NCVER

Training needs of emerging industries

Josie Misko

John Saunders

Publisher's note

Additional information relating to this research is available in *Training needs of emerging industries: Case studies – Support document*. It can be accessed from NCVER's website <http://www.ncver.edu.au>.

ISBN 1 920895 39 6 print edition
1 920895 40 X web edition
TD/TNC 76.15

Published by NCVER
ABN 87 007 967 311

Level 11, 33 King William Street, Adelaide, SA 5000
PO Box 8288, Station Arcade, SA 5000, Australia
<http://www.ncver.edu.au>

Contents

Tables and figures

Tables

Figure

Key messages

- ✧ This study examined companies and organisations developing innovative products and services. Innovative companies pass through four distinct stages of development, each with different requirements for staff employed and the types of training needed.
  - In the first stage, the organisation often consists of a few employees working almost exclusively on researching and developing a concept. These individuals usually include the originators of the idea and a few highly qualified or experienced specialists such as mechanical engineers, physicists, chemists and highly experienced tradespersons. In this stage, the company often 'buys in' the specialised qualifications, expertise and experience rather than engage in training.
  - In the second stage, more people are employed to develop and refine processes and build and test prototypes. These new employees are generally experts in their fields, often with practically-oriented qualifications and experience.
  - In the third stage, the organisation tentatively embarks on manufacture and sale of its products. At this point it requires employees for the more commonplace processes of production, administration and clerical support. Sales and marketing personnel may also be employed; however, these functions are often still handled by personnel originally involved in establishing the company.
  - In the fourth stage, the organisation engages strongly in production, sales and marketing. Lower-skilled personnel are required for production, supply and distribution. Qualified and experienced personnel are needed for marketing, sales, finance and quality control, and also for management and human resource functions. Research and development often becomes a smaller part of overall operations.
- ✧ The majority of training needs of innovative companies did not differ greatly from those of ordinary companies. Where they did differ was generally in the areas of leading-edge technology in which they were working. In such cases they were often working with technology which was in advance of that taught by vocational education and training (VET).
- ✧ Vendors of products and materials were also often at the leading edge of their fields and provided training to innovative companies.
- ✧ Overall, no great change is needed in VET training to meet the needs of emerging industries. Changes that are required mostly relate to the currency of technological knowledge possessed by VET teachers. To be of greatest value to emerging industries, VET needs to:
  - upgrade and maintain currency. To do this VET should consider:
    - working collaboratively with innovative companies in determining training needs, and developing and providing customised training applicable to the leading edge technologies involved, and
    - working collaboratively with vendors of products and materials to innovative companies, to help the vendors develop specialised training, train vendor trainers in training delivery and provide access to training facilities.

  Such collaboration potentially benefits, not only VET, in terms of maintaining currency of technological knowledge, but also innovative companies, in the form of customised, up-to-date training, and vendors, in the form of better provision of their specialised training.

Executive summary

Background and methodology

In setting out to examine the training needs of emerging industries, it was first necessary to define what constitutes an emerging industry. ‘Emerging’ implies something that is new and developing. So, for example, a new industry or segment of an industry could be developing, in which new client services were being developed and offered, or in which new technologies were being developed and applied.

For the purpose of this study, the focus was on industries in which new technologies were being developed and applied because it was felt that they would be the most demanding in terms of levels and extent of training. Companies involved in the development and application of new technology were referred to in the study as ‘innovative companies’. Factors that were taken into consideration in identifying the industries and companies to be studied were: the rate and location of innovation in government, business and not-for-profit sectors; the extent of research and development activity; and registration of patents, trademarks and designs.

Respondents from 18 companies were interviewed at length. These companies came from a wide range of sectors and all of them were involved in developing or manufacturing leading-edge products and processes. A more detailed report on each of these company case studies is available online at <http://www.ncver.edu.au> as support material for this study.

Evolving stages of development

It was possible to identify four stages of development as these companies progressed from embryonic organisations researching and developing a concept to mature companies engaged in manufacturing and marketing their products. Each of these stages had different requirements in terms of the staff they employed and the types of training required.

In the first stage, the organisation often consisted of just a few employees working almost exclusively on researching and developing a concept. These individuals usually included the originators of the idea and, depending on the industry sector, a few highly qualified or experienced specialist personnel such as mechanical engineers, physicists, chemists and highly experienced tradespersons.

The second stage required the developing and testing of concepts. More people were employed to develop and refine the processes involved and build and test prototypes. These new employees were generally experts in their fields, often with practically oriented qualifications and experience and included highly experienced tradespersons.

By the time the third stage had been reached the organisation was tentatively embarking on manufacture and sale of its products. At this point it required employees who were to be engaged in the more mundane processes of production, administration and clerical support. Sales and marketing personnel might also be employed, but often this function was still largely handled by employees who had been involved in establishing the company.

In the fourth and final stage, the organisation was substantially engaged in production, marketing and sales. Semi-skilled personnel were required for production, supply and distribution functions and qualified and experienced personnel were required to take care of marketing, sales, finance and quality control. By this time the company may have reached a size that also required specific personnel to handle management and human resource functions. Research and development was generally continued, but as a smaller proportion of the company's overall operations.

Knowledge and skills and attributes

As already noted, the workforce of a new innovative company often comprises a small, closely knit group, sharing ideas and combining resources to solve the myriad problems encountered in developing a new idea—often with some degree of secrecy to protect the company's intellectual property. In choosing employees to work in such an environment, employers therefore especially seek people with suitable values, attitudes, and dispositions.

These innovative companies sought to recruit highly skilled, qualified and experienced personnel for their research and development, technical, financial, and managerial functions. Where formal qualifications were not the main criterion for employment, they, like any other company, looked for people with proven track records, and relevant skills and experience.

There was an expectation that employees in the higher level knowledge occupations (for example, researchers, scientists, engineers, metallurgists, audiologists, technicians, accountants and marketers) would come with already highly developed fundamental skills and knowledge required for their occupations. The company would then build on these skills and knowledge to develop highly specialised expertise and customise work roles and processes to company requirements.

The type of work carried out by clerical, and general support workers in innovative and emerging industry companies was found to be no different from that which occurred in any other company. However, the focus for those involved in management, research and development, technical operations, marketing, sales and accounting could be much more specialised. The companies were often heavily dependent on the accurate targetting of niche markets at home and abroad, and they needed an ability to operate in an environment which required knowledge of how to protect intellectual property in an extremely competitive international environment. The international focus of many of the companies also required key employees, especially those who would be negotiating with people in other countries, to possess some facility with the appropriate foreign language and an understanding of the culture of the people with whom they were dealing. There was also an increasing need for accountants and directors to understand legal issues, including those relating to statutory declarations and intellectual property.

Training

The degree and higher degree level qualifications often sought by innovative companies for their research and development, technical, marketing and managerial functions are mostly available from institutions of higher education. However, emerging industry companies also need courses to develop the knowledge and skills of employees working in trades and other technical roles, clerical and administrative functions, and also manufacturing and production. They also require more specialised training in areas such as human resource management, computer operation, industry-specific and generic computer software packages (such as computer-aided design [CAD], word processing and spreadsheets), computer programming, project management, report writing, marketing, team building, language and culture, time management and quality assurance. These types of courses are already available in many vocational education and training (VET) institutions, or can be developed by providers who have experience in working with enterprises to customise training for specific needs.

Customisation and, where feasible, development of new courses by VET could play an important role in helping innovative companies to acquire the highly specialised skills needed to operate at the leading edge of technology and to access venture capital and compete in global markets. Areas of importance in this context include protection of intellectual property, application of patent law, and commercial and marketing expertise. Collaboration between VET and the companies in need of this specialised training could not only assist in the development of new training, but also enable VET teaching staff to gain increased understanding of new developments and directions in technology. Collaborative ventures might include the establishment of training facilities on-site to assist VET to deliver specialised training in the workplace.

Vendor training (training provided by the vendors of equipment and materials) was identified as one of the best ways for companies to access the most up-to-date training in their particular fields. VET providers and vendor providers might derive mutual benefit if they were to work co-operatively in providing training. VET staff would gain knowledge of latest developments, and vendor trainers would gain access to VET teaching facilities and expertise (for example, vendor trainers could access VET train-the-trainer courses).

Concluding remarks

Innovative companies in emerging industries have diverse and important training needs. While much of the higher level training and qualifications required is generally provided by higher education, VET also has a role to play in developing further knowledge and skills once experienced and qualified personnel are hired. Because these innovative companies are often operating at the leading edge of their technological fields, the further training they require is highly specialised and sometimes unique. Although VET is already well placed to provide customised training for employers, there may be extra opportunities for it to advance the currency of its knowledge by working closely with these companies to identify special requirements, develop programs to deliver the special training and extend the expertise and knowledge of its teachers.

What are emerging industries?

This study discusses the training needs of emerging industries by examining the industry areas where innovation may be occurring and using this information to identify case study companies for closer investigation. From the outset, it became evident that identification of an emerging industry is not as straightforward as it might appear. This is because all industries have the potential to develop innovative ways for doing things, or altering their traditional ways of working to take account of new developments in knowledge and technology.

When we talk about emerging industries we must not forget that industries such as out-sourced services and domestic work, which generally require low levels of training, are also emerging in the sense that they are increasing their market share. However, in this study we are concerned with industries that have implemented innovation in technology or processes and are more likely to depend on higher-order skills and knowledge.

A preliminary step has been to examine: the rate and location of innovation in government, business and not-for-profit sectors; the extent of research and development activity; and registration of patents, trademarks and designs. This information was used, in part, to select the industry sectors for further investigation.

