

# Skills and capabilities for Australian enterprise innovation

# 10

PROJECT

FINAL REPORT

AUSTRALIAN ACADEMY  
OF THE HUMANITIES

AUSTRALIAN  
ACADEMY OF SCIENCE

ACADEMY OF THE SOCIAL  
SCIENCES IN AUSTRALIA

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# Skills and capabilities for Australian enterprise innovation



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IN AUSTRALIA



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# Acronyms

ABS	Australian Bureau of Statistics	HEFCE	Higher Education Funding Council for England
ACCI	Australian Chamber of Commerce and Industry	ICT	Information and Communication Technologies
ACOLA	Australian Council of Learned Academies	IP	Intellectual property
B/HERT	Business/Higher Education Round Table	ISA	Innovation and Science Australia
BCS	Business Characteristics Survey	MRCF	Medical Research Commercialisation Fund
CEDA	Committee for Economic Development of Australia	NCVER	National Centre for Vocational Education Research
CRC	Cooperative Research Centre	NESTA	National Endowment for Science, Technology and the Arts (UK)
CRDC	Cotton Research and Development Centre	NFP	Not-for-profit
DET	Department of Education and Training	OECD	Organisation for Economic Collaboration and Development
DoI	Department of Industry, Innovation and Science	QUT	Queensland University of Technology
DVC	Deputy Vice Chancellor	R&D	Research and Development
EABLD	Expanded Analytical Business Longitudinal Database	RDA	Regional Development Australia
EEG	Engineering Excellence Group (Laing O'Rourke)	SAF	Securing Australia's Future
GII	Global Innovation Index	SME	Small and medium-sized enterprises
GVC	Global Value Chains	STEM	Science, Technology, Engineering and Mathematics
HASS	Humanities, Arts, and Social Sciences	UA	Universities Australia
		UTS	University of Technology Sydney
		VC	Vice Chancellor
		WIL	Work Integrated Learning



# Project aims

It is widely accepted that Australia needs an innovative, flexible and creative workforce with the capabilities to enable the country to maximise its opportunities. While technical and scientific capabilities are recognised as critical, there is a growing awareness that innovation also requires people who understand business, systems, culture and the way society uses and adopts new ideas. Business innovation and productivity therefore requires the interaction of a broad range of technical and non-technical capabilities. International studies have found that while building capabilities is a high strategic priority for companies and the required capabilities have evolved, the methods for building those capabilities have not. This project seeks to examine the way that Australia's high-performing enterprises identify, manage, build and mix the capabilities to succeed.



Approved aims of the project:

1. Examine how high-performing Australian enterprises identify, manage and build key capabilities.
2. Identify how technical and non-technical (usually considered to be respectively STEM and HASS-based) capabilities interact in high-performing Australian enterprises in the context of innovation challenges.
3. Outline the human resource strategies, leadership and organisational structures in such enterprises.
4. Consider the effects of innovation on both SME and large firm performance.
5. Identify best practice and findings (from both Australia and overseas) that will assist the development of policies and programs by government, industry and education institutions.



# Executive summary

## Aim

Australia needs an innovative, agile and creative workforce with the skills and capabilities to secure its future productivity. This report aims to fill a significant gap in Australia's understanding of innovation, in particular how diverse skills and capabilities—especially technical and non-technical skills—work together in enterprises to foster innovation.

Specifically, this report:

1. investigates the extent to which technical and non-technical skills underpin the different forms of innovation (technological, operational or process, product and marketing)
2. examines how innovative Australian enterprises identify, manage and build technical and non-technical skills and capabilities, and how the interaction of these skills and capabilities meets innovation challenges
3. explores the potential for industry, education and government responses to promote optimal investment in human skills and capabilities that support enterprise innovation.



## Research conducted

This project has analysed skills mixing through a range of data-gathering and research activities: desk research; comprehensive literature reviews; Expert Working Group meetings; 19 interviews with senior executives in highly innovative Australian organisations; commissioned research, which included a statistical investigation of data from the Expanded Analytical Business Longitudinal Database, augmented by analyses of Australian Bureau of Statistics' Business Characteristics Survey data; and a study on the roles of government, industry, and education and research institutions for developing innovation capabilities, incorporating interviews with over 30 experts on innovation practice and policy.

