear to offer advantages to the Scottish electronics industry. The model, although having a shorter history, does indicate a degree of 'fit' to the global economic circumstances that surround the electronics industry. This is characterised by several features including; alternative patterns of workforce organisation, the development of integrated relationships with suppliers, attention to the innovation/manufacturing link, and a focus on internalising spin-offs rather than externalising them via the labour market.(18)

The distinct features of the Japanese model owe a lot to the post-war development of Japanese industry. One aspect is the early resolution of industrial relations among Japanese firms which led to experiments with alternatives systems to the Fordist/Taylorised process of traditional assembly line techniques. The guarantee of core employee status for the workforce meant tenure of employment. This created a re-think of the role of the shopfloor worker as a fixed cost which could be utilised more as an asset. One aspect of the re-think was to devolve managerial responsibilities to shopfloor workers. It also meant that Japanese management could introduce new technology with little workforce resistance because tenure placed pressure on utilising labour in other ways. In contrast to the US model where innovations were externalised, Japanese managers were under pressure to develop new products to absorb labour thus creating an internal pressure for innovation. As Florida and Kennedy note, "The end result was a powerful new model of production organisation designed to harness the knowledge as well as physical labour output of shopfloor workers....at filling in the pores of the working day by tapping the full and complete capabilities of their workers."(19)

One organisational mechanism that has been used effectively to achieve this greater utilisation has been the development of the self-managing team. These have been used in devolving responsibility, socialising the production process, generating self-induced discipline amongst the workforce, and harnessing the inherent problem-solving capabilities of shopfloor staff. It is not clear, however, whether these improvements were a self-conscious attempt at generating improved shopfloor presence or were simply a result of cultural processes being used to reach traditional Japanese-style consensus

decision making. However, several American MNEs during the mid 1980s recognised these advantages and have moved to exploit them to the same extent as the Japanese. These firms remain the exceptions rather than the rule.(20)

A third feature of the Japanese model is the use of integrated relationships between Japanese electronics manufacturers and their suppliers. This has its most obvious public showing in the development of the 'Just-in-Time' (JIT) buyer/supplier linkage which has been a feature of Japanese industrial organisation that many American and Western European firms have tried to copy with varying degrees of success (or lack of) since the late 1980s.

The use of integrated linkages between buyers and suppliers rests more with the organisational framework which underpins JIT than with the physical embodiment of the process itself. This framework is characterised within the Japanese model by four elements. First, co-location and agglomeration create necessary size to make the relationships effective. Second, tiered production networks link the right manufacturing element to supply group. Third, communication and interaction are achieved via shared management and engineering personnel. This establishes within the relationship collective problem-solving responsibility. Fourth, shared responsibility and integrated relationships foster collaborative research and development. Finally, shared ownership is often apparent in these relationships. These are features of one element of the Japanese model that are difficult to copy in the west due to the amount of time they take to develop, and the amount of trust that is needed to engender them. Arm's length supplier linkages do not foster integrated relationships.

Japanese electronics MNEs use the JIT linkage relationship to establish complexes of smaller suppliers. For example, 70 per cent of NEC and Epson parts are made by outside suppliers shifting the cost basis to those suppliers rather than the MNE.(21) However, the supply relationship is there to be taken advantage of by subcontracting firms in terms of improving their own performance standards. This is something that Scottish suppliers have been criticised for in the past.

Another feature of the Japanese model is the generation of internal, sponsored, spin-off companies, backed by the MNE and developed in-house until sufficient size and capability have been developed. This is also an effective form of reducing management hierarchies, a current management vogue, by outplacing senior executives.

The final feature of the Japanese model is the emphasis placed upon the R&D/manufacturing linkage. In this, the Japanese model copies the US one in the use of team-based R&D development procedures. However, the Japanese model lengthens the time the team operates together and extends to include and incorporate the manufacturing element. This establishes a level of

functional integration with teams developing out of research and development projects and continuing in existence through to the point of shopfloor assembly of the product.

