SKILL FORMATION IN SMALL, LEADING EDGE ENTERPRISES

Report to the Dusseldorp Skills Forum

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Executive summary

The subject of this report is the skill formation practices, policies and needs of small to medium-sized firms that are significant exporters and users of knowledge workers. Its purpose is to explore ways in which public policy can be directed to lifting the skills-related constraints faced by these enterprises.

The main findings of the study, based on twelve case studies, are that many small, high-tech exporters may have reached a plateau. There is little evidence that the enterprises studied have made a successful transition from an ad hoc, craft mode of product development to an organisational structure that is capable of further expansion and consolidation.

One aspect of the failure to implement new systems is the general absence of sophisticated human resource policies. This is despite the widespread importance that these enterprises gave to the role of R & D and highly qualified knowledge workers.

The case studies show the key aspects of skill formation and several deficiencies in the skill formation practices of some leading edge, high-tech exporters. These include a close link between R & D and the need to employ high level skills. However, there is often a separation between high level skills required for the R & D work and the more standardised skills needed in the manufacturing process.

There is also an increasing importance given to linkages between the high-tech exporters and new, collective research and training arrangements such as Cooperative Research Centres. There are signs that learning networks are emerging from these linkages.

The major skills formation strategy employed by small firms heavily reliant on knowledge workers is finding and retaining people with the right technical and social skills. On-the-job learning and in-house skills development are the most significant modes of skills acquisition once recruitment takes place.

The shortcomings identified by the case studies include the lack of attention paid to longer-term human resource strategies beyond a concern with recruiting people with the 'right skills'. The lack of a systematic approach to on-the-job training is the most visible expression of the ad hoc, informal nature of the operational style of many of the enterprises studied.

A major conclusion of the study is that Cooperative Research Centres, the new Cooperative Multimedia Centres and industry associations such as the Technology Industries Exporters Group offer considerable potential to act as independent brokers to foster better skill formation practices.

A major focus of a skills formation broker should be on lifting the quality of on-the-job learning. One means of doing this is to arrange structured work placements for tertiary and post secondary students as part of their course. This would provide the opportunity for employers to nominate mentors or workplace trainers to receive training in how to improve existing training practices. Closer links to educational providers may also bring benefits to the enterprise in the form of more appropriate training based on a better understanding of the needs of the workplace.

There is also some evidence that intermediate or technician level skills may be under represented in the firms under study. Establishing closer links between workplaces and students undertaking full-time courses at the Associate Diploma level through structured work placements may help to lift the status and acceptance of intermediate skills.

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1. INTRODUCTION

A recent Yellow Pages Small Business Survey of Small Business Growth Aspirations and the Role of Exports found that while only 8 per cent of small business is experiencing high growth rates (averaging 10 per cent in the last year), these firms accounted for 27 per cent of the gross employment growth of established small businesses. These high growth businesses are also significant exporters.

The McKinsey study of ‘Emerging Exporters’ for the Australian Manufacturing Council in 1993 first highlighted the contribution made by some 700 small and medium sized enterprises to the marked improvement since 1986/87 in Australia's export of ‘elaborately transformed manufactures’. A further study by the LEK Partnership in 1995 entitled ‘Intelligent Exports and the Silent Revolution in Services’ highlighted a 14 per cent growth in service exports between 1963 and 1993.

These studies have suggested a considerable potential exists for improving Australia's trade performance and standard of living if the constraints on these companies' capacity to export are eased. This study is a contribution to the debate on what are the appropriate ways for public policy to assist small and medium sized enterprises to lift their export performance.

The McKinsey Report gave particular emphasis to the constraint imposed by the lack of suitable employee and management skills. A particular problem the report identified was the need for the successful exporters to make the transition from being a small, privately run outfit to become ‘ a medium-sized, professionally managed unit, incorporating all the systems and operational capabilities of modern enterprises’ (Mc Kinsey & Co 1993:52).

There is evidence that skill shortages are likely to limit the growth of leading edge manufacturing exporters. A 1991 ABS survey of manufacturing firms using advanced technology reported that 30 per cent of establishments were having difficulty getting staff with the required skill for the normal operation, maintenance or programming associated with the technology (ABS 1991:27).

2. THE PROJECT BRIEF

The following study of skill formation in small, leading edge enterprises was commissioned by the Dusseldorp Skills Forum. The project brief was to use case study methodology to investigate and report on the skill formation methods used in two types of firms:

- small to medium sized, leading edge manufacturing firms that have captured significant export markets and

- small to medium size firms that need to employ significant numbers of knowledge workers. Examples include software design and manufacture, personal computer network support, desk top publishing, database management, media production, and graphic design and printing.

It was recommended that the McKinsey study of Emerging Exporters and Peter Robert's columns in the Australian Financial Review be used as sources to identify ‘the types of firms at or striving to reach national and international best practice...'. The consultant was also asked to identify ways in which the skill formation processes used by the enterprises studied might be helped through public policy or other initiatives.

The specific issues to be reported on are to include the following:

- what are the mix of qualifications and qualification levels within the enterprise?
- To what extent to which the external labour market is relied upon rather than internal skill formation strategies?
- If external labour markets are used to obtain necessary skills, the extent to which formal qualifications, in-firm development and training in other enterprises and varied employment experience have combined in developing the skills of the individuals recruited to key production positions.
- Some comment on the extent to which the resulting skill levels and mixes appear to have resulted from chance rather than planned career development could also be made.
- If internal training and development strategies are used by the enterprise, the nature of these strategies, and the balance within them between in-firm formal training, informal on-the-job learning, job and task rotation, and external courses. Comment could also be made on the extent to which strategies are planned rather than driven by need and circumstance.
- Where external training providers are used, the types of provider used and the factors leading to the choice of particular providers.
- The demand for 'multi-skilling' and the extent to which existing national competency standards are relevant to the particular skill mixes demanded by the firm.
- The extent to which key competencies are essential to the firms' quality and competition strategies.
- The extent to which access to the most recent international developments forms part of the firms' skill formation and competitive strategies, and the ways in which this access is obtained.
- The relationship between research and development, product design and in-plant innovation, and in particular the role of non-degree qualified workers in innovation, product development and design.
- The relationship between theoretical knowledge and practical skills required in both degree-qualified and non degree-qualified workers.
- The extent to which youth (those under the age of 25) are employed, developed and trained by the enterprise, the reasons why if they are not, and the extent to which they are seen as a competitive advantage or disadvantage.

3. CASE STUDY SELECTION

The following sources were consulted to identify suitable enterprises to approach: McKinsey study of Emerging Exporters, Austrade, Victorian Department of Business and Employment, Federal Department of Industry, Science and Technology; Metal Trades Industry Association and Roberts Reports, from the Australian Financial Review, 1989-1994.

After a preliminary identification of thirty-five companies, it was decided to focus in on enterprises in Melbourne as this was the location of two-thirds of the companies identified. Further names of enterprises in Melbourne were added as information became available from the above sources.

In total, some thirty companies were sent letters and nine accepted the invitation to participate in the study. These nine companies who responded are:

- Farley Cutting Systems Australia Pty Ltd;
- Lochard Environmental Systems Pty Ltd;
- GBC Scientific Equipment Pty Ltd;
- Beam Software Pty Ltd;
- IEI Australia Pty Ltd;
- Moldflow Pty Ltd;
- Merino Gold Pty Ltd;
- ANA Software;
- Stuart Pettigrew Design Pty Ltd

Two of the case studies are only partially complete as the questionnaire was not returned for ANA Software and the information for Stuart Pettigrew Design was only based on a questionnaire response. In addition, another three case studies of emerging exporters have been included from an earlier study. These case studies were carried out by Mariana Brkich under the supervision of the author in August-September 1993 and covered a similar range of questions. For reasons to do with an undertaking given at the time, their identities have been kept confidential.

4. METHODOLOGY

Enterprises were sent a questionnaire in advance. The questionnaire sought background information on the enterprise: major products; vision or mission statement; numbers employed; job categories; age profile; assessment of overall company performance; annual turnover in sales and proportion of sales exported. Information was also sought on future expectations about sales over the next five years compared with sales growth over the past five years; number of years in existence at the time of first significant export; main source of competitive advantage in exporting; and what are the constraints faced by the firm in achieving export growth over the next five years.