## Summary of research results

### **Innovation requires a diverse mix of skills and capabilities**

The basis for innovation—including new products, services, processes or business models—in a knowledge-based economy is diverse and pervasive. Innovation is not just based on research, science or technology, or even on entrepreneurial skills. Managerial and marketing skills, organisational, social, economic and administrative knowledge, and intellectual and creative capacity are also required to successfully translate new opportunities, ideas and discoveries into innovation.

The current focus on science and technology skills inputs is not sufficient to address Australia's shortcomings in innovation. A distinguishing feature of Australia's leading innovative enterprises, both for-profit and not-for-profit, is that they access and thoroughly mix technical and non-technical skills and capabilities as a basis for success.

Statistical analyses of large-scale Australian data corroborate that a broad range of different skills are associated with different types of innovation. The future of high value, high paid work depends on Australia learning the lessons from leading innovative enterprises, such as those discussed in this report.

The findings and implications of this report have the potential to broaden yet complement the current policy focus on science and technology, enabling a more holistic approach to tackling Australia's innovation challenges that teams humanities, arts and social sciences (HASS)-based skills with science, technology, engineering and mathematics (STEM)-based skills.

## Australia can become a more efficient innovator

The 2015 Global Innovation Index reveals that Australia is a relatively inefficient innovator. The Index ranks input measures (institutions, human capital and research, infrastructure, market sophistication, business sophistication) and output measures (knowledge and technology, creative) of 141 countries. Australia's overall ranking for innovation inputs is reasonable (10<sup>th</sup>). However, the overall ranking for innovation outputs is significantly lower (24<sup>th</sup>). This disparity means Australia has a low innovation efficiency ratio score.

The Index indicates that Australia generally has the relevant skills but lacks the capacity to manage and use these skills and other inputs for innovation. In particular, the Index indicates shortcomings in the capacity of Australian businesses and the overall innovation system to bring innovations to application and to disseminate them in markets and society. Australia has low scores in business sophistication

inputs (24<sup>th</sup>), with particular shortcomings in innovation linkages (38<sup>th</sup>) and knowledge absorption (63<sup>rd</sup>), and low scores in knowledge and technology outputs (39<sup>th</sup>), especially knowledge impact (32<sup>nd</sup>) and diffusion (99<sup>th</sup>). See Chapter 2 for details.

## Australia's innovative enterprises thoroughly mix technical and non-technical skills for innovation

Successful innovation into the future depends on the core components of the Australian innovation system—Australian enterprises, education practice, and government policy—moving beyond a dominant focus on technical skills to also consider the other sets of skills that are necessary. Technical skills are necessary, and in many cases foundational, but are not sufficient for successful, sustained innovation.

This report takes the approach of 'bundles' of skills for innovation by framing:

- individuals as bundles of skills and competencies
- teams and organisations as bundles of people with complementary skills
- networks as bundles of organisations (networks, supply and value chains).

This is in line with international evidence that investing in human capital is a critical element in driving higher levels of innovation. However, it is not simply a matter of increasing the supply and diversity of skills at the individual level. Rather, it is how skills are brought together within organisations, industries and innovation 'ecosystems'. It is also how these skills are combined with physical capital and effective organisational systems to yield fresh ideas that generate new products or services, new applications of technologies in production, and new ways of marketing and distributing those goods and services. This approach aligns with the shifts in thinking about innovation over recent decades, from 'first generation' linear approaches, to 'second-generation' systems approaches, to 'third generation' ecological approaches. See Chapter 3 for details.

Organisations need the competencies to source and retain this skills mix and position themselves as valuable partners in the innovation ecosystem. This report shows how leading innovative Australian enterprises identify, manage, build and mix the skills and capabilities needed to meet innovation challenges and succeed in increasingly competitive, digitally-disrupted, globalised markets.

While there is a widespread perception that STEM-related skill shortages are inhibiting innovation, this is generally not the case among Australia's leading innovative enterprises. Instead, innovative organisations exhibit distinctive ways of addressing the challenges by efficient skills mixing for innovation, at the individual, organisational and systems/sectoral level.