Technological innovation

The Australian Bureau of Statistics ABS (1998) has used the concepts and standard questions developed by the Organisation for Economic Co-operation and Development (OECD) and Eurostat to collect information on innovation in the Australian manufacturing sector between 1994 and 1997. Innovation has been categorised as 'a series of scientific, technological, organisational, financial and commercial activities'. Innovative businesses are classified as those which have 'implemented technologically new or significantly improved products or processes during the period under review' (Australian Bureau of Statistics 1998, p.3).

Rate of technological innovation

The Australian Bureau of Statistics reports that the rate of technological innovation in the manufacturing industry and especially in small businesses (with fewer than ten employees) had dropped. In the three-year period from 1991 to 1994, it stood at 27% for businesses with fewer than ten employees, dropping to 19% in the next three-year period. For businesses with more than ten employees, the rate had dropped three percentage points, from 50% to 47%. The survey also indicated that although businesses that were involved in innovative activities represented just a quarter of all manufacturing businesses, they accounted for 66% of all employment and 75% of total turnover. This would suggest that larger employers are more likely to engage in technological innovation.

Over the three-year period 1994–1997, the most prevalent type of innovation was product innovation, as reported by 23% of all businesses. Over the same period, process innovation was reported by 18% of manufacturing businesses. Corresponding figures for the preceding three-year period were 30% and 23% respectively.

Technological innovation was highest in the petroleum, coal, chemical and associated product industry (42% of all businesses), followed by the non-metallic product industry (36% of all businesses) and the food, beverage and tobacco industry (36% of all businesses). Technological innovation in the machinery and equipment industry was reported by 35% of all businesses. The lowest rate of technological innovation was found in the textile, clothing and footwear industry (15% of all businesses), followed by the wood and paper product industry (16% of all businesses).

The rate of technological innovation was also related to business sales. Just under a fifth (19%) of businesses demonstrating less than one million dollars in sales were involved in technological innovation, whereas 85% of those businesses with more than $100 million dollars in sales were so involved.

Across Australian states and territories, the proportion of businesses undertaking technological innovation was generally similar. However, the rates ranged between 24% and 29% for all states, bar the Northern Territory, which posted a 16% rate.

Why businesses undertake technological innovation

The overwhelming majority of businesses reported undertaking technological innovation in a bid to reduce costs (92%), maximise profits (92%), improve productivity (89%), respond to customer needs (88%), improve quality and speed of service (88%) and increase market share (85%). Other important reasons included being at the forefront of their field (80%), expanding product range (79%), improving staff safety and working conditions (79%), establishing a new market (78%), being environmentally aware (70%) and meeting government standards and regulations (70%).

Where businesses get their ideas

The Australian Bureau of Statistics also reports that, in the main, businesses obtained their innovative ideas from both internal and external sources. In 80% of cases, management had been mostly responsible for sowing the initial seeds of ideas. Proportions of other staff contributing innovative ideas were: marketing (27%), production (23%), technical (18%), and research and development (12%). External sources for ideas included clients or customers (32%), competitors (25%) and fairs and exhibitions (24%).

'Abandoned' innovations

The rate at which innovative projects were abandoned was also low. The results of the Australian Bureau of Statistics' survey showed that, in just under 10% of cases, businesses had abandoned an innovative project. However, the rate of abandoning projects was less for businesses with fewer than ten employees than for large businesses with 500 or more employees (6% and 52% respectively). Generally projects were abandoned at the design and feasibility stages (44% and 29% respectively). There was less likelihood of abandonment as the duration of the implementation process increased. The most frequently reported reasons for abandonment were high and difficult-to-control costs (70%), competing resources or priorities (61%), and expected low returns (53%).

The impact of technological innovation on businesses

In the main, businesses reported that employment levels had increased with technological innovation. This mostly comprised increased employment of production staff (reported by 33%

of businesses), increased levels of production activities (61% of businesses), and increased profits (38% of businesses). Only 2% of businesses reported decreases in levels of production and 7% reported decreased profits with respect to innovation implementation.

Expenditure on innovation

Between 1994 and 1997, a total of $3.9 billion was spent by industry on technological innovation. Of this, a total of $1500 million was spent by the machinery and equipment industry, representing the highest amount spent, followed by the petroleum, coal, chemical and associated product industry ($640 million), and the food, beverages and tobacco industry ($590 million). Lowest spending on technological innovation was the textile, clothing, footwear and leather industry at $110 million. Most of this expenditure was on research and development (50%), and 'tooling-up' (29%). Training associated with the introduction of innovation (for all but the metal-product industry) accounted for the lowest expenditure (3%).

Use of advanced manufacturing technologies

In the main, advanced manufacturing technologies were found in design and engineering, communication and control and fabrication and machining.

Research and development

In May 1990 the Commonwealth Government funded the establishment of the Co-operative Research Centres (CRCs) program to create linkages between existing industry sectors, research organisations, educational institutions and government agencies. These centres drew together researchers and research users to identify industry-relevant research and to turn the results of this research into successful commercial ventures. For example, the Australian Co-operative Research Centre for Renewable Energy (ACRE) has been set up to bring together research capabilities and market knowledge into sustainable energies and is committed to the greenhouse gas abatement technologies.

By May 2002 there were 62 Co-operative Research Centres in operation in the following fields:

- Manufacturing and technology (11 centres)
- Information technology (7 centres)
- Mining and energy (8 centres)
- Agriculture and rural-based manufacturing (12 centres)
- Environment (15 centres)
- Medical science and technology (9 centres)

Appendix A lists Co-operative Research Centres that were in operation as at May 2002 (as specified on the CRC web page). A survey of Co-operative Research Centre directors, conducted by the Department of Industry, Science and Resources, asked them to identify emerging industries in their sectors and to describe skills that were required in these industries. Although responses were not forthcoming from all the centres, the findings indicated that, in many cases, there were stronger demands for skills at the associate professional, professional and managerial levels.

The study also found that many of the identified emerging industries were not confined to specific industry sectors and tended to 'transcend' traditional sectors. For example, there were strong connections between information-based industries and some traditional industries such as the mining service industry, and between biotechnology industries and agricultural sector industries.

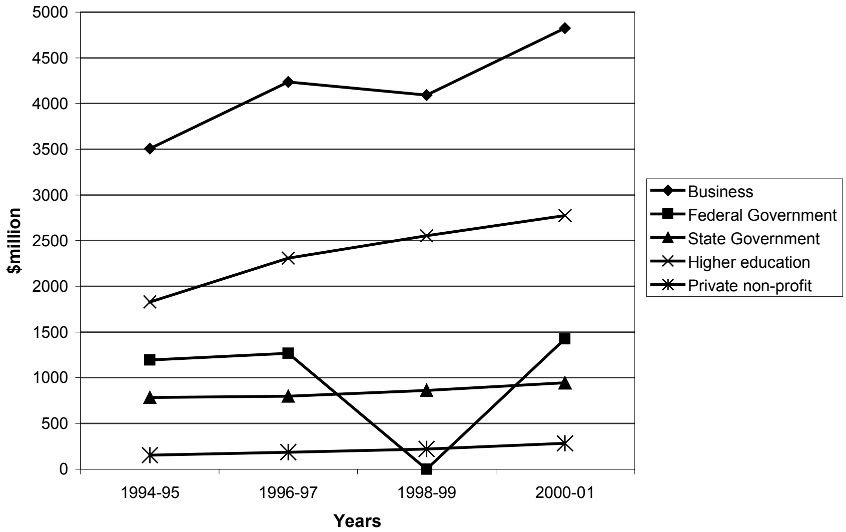
The survey highlighted the need, first, to develop strong linkages between the education and training sectors and industry, so that education and training could respond more quickly to needs as they emerged and, second, to develop linkages between these sectors and the research community.

Expenditure on research and development

Another indication of effort expended on innovation is the expenditure on research and development activities. The Australian Bureau of Statistics (2002) reports that gross expenditure on research and development (GERD) for all sectors has increased steadily over the last decade (see figure1).

The most prevalent type of activities on which funds were expended were experimental development (38%), followed by applied research (36%), strategic basic research (15%) and pure, basic research (10%).

Figure 1: Gross expenditure on research and development, by industry sector



The Australian Bureau of Statistics also reports that the higher education sector accounted for 79% of all pure research expenditure, with 42% of expenditure on strategic, basic research providing the major contribution to this function. The government sector accounted for 38% of expenditure on applied research and provided the greatest contribution to this activity. The business sector accounted for 86% of experimental development activity.

The great majority of the business sector's research and development effort was devoted to engineering and technology (55%) and information, computing and communication sciences (26%). Engineering and technology accounted for the greatest research effort for the Commonwealth Government (25%), followed by agricultural, veterinary and environmental sciences (16%), information computing and communication sciences and earth sciences (each 13%). For state and territory governments, the greatest research effort was in agricultural, veterinary and environmental sciences (57%), medical and health sciences (17%) and biological sciences (11%). For the private non-profit sector the majority of research and development was in medical and health sciences (64%) and biological sciences (27%).

Patents, trademarks and registrations

The number of patents, trademarks and registrations lodged with responsible regulatory agencies may also give an indication of the areas in which innovation is occurring.

Patents

Industry Patents Australia (IP Australia) is the agency which registers patents in Australia. It defines a patent to be a 'right granted for any device, substance, method or process which is new, inventive and useful' with the aim of providing protection for inventors. Patents in Australia are either *standard patents*, which provide 'long-term protection and control over an invention' for up to a period of 20 years, or *innovation patents*, which do so for a maximum term of eight years. Innovation patents have replaced what were originally *petty patents*. In return for this patent protection over their inventions, inventors must provide IP Australia with a comprehensive description of how the invention works. This then enters the public domain and may be used by others for further research and investigation. These arrangements do not include 'artistic creations', and 'mathematical models, plans, schemes or other purely mental processes'.

The total number of patents granted between 1991 and 2001 is provided in table 1. On close examination, these data indicate there was a slump in the number of patents granted in 1994, 1995, 1996 and 1997. This downturn reflects the Australian recession of the early 1990s and may represent the reduced amount of investment that inventors could attract for their inventions, and consequently a decrease in the number of patents that were granted during that time.