Specific questions about training arrangements included: existence of a personnel policy and if so, what is special or different about it; relationship of the personnel policy to a company plan; importance of the skill of an employee in determining pay; other factors used to determine pay; skill formation strategies used; existence of a training plan; proportion of payroll spent on training and trend over the last three years. Information was also sought on skill shortages experienced, use of external trainers and why choose a particular one; use of national and key competency standards; the extent to which youth are employed, developed and trained; and participation in industry-wide training initiatives. The three case studies conducted in 1993 also included questions on how companies adjust the labour input in response to a change in demand.

The main form of data collection consisted of an interview for between one and a half and two hours with a senior management person. Titles of the persons interviewed were: one Chairman, five Managing Directors, two Corporate Affairs Managers, one International Marketing Manager and one Personnel Manager.

5. CASE STUDIES PROFILE

Tables 1 presents a profile of the enterprises chosen for study. Their key features are outlined below:

- all the enterprises were founded in the last 25 years, with half only existing since 1980

- all enterprises studied have passed beyond the start-up phase with its heavy reliance on the founding entrepreneur to a stage where usually they are seeking to consolidate their early rapid growth

- the size of the firms varies from four to 176 employees with most between fifty and 120 employees

- the industries in which the enterprises are located vary from metal and plastics manufacturing, textiles to graphic design and publishing

- the range of products vary from computer and graphic design services to machine tools, scientific instruments and early warning fire detection equipment, software programs, ultrafine wool garments and multimedia games

- the focus of most exporters is on serving a small number of customers in niche markets. Only the multimedia and related products are produced for a mass market

- all except the smallest firm are involved in exporting with the proportion of sales varying from sixty to 98 per cent for all but one exporter all the enterprises which are exporters fit the McKinsey study definition of exporters that are born global. This refers to the fact that the firms have started exporting very early in their life and they export most of their sales. Most of the firms that are exporting did so within the first five years of start up.

TABLE 1: PROFILE OF CASE STUDIES

Company and Year Started	Size	Industry	Products	% Exported	Born Global
Farley 1983	65	Machine tool design and manufacture	· CNC Profile Cotler · CNC Controllers · Applications software	70	Yes
Lochard 1990	54	Software development & equipment manufacture	· Airport noise and flight track monitoring equipment	95	Yes
GBC 1978	176	Design and manufacture of scientific instruments	· Spectrometers	90	Yes
Beam 1980	60	Multimedia software development	· Interactive multimedia games	95	Yes
IEI 1970	120	Fire Protection apparatus: design and manufacture	· VESDA very early smoke detection apparatus	76	Yes
Moldflow 1978	120	Software for the Plastics Industry	· Software for plastics manufacture	98	Yes
Merino Gold 1989	15	Texiles and clothing	· Soft woollen knitwear. · woollen suiting fabric	?	Yes
ANA 1989	11	Computer software	□ reverse engineering □ client saver systems.	?	Yes
Stuart Pettigrew Design	4	Graphic Design	□ publication design □ visual identity design □ packaging design	None	No
Induction Heating Systems 1973	94	Metal manufacturing	· induction heating system · resistance welding machines	70	Yes
Travel Guide Publisher 1984	76	Book Publishing	Travel Guides	85	Yes
Thermal Paper Products Manu-facturer 1978	52	Printing Industry	Thermal coated paper products	60	Yes

TABLE 2: WORKFORCE PROFILE

Company and Year Started	% Trades	% Para Prof Technician	% Professional/ Manage (with Professionals in brackets)	% R & D (prop of sales)	% Labour Turnover
Farley 1983	29	14	.... 39 (26)	10-12	15
Lochard 1990	-	7	87 (74)	28-30	7
GBC 1978	19	8	23 (16)	15	Low historically but recently increased for sofftware engineers
Beam 1980	-	-	97 (75)	40	10
IEI 1970	3	3	13 (7)	5	low 1%
Moldflow 1978	3*	5*	72 (67) *	20	20
Merino Gold 1989	53	-	20 (0)	Assistance from CSIRO	-
ANA 1989	-	-	100 (80)	Substantial	Medium
Stuart Pettigrew Design	-		100 (75)	-	Low
Induction Heating Systems 1973	high prop. in manu-facturing have trade background.	2/3 of Technical, Engineering & Service Staff are technicians.	1/3 of Technical staff h ave degrees.	R & D effort considered critical.	Very low
Travel Guide Publisher 1984	-	48	52 (33)	-	?
Thermal Paper Products Manu-facturer 1978	17	10	8 (4)	Company places heavy emphasis on R & D of new products.	Very low

* Refers to headquarters facility only.

Table 2 presents information on the workforce profile of and significance of R&D to the companies studied. The key points are:

- in terms of the skills profile of the enterprises studied, trades-qualified and technician-level workers are only significant in a small number of cases

- more important are knowledge workers with tertiary qualifications. The proportion of managerial & professional workers varies from 8 per cent to 100 per cent. Within this group, professionals represent from 4 to 75 per cent of the workforce. Typically, engineers are the major group of professionals

- the high proportion of tertiary qualified workers in most of the firms reflects the strong emphasis given to research and development. The proportion of sales spent on R & D for the six firms for which information is available varies from 5 to 40 per cent.

- linkages between firms and research bodies have improved recently for several enterprises through the establishment of Cooperative Research Centres and closer ties to other research facilities

A closer look at the major activities and technologies of the firms studied suggests a grouping of enterprises into either high-tech or medium level technology. The high-tech enterprises are so defined because of their focus on sophisticated and complex value-added products. In seven cases, the high value-added activity is software development (Farley Cutting Systems, Lochard Environmental systems, GBC Scientific Equipment, Beam Software, IEI, ANA Software and Moldflow). All these enterprises use leading-edge technology to place them at the forefront of their competitors in world markets. In six cases, these firms are serving niche markets with only a small number of significant competitors. Only Beam Software with its focus on interactive multi media products is aiming at a mass market. All these high-tech firms are significant exporters except one (ANA Software).

Medium-level technology is the basis of production in three cases: Merino Gold, Travel Guide Publisher and Thermal Paper Products. The products of these firms can compete well on overseas markets but there are significant competitors. The characteristics of high-tech companies compared with more traditional enterprises are shown in the table below.

TABLE 3: **FEATURES DISTINGUISHING HIGH TECHNOLOGY FROM TRADITIONAL FIRMS**

Dimensions	*High Technology*	*Traditional*
Product	Cutting edge of technology	Well established
Industry	Electronics/computers/chemical	Mfg./services/misc.
Rate of innovation	High	Low
R & D expenditures	High	Low
R & D employees	High proportion	Low percentage
R & D employee attrition	High	______
Firm size	Smaller	Larger
Mortality rate	Higher	Lower
Rate of growth	Higher	Lower
Profits	Higher but variable	Lower but stable
Geographic concentration	High	Low
Organisational life cycle	Start-up/growth	Mature/decline
Product life cycle	Three years	Eight years

Source: Gomez - Mejia and Welbourne 1990: 256

The case studies in the following analysis have therefore been grouped according to their level of technology and export performance.

- Seven enterprises can be identified as high-tech, significant exporters with an extensive reliance on tertiary qualified, knowledge workers. These are: Farley Cutting Systems, Lochard Environmental Systems, IEI Australia, GBC Scientific Equipment, Moldflow, Beam Software and Induction Heating Systems.

- Another group of three enterprises use medium level technology and knowledge workers to achieve significant export performance. These enterprises are: Thermal Paper Products, Travel Guide Publisher and Merino Gold.

- A third group of two case studies illustrate the use of knowledge workers predominantly within the domestic market (ANA Software, Stuart Pettigrew Design).