2. Organisational issues for management and workforce in the Scottish electronics industry

In an earlier paper for this commentary it was pointed out that the Japanese model was well known to American counterparts in the electronics industry.(22) One element of having this knowledge available was the need to find degrees of fit between what was appropriate for Japanese firms in their own environment and what could prove applicable to a Western European setting such as, Scotland. The emphasis placed on issues such as, the exploitation of human resources requires to be tailored (sic) to the environment, "American recognition that to compete effectively on global markets against competitors such as, Japan, does not mean adopting Japanese management techniques per se. What firms such as, Digital et al do regard as important is the recognition that human resource development can address technological and strategic problems."(23)

The comparison of the US and Japanese models also brings to light the need for change amongst the operating subsidiaries of American MNEs present in Scotland as well as the opportunities that may arise from the presence of the Japanese MNE contingent. The analysis here is divided into two areas - management issues associated with internal and external organisation, and workforce issues associated with work design and degrees of manufacturing responsibility. Florida and Kennedy argue in their article that the Japanese model is best suited to the electronics industry and that, "Over time, this is likely to imply a gradual shift in the centre of gravity of economic and technological power toward Japan and increasing imitation and diffusion of the Japanese model by other firms and nations."(24) If this is the case, then the Scottish electronics industry needs to be aware of the likely implications of such a shift. To the extent that inward investment is targeted more towards the Far East, there is overt recognition already. However, there is also a need to look at the likely impact on organisational issues within firms based in the Silicon Glen area.

In terms of internal, managerial issues, the ability to devolve power to the shopfloor becomes crucial. To ensure manufacturing effectiveness over time, and to eradicate the inherent immobility created by high levels of continuous flow assembly via fully automated lines, the organisation of work in the electronics industry will be divided into self-managing teams where the workforce achieve responsibility for determining and meeting production schedules. This leaves the manager in such an environment with spare time on his hands. To take advantage of this managers will become more involved in planning issues such as, external vendor management. One implication of this is that the days of the functional

specialist in management are numbered. This will also be confirmed by the adoption of the team approach from R&D through to manufacture.

There are also management implications in terms of the external environment for supplier firms. If, as appears likely, the Japanese model is the one that is accepted as the industry norm, then the generation of more integrated supplier linkages will mean more permanent buyer/supplier relationships. The difficulty with this is that the Scottish electronics industry is not geared up for such linkages. It never was, and may never be, able to cope with such relationships. The single market may not assist this process. Physical proximity is only an advantage where suppliers can compete effectively with other firms, or where bulk items such as, metal fabrication are concerned. Individual American MNEs present in the Scottish economy have made serious attempts at developing high quality supplier networks but the overall picture is still a gloomy one. The major electronics companies spend around £3 billion on bought in components and subcontract work. At most, Scottish firms receive 15 per cent of this business. There is still a lot of work to be done in supplier development.

Further opportunities will present themselves via Japanese electronics firms. Examples are already apparent with the arrival in the UK of other Japanese MNEs. For example, Toyota's engine plant on Deeside will by 1995 have local supply content running at 80 per cent, half of which will be supplied by UK firms who have made it onto the 400 strong short-list of suppliers along with firms from Germany, France, Spain and Italy.(25) This, by far, exceeds the 30 per cent local content cited by many American electronics firms which includes all of Europe as local (even though the overall figures do not bear this out). Clearly, opportunities exist for the development of long-term supply linkages with Japanese MNEs in the electronics industry. It may be time that these opportunities were actively exploited.

The internal workforce issues have been hinted at above. The environment for manufacturing workers will improve remarkably with the adoption of alternatives to the assembly line techniques characteristic of Taylorised firms. For example, the emphasis on training in teamwork and cooperation is essential to the consensus management style of Japanese business. Work groups are one of the fundamental units of any large Japanese company and job responsibilities and duties are shared between all members of the group, and cooperation is a must if it is to run smoothly. Therefore, we can expect to see more adoption of changing forms of work organisation in American manufacturing plants based in Scotland as they struggle to compete effectively against the greater flexibility of Japanese rivals.

3. Implications for the generation of start-ups

Perhaps the most difficult area to analyse in relation to the comparative model of US/Japanese organisation

within the electronics industry is the impact on the number of start-ups and their progression. Neither the US model, which in its domestic economy spawns a plethora of start-ups but in Scotland apparently hinders them, or, the Japanese model of internally-generated and nurtured new firms, offers any comfort for the development of indigenous enterprise.