Table 1: Number of patents granted between 1991–2001

Year	Number of patent grants	% of total ten-year patent grants
1991	12 631	9.4
1992	12 888	9.6
1993	12 727	9.5
1994	11 664	8.7
1995	9 672	7.2
1996	8 987	6.7
1997	9 464	7.1
1998	14 784	11.0
1999	13 529	10.1
2000	13 892	10.4
2001	13 977	10.4
1991–2001	**134 215**	**100.0**

Source: Department of Industry, Tourism and Resources (2002)

Identifying the patents by technology group provides an indication of the fields that have increasingly made use of the patent system. This can give some indication of where innovations may be occurring. Table 2 presents a breakdown of the number of patents granted to the ten most prolific technology groups between 1991 and 2001. Appendix B provides full details of patents granted to all technology groups during that period.

Table 2: Top ten technologies, by total number of patent grants for 1991–2001

Technology	Total number of grants over 1991–2001 period	% of grants
Organic fine chemicals	14 709	11.0
Pharmaceuticals, cosmetics	9 372	7.0
Medical engineering	8 527	6.4
Telecommunications	7 971	5.9
Analysis, measurement, control	6 674	5.0
Handling, printing	6 395	4.8
Biotechnology	6 292	4.7
Consumer goods & equipment	6 144	4.6
Civil engineering, building, mining	6 121	4.6
Macromolecular chemistry, polymers	6 102	4.5
Other*	55 908	51.5
Total	**134 215**	**100.0**

Note: * (see appendix C)

Source: Department of Industry, Tourism and Resources (2002)

The information in table 2 provides us with data on the total number of patent grants for different technology groups. However, if we examine the data according to the number of patents granted per year for the decade (see appendix B), we find that there are some industries which have experienced dramatic increases over the ten-year period, with the remainder remaining stable or having experienced slight declines in activity.

Taking the total number of annual grants for each technology group as a proportion of the total number of grants for the year in which they were granted, we find that the organic fine chemicals technology group has experienced a gradual decline (of about three percentage points) from 1991. This is despite the fact that the group was granted the greatest number of patents for that period. The technology groups which have shown considerable increases over the decade are pharmaceuticals, cosmetics, medical engineering, telecommunications, biotechnology and, to a lesser extent, information technology. These details are contained in table 3.

Table 3: Technology group by proportion of total annual patent grants for 1991–2001 (percentage)

Technology group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Pharmaceuticals, cosmetics	5.2	5.6	5.4	5.4	5.9	6.4	6.7	7.6	9.4	8.9	9.1
Medical engineering	4.1	4.8	4.8	6.5	6.7	6.4	7.0	7.2	7.1	6.8	8.3
Telecommunications	3.5	4.2	4.5	4.8	5.3	5.1	6.7	7.5	7.0	8.5	7.3
Biotechnology	2.7	3.3	4.1	4.0	4.7	4.3	4.7	5.3	5.6	6.1	6.2
Information technology	2.0	2.0	2.2	2.0	2.0	2.5	2.1	2.1	2.5	2.8	2.6
Other	82.5	80.1	79.0	77.3	75.4	75.3	72.8	70.3	68.4	66.9	66.5
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Department of Industry, Tourism and Resources (2002)

Trademarks

According to IP Australia, a trademark can be a 'word, phrase, letter, number, sound, smell, shape, logo, picture, aspect of packaging or a combination of these'. Although the registration of a trademark is not mandatory, traders are advised to protect trademarks through formal registration.

The number of trademarks registered under the Australian Trade Marks Act over the period 1993 to 2001 also showed considerable increases, with substantial increases experienced since 1995. Table 4 provides details on the number of trade marks registered in Australia from 1993 to 2001.

Table 4: Number of trademarks registered between 1993 and 2001

Period	Number of registrations	% of total registrations
1993–1994	15 417	9.5
1994–1995	17 137	10.5
1995–1996	17 845	10.9
1996–1997	21 786	13.4
1997–1998	24 534	15.1
1998–1999	21 508	13.2
1999–2000	16 759	10.3
2000–2001	28 010	17.2
1993–2001	**162 996**	**100.0**

Source: Department of Industry, Tourism and Resources (2002)

There are 42 different classes of trademarks in the Australian trademark system. The number of trademarks registered within these 42 classes for the 2000–2001 period increased by almost two-thirds (65.1%) over total 1999–2000 figures. These details are provided in table 5.

Table 5: Subject matter of trademarks registered in 1999–2001

Trademark class[1]	No. of registrations		Increases over period	
	1999–2000	2000–2001	Number	%
Scientific and commercial apparatus or instruments	3007	5016	2009	66.8
Advertising and business services	1910	3641	1731	90.6
Insurance and financial services	871	1639	768	88.2
Bleaching, cleaning preparations, perfumery, cosmetics	845	1410	565	66.9
Communication services	574	1154	580	101.0
Wines, spirits, liqueurs	504	958	454	90.1
Lighting, heating, cooling, ventilating, water supply	481	807	326	67.8
Transport and storage services	442	773	331	74.9
Fresh fruits and vegetables, animal products	382	704	322	84.3
Jewellery, clocks, precious metals and stones	286	529	243	85.0
Cutlery, side arms, hand tools, instruments	149	259	110	73.8
Fuels, oils, greases, tallows, waxes	131	223	92	70.2
Haberdashery	66	130	64	97.0
Yarns, threads	16	52	36	225.0
Firearms, ammunition, explosives	28	47	19	67.9

Note: [1] The complete description of the 42 classes is set out in the Fourth Schedule to the Trade Marks Regulations
Source: Department of Industry, Tourism and Resources (2002)

Designs

Designs that have an 'industrial or commercial use' can also be registered with IP Australia. This registration is used to protect the 'visual appearance' of a design, so that without the agreement of the designer, no one else may use it. According to IP Australia, the term *design* refers to the 'features of shape, configuration, pattern or ornamentation which can be judged by the eye in finished products'. However, designs that are 'essentially artistic' are not covered by this registration and must be covered by copyright legislation. Design registration only applies to the appearance of the product and not to its workings.

Between 1999 and 2001 there was an overall reduction in the number of registered designs with all but 12 of the design classifications experiencing a decline. However, dramatic increases were seen in:

- articles for the care and handling of animals
- recording, communication or information retrieval equipment
- textile piece-good articles, artificial and natural sheet material.

A breakdown of the top 12 subject matters of design registrations appears in table 6.

Table 6: Subject matters for which design registrations increased, 1999–2001

Subject matter category	Number of designs		Increase over period	
	1999–2000	2000–2001	Number	%
Packages and containers for the transport or handling of goods	303	349	46	15.2
Tools and hardware	311	346	35	11.3
Household goods, not elsewhere specified	247	276	29	11.7
Recording, communication or information retrieval equipment	150	256	106	70.7
Machines, not elsewhere specified	126	156	30	23.8
Articles of clothing and haberdashery	134	148	14	10.4
Equipment for production or distribution of electricity	100	102	2	2.0
Articles of adornment	79	99	20	25.3
Clocks, watches and other measuring instruments, checking and signalling instruments	67	81	14	20.9
Building units and construction elements	69	74	5	7.2
Textile piece-good articles, artificial and natural sheet material	38	63	25	65.8
Articles for the care and handling of animals	3	25	22	733.3

Source: Department of Industry, Tourism and Resources (2002)

Also important has been a publication examining influences on Australia's international trade for the new millennium (Commonweath of Australia, Department of Foreign Affairs and Trade 2001). This publication reports the increasing importance of information technology industries, internet commerce, high speed broad-band television, developments in switches and transmitters, photonics (which can be used to generate energy, detect images, communicate signals and process information), and satellite communication technologies. In addition, value-added goods, including medical and health services, legal, financial and other professional services, are also expected to have a major impact on international trade. Modern biotechnologies (for example, human therapeutics, agricultural biotechnology, industrial biotechnology, materials science, bio-engineering and environmental management) and technological advances in genetics, brain science, physical and chemical sensing devices, and the production of polymers, ceramics and composites are also considered to provide substantial export opportunities for Australia. There is also an increased interest in harnessing the benefits of nano-technologies that use molecular engineering to manufacture goods from raw atoms to provide items which are stronger, lighter or miniaturised. Further developments in sensor technologies are also envisaged. These technologies will have applications for the mining, defence and medical industries.

The case studies

We have seen in the preceding chapter that the great majority of the business sector's research and development effort during the last decade was devoted to engineering and technology, and also to the information, computing and communication sciences. Engineering and technology accounted for the greatest research effort for the Commonwealth Government, followed by agricultural, veterinary and environmental sciences, information computing and communication sciences, and earth sciences. For state and territory governments, the greatest research effort was in agricultural, veterinary and environmental sciences, medical and health sciences, and biological sciences. For the private, non-profit sector, the majority of research and development was in medical and health sciences and biological sciences. In addition, information on patent activity shows increased activity is mainly in pharmaceuticals (cosmetics), medical engineering, telecommunications, bio-technologies, and information technology.

With this in mind, the researchers identified a set of companies that were operating in some of these areas. These companies provided information to researchers, via structured telephone interviews, on the work conducted by the enterprise, its business activity, recruitment and selection procedures, staff qualifications, staff training, and skill and training requirements for the future.

Case study companies

A list of participant companies indicating industry sectors, and area of manufacture or service is shown in table 7. Companies have been given fictitious names to preserve confidentiality.

The companies in table 7 were either concerned with research and development only, or a combination of research and development, manufacturing and production, and commercialisation of goods and services. Typically, they operated within an environment which required them to look for markets both at home and overseas and all relied heavily on a workforce that had specifically relevant qualifications and work experience. In the main, they 'bought in' experience and knowledge by hiring employees who already had the qualifications, experience, skills and attributes relevant to the enterprise, and the job they were hired to do. However, because of the highly specialised, even unique, nature of the skills and knowledge required, these sometimes had to be custom-developed by the company.