Much of the following analysis concentrates on six high-tech exporters: Farley Cutting Systems, Lochard Environmental Systems, IEI, GBC Scientific Equipment, Moldflow and BEAM Software. This is because they meet the project brief's specification of being both small to medium sized, leading-edge manufacturing firms that have captured significant export markets and employers of significant numbers of knowledge workers. These enterprises also have a range of characteristics in common. They, therefore, offer valuable insights into the problems and constraints faced by small, innovative companies experiencing rapid growth.

6. FINDINGS

Tables 4 and 5 summarise some of the major points about the skill formation processes and strategies pursued by the enterprises studied.

- **Importance of capacity to innovate:** serving niche markets requires meeting the current and potential needs of customers by maintaining a high level capacity to innovate

- **Importance of R & D:** a significant feature of high-tech exporters is the role played by R & D to maintain a high capacity to innovate (see Table 2)

- **Importance of skills:** the strong emphasis on R & D has direct effect on skill formation requirements at the professional level (see Table 4).

The strong emphasis on leading-edge expertise means that the up-to-date skills life cycle of a well-qualified knowledge worker is short. For software engineers, for example, this might be three to five years only. Three of the high-tech exporters referred to the need to replace R & D workers with outdated skills. The need to recruit high cost expertise extensively in the initial growth phase of a high-tech start up creates an early dependence on the external labour market for this expertise.

The high-tech exporters identify as important constraints to achieving export growth over the next five years the lack of employee and management skills after the problems of increasing competition, lack of finance, high service demands and product regulations. This finding is similar to the results of a survey of 310 small and medium-sized exporters conducted in August 1992 by McKinsey and Company where lack of management skills was also identified as a significant constraint to exporting (McKinsey & Co 1993: 52).

- Formal qualifications and training in other enterprises are seen as the most important backgrounds of employees recruited to key production positions. This background is often supplemented by in-house formal training (see Table 4). This suggests a strong reliance on the external labour market for skills in demand

- Labour turnover varies from the very low (1 per cent) to a high of 20 per cent. It is considered a problem for five of the enterprises studied (see Table 2).

- Skill shortages are also a problem for at least five high-tech exporters (see Table 5)

Table 4: relative importance of different skill formation arrangements

Company	**Importance of skill in deciding pay for each occupation** (5 = very important) • Plant operators • clerks, sales • trade persons • para professionals • professional/management	**Background of key prod employees** (5 = very important) • formal quals • in-firm devel • training in other enterprises • varied employ experience	**Types of training** (5 = very important) • formal in-house • informal on-the-job learning • job and task rotation • external	**• Use of industry competencies** **• key competences** (5 = very important)
Farley Cutting Systems	□ 2 □ 3 □ 5 □ 4 □ 5	4 2 **5** 3	3 5 2 2	4 5
Lochard Environment Systems	□ - □ 5 □ - □ 5 □ 5	4 4 **4** 3	4 4 3 3	2 -
GBC Scientific Equipment	□ 5 □ 4 □ 5 □ 4 □ 4	+ 5 - - 5	5 4 2 1	1 1
Beam Software	□ - □ 4 □ - □ - □ 5	4 3 **4** 3	2 5 1 1	1 1
IEI (Australia)	□ 4 □ 4 □ - □ 3 □ 4	3 4 2 3	4 3 4 3	4 4
Moldflow	□ - □ - □ - □ 5 □ 5	4 2 3 3	4 2 3 3	1 5
Merino Gold	□ 5 □ 5 □ 5 □ - □ 5	3 5 4 3	2 5 4 4	1 5
Stuart Pettigrew Design	□ - □ - □ - □ 4 □ 4	□ 3 □ 4 □ 4 □ 5	□ 2 □ 5 □ 4 □ 2	2 -

+ Software Engineers Only

- there is some evidence of an over-reliance on tertiary qualified workers at the expense of more appropriate and lower-cost, technician-level workers. This appeared to be the situation particularly in the case of engineers

- the work of trades-qualified and technician-level workers in some cases is separate from and not integrated with the work of the higher-level knowledge workers in R & D activities

- TAFE is used to provide training for five of the case studies. Commercial providers are also used by seven of the enterprises. No enterprise has a close working relationship with any external trainer including TAFE.

- Evidence of collective training arrangements beyond the enterprise is emerging through the new human resources group within the Technology Industries Exporters Group (TIEG), the student work placement activities of the Fire Protection Industry Association and the focus on 'mentoring arrangements' for training purposes as a function of the proposed Cooperative Multimedia Centres.

- significance of industry and key competencies: national competency standards are only seen as relevant to the particular skill mixes of two enterprises. On the other hand, key competencies are identified as important for the quality and competitive strategies of four of the eight enterprises asked this question (Table 4)

- services associated with installing and maintaining a product are often seen by customers in niche markets as just as important as the product itself. Workers with technical skills are increasingly required to exercise social skills in responding to the needs of customers. These latter skills in particular are seen as requiring in-house development.

- skill formation strategies: the age and qualifications structure of the workforce in each company makes it clear that these enterprises are atypical of manufacturing industry in general. As there are relatively few trades-qualified workers and a high proportion of tertiary qualified workers, there are few opportunities for entry level workers in the form of secondary school leavers as apprentices or trainees. The most common entry level age group is 20 to 24 years (see Table 1).

TABLE 5: SKILL FORMATION ARRANGEMENTS

	Personnel Policy in place and whether related to company plan	Training plan? /proportion spent on Training	**Skill shortages**	Students in work placement	Youth Focus *
Farley Cutting Systems	No/No	No/ 3%	• NC Machinists • Machine tool fitters • service technicians	Yes	4 5 5
Lochard Environment Systems	Yes/Yes	Yes/ approx 10%	No	Yes	4 4 4
GBC Scientific Equipment	No/No Developed but not yet implemented	No/ 2%	• software engineers • fabrication trades	Yes	2 2 2
Beam Software	No/No	No/ 5%	• Windows programmers • graphic artists	Yes	5 5 5
IEI (Australia)	No/No	No/ □ 1%	No	Yes	2 3 3
Moldflow	No/No	No/ 3%	• Polymer Scientist • Stress analysts	Yes	4 4 3
Merino Gold	Yes/Yes	Yes/ ?	• Linkers • Knitwear machinists • dyeing skills • mgmt skills	No	2 3 3
ANA Software	No		?	No	
Stuart Pettigrew Design	No/No	No/ ?	No	No	- - -
Induction Heating System	Yes/Yes	Yes/ ?	n/a		
Travel Guide Publisher	No/No	No/ ?	n/a		
Thermal Paper Products	Yes/No	No/	n/a		

* • youth employed by the enterprise
• youth developed by the enterprise
• youth trained by the enterprise

- the most important means of imparting skills within the enterprise are seen as on-the-job learning and in-house formal training. Less important are job/task rotation and external courses (see Table 4). Nonetheless, the on-the-job training is not systematic. There is no evidence of employees acting as mentors and receiving formal training to enable them to find the most effective way of imparting on-the-job learning.

- Although in all cases, skill is regarded as important in deciding how employees are paid, there is often a lack of an explicit human resource strategy or systems such as training plans, succession planning and the introduction of team work (see Table 5). The proportion of payroll spent on training is not high for most high tech exporters. The notable exception is Lochard Environment Systems with 10 per cent of payroll expenditure on training (see Table 5).

- However, attention is often given to recruitment procedures, induction training and performance reviews. The latter initiatives indicate the existence of a skill supply strategy but usually without the backing from a more extensive set of policies

- formal or informal work placements for tertiary students have been used by six firms as part of their skill supply strategy (see Table 5).

- **Youth Focus?** Many enterprises are favourably disposed to employing, developing and training young workers although this is in all cases not an explicit policy (see Table 5). As noted above, this preference usually takes the form of work placements for tertiary students on a formal or informal basis. In some cases it involves the employment of apprentices.