New firm formation is a sign of a healthy and dynamic economy. However, Scotland is characterised by low company start up rates, few business failures, and limited business success. Scotland has few, if any, high flying indigenous start-ups of the likes of Compaq in the United States. These types of firms are a necessity in economic development of the economy. The problem is again one related to the entrepreneurial climate for start-ups and their founders. Recent evidence suggests that there are five ways to improve the start-up situation in Scotland:

1. Establish technology 'incubators' to build up ideas emanating from universities and colleges which need support and advice;
2. Government support for venture capitalists;
3. Inward investment projects with integrated R&D content;
4. Attraction of expatriate scots currently employed in the electronics industry in America;
5. Improved commercial links between universities and industry.(26)

These suggestions work largely on the assumption that technology-generated start-ups have successfully emanated from the university sector. However, if there is one thing which has characterised Scottish electronics over the last twenty years, it has been the wholesale failure of university-generated new technology firms to make any impact on the domestic or international electronics scene. One would not deny that the level of electronics research undertaken at Scottish universities is of a very high standard, what is missing is the development element.

The successful indigenous firms in electronics have come from outwith Scottish academia and what is required here is the generation of new start-up ideas from the existing foreign-owned base, or that of the newly arrived foreign-owned base of Japanese MNEs. There appears to be a logical argument here. What prevented subsidiary spin-offs in the past was the branch plant status of these operations and an inherent lack of entrepreneurialism. However, this is being eradicated and if the research evidence is true, more American MNE subsidiaries have a higher level of R&D and marketing capability which is the basis for new firm formation. However, this has not been accomplished as yet, and is perhaps in need of a

push. Within Scottish Enterprise the emphasis is wrong. Rather than drawing attention to the significant base of activity in Scottish academia, there should be encouragement of spin-offs from those foreign subsidiaries which currently boast significant capabilities in R&D and marketing.

Depending on the level and speed of development of the Japanese and Far East presence, there may be similar experiences to those of US firms currently present in the Scottish electronics industry. There will be a confidence phase that firms will go through in terms of supplier contracts and developing indigenous management. However, if the Japanese model is to be believed there may be an opportunity to develop sponsored spin-offs which do not necessarily have to be Japanese in origin. Whereas American electronics subsidiaries have actively discouraged management start-ups (either overtly by making internal management projects too attractive to leave the subsidiary, or, covertly by discouraging parent/start-up linkages), there are opportunities that the Japanese model may offer. Granted these potential start-ups will be parent financed and will retain sizeable parent ownership, but they offer the potential of maintaining a permanent relationship with the Japanese subsidiary. This is something that has not happened with American subsidiaries in Scotland and therefore perhaps the Japanisation of Scottish electronics is no bad thing.

4 Strengthening our weaknesses to take advantage of opportunities

One element which could assist this process of new firm formation would be some form of strategy at a macro level. None currently exists that one could openly point to as being either effective or well publicised. There is a need here for a combination of associated organizations to come together and actively foster new firm generation. From the perspective of government, more needs to be done in relation to the encouragement of managers from subsidiaries to take start-up ideas forward. This may even mean a shift in emphasis. As Jim Manderson of Digital notes, "The advantages offered to incoming companies are more than would be offered to people setting up their own businesses. I do not think there is enough inducement." Similarly, MacPherson notes, "If Silicon glen is to have a lasting benefit, it's essential to devote as much resource to indigenous industry as is spent on attracting overseas companies."(27) Some possible steps along the way may assist the development of electronics industry in Scotland.

Step one involves equalising the inducements for start-ups at home compared to investment from abroad. If there are limited opportunities for new firm formation from either American or Japanese subsidiaries in Scotland these need to be encouraged both in financial and practical terms. One method of doing so would be for Scottish Enterprise to actively fund company development and new venture establishments. Yet the

slashing of budgets within Scottish Enterprise has already led to severe reductions in the amount of monies allocated to such programmes.