Company sizes varied from four employees to 110 employees, with most being in the ten to 30 employee range. As a rule, those with few numbers of employees were primarily engaged in research and development. As companies extended their operations from research and development to production, manufacture, marketing and sales, numbers of employees generally increased markedly.

Table 7: Participating companies, industry sector and nature of endeavour

Company	Industry sector	Technology used, goods produced, services provided
AeroEngCo.	Aeronautical engineering	Medium-size plane manufacture
AgEquipCo.	Agricultural and mechanical engineering	Agricultural spraying machinery
StrainGaugeCo.	Aviation and mechanical engineering	Diagnostic strain devices
ElectroChargeCo.	Electrical engineering	Electrical storage devices
SecuritySoftCo.	Electronics and information technology	Security software
FibreOpticCo.	Electronics and telecommunications	Fibre optics
SunPowerCo.	Energy	Solar power pumps and water treatments
EnergyCellCo.	Energy	Energy generation
ToolingCo.	Engineering	Manufacturing dies and machine tools
CellGrowCo.	Health, medical research	Growth of cell tissues
CompuHealthCo.	Health, medical research	Medical diagnostic tools
CompositesCo.	Materials–engineering	Composite materials technology and manufacture
FinishesCo.	Materials–engineering	Metal treatments to surfaces
AlloyCo.	Materials–engineering and manufacturing	Titanium products manufacture
FanTechCo.	Mechanical engineering	Fluid and fan technology
EarCo.	Medical technology, health and electronics	Hearing enhancement appliances
ScanningCo.	Medical technology and health	Medical scanning devices
CallingCo.	Communications	Speech recognition appliances

Companies provided employees with professional development opportunities at company expense. This was usually in the form of short courses delivered either at the workplace or off-site by providers who had the relevant expertise and ability to run programs. In addition, employees were encouraged to engage in formal external courses either to upgrade qualifications or acquire new qualifications. Employers generally provided staff with time off to attend training and or subsidies to meet tuition costs.

Occupations

The occupational categories of employees in these companies covered a diversity of areas, with the extent of this coverage increasing with the size of the company. Larger companies involved in research and development, production and manufacturing, and distribution, had a full complement of employees in each of the relevant categories. However, employees in smaller companies tended to share a variety of tasks and were required to be multi-skilled. The categories of occupations included:

- managers and administrators
- research and development personnel (for example, scientists, engineers, researchers, medical personnel, metallurgists)
- para-professionals, technicians and tradespersons (for example, in draughting, electrical, electronics, mechanical engineering and laboratory work)
- financial and corporate services personnel (for example, accountants, book-keepers, human resources consultants, trainers)
- sales and support personnel (for example, marketing personnel, sales consultants)

- ✧ clerical and administrative personnel (for example, receptionists, accounts clerks, personal assistants)
- ✧ production and manufacturing workers.

Recruiting the right employees

The majority of case-study enterprises reported that they recruited employees with the relevant skills, knowledge, experience and level of qualifications that were relevant to their particular work.

Formal qualifications

In general, applicants for jobs not directly involved in the research or development process, or specialist positions requiring certain qualifications, accreditations and expertise (for example, quality assurance, accounting, marketing, and diagnostic testing) did not require any formal qualifications. For these roles it was important for job applicants to demonstrate that they had the necessary experience and track record to be able to perform the work.

If a company had a research and development function (for example, companies involved in bio-technologies, growing cell tissue or generating energy) it would recruit research and development personnel with the relevant technological, scientific, engineering, or medical backgrounds and qualifications. In many cases these employees were required to have either higher degrees, graduate diplomas or bachelor degrees. Technicians and para-professionals (for example, electronics and electrical tradespersons, draftspersons, and instrument fitters) required the relevant trade or technical qualifications that were essential to their jobs. In some companies the technicians also held a bachelor degree or part of a bachelor degree, typically in a scientific or engineering field.

In the main, accountants had degree-level qualifications in their particular fields, with a small number also holding a Certified Practicing Accountant (CPA) qualification. Clerical administrative personnel, including personal assistants, generally required no formal qualifications apart from those acquired in secondary school. This was also the case for those in sales support or warehousing occupations.

One company was involved in manufacturing products especially sought by domestic and overseas military establishments. To market and sell its products to establishments overseas, the company hired agents with a military background and access to military networks that gave them the personal contacts required. Companies involved in developing high technology medical equipment tended to hire personnel with medical qualifications, engineers and scientists.

Managers of particular company operations were expected to have expertise, experience and qualifications relevant to those operations, in addition to the required supervisory, problem-solving and decision-making skills required of people in leadership positions. Quality assurance managers and occupational health and safety managers were expected to have the necessary quality assurance or safety training accreditations.

Table 8 presents information on the number of companies who identified specific qualification levels for their workers in various occupational roles.

Table 8: Formal qualifications and licences of employees in specified occupational categories

Qualification	Managers	Research and development	Technicians	Financial	Sales	Clerical	Production	Corporate
PhD	•••	••••						•
Masters	•	•••	•					
Graduate Diploma		•						
Bachelor	••••••••	•••••••• •••	••••	•	•••	••	•	••••••
Diploma, associate or advanced diploma	•	••	•••••			•	•	•
AQF certificate or trade qualification	••		•••••••	•	•••		••	
Years 11 & 12						•	••	•
Special licences	•		•	••				

Fields of study

Analysis of the fields of study that employees had been engaged in prior to commencing with a company indicated that the two most common fields were engineering and science. This was especially true for managers, research and development personnel and technicians. The next most common field of study was business—which was important for employees dealing with financial matters, for managers and for sales personnel. Table 9 provides a breakdown of the fields of study according to individual roles.

Table 9: Frequency with which field of study was nominated, by occupational category

	Managers	Research and development	Technicians	Financial	Sales	Clerical*	Production	Corporate
Engineering (e.g. mechanical, electrical electronics, aviation, chemical, computer, audiology)	9	8	10		2		3	1
Science (e.g. science, biochemistry, metallurgy, rheology, solid works, materials, physics, pharmacology, molecular biology, cellular biology, medicine, bio-medicine)	6	13	2					
Business, finance and accounting	7			7	5			1
Logistics	1							
Quality assurance	2							1
Law					1			2
Information technology		2	2		1			1
Design			1		1			

Note: *Clerical workers did not generally have prior studies.

A breakdown of formal qualifications and accreditations held by different occupational groupings for eight of the case study companies is provided in table 10.

Table 10: Type of qualifications, by occupational group

	Managers	Research and development	Technicians	Financial	Sales	Clerical*	Production*	Corporate
Engineering	••••••	••••••••	••••••		••			•
Science	•••	•••	•					•
Biochemistry		•						
Metallurgy		•						
Rheology		•						
Master of Business Administration, commerce, economics	••••	•		•••	••			
Accounting	••			•••••	••			••
Quality assurance	••		•••					•
Electrical/electronics	•		•••					•
Draughting			•					
Information Technology		•	•		•			•
3D-computer-aided design/SolidWorks			••					
Aviation engineering			•					
Materials science			•					
Physics			•					
Law					•			
Logistics	•				•			
Pharmacology	•	•						
Molecular biology	•	•						
Cellular biology	•	•						
Chemical engineering								
Computer engineering	•							
Medicine	•							
Audiology engineering		•						
Bio-medicine		•						

Note: Clerical and production workers did not have prior qualifications.

Attributes

In addition to experience and qualifications necessary for the job, emerging industry employers also sought attributes which were sometimes outside the norm for a particular occupational category. For example, one company (dealing with exporting diagnostic technology to overseas military organisations) expected not only its managers, but also its research and development personnel, technicians, financial managers, clerical, sales and support personnel and other corporate support personnel to present a professional appearance. This was especially important for those whose task it was to market to and attract clients in overseas markets. Another company, involved in the generation of alternative energies, expected all employees to have a 'passion' for protecting the environment through adoption of alternative energy sources.

A proven track record, the ability to fit into the organisation and to be a good team player were also highly valued employee attributes in many of the case-study companies. Spatial and manual dexterity, mechanical aptitude and good hand-eye co-ordination were generally expected of production workers. Vision and leadership were expected of managers. Openness to new ideas, passion for the product or field, commitment to the organisation, and the ability and willingness to develop and learn were also favoured attributes.

Required skills and knowledge

To understand the types of skills and knowledge important to case-study companies, researchers asked respondents to describe the specific skills and knowledge areas expected of different occupational roles in their organisations. Their responses indicated that an understanding of quality assurance was required of all employees and, apart from those in corporate support or production roles, all employees required at least some skills in using computers and software applicable to their particular jobs. In addition, public relations skills were generally required of all occupational groups other than clerical and production personnel.

Managers

In the main, case-study companies required their managers to have relevant managerial experience and supervisory skills necessary for overseeing the work of others. They needed managers to be skilled in planning, budgeting, business administration, as well as time and project management. Managers were also expected to have marketing and entrepreneurial skills and to be knowledgeable about company products and intellectual property issues. They were required to have the ability to solve problems, negotiate solutions and make appropriate decisions. They also needed to be skilled in public relations and able to relate well with clients and staff. Where they were involved in marketing products in international markets, they also particularly needed to have an understanding of the culture of the international companies and the countries with which they interacted or traded. Understanding of the language was also valued (but not necessarily essential). Report-writing skills and skills in using computers and job-specific software were also essential.

Research and development personnel

Research and development personnel required similar skills to managers. They needed to have expert knowledge and experience of their particular fields. However, unless they were also in managerial roles there was less focus on negotiation skills, market knowledge, time management, occupational health and safety, product knowledge, and international language and cultural understanding.