7. ANALYSIS

The following section examines in greater detail four aspects of the nature of the enterprises studied. The first aspect describes the growth stages of new high-tech start-ups and assesses to what extent firms have made a successful transition through the various phases identified. The second aspect of the case studies given greater attention is an examination of their production mode and the consequences for the type of skills required. The third facet of the case studies probed in greater depth is the significance of the emergence of learning networks based on collaborative arrangements between enterprises, industry associations and publicly funded agencies. The final dimension explored is the nature of the skill formation strategies employed by the case studies, with particular attention given to the high-tech exporters

7.1 Stages of growth

The background information on each enterprise offers the opportunity to distinguish the different stages of development reached. An English study has identified six stages in the growth of small and medium-sized, high-tech companies (Dodgson and Rothwell 1989). Different stages of a firm's evolution can help to illustrate how different sets of management and operational skills are required. The stages or phases do not represent a strict chronological path; they may run concurrently. Nevertheless, each stage is seen as marking a critical threshold in the development of a company. The transitional stages identified by the study are:

- Start up

- Technological and scientific consolidation.

- Internationalisation of markets.

- Professionalisation of management.
- Vertical integration.
- Product and business diversification (Dodgson and Rothwell 1989: 150).

Stage one: Start-up

A common pattern discernible from the case studies is for an individual or small group of people to take up the challenge of developing and making a product based on new technology. This start-up stage also requires entrepreneurial skills to attract capital investment to underwrite the initial period of product development until a position in the market is established. In four cases (Farley Cutting Systems, IEI, GBC Scientific Equipment and Moldflow), an engineer (or engineers in GBC's case) invented, developed or saw the potential of a particular process (plasma cutting system, smoke detection apparatus, atomic absorption spectrophotometer and computer-aided engineering) and took on the role of entrepreneur to turn the new process into a commercial product.

The other companies (Beam Software, ANA Software, Travel Guide Publisher) started with a concept or service and turned it into a product that could be marketed widely (interactive computer games, software to update mainframe computer systems, and travel guides). In two cases, not classified as high-tech, (Induction Heating Systems and Thermal Paper Products), the technology was already established and technology transfer and/or internal development have been used to expand the product range.

Stage Two: Technological/Scientific Consolidation

Having established a company, a crucial early but continuing phase for the founder(s) is to consolidate its technological/scientific capability as the base on which all other activity depends. To develop leading-edge technology, the new enterprise has to bring together people with the requisite expertise and to work together to master levels of knowledge often nonexistent elsewhere (Dodgson and Rothwell 1989).

Working, marketable prototypes need to be developed from untested concepts or prototypes produced under laboratory conditions with little regard to cost. This requires considerable scientific and technological expertise that soon outstretches the resources of the company's founder or founders and the small group of knowledge workers he has been able to gather. An early priority for the start-up high-tech company is to ensure that the requisite skills are available in-house or can be obtained and assimilated from external sources (Dodgson and Rothwell 1989:150).

The initial impetus for the high-tech company comes from R & D and this focus continues to have a strong influence on what sorts of personnel recruited to the fledgling organisation. A characteristic of most of the high-tech start up case studies is their rapid employee growth (Farley, Lochard, GBC, Beam, IEI and Moldflow). This creates a heavy reliance on the external labour market to find the skills that are needed because there is insufficient time available to cultivate internally the expertise required.
Lochard Environmental Systems has experienced the most rapid growth from start-up in 1990. Between

June 1992, employee numbers increased from ten to fifty-four in early 1995. Farley Cutting Systems has grown from three to sixty-five people over a twelve-year period. GBC Scientific Equipment has grown from only nine people in 1983 to 165 in 1995. Beam has grown from thirty-five employees in 1989 to seventy in 1993 but in early 1995 had settled at sixty employees. Travel Guide Publisher had grown from forty staff in 1989 to sixty staff in 1993. Periods of rapid staff growth do not necessarily take place immediately after start up. They may be a consequence of the development of a new technology/product line or expansion into overseas markets (eg. Beam Software).

For most high-tech firms, however, the immediate need to recruit appropriate expertise is the first major human resource issue faced. Other data on high-tech firms in the United States suggest that recruitment of the best available talent in the early stages of a company's life cycle is critical (Kochan and Chalykoff 1987). Small start-up, high-tech firms need to recruit aggressively on the external labour market for technical expertise. The ability to get a new product to market quickly becomes a critical survival issue. The costs of employing the appropriate expertise are given a low priority. Because timing is crucial, new firms recruit externally rather than develop the needed expertise internally by investing in training to upgrade the skills of existing employees (Kochan & Chalykoff 1987:192). This strategy, however, has consequences for enterprises at a later stage of their development.

Stage Three: Export success

Most of the firms studied were selected from a population of small to medium-sized firms that are significant exporters. Nevertheless, it is important to note that these firms are not only exporting at least two-thirds of their product (commonly it is over 90 percent) but that typically this was their orientation from their beginning. The limited nature of the Australian market means that high-tech companies from the beginning need to export overseas. These companies have been characterised by the McKinsey Report on Emerging Exporters as ‘born global.’

The demands of marketing overseas have involved greatly increased costs for the new companies. Overseas marketing often requires establishing offices staffed by company employees (Farley, Lochard, GBC, IEI, Moldflow, Induction Heating Systems, and Travel Guide Publisher). The ability to recruit suitable marketing managers can be a major constraint on company growth (Dodgson and Rothwell 1989:151).

Stage Four: the professionalisation of management

A major transition for a small to medium sized, start-up company is the implementation of middle level systems to ensure stability. This is most often expressed as a change in management from the owner/founder to control by a professional manager as chief executive. In other instances, it takes the form of setting up new management systems under the continuing control of the founder(s).

The founders of high-tech start-ups obviously possess significant scientific and technical skills often combined with entrepreneurial ambition and flair. However, these attributes do not necessarily make them always the best equipped to handle the formal aspects of management. These aspects include creating appropriate financial control and reporting systems, personnel management and creating effective organisational structures by more delegation of responsibility (Dodgson and Rothwell 1989:151). This transition from founder to professional CEO was evident in the cases of Beam Software, IEI, Moldflow and Merino Gold. In other cases, new systems were being implemented under the direction of the company founder or founders (Farley Cutting Systems, GBC Scientific Equipment, Lochard Environmental Systems).

Moldflow's case is a good example of this phase. The new Chief Executive with professional qualifications in management was appointed some nine years after the company was founded. More recently the founder has sold out to a private investment syndicate that includes the CEO and two other senior executives. With these changes has gone the formation of seven strategic business units that operate independently with their own clearly defined objectives and strategies.

From a skill formation strategy perspective, it is this transition that is crucial to developing a medium-term perspective on how to meet future skill needs. The failure to shift focus from the early post start-up concerns of building up a pool of internal resources despite costs can result in significant cost overheads. Frequently, a continuing heavy reliance by the now established enterprise on the external labour market is no longer appropriate or beneficial. Difficulty in making this transition to internal systems of skills formation was facing many high-tech exporters: eg. Farley, Lochard, GBC, Beam and Moldflow. In all cases, the transition to a more systematic, planned approach to human resources development has been nonexistent or, at best, only partial.

Stage Five: Vertical Integration

This stage can take the form of either taking on a manufacturing function or incorporating other company's proprietary products to form systems. In the former case, high-tech start ups such as Farley, Lochard, GBC and IEI have extended their product design and development work to include the manufacturing function. In the latter case, Moldflow and Beam Software in particular have both incorporated other proprietary products or processes to offer more comprehensive systems.

Stage Six: Product and Business diversification

All the firms studied had or were seeking to diversify their product range. For Beam, this involved going beyond producing interactive multi media games to the development of ‘infotainment’ products for Japanese schools. Farley has developed six products with further customisation of each product to the particular needs of a customer. GBC Scientific Equipment has extended its product range through the in-house development of spectrophotometers and the acquisition of another company that produced emission spectrometers. IEI has extended its product range to include programmable, micro processor - based early warning smoke detectors. Similarly, Lochard is developing a more advanced monitoring system as well as offering extensive customisation to meet the requirements of each user. Moldflow has diversified its operations to include material testing, research for customers, the development of technology to set-up, monitor and control injection moulding machines and consulting work. Thermal Paper Products is moving to sell its patented technology as a ‘product range.’