## Innovation requires skills mixing in individuals

Highly innovative organisations interviewed for this report focus strongly on acquiring and developing the broad skills they need to be innovative. Most attribute their recruitment success to using non-traditional human resources (HR) approaches and providing a desirable work environment.

They spend substantial time and resources finding and developing the right employees. They recognise that attitudes, cultural fit with the organisation, and 'cleverness' or 'emotional intelligence' are as important, if not more important, than technical skills requirements. As well as relevant technical (professional) skills, candidates also need to possess non-technical skills, such as analytic and critical thinking, problem solving, social or cultural knowledge, creativity, leadership, communication and people skills. This often makes technical skills and disciplinary fields a secondary consideration.

These organisations invest in developing technical and other skills internally, while also accessing skills and information related to innovation through their external networks. While larger companies can invest more in specialised staff and achieve a skills mix through specifically

assembled teams, start-ups need leaders with broad skills and can add additional skills variety through contractors.

In addition, innovative organisations support other opportunities for sharing knowledge internally or externally. Highly innovative organisations embrace opportunities to include and exchange knowledge with students at any time of their education, such as through cadetships, internships and joint PhD projects. Such Work Integrated Learning (WIL) can provide exposure to potential future employees, expose the organisation to new ideas, and provide an inexpensive way to approach ideas and projects that would otherwise be neglected. However, WIL requires strong resource commitment, and is very uneven across the undergraduate university experience.

For decades, major reports have identified shortcomings in leadership and management capability in Australian enterprises. Highly innovative organisations consciously develop expertise in leadership and management capability by investing in recruitment, graduate programs and job rotation, internal development, and offering appropriately designed jobs and work-life balance initiatives. Such leadership and management skills are less evident in small and medium enterprises (SMEs), including entrepreneurial start-ups.

Formal education no longer provides a sufficient skills basis for the rest of a person's working life. Individuals and organisations need continual skills development, while universities and other teaching institutions need to teach more broadly across disciplines, covering transferable skills alongside specialist knowledge. Highly innovative organisations provide considerable training and encourage self-directed learning and other forms of continuous development. Especially in areas where skills are outdated very quickly, organisations focus on learning abilities and more fundamental skills.

Highly innovative organisations also pay attention to how work is organised (often focusing on flexibility and autonomy), incentive structures and clear career pathways. The

'right' work environment frequently includes non-traditional review and career progression arrangements, social spaces and amenities, flexible work conditions, work-life balance initiatives and health checks. As employers, these organisations view themselves ideally as social communities that empower members to unfold their innovative capabilities. See Chapters 4 and 5 for details.

### **Innovation requires skills mixing across teams and across organisations**

To maintain their external focus, cross-functionality and adaptiveness, leading organisations form teams by hiring staff from outside their own sector.

Innovative organisations do not rely on new people simply being 'work ready'. Leaders in these companies are especially aware of the need to future-proof against the increasing commoditisation of technical skills. Job development and rotation are important to develop a whole-of-organisation mindset.

Diversity in its various forms—including skills diversity—is critical in all innovative organisations. The need for skills diversity is based on the realisation that much innovation happens at the intersection of different disciplines and ways of thinking about problems. Highly innovative organisations have strong track records of 'holism' in their HR approaches.

However, the evidence suggests that, on average, organisations are underinvesting in the types, level and mix of skills required to be innovative. Lean management principles focusing only on core competencies can lead to a narrowing of skills sets, hollowed out middle management and undervalued HR departments operating under pressure. In contrast, innovative organisations recognise the value and importance of HR and skills considerations, irrespective of the size of the enterprise or formality of the HR function.

Accessing skills both internally and externally is an essential element of third generation innovation thinking. The viewpoints and ideas from other organisations, often outside the sector, are greatly valued in advancing innovation. Innovative organisations use partners, contractors, networks and clusters to access external expertise to complement their internal skills. This is particularly the case for smaller organisations or start-ups with limited resources to attract and retain internal skills diversity.

These innovation skills requirements set expectations for the design of undergraduate and postgraduate curricula, for where companies need to invest in training and development, and for government considerations in designing frameworks for national strategies around skills development.