Technicians and para-professionals

Those who were in technician or para-professional positions were also required to have relevant qualifications and experience together with some of the skills required of managers and researchers. However, for these workers there was greater emphasis on the technical process or trade skills required for developing or manufacturing company products. Unless they were in team leader or supervisory roles, there was less focus on supervisory and people skills, knowledge of intellectual property, business administration, financial skills and knowledge, time management, product knowledge and language and cultural understanding.

Financial personnel

Financial personnel (including accountants) required relevant qualifications and experience, financial skills and knowledge, also an understanding of intellectual property issues. They needed to be able to work with computers and relevant specialised software and were expected to understand the market in which the company operated. However, unless they were also managers, they were not required to have skills in supervision, business administration, time management, marketing and entrepreneurship. Financial personnel were not required to have high-level knowledge of company products or international languages and cultures.

Sales personnel

Sales personnel required very similar skills to managers; however, there was no major emphasis on report-writing, understanding of occupational health and safety or time management skills. Although good people skills were required, they did not need skills in supervision or business administration, unless in managerial positions. Whereas managers required marketing and entrepreneurship skills, sales personnel required marketing and selling skills. Like managers, these sales personnel needed good planning skills, good public relations skills and an understanding of intellectual property. Sales personnel in companies operating in the international market were expected to have an appreciation of international languages and cultures.

Clerical, corporate support and production personnel

Clerical personnel required an understanding of quality assurance processes, and skills in using computers, answering telephones and book-keeping.

Corporate support personnel were required to have skills in planning, report writing, public relations, business administration, project management, relevant technical processes, and an understanding of intellectual property issues and the field in which the company worked.

Production employees were required to have an understanding of the quality assurance process.

Table 11 summarises the skills and knowledge reported by respondents for the different occupational categories.

Taken as a whole, the skills and knowledge expected of employees in emerging industries can be grouped according to type, namely technical, managerial, financial, commercial and legal. These groups are presented in table 12.

Table 11: Skills, knowledge and experience required, by occupational category

Skill/knowledge/experience	Managers	Research and development	Technicians	Financial	Sales	Clerical	Production	Corporate
Relevant qualifications and experience	•	•	•	•	•			
Supervisory skills	•	•						
People skills	•				•			
Problem-solving skills	•	•	•					
Negotiation skills	•				•			
Market knowledge	•			•	•			
Occupational health and safety	•		•					
Quality assurance	•	•	•	•	•	•	•	•
Financial skills and knowledge	•	•		•	•			
Computer skills	•	•	•	•	•	•		
Relevant specialised software expertise	•	•	•	•				
Mechanical skills			•					
Technical skills for job (process and trade skills)			• [1]					•
Report writing	•	•	•					•
Project management	•	•	•					•
Planning skills	•	•		•	•			•
Public relations skills	•	•	•	•	•			•
Intellectual property	•	•		•	•			•
Business administration skills	•	•						•
Marketing and entrepreneurship	•	•	•		•			
Decision-making skills	•	•	•					
Time management	•							
Product knowledge	•				•			•
Language—cultural understanding	•				•			
Book-keeping skills						•		
Telephone skills						•		
Knowledge of company field (science, etc.)					•			•

Note: [1] Take instructions, follow design drawings, testing techniques, computer-aided design – computer-aided manufacturing(CAD-CAM), computer numerical control, electrical, electronics, laboratory techniques, fitting and turning, telephony C++

Table 12: Types of skills and knowledge needed in emerging industries

Technical	Managerial	Financial	Commercial	Legal
Computer skills	Supervisory	Goods and Services Tax	Market knowledge	Intellectual Property
Research skills	People skills	Fringe Benefits Tax	Good public relations skills	Patents
Take instructions	Problem-solving	Cost/benefit analysis	Marketing	Contracts
Follow design and drawings	Negotiation	Contracts	Entrepreneurial	Statutory reports
Testing techniques	Occupational health and safety	Revenues	Selling skills	
Fitting and turning	Quality assurance	Budgeting	Purchasing skills	
Report writing	Project management	Purchasing, stock movement	Language and cultural understanding	
Scientific method skills	Planning skills	Business Administration	Communication skills	
Understanding of science	Decision-making	Business knowledge		
General fitting and mechanical skills	Time management	Statutory and financial reporting		
Computer-aided design	Language/cultural	Cost account book-keeping		
Computerised numerical control	Report writing	Computer skills		
Multi-skills	Entrepreneurial			
Knowledge of software for field	Computer skills			
Electrical				
Medical skills and knowledge				

Required attributes

Respondents also identified a number of attributes that they required of their employees for the various occupational areas. These included appropriate grooming, proven track record and appropriate dispositional qualities. A proven track record, the ability to work in a team and organisational fit were qualities that were required of workers across virtually all occupational categories. Manual and spatial dexterity, mechanical aptitude and work accuracy were identified as attributes required of production workers. For managers, research and development personnel, technicians, para-professionals and financial officers, the ability to keep up-to-date with state-of-the-art technology was an important attribute, as were knowledge, ability and willingness to learn and develop. Creativity and openness to new ideas were required of research and development personnel, as well as technicians and para-professionals. Managers were expected to show leadership and vision. For one company (involved in work associated with environmental issues), passion for the company's field of work and commitment to the company and its products were highlighted as important attributes.

The pattern of attributes across various occupations is summarised in table 13.

Table 13: Attributes required of employees in emerging industries (frequency of nomination)

Attribute	Managers	Research and development	Technicians and para -professionals	Financial	Sales/support	Corporate support	Clerical	Production
Ability to fit in	•	•	•	•	•	•	•	•
Ability to learn and develop	•	•		•				
Ability to work independently		•	•	•				
Accuracy								•
Commitment								•
Creativity, innovativeness	•	•	•	•	•	•	•	•
Currency—state-of-the-art	•	•	•	•				
Hand-eye co-ordination								•
Initiative	•	•	•	•	•	•	•	•
Integrity	•	•	•	•	•	•	•	•
Leadership	•							
Manual dexterity							•	•••
Mechanical aptitude								•
Multiskilled							•	•
Open mind to new ideas	•	•	•					
Passion for product or field	•	•	•	•				
Professional appearance	•	•	•	•	•	•	•	•
Proven track record	•	•	•	•	•	•	•	•
Respect for others	•	•	•	•	•	•	•	•
Spatial dexterity								•
Team player	•	•	•	•	•	•	•	•
Vision	•							

Training provided for employees

Although most workers (especially those in highly skilled positions) obtained jobs with emerging industry companies because they possessed the necessary qualifications, skills and knowledge for their jobs, they were also expected to undertake further training.

Developing company-specific skills

There were instances where companies required highly specialised skills, knowledge and experience. Employers often pointed out that because many of these requirements were so specialised or extraordinary, it was virtually impossible to find people who could satisfy them. In such cases, they recruited employees who possessed the closest relevant qualifications, attributes, generic skills and knowledge, and then provided them with customised training for the company's particular products and processes. The closest relevant qualifications were often in science, engineering and information technology.

Extra training necessary

We use fibre optics or laser optics, these are the things that are important to us. The laser is our basic optical tool. It is a technically complex area—a bit of a boutique technology which lies outside of the communications area. We use the technology in such a different way that, if we get an experienced Telco employee, there is a substantial amount of training necessary. FibreOpticCo

As well as the highly specialised jobs within these enterprises, there are, of course, the more routine administrative and support roles not requiring extraordinary skills knowledge and experience.

Once a company had progressed through the prototype stage and finalised the design of a product it would then move into the production stage, hiring the necessary production workers and associated support staff. In the main, production workers were not required to have any particular qualifications, although the innovative nature of the product sometimes necessitated some specialised training. It was at this point that the focus and size of the company could change significantly (more about which will be said later). Some companies elected to outsource production rather than have to contend with the associated complexities that would arise from sudden change in scale or scope of activity.

Information collected on the type of training that companies provided for their employees according to occupational category is detailed in table 14.

Because of the innovative nature of their operations, it is clear that the great majority of these companies required employees with extremely specialised skills and knowledge (for example, fibre and laser optics, capacitive storage of electrical energy, cochlear implants, fan technology, forging of titanium and speech recognition computer programming). In many cases the required training was not available from traditional providers, so the companies undertook it themselves. Although some of these companies would welcome the availability of the necessary training, they recognised that, because the market would be so small, it was not feasible for training providers to develop and offer it in the traditional manner.

There were companies (such as one specialising in aeroplane development and manufacture) already working in collaboration with technical and further education (TAFE) and other training providers to develop company-specific or narrow sector-specific training. In some cases the training was already available, but inaccessible because it was offered in only one or a few locations in Australia or overseas. Provision of resources to companies for the development of materials and delivery of training could be a valuable step towards helping them maintain and enhance their competitive edge.