7.2 Production mode and skill requirements

The major focus of higher value-added activity for the six high-tech case studies is software development. The manufacturing activity of four of the six high-tech case studies is additional to the main source of competitive advantage which is the design and development of software systems. In fact, the term 'systems' appears in the names of two of the companies (Farley Cutting Systems and Lochard Environmental Systems).

The product development strategy pursued of these high-tech exporters is one typified as 'craft -oriented.' Their operations can be categorised as 'craft-oriented job shops.' This involves operating within a small, loosely structured environment with highly skilled employees to tailor products to customer specification or to make a best-seller design. The characteristics of craft- oriented job shops compared with factory-oriented and product/application approaches to software development have been identified by Cusumano in his study of Japan's Software Factories (1991). These characteristics are shown in Attachment 1. The craft-oriented approach has the following key features:

- a focus on customising products or processes for individual products and attaining high premiums for this service.
- emphasis is on process flexibility for customer requirements
- project-based R & D
- dependence on highly skilled workers
- minimal reliance on process standardisation
- computer-aided tools are individual or project oriented
- emphasis on customised products and customer service.
- customer requirements together with product and process flexibility are given precedence over process efficiency.
- little strategic management or integration beyond projects
- few economies of scale or scope
- best suited to medium-sized, innovative custom projects.

In contrast, the factory development approach relies on more standardised worker skills and incremental product improvement. This approach makes extensive use of quality control processes and high level strategic integration and management to run large scale, complex but routine projects. The product or application-oriented projects approach, on the other hand, aims to mass produce and sell low-price commodity products. This approach uses highly skilled designers to focus on developing innovative products for a broad market. There is little emphasis on process efficiency or incremental improvement (Cusumano 1991:30).

The craft-oriented approach is often strongly reinforced by the attitudes highly skilled knowledge workers who are so essential to this type of product development. Programmers, software engineers, computer scientists and their managers usually prefer minimal controls to promote the free exchange of information and individual creativity. Some organisational theorists have attributed this workforce resistance to the imposition of a standardised set of work methods to the sheer complexity and still-evolving nature of the technology used in the software development industry (Cusumano 1991:33).

This analysis suggests that where the environment and technology are both dynamic and complex, the most appropriate response is ad hoc, project-based, organisational structures and constant mutual adjustments. The result is job-shop or craft modes of operation rather than conventional factories based on standardisation. The latter, it is claimed, appear better suited to more stable industries and simpler tasks.

A job-shop or craft process, characterised by the ability to adjust easily to change or customer variations, would then appear more appropriate for a complex, unstandardised technology such as software, especially since producers make unique products or customise for individual users (Cusumano 1991:36).

The different types of organisational response to different technologies are shown in the table below.

Table 4 : Organisational Structure and Technology

Structure	**Technology**	**Tasks & Problems**	**Characteristics**
Machine bureaucracy	**Routine, mass production**	**Few exceptions, well defined**	**Standardised and de-skilled work, centralisation, internal divisions of labour, high formalisation of rules and procedures**
Professional bureaucracy	**Engineering**	**Many exceptions, well defined**	**Standardised and specialised skills, decentralisation, low formalisation**
Adhocracy	**Non routine**	**Many exceptions, ill -defined**	**Specialised skills but few or no organisation standards, decentralisation low formalisation**
Simple structure	**Unit or craft**	**Few exceptions, ill-defined**	**Few standardised specialised skills, centralised authority but low formalisation**

Source: Cusumano 1991:40

Machine bureaucracies are based on standardised tasks, utilise low level skills and are organised into functional departments answering to a centralised authority. High levels of mechanisation or automation and formal divisions of labour are also characteristics. Machine bureaucracies operate in stable environments and focus on relatively simple tasks. This classification applies particularly to factories using mass production techniques.

Professional bureaucracies, on the other hand, use standardised but specialised skills, procedures and tools to control the work process in contrast to a conventional administrative structure. The environment in which professional bureaucracies operate is a stable one but the tasks are complex. Examples are engineering consultancies, universities and hospitals.

Adhocracy refers to a team or teams of specialists relying on temporary or project-based structures and procedures. The environment they operate in is a dynamic one and the characteristics of the tasks they perform are complex.

In contrast, a *simple structure* is characterised by little or no formal procedures or processes, and decision making is done by one person or a small group. The environment is dynamic but the tasks performed are comparatively simple. Examples are high-tech firms in their start up phase or small software producers as in the multi media industry focusing on one or two aspects of the production process. As these simple organisations, projects or production groupings grow in size, more elaborate structures and controls become essential to operate efficiently. It is necessary, however, to find a balance between informality and formality to avoid negative results (Cusumano 1991:36-41).

The high-tech case studies (Farley Cutting Systems, Lochard Environmental Systems, IEI, GBC Scientific Equipment, Moldflow and BEAM Software) have started with and, to a great extent, continue to operate with craft technologies and ad hoc organisational structures. Although each enterprise has gone on to develop its own products, there is a strong emphasis on customising each product to meet the particular needs of an individual customer. Farley Cutting Systems does not build any two machine tools alike. Lochard Environmental Systems customises their monitoring and data analysis software to the requirements of each installation.

GBC Scientific Equipment produces, besides their complex instrumentation, a range of accessories and software to form ‘integrated systems of unparalleled accuracy’ to meet the specific requirements of each customer. Similarly, IEI's very early warning smoke detection apparatuses now also include a programmable micro processor and system management software to provide greater product flexibility. Moldflow is continually upgrading its software and increasing the range of services it offers its customers. Beam Software is making qualitative changes to its product range to develop new interactive multi media games incorporating movie sequences. Induction Heating Systems manufacture one-off and built-to-order systems that require a significant amount of research and development to ensure that they meet the customer's needs.

This emphasis on unique designs and adaptability to customer requirements and functionality results in a need to hire workers with high level expertise to design, develop and modify as required the products being marketed. Even with the manufacturing process associated with many of the high tech exporters, there is a demand for skills that can operate in a craft-like fashion. This might entail the skill, for example, to program a CNC mill to cope with small batch production as the case of Farley Cutting Systems showed.

The ad hoc and uncertain nature of this specialised work means that organisational structures do not need to be large, nor are sophisticated systems needed. Nevertheless, as products become more standardised, and there is an attempt to reduce costs and expand production, the size of the organisation grows. With a greater focus on a more standard product development process, the need for many workers with high level skills is reduced. This new stage brings with it the need for organisational systems that can control and pace work in a more predictable and methodical way.

Most of the high-tech case studies are in the process of making a transition from ad hoc or project based organisational structures that have been driven strongly by the concerns and needs of the experts recruited early in the life of the company. The next stage involves balancing customer needs and functionality with production costs and quality. It involves adopting management systems that increase stability and reliability. These systems are particularly important in relation to the human resource issues of recruitment, skills upgrading and replacement of employees with specialised skills. Cusumano shows how Japanese software factories have been able to make a successful transition from craft to factory modes of software production. This has been done by achieving ‘a delicate but effective balance of process efficiency and flexibility in the production of unique and customised software products’ (Cusumano 1991:19). How to control the escalating costs of using a large number of knowledge workers is a major issue facing the high-tech exporters. Continuing dependence on a craft mode of operation constrains the capacity of firms using advanced technology to expand and to be able to compete beyond niche markets.

The enterprises with medium-level technology (Thermal Paper Products, Travel Guide Publisher, Merino Gold) follow more closely the machine bureaucracy model. The greater attention given to the production of large-scale quantities, using more standardised processes is the distinguishing feature of these enterprises. This approach to production generates the need for skills which are more standardised to manage large, complex but more routine projects. The emphasis is to achieve incremental improvement and less on maintaining a wide capacity to problem solve in an uncertain environment. There is an effort to balance process/organisational efficiency with process flexibility and individual creativity (Cusumano 1991:30).