Step two is linked to trying to get the foreign sector to play ball and encourage new firm formation from within their own ranks. The job of the inward investment agency should not end on the public announcement of a new arrival. Both government agencies and subsidiary operations themselves need to actively encourage the departure of managers from these subsidiaries to form start-ups. It is about time that the plant managers of subsidiary operations began actively encouraging their managers to leave the nest and set up in business for themselves. The age-old complaint that there are no indigenous suppliers of merit is a double-edged sword because potential new suppliers are not given any incentive to become entrepreneurial. Similarly, work needs to be done on encouraging managers with ideas within subsidiaries to take the 'leap' into firm formation. Although a number of American electronics subsidiaries are experiencing the recession currently, the timing may be right. Potential market downturn may be viewed in this sense as more of an opportunity than a threat, if seen in the correct light as providing the impetus for managers within recession-hit subsidiaries to move onto new pastures in the form of business start-ups. This is where a strong link between Scottish Enterprise's Industry Division and the American original equipment manufacturers' (OEMs) subsidiaries based in Scotland could foster firm formation. Yet this division has had to undergo budget cutbacks in 1991/2 of around 45 per cent between probable and actual budget spends. This means that some elements of economic development have had to be severely restricted or in some instances have had to go. The most serious of these in relation to firm development are areas such as, developing new ventures and liaison with OEMs.

Steps three and four involve some form of investment. By establishing some form of 'incubation centre' as mentioned earlier some of the classical start-up errors could be avoided - step three. This could be done in accordance with current thinking which emphasises the training element of economic development, and was one of the reasons for the formation of Scottish Enterprise. Would it not be a sign of the sincerity of such an organisation to found a centre with the sole prerogative of generating new indigenous start-ups from the current foreign-owned base? There are precedents for this which indicate that this route can be successfully exploited. The Institute of Polymer Processing Technology is an example where Scottish Enterprise funds development. An Institute of Supplier Development or New Firm Formation might be just the sort of venturing that meets both foreign-owned firms' supply needs and establishes new start-ups in the Scottish electronics industry. The supplier development programme within Scottish Enterprise has been one of the few which has maintained most of its budget spend.

Although the funding of an incubator centre may be minute by comparison to the budget of 'Locate in Scotland' or the Scottish Business Centre in London, the availability of adequate levels of venture capital is another matter. Perhaps LIS should be targeted with the objective of attracting higher levels of venture capital investment from abroad, from Europe, the United States, or Japan. If, as appears to be the case we cannot or, will not, provide adequate levels of finance on our own, then maybe others are willing to take the risk.

Conclusion

This paper has looked at the US versus Japanese model of development of the electronics industry and has isolated the closer linkage between research and development and production, integrated long-term supply relationships, and more effective forms of work organisation within manufacturing as factors which make the Japanese model more likely to be effective in the long term. This threatens the presence of American firms who do not follow the model, or persist in some of the techniques characterising the previous success of the US model.

It has also looked at the implications of these models for the Scottish electronics industry in terms of managerial issues, supplier linkages, work organisation practices and the generation of indigenous start-up firms emanating from the foreign sector. It concludes that there is a greater likelihood of success in terms of firm formation and stronger linkages via the Japanese model than have been apparent from experience with the American presence in electronics in Scotland. However, a number of steps could be undertaken to actively assist this process.

Something has to be done. There are a number of threats and opportunities currently facing the Scottish electronics industry. The single market may shift emphasis away from peripheral to core regions, the opening up of Eastern Europe will certainly challenge the low cost status of Scotland as an electronics manufacturing centre. We constantly bemoan the indigenous sector's inability to take advantage of the opportunities offered by the growth of the foreign-owned sector. The situation calls out for some form of action. There are opportunities presented by the presence of Japanese subsidiaries and the inclination towards the Japanese model pointed out earlier. Whether these are realistic opportunities that will present themselves in the form of quasi-indigenous start-ups is as yet unknown. However, it may be worthwhile taking action ourselves to actively encourage start-ups from within the current foreign base where these present themselves. They have first to be identified, they have then to be committed to (by all interested parties), and then acted on. The loss of 25,000 jobs whether a realistic figure or only partly correct is a missed opportunity. These opportunities do not present themselves as often as we would like. Therefore, it is worthwhile considering the prospects for the future and

taking some action to try and encourage the growth of indigenous start-ups from the foreign firm base in electronics.

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