Table 14: Training provided, according to occupational category

Attribute	Managers	Research and development	Technicians and para-professionals	Financial	Sales and support	Corporate support	Clerical	Production	Supervisors/ team leaders
Intellectual property, patents	•	•	•			•			
Quality assurance	•	•	•	•		•			
Project management	•	•	•	•		•			
Letter and report writing	•	•	•	•	•	•	•		
Negotiation skills	•	•	•	•	•	•	•		•
Supervisory skills									•
Software packages		• [2]	•	•			•		
Occupational health and safety	•								
Performance management	•	•	•	•	•		•		
Principles of adult learning	•	•	•	•	•		•		
Laboratory and clinical techniques	• [1]	•	• [1]						
Entrepreneurial skills	•	•	•	•					
Marketing	•								
Team-building	•	•	•	•	•	•	•	•	
On-line training	•	•	•	•	•	•	•	•	
Language and culture	•				•				
Leadership skills	•								•
Conferences		•							
Keeping current		•	•	•					
Upgrading qualifications (e.g. relevant degree)		•	•	•					
Time management		•	•						
Data collection and analysis				•					
On-job training		•	•						•
Upgrading knowledge		• [3]	• [4]	• [7]	• [8]				
Upgrading technical skills		• [5]	• [6]		• [9]			•	
Train-the-trainer		•	•						

Notes:
[1] … and manufacturing techniques
[2] … and software relevance
[3] e.g. Solid Works software, opto-electronics, computer science
[4] e.g. opto-electronics, statistics, computer science
[5] e.g. cochlear implant courses, aero skills courses, developing hand skills, computer-aided design, computerised numerical control, multi-skilling
[6] e.g. cochlear implant courses, instrument technician, aero skills courses, developing hand skills, computer-aided design, computerised numerical control, speech recognition
[7] e.g. Goods and Services Tax, Fringe Benefits Tax
[8] e.g. Solid Works software
[9] e.g. sales skills

Skills for different stages of development

It is clear from the findings that skill requirements change according to the stage of company development. The transformation of case study companies often began with initial research and development, culminating in major production, marketing and sales. The stages of company development also had an important bearing on the type of skills and training required. Smith (1999) outlines a staged development process for an organisation engaged in innovation. Based on this concept, four stages of company development were identified. These four stages and the skills and training required are described below.

Stages of development in a typical emerging industry company

1. Initial research and development

   In this stage the organisation often consists of just a few employees, usually the originators of the idea plus a few specialist personnel who are often highly qualified or experienced (examples include mechanical engineers, physicists, chemists and highly experienced tradespersons). Interestingly, the originators of the ideas and companies do not always have high level qualifications in any of the relevant fields (for instance, the inventor of a new concept in fan engineering was originally an osteopath who, through an interest in hovercraft, became a self-taught engineer and his principal colleague in the venture was originally a computer engineer).

2. Development and testing of the concept

   As the idea takes shape more personnel are employed to develop and refine the processes involved, and in the case of a product, to build and test prototypes. These additional personnel are generally experts in their fields, often with practically oriented qualifications and experience, including tradespersons.

3. Initial production and marketing

   By the time this stage is reached, the organisation is tentatively embarking on manufacture and sale of its product. In order to achieve this end, new personnel with the basic qualifications for their job are employed and the company then teaches them the specialised knowledge and skills they need—knowledge and skills which are often not available from external training organisations. At this point of its development, the company is in the initial stages of hiring a new component of its workforce, comprising lower level employees who will be engaged in the more mundane processes of production, administration and clerical support. Sales personnel may be employed, but often this is still largely handled by some of the initial higher level employees.

4. Major production, marketing and sales

   In this stage the company has completed the transformation from one engaged almost exclusively in research and development to one deeply involved in production, marketing and sales. Companies that have reached or are moving into this stage are far more involved in employing semi-skilled personnel for production, supply and distribution functions. As well, they are employing personnel with qualifications and experience in marketing, sales and finance. Research and development generally continues, but often as a smaller proportion of the company's overall operations.

The skill needs of management teams may also change as the focus of a company broadens from research and development to accommodate manufacturing, marketing and sales (Department of Education, Science and Training 2002a).

The findings of this study also highlighted several issues which have an important bearing on the provision of training for companies in emerging industries and, ultimately, on the competitiveness, even survival, of emerging industry companies in the international marketplace. These issues are discussed next.

Commercial acumen

Some respondents suggested that emerging industry companies in Australia tend to lack the commercial knowledge and skills needed to promote and profit from their ideas on the international market. One, who came from an overseas country, neatly summed it up as a lack of 'commercial acumen'. He advocated that all employees (even down to shop-floor workers) should have an awareness of the issues related to competition and entrepreneurship.

If Australian companies in emerging industries are to achieve anything like their full potential, this is an area of training that should not be overlooked.

Increasing competition from industrially developing countries

The managing director of a tooling company highlighted the effect on Australian companies of increasing competition from companies in industrially developing countries. He felt that companies in these foreign countries already had in place machines and equipment equal to the best in Australia and were in the process of acquiring the knowledge and skills to use them, through business arrangements and technology exchanges with Australian companies. Australia, he says, must strive to keep abreast of technological development and train employees in the use of the most modern equipment. Another respondent suggested that Australia has already lost a lot of its 'craft' industries to overseas competitors because it has failed to keep up to date with technological change. Yet another believed that this had led to companies, like his own, moving their manufacturing processes overseas. (This manager was planning to send employees to Thailand to supervise its product finishing operations in factories there.)

Overseas companies seek Aussie 'know-how'

We give a lot of on-site training. In the type of work our company does, every task is different, so we are constantly striving for better ways of doing things, constantly experimenting to find ways of doing it better and more cost effectively. We have to do this to stay competitive… For example, other countries such as China are well into CNC [computerised numerical control] and we have to keep up with them [technologically] to stay competitive. They have the technology but not the individual toolmaking skills we have developed over the years. What they are currently trying to do is buy those skills through business arrangements and technology exchanges. They are trying to learn from us how to do it—they've got the machinery, they just need the know-how. Once they get that they won't need us any more.

ToolingCo.

One of the biggest obstacles faced by innovative companies is the lack of training available for people working at the leading edge of technology or for people working in small, highly specialised sectors of industry. One company working in a specialised sector of the electrical industry found it impossible to obtain specialist and 'state-of-the-art' training for its employees. This company had to employ people with high-level underpinning knowledge and skills and then provide them with specialised in-house training—a solution employed by many of the case-study companies.

Highly specialised and leading-edge technology training not available

Even when the company recruits an employee with an Aircraft Maintenance Engineers' qualification, it cannot put them to work without on-job training. The type of work [our company] undertakes does not exist anywhere else in Australia. In-house training is necessary.

…I don't believe there is a recognised course available for aircraft draughtspersons. Essentially you find someone who can draw, and if they haven't worked in the aircraft industry, you have to train them. We have just put on a young fellow as a trainee draughtsman who is very good at CAD [computer-aided design] but knows nothing about aeroplanes. AeroEngCo.

Companies such as these also accepted that it was unrealistic to expect such specialised training to be available 'off-the-shelf'. In addition to providing their own training, a number of case-study companies also engaged in co-operative training ventures with an established registered training organisation (that is a training provider that is registered to deliver accredited training under the Australian Qualifications Framework). In such an arrangement, the registered training organisation and the company jointly customised existing training or developed new training. The training was delivered by the registered training organisation on-site, a good deal of it often being on-the-job. For example, an aircraft manufacturing company interviewed was, at the time of interview, establishing a training scheme in which the registered training organisation trainers would conduct formal training at the site for a full week, at the beginning of each month. The registered training organisation was also to provide the qualified assessors to conduct the assessments. In other cases, companies sent their employees off-site to access formal training. Where training was only available overseas (for example, speech recognition appliances), employees were sent overseas (Singapore) for training. If there were a number of employees that needed to be trained, then the company would arrange for the off-shore trainer to come to Australia.

Project management

Project management is particularly important to international clients because they are unable to visit the company regularly, but they want assurance about the progress of their job. ToolingCo.

Identifying training needs

Respondents identified a range of training needs that were especially important to companies operating at the leading edge of their field in emerging industries.

Report writing

Training in report writing would also be useful. I recently had to get on the internet and write research reports for a large US company. Good report writing is important to the image of the company. FanTechCo.

Endorsing the need for commercial acumen, many of the companies placed a high priority on training in the areas of commerce and business, particularly in general commercial skills, developing quotations for goods, drawing up contracts, developing and managing distribution networks, marketing, sales and project management. This training often needed to encompass the international environment because many of the companies were operating, or planning to operate, internationally. This international focus also prompted some companies to seek training in language and cultural awareness relevant to the countries they were dealing with.

Patent law

…all the patent laws in the European Union are radically different to what they were five years ago. I would like ongoing training for our employees who have to deal with this aspect of our work. CompositesCo.

Because the companies were often heavily engaged in research and development, training in research methods and report writing was especially important. These skills were needed to enable the companies to establish credibility as part of the process of getting their new ideas and products accepted. Other important areas of training in relation to development of new ideas and products were project management, management and protection of intellectual property, and also awareness and understanding of patent law.

Recognised standards

We are continually having to go back to text books ourselves to find out the right way to do it [testing]. We have to have our test rigs set up to international standards, so a course covering international standards as well as Australian standards would be valuable. When you start publishing results of experiments and will be quoting figures to overseas people in, say, Europe or the US, we have to be using an ISO standard. FanTechCo.

In support of their international plans and interests, some companies were keen to pursue training in the understanding and application of international (ISO) standards.

But what has been learned?

One of the biggest problems we have is trying to decipher what applicants have actually done in their training. A lot of people coming through with electronics certificates have actually studied more in computer software electronics. We have found it hard to determine what their skills and knowledge are before we actually interview them. Many know a lot about computer-related technology but can't work with a circuit board. Out of 30 applicants for a position, we might interview six, and out of that six, only find one that is suitable. To minimise this problem, we really have to spell out in detail what we want.
ElectroChargeCo.

Specification of qualifications

Several companies highlighted a problem they encountered in understanding the nature of the qualifications cited in job applications. As already noted, the fact that these companies were working at the leading edge of knowledge and technology in their field meant that they relied on employees having highly-specific knowledge and skills. At times the qualifications cited by applicants did not provide adequate information for drawing up short-lists for selection interviews.

Conclusion

In this study we have identified the skill sets and training requirements of a group of companies developing new ideas and applying 'innovative technologies'. We have also identified attributes needed for various categories of occupations within such companies. The study has highlighted some important training issues faced by companies working at the leading edge of technology. This information has been used to derive important implications and directions for vocational education and training as it applies to companies engaged in innovation and operating in emerging industries.