7.3 Emergence of learning networks

Ready access to a pool of technical expertise is said to be a key feature of the relative success of small, high-tech start-ups in California's Silicon Valley compared with the closed internal labour markets of the large computer firms on Boston's Route 128 (Saxenian 1994:37). The localised accumulation of technical knowledge enhanced the viability of Silicon Valley start-ups and helped to reinforce a shared technical culture. Close working relationships were developed between public education providers such as community colleges and universities to supply needed skills and research capacity (Useem 1986, Saxenian 1994:66). The result for firms in Silicon Valley has been ‘shifting patterns of competition and collaboration’ to enable specialised producers ‘to learn collectively and to adjust to one another's needs’ (Saxenian 1994:161).

The case studies showed evidence of the early emergence of similar networks. This has taken the form of a

Cooperative Research Centre in Intelligent Manufacturing Systems and Technologies for two high-tech firms (Farley Cutting Systems and Moldflow). There are also other joint projects with the CSIRO and bilateral projects with universities, often involving the exchange of academic staff (Farley Cutting Systems, GBC Scientific Equipment, IEI Australia and Beam Software). Six Cooperative Multimedia Centres are to be established by the Federal Government by June 1995 to provide a similar research and development capacity for that industry.

In other cases, the evidence of the importance of learning networks includes the formation of strategic alliances with larger enterprises or overseas research bodies. Lochard Environmental Systems has close links with Siemens Nixdorf (Germany) and Thomson-CSF (France) as well as working closely with the Dutch National Aeronautical Laboratory. Lochard management expressed the view that joint ventures and consortia are essential to the survival of small firms like Lochard in the future. This is due to the large size of the market which means that the extent of the intelligence required is beyond the resources of small enterprises.

This growing recognition of the value of collaborative ties is in contrast to the situation some three to four years previously. The McKinsey survey of Emerging Exporters in 1992 showed that only one in ten emerging exporters had research connections to an outside research institution such as the CSIRO or a university (McKinsey & Co 1993:54).

7.4 Skill Formation in the high-tech case studies

How the six high-tech case study firms find and retain the skills they need can best be described as simple, immediate and non-strategic. The skill formation process followed is a continuation of the approach used in the early start up period. The prime concern has been to recruit the necessary skills, often without regard to cost or the distorting effect this may have on existing pay levels within the firm. The external labour market (ELM) has been the most important source of skills. In addition, skills are enhanced on-the-job through in-house, formal training or more informal learning. However, this training is not planned or made available in a systematic fashion. It is usually ad hoc and justified by whether it meets an immediate operational need.

The short life cycle of skills for knowledge workers referred to in three of the case studies (Farley, IEI and GBC) may reflect a failure to provide opportunities for professional and technical staff to take extended periods of leave (a sabbatical) or shorter periods for further training.

Recruitment strategies

Formal qualifications are used as the starting point for selecting a new employee from the ELM. The two options are to engage a new graduate straight from a tertiary institution or to select someone with the required qualifications, training and work experience. In both instances, there is often considerable attention paid to selecting the 'right' person to ensure that, besides their technical ability and experience, they have the appropriate social attributes to 'become part of the team.'

The mechanism for hiring new graduates is often through a period of vacation employment while still a tertiary student. This practice has been followed by Farley, Beam Software, Moldflow, GBC, and Lochard.

This strategy gives an opportunity for both parties to assess each other, without obligation.
There are also more formal work placement arrangements that have been utilised by some firms. Farley Cutting Systems have had students under the National Teaching Company Scheme. These have been generally used on engineering projects although a student was recently engaged on a project to investigate marketing issues. BEAM software used the Research in Industry Program to underwrite the cost of a Masters student working with the company while writing a thesis. IEI has been approached by its industry association to provide structured work placements for students from the Diploma course in Fire Technology at Swinburne.

An immediate benefit of this trial period of work is to maximise the initial fit between the skills and expectations of the individual and the needs and working arrangements of the enterprise. However, this skill supply strategy of focusing on best fit at entry point is often not accompanied by formal policies and practices on training, job rotation and mentoring. These are also necessary to ensure that the skills of the new recruit are upgraded and expectations of career advancement are being met.

New graduates can be an unreliable source of human resources if their expectations about salary advancement, work variety and career prospects are not met. Small enterprises of their nature may be unable to offer the salary increases or other career opportunities which large enterprises can. The response of one small software developer was to seek information regularly from their employees in the form of a personal development plan. This was then used to work out the best response to the individual's expressed needs. Even so, it was not expected that an employee will stay for more than three years.

Engineers in place of technicians

Evidence from some case studies (Farley, Lochard, Moldflow) suggests that the low cost of graduates, both in relative terms to other skilled labour within Australia and on an international comparative basis, could create an incentive for employers to substitute more highly qualified workers for less qualified workers. The starting salary of a software engineer at $A30,000 is considerably below the starting salary of $US40,000, common in the United States in the early 1990's (Gomez-Mejia & Welbourne 1990). Beyond the high starting salaries for new graduates in the US, generous benefits are also provided such as relocation allowances, front-end paid vacations, settling in allowances at time of hire, post graduate education tuition reimbursement and parallel promotion ladders leading to challenging and high status projects.

Australia is now regarded as a low-cost centre for high-quality R & D (Roberts 1994: 751). One key factor in the low cost structure is the relatively low wages for specialists such as engineers. It has been estimated by one multinational operating an R & D facility in Australia that product engineering and development costs in Australia are about two-thirds of the cost of developing similar systems in the US (Roberts 1994:751).

Given these lower costs, employers may be consciously or unconsciously employing engineering graduates in place of technicians. The advantages of a greater use of professional staff may be a higher level of flexibility in responding to problems and versatility in how they are deployed. The onus, however, is on the employer to ensure that the more highly qualified workers are utilised to full advantage. Problems may result, however, if they are to substitute for technicians' work because they only cost a small premium extra. The difficulty with this strategy is that tertiary graduates may soon become frustrated with their job. If graduate engineers with high expectations, for example, are given work that is limited in scope and with little opportunity for training, they are likely to become dissatisfied with their work roles. This, in turn, is likely to lead a move to another employer offering better work prospects and skills enhancement opportunities.

Over reliance on tertiary-qualified, technical expertise may also build in high salary cost structures. This would result from employees with higher level skills commanding higher salaries over time, resulting from internal progression or external salary pressures due to high levels of mobility. In one case study (IEI Australia), cost pressures had caused the company to reduce the size of its R & D function from twenty to eight employees and to rely more on technician level skills for testing and validating equipment.

There is evidence of a substantial surplus of professional engineers in Australia in most disciplines since the mid 1980's (Halton 1992:18). It has been estimated that there are 2,500 professional engineer migrants arriving each year against an estimated demand of between 140 and 570 per year (Birrell, Healy and Smith 1992, cited in Halton 1992:18).

Evidence of the ready availability of overseas-born engineers is confirmed by three of the case studies. Most of the software engineers at Farley Cutting Systems, Lochard Environmental Systems and Moldflow were born overseas but were recruited domestically. A wide range of countries is represented although there was a concentration of Chinese-born engineers in two companies. Only one company (GBC Scientific Equipment) reported difficulties in recruiting engineers but this was addressed by lifting salary levels.

Recruitment of well-qualified, experienced employees on the open market may also have longer term detrimental results for the employer. Meeting the market price can be costly and is likely to distort the basis for paying existing employees. Reliance on the ELM to recruit the right mix of skills needed may result in considerable delays in finding the right person. Extensive use of the ELM also means that the enterprise is subject to poaching offers and is required to make a counter offer if the employee's skills are undervalued. This again is likely to distort the remuneration system.

The ‘hyper mobility of high-tech labour’ has been criticised by Florida and Kenny (1990) in their analysis of small ‘break through’ companies in the USA. The high turnover of high level expertise is seen as disrupting R & D projects, making it difficult for enterprises to develop institutional memory based on the cumulative expertise and knowledge of the workforce working together over an extended time. The high turnover of skilled staff also makes it difficult for high- tech enterprises to engage in long-term planning (Florida and Kenny 1990:92-95).

In addition, firms are likely to be reluctant to invest in further opportunities for skills upgrading if there is a likelihood that employees may leave. A rational, short-term response of management to under-invest in training may be condemning that enterprise to a stunted growth, particularly in the face of competition from Japanese enterprises that operate on a long-term calculus of the benefits of investing in training.