Similar requirements to other companies—but with some important differences

At face value, the skills, knowledge and attributes identified for these companies are very similar to those required by companies which may not be operating in an 'emerging' or innovative field. To make a profit in a market economy, whether or not they operate in emerging fields or in more traditional business areas, companies certainly require adequate managerial, technical, financial and commercial expertise, together with quality assurance and occupational health and safety mechanisms.

In the early stages of an innovative company's existence, the workforce is often a small, closely knit group, sharing ideas and combining resources to solve the myriad problems encountered in developing a new idea—often with some degree of secrecy to protect the company's intellectual property. In choosing employees to work in such an environment, employers therefore especially seek people with suitable values, attitudes, and dispositions.

As with other companies, these companies wanted their managers to have a knowledge of the business and possess the managerial and supervisory skills to provide leadership, in the development and production of goods and delivery of services. What differentiates these companies from others are their innovative products and services—with many operating at the cutting, or leading, edge of their fields. Because of the nature of their work, these companies sought to recruit highly skilled, qualified and experienced personnel, especially for their research and development, technical, financial and managerial functions. Where formal qualifications were not the main criterion for employment, the companies, like those in other industries, hired people with proven track records and relevant skills and experience.

There was, however, an expectation that employees in the higher level knowledge occupations (for example, researchers, scientists, engineers, metallurgists, audiologists, technicians, accountants and marketers) would come with already highly developed fundamental skills and knowledge required for their occupations. The company would then build on these skills and knowledge, to develop highly specialised expertise and customise work roles and processes to company requirements.

The type of work carried out by clerical, and general support workers was no different from that which would be expected in any other organisation. However, the focus for those involved in management, research and development, technical operations, marketing, sales and accounting was much more specialised. These companies were heavily dependent on the accurate targetting of niche markets at home and abroad, also the ability to operate in an environment which required a knowledge of how to protect intellectual property in an extremely competitive international market. In addition, the international focus of many of these companies required key employees who were to operate in these international locations to possess knowledge of different languages and an understanding of different cultures. Increasingly there is a need for accountants and directors to have an understanding of legal issues, including statutory declarations and intellectual property concepts.

Implications for vocational education and training

The degree and higher-degree level qualifications often sought by these companies for their research and development, technical, marketing and managerial functions are available from institutions of higher education. Nevertheless, a large proportion of the skills, knowledge and experience identified by these companies can also be provided by the vocational education and training (VET) sector. It would be a mistake, however, to conclude that VET requires a major change in the number and types of courses and programs that are currently on offer.

Emerging industry companies need many of the same general courses as other technology-oriented companies. These include courses to develop the knowledge and skills of employees working in trades and other technical roles, clerical and administration functions, and manufacturing and production. They also require more specialised training in areas such as human resource management, computer operation, use of industry-specific and generic computer software packages (such as computer-aided design, word processing and spreadsheets), computer programming, project management, report writing, marketing, team building, language and culture, time management and quality assurance. These types of courses are already available in many VET institutions or can be developed by providers who have experience in working with enterprises to customise training for specific needs.

Customisation and, where feasible, development of new courses can play an important role in helping innovative companies acquire the highly specialised skills needed to operate at the leading edge of technology, access venture capital, then enter and compete in global markets. Areas of importance in this context include protection of intellectual property, application of patent law and commercial and marketing expertise. It can also include skills for negotiating contracts in different cultures. This collaboration can also provide the VET teaching staff with increased understanding of new technologies. In addition, company training facilities can be established to assist VET to provide specialised training to workers on-site.

Vendor training (training provided by the vendors of equipment and materials) was identified as one of the best ways for companies to access the most up-to-date training. VET providers and vendor providers may be able to gain mutual benefit by working co-operatively in providing training: VET in gaining knowledge of latest developments and vendors in gaining access to VET teaching facilities and expertise (for example, vendor trainers might undertake VET train-the-trainer courses).

Finally, in working with innovative companies, VET must recognise that company training needs will change as they move from research and development to manufacturing and trading. In their early stages of development, these companies often comprise a small nucleus of workers who are highly knowledgeable in specific areas and have high-order technological expertise. However, they may lack relevant knowledge of manufacturing design technology, strategies for the protection of intellectual property, patent law or procedures for raising and managing capital.

Towards the end of this development cycle, the focus of the companies will often have shifted to processes required for the manufacturing, packaging and selling of products. This requires knowledge and skills in production management, human resource management for a larger and more diverse workforce, as well as promotion and marketing of goods.

Concluding remarks

This study has identified training requirements of innovative companies operating in manufacturing environments. Although a considerable proportion of the skills and knowledge required by such companies is often provided by the higher education sector, VET also has an important role to play. In providing the training described in this report, the VET sector will be making an important contribution to the enhancement of Australia's reputation as an intellectually resourceful and innovative nation.

References

Australian Bureau of Statistics 1998, *Innovation in manufacturing 1996–1997,* cat.no.8116.0, ABS, Canberra.

—— 2002, *Research and experimental development 2000–2001*, cat.no. 8112.0, ABS, Canberra.

Department of Education, Science and Training 2002a, National Industry Skills Initiative Emerging Technologies Working Group report and action plan, September 2002, DEST, Canberra.

Department of Education, Science and Training 2002b, *Compendium 2002*, viewed July 2002, <https://sciencegrants.dest.gov.au/CRC/HTMLDocuments/Documents/PDF/Compendium_2002.pdf>.

Department of Foreign Affairs and Trade 2001, *Australia's trade: Influences into the new millennium,* Green Advertising, Canberra.

Department of Industry, Tourism and Resources 2002, unpublished data provided by IP Australia, September.

Smith, G 1999, 'Australia's innovative environment compared with USA experience', paper presented at the Australian Academy of Technological Sciences and Engineering seminar, Technology, Innovation and Australia's Future, July, Melbourne.

Appendix A

Table 15: Co-operative Research Centres operating in May 2002

Manufacturing Technology Co-operative Research Centres

- Advanced composite structures
- Australian maritime engineering
- International food manufacture and packaging science
- Welded structures
- Polymers
- Bioproducts
- Micro technology
- Intelligent manufacturing systems and technologies
- Cast metals manufacturing
- Construction innovation
- Functional communication services
- Innovative wood manufacturing
- Railway engineering and technology

Agriculture and Rural-based Manufacturing Co-operative Research Centres

- Sustainable production forestry
- Tropical plant protection
- Viticulture
- Cattle and beef quality
- Value-added wheat
- Sustainable aquaculture of finfish
- Australian cotton
- Australian sheep industry
- Sustainable sugar production
- Innovative dairy products
- Molecular plant breeding
- Sustainable rice production

Environment Co-operative Research Centres

- Waste management and pollution control
- Antarctica and the Southern Ocean
- Australian weed management
- Biological control of pest animals
- Catchment hydrology
- Coastal zone, estuary and waterway management
- Great Barrier Reef World Heritage Area
- Fresh water ecology

- Tropical rainforest ecology and management
- Tropical savannas management
- Conservation and management of marsupials
- Water quality and treatment
- Weed management systems
- Sustainable tourism
- Plant-based management of dryland salinity
- Greenhouse accounting

Mining and Energy Co-operative Research Centres

- Mining technology and equipment
- Australian petroleum
- AJ Parker, hydrometallurgy
- Clean power from lignite
- Coal in sustainable development
- Landscape environments and mineral exploration
- Predictive mineral discovery
- Australian renewable energy

Information and Communications Technology Co-operative Research Centres

- Enterprise distributed technology
- Australian photonics
- Sensor signal and information processing
- Australian telecommunications
- Satellite systems
- Smart internet technology
- Technology-enabled capital markets

Medical Science and Technology Co-operative Research Centres

- Cellular growth factors
- Eye research and technology
- Cochlear implant and hearing aid innovation
- Vaccine technology
- Diagnostics
- Aboriginal and tropical health
- Discovery of genes for common human diseases
- Asthma
- Chronic inflammatory diseases

Source: Commonwealth Department of Education, Science and Training (2002b)

Appendix B

Table 16: Technology group by proportion of total annual patent grants, 1991–2001

Technology group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Organic fine chemicals	12.0	12.6	12.0	11.5	10.7	10.0	11.4	10.7	11.1	9.4	9.2
Pharmaceuticals, cosmetics	5.2	5.6	5.4	5.4	5.9	6.4	6.7	7.6	9.4	8.9	9.1
Medical engineering	4.1	4.8	4.8	6.5	6.7	6.4	7.0	7.2	7.1	6.8	8.3
Telecommunications	3.5	4.2	4.5	4.8	5.3	5.1	6.7	7.5	7.0	8.5	7.3
Biotechnology	2.7	3.3	4.1	4.0	4.7	4.3	4.7	5.3	5.6	6.1	6.2
Civil engineering, building, mining	4.1	4.0	4.5	4.8	4.8	5.1	4.9	4.2	4.2	5.0	5.0
Handling, printing	4.0	4.3	4.6	5.0	4.7	5.1	5.7	5.3	4.4	4.6	4.9
Consumer goods & equipment	4.3	4.2	4.1	4.7	4.7	5.3	5.2	4.5	4.4	4.6	4.7
Analysis, measurement, control	5.2	4.9	4.8	4.9	5.8	4.9	4.6	4.9	4.9	5.3	4.5
Basic chemical processing, petrol	3.8	3.8	3.6	3.2	3.8	3.5	3.3	3.3	3.7	3.8	4.0
General processes	4.2	4.7	3.9	3.9	4.0	3.8	3.5	3.7	3.3	3.3	3.6
Macromolecular chemistry, polymers	6.5	5.8	5.8	5.0	4.4	4.6	3.3	3.9	3.8	3.4	3.6
Material processing	4.6	4.2	4.7	4.4	4.6	4.6	4.0	4.3	4.0	3.6	3.6
Electrical devices – electrical engineering	4.0	3.0	3.0	2.8	3.3	3.5	3.3	3.0	2.9	2.9	3.4
Information technology	2.0	2.0	2.2	2.0	2.0	2.5	2.1	2.1	2.5	2.8	2.6
Materials, metallurgy	3.4	3.3	3.3	2.9	2.7	2.8	2.3	2.8	2.6	2.6	2.5
Transport	2.5	2.7	2.9	2.7	2.8	3.1	2.8	2.7	2.8	2.8	2.4
Mechanical elements	3.0	3.0	3.4	3.7	3.2	2.8	3.0	2.7	2.2	2.1	2.2
Agriculture, food	1.9	1.9	1.9	1.9	1.6	2.0	1.7	1.8	1.9	1.9	1.9
Agricultural/food machinery	1.5	1.4	1.6	1.7	1.5	1.6	1.9	1.6	1.6	1.6	1.6
Surfaces, coatings	2.3	2.3	2.1	2.0	1.3	1.4	1.8	1.7	1.8	1.6	1.5
Optics	2.1	2.0	1.9	2.2	1.8	1.3	1.5	1.5	1.7	1.8	1.5
Mechanical tools	1.6	1.4	1.5	1.8	1.6	1.9	1.6	1.7	1.4	1.3	1.4
Engines, pumps, turbines	1.6	1.2	1.3	1.4	1.4	1.5	1.3	1.1	1.1	0.9	1.0
Thermal techniques	1.5	1.5	1.1	1.5	1.4	1.5	1.3	1.3	1.2	1.3	1.0
Audiovisual	1.3	1.3	1.6	1.3	1.5	1.4	1.1	1.1	1.4	1.0	0.9
Misc/not yet identified	5.3	5.0	3.5	2.1	1.9	1.7	1.6	0.9	0.5	0.5	0.8
Environment, pollution	0.6	0.6	0.7	0.9	1.0	0.9	0.7	0.9	0.8	0.7	0.7
Semiconductors	0.5	0.3	0.4	0.5	0.3	0.3	0.3	0.2	0.3	0.3	0.4
Space technology, weapons	0.6	0.4	0.5	0.4	0.5	0.3	0.5	0.4	0.4	0.4	0.4
Nuclear engineering	0.2	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1
All groups	**100.00**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Department of Industry, Tourism and Resources (2002)

Appendix C

Table 17: Technologies, by total number of patent grants for 1991–2001

Technology	Total number of grants over 1991–2001 period	% of grants
Organic fine chemicals	14 709	11.0
Pharmaceuticals, cosmetics	9 372	7.0
Medical engineering	8 527	6.4
Telecommunications	7 971	5.9
Analysis, measurement, control	6 674	5.0
Handling, printing	6 395	4.8
Biotechnology	6 292	4.7
Consumer goods & equipment	6 144	4.6
Civil engineering, building, mining	6 121	4.6
Macromolecular chemistry, polymers	6 102	4.5
Material processing	5 630	4.2
General processes	5 094	3.8
Basic chemical processing, petrol	4 880	3.6
Electrical devices – electrical engineering	4 276	3.2
Materials, metallurgy	3 802	2.8
Mechanical elements	3 768	2.8
Transport	3 661	2.7
Information technology	3 060	2.3
Misc/not yet identified	2 873	2.1
Agriculture, food	2 511	1.9
Surfaces, coatings	2 452	1.8
Optics	2 368	1.8
Agricultural/food machinery	2 131	1.6
Mechanical tools	2 055	1.5
Thermal techniques	1 766	1.3
Audiovisual	1 674	1.2
Engines, pumps, turbines	1 666	1.2
Environment, pollution	1 034	0.8
Space technology, weapons	611	0.5
Semiconductors	439	0.3
Nuclear engineering	157	0.1
Total	**134 215**	**100.0**

Source: Department of Industry, Tourism and Resources (2002)

Appendix D

Table 18: Technology areas by total patent grants for 1991–2001

Technology group	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Electrical devices – electrical engineering	506	393	383	324	318	315	316	439	392	408	482
Audiovisual	164	169	205	147	144	124	104	163	186	141	127
Telecommunications	446	535	573	562	515	461	630	1111	942	1179	1017
Information technology	250	264	284	236	198	224	198	314	338	388	366
Semiconductors	59	37	56	56	28	27	24	27	34	41	50
Optics	270	252	245	256	175	117	144	217	236	253	203
Analysis, measurement, control	657	633	614	573	559	442	440	719	668	735	634
Medical engineering	514	615	616	753	651	573	662	1065	965	951	1162
Organic fine chemicals	1515	1627	1528	1340	1034	901	1077	1595	1501	1306	1285
Macromolecular chemistry, polymers	818	751	740	586	427	409	317	571	516	469	498
Pharmaceuticals, cosmetics	651	721	690	632	569	579	638	1121	1269	1233	1269
Biotechnology	338	420	520	470	452	389	446	785	752	851	869
Materials, metallurgy	427	428	419	336	263	253	215	409	349	360	343
Agriculture, food	236	251	240	227	159	184	158	265	262	269	260
General processes	529	604	495	451	388	344	332	547	449	453	502
Surfaces, coatings	293	301	265	228	130	127	174	257	238	225	214
Material processing	575	538	597	509	441	413	376	631	540	507	503
Thermal techniques	191	187	146	178	138	136	126	195	156	175	138
Basic chemical processing, petrol	476	494	464	373	370	317	314	485	503	530	554
Environment, pollution	81	83	87	100	95	85	70	132	102	95	104
Mechanical tools	200	184	187	208	151	168	155	245	183	182	192
Engines, pumps, turbines	204	160	165	158	138	132	119	169	145	131	145
Mechanical elements	381	382	436	433	309	250	288	399	301	287	302
Handling, printing	507	557	586	582	458	455	538	784	600	645	683
Agricultural/food machinery	184	175	206	204	142	147	177	240	218	220	218
Transport	318	346	368	312	266	283	264	403	376	386	339
Nuclear engineering	19	19	12	24	12	15	6	12	12	13	13
Space technology, weapons	81	57	66	52	45	31	48	61	60	61	49
Consumer goods & equipment	547	539	526	548	455	475	496	668	601	639	650
Civil engineering, building, mining	521	516	567	561	463	457	461	623	567	693	692
Misc/not yet identified	673	650	441	245	179	154	151	132	68	66	114

Source: Department of Industry, Tourism and Resources (2002)

Appendix E

Table 19: Subject matter of trademarks registered in 1999–2001

Trademark class 1	No. of registrations		Increases over period	
	1999–00	2000–01	Number	%
Scientific and commercial apparatus or instruments	3 007	5 016	2 009	66.8
Advertising and business services	1 910	3 641	1 731	90.6
Educational and entertainment services	1 588	2 642	1 054	66.4
Clothing, including footwear and headgear	1 723	2 522	799	46.4
Paper and printed matter, stationery	1 472	2 422	950	64.5
Pharmaceutical products, herbicides, pesticides	1 335	2 098	763	57.2
Insurance and financial services	871	1 639	768	88.2
Bleaching, cleaning preparations, perfumery, cosmetics	845	1 410	565	66.9
Coffee, tea, cocoa, sugar, spices, flour, cereal products	946	1 382	436	46.1
Communication services	574	1 154	580	101.0
Articles for sport or amusement, armaments	739	1 109	370	50.1
Construction and repair services	652	1 042	390	59.8
Meat, fish, poultry, dairy products, edible fats, preserves	697	1 012	315	45.2
Wines, spirits, liqueurs	504	958	454	90.1
Adhesives, preservatives, industrial chemicals	543	867	324	59.7
Machines, machine tools	538	816	278	51.7
Lighting, heating, cooling, ventilating, water supply	481	807	326	67.8
Transport and storage services	442	773	331	74.9
Vehicles, ships, aircraft	485	768	283	58.4
Surgical, medical, dental instruments and apparatus	504	729	225	44.6
Fresh fruits and vegetables, animal products	382	704	322	84.3
Cast and rolled metal products	407	654	247	60.7
Furniture etc.	422	641	219	51.9
Domestic utensils, glassware, brushes, sponges, etc.	415	623	208	50.1
Leather goods	388	614	226	58.2
Beer, ale, porter, mineral and aerated waters	360	571	211	58.6
Jewellery, clocks, precious metals and stones	286	529	243	85.0
Building materials, natural and artificial masonry	335	512	177	52.8
Piece goods, linen and textiles not included elsewhere	291	394	103	35.4
Packing, stopping and insulating materials	209	303	94	45.0
Material treatment services	192	301	109	56.8
Cutlery, side arms, hand tools, instruments	149	259	110	73.8
Paints, varnishes, lacquers, dyes	188	230	42	22.3
Fuels, oils, greases, tallows, waxes	131	223	92	70.2
Haberdashery	66	130	64	97.0
Tobacco, matches, other smokers' articles	109	122	13	11.9
Rope, string, cordage, tents and tarpaulins	97	120	23	23.7
Carpets and floor coverings	72	102	30	41.7
Yarns, threads	16	52	36	225.0
Firearms, ammunition, explosives	28	47	19	67.9
Musical instruments	24	31	7	29.2
Miscellaneous	2 065	3 752		
All trademark subject areas	26 488[2]	43 721[2]	17 233	65.1

Notes: [1] The complete description of the 42 classes is set out in the Fourth Schedule to the Trade Marks Regulations
[2] This is the sum of the column above this number, which is more than the total of registered trade marks, since trade marks may be registered in more than one class. Each trade mark is registered, on average, in about 1.6 classes

Source: Department of Industry, Tourism and Resources (2002)

NCVER

The National Centre for Vocational Education Research is Australia's primary research and development organisation in the field of vocational education and training.

NCVER undertakes and manages research programs and monitors the performance of Australia's training system.

NCVER provides a range of information aimed at improving the quality of training at all levels.

ISBN 1 920895 39 6 print edition
ISBN 1 920895 40 X web edition