The high turnover of skilled workers can impede an enterprise's ability to innovate and stay ahead of its rivals. The absence of internal mechanisms for retaining, enhancing and renewing skills could create an invisible barrier beyond which new high-tech enterprises are unable to expand. Reliance on new graduates and high cost specialists with their high levels of turnover may produce 'niche companies.' This refers to small firms that are unable to grow into larger enterprises with stable, integrated high-technology capabilities. It is argued, based on the Japanese enterprise model, that only larger enterprises are able to sustain long-term R & D efforts or to follow through on innovations (Florida and Kenny 1990-97).

8. RESPONSE

The skill formation requirements of the high-tech case studies are shaped by their focus on R & D. It is the strong emphasis on R & D at the start-up stage that causes the new company to recruit high level expertise. The importance of R & D to the high-tech exporter is shown by the development of close linkages to research bodies.

Establishing closer links between research/education institutions and the workplace

Given the close connection between R & D and the need for leading-edge skills, these linkages suggest valuable avenues for providing assistance to firms to upgrade their expertise. Many universities of technology (Swinburne, RMIT, UTS) already have cooperative education programs in several disciplines that provide for work placements for students as part of their course. Several enterprises (Beam Software, IEI, GBC, and Lochard) expressed an interest in providing structured work placements for students during their courses, provided the arrangements were beneficial to both parties.

The Cooperative Education in Engineering program at the Swinburne University of Technology provides a model for how such a program works. A recent DEET assessment showed that Swinburne was the top university for graduate job prospects and this was attributed by an official university newsletter to Swinburne's 'industrial training' or cooperative education program (Swinburne University of Technology 1994:4). The industry placement program in engineering covers two periods of six months. The two periods are in the first semester of the third year and the second semester of the fourth year with a return to university course work for the final semester. The length of the completed degree is 4.5 years.

The two work placements are regarded as part of the course structure. The student has an academic supervisor as well as a designated mentor in the workplace. The academic supervisor is expected to make one or two visits to the student's workplace and to maintain more frequent contact with the student by phone. At the conclusion of the work placement, the student writes a report that is assessed by both the workplace mentor and the academic supervisor, with a pass or fails mark awarded.

Another feature of the Swinburne Program are the options of either entering the work placement as a paid employee subject to the same employment conditions as other full time employees or for the student to retain his/her student status by being funded through a scholarship. The former option can involve payment as an employee at the rate of 60 per cent of the graduate engineer's rate for students who have completed their second year and 80 per cent of the graduate engineer rate for students who are in the fourth year. However the guide to employers notes that ...'placement and experience are the primary objectives, with pay and conditions being negotiable factors between employers and students' (Swinburne University of Technology 1994a:5).

An alternative to paid employment is a scholarship. Employers wishing to exercise this option are asked to commit to an annual donation to a scholarship fund for four years and to provide forty-eight weeks of an ‘industry-based learning placement’ for scholarship holders. The total contribution expected is $32,000 per scholarship.

Students receive a fortnightly stipend of $300 for the duration of their course commencing in the second year. The advantage to the employer of this arrangement is not having to make WorkCover, Superannuation or pay roll tax payments. Swinburne has appropriate accident insurance to cover the student in the case of accidental injury while on a work placement. Nevertheless, scholarship students on placement are to be considered, for administrative purposes, as employees of the company and subject to all conditions applying to employees of that company. Where students are required to undertake work beyond their normal hours of work, they may be paid accordingly. Then, the sponsoring organisation is liable for the additional payments although the university's insurance policies will continue to apply.

The benefits to the employer of the work placements are seen to be, in the short term, an additional resource to carry out a useful engineering activity such as laboratory work, design, measurements, quality assurance or testing. In the second placement, students are regarded as more ‘results oriented’ and can be given problem-solving tasks and assigned individual projects.

The longer-term benefits to the employer are seen to be the opportunity to evaluate a potential graduate's suitability to the organisation. It is said to be not uncommon for employers to make a conditional job offer to fourth year students before their graduation in the following year. Some projects commenced while on work placements may become the basis for a student's final year project. This can lead to a closer association with university staff and further benefits to the company. Many employers are also said to gain benefits from continuing contact with lecturing staff and Swinburne's high-technology facilities in equipment and research (there are, for example, four research centres within the School of Biophysical Sciences and Electrical Engineering) (Swinburne University of Technology 1994 b:4).

The cooperative education or industry-based learning placement model offers a range of benefits similar to the close association Japanese enterprises have with particular high schools and universities. Three sets of benefits have been identified by Rosenbaum (Rosenbaum 1994). These are, first, fostering value for academic skills by employers so that they are prepared to make some effort to obtain graduates with these skills. Second, students are likely to exert more effort because their academic performance is highly relevant to their future careers. And third, teaching staff accrue additional authority based on their close association with employers and ability to offer dependable evaluations of students (Rosenbaum 1994: 3-8).

The application of this model of cooperative education on a broader scale in Australia is likely to meet the needs of most parties concerned with the education to work transition process. The model appears to function well in a number of universities of technology settings. There is, however, no reason it could not be extended to include other disciplines with a strong vocational orientation both within the universities of technologies, the older universities and to technician-level training in TAFE.

Limitations of the cooperative education model

A UK evaluation of the value of industrial placements based on students' views showed that they were a 'highly useful learning opportunity' for most students (Pickles 1993). However, the evaluation showed that the quality of the work experience varies considerably (Pickles 1993:210). The evaluation results showed that work placements for some students offered an opportunity to get technical skills and/or new knowledge. In other instances, personal skills were improved and a general exposure to a business environment was judged beneficial.

The least successful aspects of the placements were identified as: insufficient work, not enough challenge or involvement in a specific project and not enough involvement with management. These results suggest that there is a need to provide employers offering places with assistance to ensure that the placement is beneficial to both parties. Staff of educational institutions may not be in the best position to offer this assistance due to other commitments and possible lack of experience in workplace training practices.

9. RECOMMENDATIONS

The case studies have identified the key aspects of skill formation and several deficiencies in the skill formation practices of some leading-edge, high-tech exporters. The key aspects include:

- a close link between R & D and the need to employ high-level skills
- a separation between high level skills required for the R & D work and the more standardised skills needed in the manufacturing process
- increasing importance of linkages between the high-tech exporters and new collective research and training arrangements
- use of several recruitment strategies to find people with the right technical and social skills
- a strong focus on on-the-job learning

The shortcomings include:

- little attention paid to longer term human resource strategies beyond a concern with recruiting people with the 'right skills'
- use of informal, and typically unsatisfactory, methods of work placement for tertiary students such as vacation employment
- lack of a systematic approach to on-the-job training

These strengths and weaknesses of skill formation arrangements of leading-edge exporters suggest several options for addressing their needs. The human resource issue of most interest to the enterprises studied is how to find the right person. This means someone to not only to fill a specific technical gap but also someone who can fit in well with the social aspects of the work environment such as project-based work. This issue can be addressed through setting up opportunities for prospective employees to show their abilities and capacity to adapt to the firm's particular work environment.

The well-established model for doing this is the cooperative education or industrial placement program of some universities of technology. The coverage of such programs is limited to certain disciplines at tertiary education level. The involvement of employers in such formal placements may also be limited as only one case study workplace had been approached to participate.

It is proposed that more linkages be established between the providers of skills and the end users. The agencies best placed to foster these linkages are industry associations because they are likely to have a high credibility with individual employers. The case studies showed that there were three associations or groups operating at a sectoral level which were coordinating mutually beneficial arrangements for their members. The Technology Industries Exporters Group (TIEG) (based in Sydney) has established a human resources support group for small to medium-sized companies. The support group aims to provide assistance with training and development, recruitment as well as advice on how to lift staff performance, motivation and productivity individually and as group.

Other intermediary bodies likely to have similar levels of acceptance among employers are the cooperative research and multimedia centres established as independent bodies with strong input from the private sector. Independent brokers attached to these bodies could also work with companies to set up suitable arrangements. The Australian Interactive Multimedia Association has proposed the development of ‘mentoring’ programs involving joint education and training activities between education providers and industry as one of the activities of the proposed Co-operative Multimedia Centres might undertake.

These examples of industry association interest or involvement suggest that these bodies are likely to be happy to provide assistance to their members in this area. The form of assistance, however, needs to go beyond merely arranging places. Maintaining contact with employers and the student/employers during their placements is also needed. This continuing contact can also be an opportunity to help firms make the most of on-the-job learning opportunities for not only those on a work placement but for all employees.

For work placements to be successful for both student and the employer, due attention has to be paid to the workplace mentoring arrangements. This involves ensuring that at least some key individuals in the workplace have access to information and opportunity for training as a workplace trainer. This might only need to take the form of a short workshop on how to:

- offer systematic on-the-job opportunities;
- evaluate progress; and
- assess whether competencies and knowledge have been acquired.

The case studies showed that in-house training, both formal and informal, is regarded as more important than job task rotation and external courses. On-the-job learning is regarded as important or very important (rated 4 or 5 on a 5-point scale) in four of the high-tech case studies. There is, however, no evidence that these firms have the internal resources to provide good quality learning opportunities. Only one firm that regarded on-the-job learning as their most important form of training had a training plan. Another enterprise with 176 employees had only one employee in the production area with train-the-trainer training.

On-the-job training or learning needs to be treated as a discrete activity to ensure that it is approached in a methodical way. Recognising who is responsible for delivering on-the-job training is often a first step in treating this form of training with the attention it deserves. The essence of the role on the workplace trainer or mentor is *modelling* a skill, *coaching* in different ways the person who is learning what they should do, and *giving feedback* on how they are performing (Henry, Jones, Arthur and Pettigrew 1991:73).

On-the-job training needs to be recognised also as an activity that is closely tied to achieving an enterprise's business objectives. If it is not given due attention, it is possible that poor practices may be simply reinforced by cynical, inadequate or simply unaware trainers in the workplace (Sloman 1989: 41). The same practices that are a feature of systematic off-the-job training need to apply also to on-the-job training. These include identifying what training is needed, planning training provision, doing training and evaluating it.

On-the-job training also needs to be integrated with other forms of training. The key to a more systematic approach is training the role of on-the-job trainers. The forms of training involved for workplace trainers could be small group discussions, supported by newsletters and bulletins to enhance the recognition of the role of in-house trainers. Outside assistance might be available through a resource person located in an industry association. This person could charge out their services to cover activities such as helping structure work placements and providing training for supervisors and team leaders in how to make the most of on-the-job learning.

The case studies also highlighted the greater role technician level workers might play in high tech workplaces. The opportunity to do this could be provided through work placements for students undertaking the Associate Diploma level courses in TAFE. Many of these students are already full time employees but a significant proportion is not. In Victoria in 1993, for example, of the 41,454 students undertaking courses at the associate diploma level, just over a third (35.4 per cent) were full time students. The proportion was 52 per cent for science and 38 per cent for engineering/surveying students. These figures suggest that there is considerable potential for lifting the status of and expanding the opportunities for the employment of more technical workers by arranging structured work placements for full time students during their course.

10. CONCLUSION

The above findings and analysis suggest that many small to medium-sized exporters may have hit a barrier to their growth. These firms are heavily reliant on knowledge workers but the absence of due attention to the issues of internal skills development is likely to stunt many small exporters. The lack of human resource systems is stopping many of these enterprises from making the transition to larger enterprises. Unless this transition is achieved, they will not be able to consolidate their position by continuing to innovate and expand their operations on a world-wide scale. What is required is an investment of resources beyond the immediate performance requirements of the organisation (Henry, Jones, Arthur and Pettigrew 1991:72).

Recent efforts to develop collective research and training arrangements, however, suggest one way this problem can be addressed. Cooperative Research Centres and industry associations such as the Technology Industries Exporters Group offer considerable potential to act as independent brokers to foster better skill formation practices. A major focus of this activity should be on lifting the quality of on-the-job learning as this is the most prominent feature of how skills are developed by the enterprises studied.

The absence of structured training and other formal human resource practices in small, high tech enterprises may reflect not merely a preoccupation with operational issues but also a less formal way of going about their business. This latter aspect needs to be taken into account by developing skill formation practices that accord more closely with an enterprise's more general mode of operation. The ad hoc and often invisible processes used to impart skills which are embodied in the concept of on-the-job learning need to be recognised and made explicit (Henry, Jones, Arthur and Pettigrew 1991).

Formal training common in large enterprises and educational institutions may be built on a conventional view of learning where

- the learner is a passive vessel into which knowledge is poured.
- Learning occurs through a strengthening of bonds between stimuli and correct responses.
- Skills and knowledge are best acquired independently of their contexts of use to ensure transfer to new situations.
- The individual's ability to learn is seen as largely innate.

In small, high-tech enterprises, there appears to be more scope for workplace training to be based on learning as a process. This approach is based on the following propositions:

- Learners learn best by doing -- by actively working on substantial problems in meaningful contexts.
- Learning is a quintessential social activity.
- The context of learning is a key determinant of what is learned and how well that learning transfers to new situations.
- Human beings are by nature sense-making creatures with a remarkable ability to learn. (Florida and Jenkins 1993: 12)

This study has highlighted the need to give greater attention to how on-the-job learning is conducted in small enterprises making extensive use of knowledge workers. One way to do this is to arrange structured work placements for post-secondary and tertiary students as part of their course. Many of the enterprises studied are prepared to recruit qualified, young people if there is an extended mutual trial period available. A fundamental concern of these firms is how to find and hold employees with both the right technical and social skills.

A structured work placement provides the opportunity for employers to nominate mentors or workplace trainers to receive training in how to improve existing training practices. Simple techniques using group discussions led by a facilitator could help to bring greater reliability into existing practices to ensure that they achieve specified outcomes. Closer links to educational providers may also bring other benefits to the enterprise reliant on knowledge workers. This is likely to be in the form of more appropriate vocational education and training based on a better understanding of the needs of the workplace.

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Attachment 1 Spectrum of Product-Development Strategies

Craft-Oriented Job-Shops

Strategy
Customise products and processes for individual customers
Attain high premiums for this service

Implementation
Emphasis on process flexibility for custom requirements
Unlimited range of products and customer needs
Little opportunity for process/quality analysis/control
Project-based process R&D, if any
Dependence on highly skilled workers
Minimal reliance on process standardisation
Little opportunity for systematic reuse
Computer-aided tools individual - or project-oriented
Emphasis on customised products and customer service

Tradeoff
Customer requirements, product & process flexibility and invention, if necessary, over process efficiency

Assessment
Little strategic management or integration beyond projects
Few economies of scale or scope
Best suited for medium-sized, innovative custom projects

Factory Development

Strategy
Efficient production of different products
High price-performance
Effective management of large, complex but routine projects

Implementation
Management commitment/investment in process improvement
Broad but more limited product-process market focus
Extensive process/quality analysis/control
Tailored and centralised process R&D
Standardisation & leveraging of worker skills
Dynamic standardisation
Systematic reuse of product components
Extensive use of computer-aided tools
Incremental product improvement

Tradeoff
Effort required to balance process/organisational efficiency with process flexibility & individual creativity

Assessment
High level of strategic integration & management
Offers systematic economies of scope
Well-suited for large-scale, complex projects where standards, re-use, and managerial skill are important

Product - or Application-Oriented Projects

Strategy
Design of a best-seller product
Mass production and sale of low-priced commodity products

Implementation
Emphasis on product appeal (to produce a best seller)
Focus on particular applications for broad market
Process efficiency less important than design appeal
Process R&D to suit particular products
Emphasis on highly skilled designers
Little emphasis on process standards
Reuse less important than best-seller designs
Tools useful if do not constrain designers
Innovation more important than incremental improvement

Tradeoff
Product innovation or differentiation over process efficiency in design

Curtain Consulting, Melbourne

Assessment	Little strategic management or integration beyond projects High potential economies of scale in package sales Not suited for large-scale, complex projects

Source: Cusumano (1991: 30)