## Meeting innovation challenges over time

Innovative companies interviewed for this project support the findings of previous research that shows leaders who are 'T-shaped'—those with deep knowledge in one field and broad understanding across many other fields—tend to run more innovative organisations. Leadership for innovation often requires stepping outside the company's traditional core competencies to develop diversity of skills at all levels of the organisation.

As noted, innovative organisations highly value employee skills beyond technical specialisations. In particular, they often regard an understanding of global markets, competition and customers as essential to understand the organisation's full value proposition. Almost all the innovative organisations interviewed are connected to global supply chains and clusters that enable growth to support innovation.

An invaluable attribute for successful innovators is to understand innovation from the perspective of customers and users of products and services. Innovative organisations are developing skills that help them make sense of customer information and deduce what customers will want next.

Innovation and related activities are characterised by a high degree of uncertainty. Investments that contribute to innovation often do not pay off immediately, but require a long-term approach. In contrast, shareholder and business expectations may emphasise short-term profits over long-term sustainability and reinvestment. To sustain innovation, organisations need to balance these competing demands. Highly

innovative organisations shield their business from a profit-driven, short-term focus, instead focusing on longer-term sustainable generation of value. This relates to both capital and skills investment for innovation.

Where necessary, innovative enterprises invest heavily in research and development (R&D) including through collaboration and partnerships with universities. They ensure R&D activities are well-connected with their business and financial experts to avoid developing innovations with limited potential for generating value. Innovative companies practice bringing together technical engineering and complex stakeholder-centric thinking, and actively prepare for future workforce requirements.

The Industry Growth Centres initiative can improve Australia's innovation performance, and the re-elevation of CSIRO's role in innovation transfer between research and industry, as described in the National Innovation and Science Agenda, is a first necessary step towards optimising partnerships across the innovation system.

Government policy can support dynamism and flow within the innovation system by facilitating collaboration and cooperation. A major role for government is providing conditions that support the mix and use of skills beyond organisational and sectoral boundaries. The National Innovation and Science Agenda intends to stimulate collaboration between researchers/academics and business. However, it does not address the need for improved collaboration between enterprise and the tertiary education sector in general, or measures to increase business-to-business collaboration for innovation. Innovation policy should also provide a balanced narrative about the major inputs to innovation, including the contribution of HASS disciplines alongside STEM disciplines.

## Findings and implications

### Overarching findings and implications for enterprise, education and government

#### **Finding 1**

***Innovation policy-makers, industry leaders and innovative organisations increasingly recognise the complex ecosystem required to support enterprise-level investment in skills and innovation.***

Government, industry, and education and research institutions can tackle Australia's innovation challenges by adopting holistic system-level approaches to innovation policy settings.

This involves integrating and aligning policy responses designed to influence investments in skills and capabilities for innovation, at the individual, enterprise and system level. There is a crucial role for the newly established authority Innovation and Science Australia to refine and target Australia's performance in skills mixing for innovation.

#### **Finding 2**

***By international standards Australia has an average track-record of innovation, reflecting issues across all levels of the innovation ecosystem. In particular, Australia could more effectively turn innovation inputs, such as investments in human capital and research, into knowledge and technology innovation outputs.***

Government, industry, and education and research institutions can more efficiently turn innovation inputs into outputs.

While the Industry Growth Centre initiative has prompted some changes to research and commercialisation in specific industries, further incentives could increase collaboration for innovation, dissemination of outcomes, and the general external focus of organisations. A National Innovation and Science Agenda initiative, Australia's Global Innovation Strategy, aims to promote links with leading international

bodies. Future innovation policy could place a heightened focus on collaboration in general, with higher-order skills integration for innovation built into this collaboration model.

#### **Finding 3**

***Highly innovative organisations are embedded within strong innovation ecosystems that enable access to skills bundles. As well as internal skills development, they use external labour markets, and collaborative relationships with other organisations and networks.***

Government, industry, and education and research institutions can support innovation by encouraging the formation and integration of networks and clusters.

This includes government investment in regional infrastructure (e.g. business parks) and co-location with universities and research institutions. While tax incentives to locate in specific regions can accelerate cluster formation, it is also important that this proximity of complementary enterprises provides sufficient long-term benefits. The Industry Growth Centres are a ready mechanism to support such developments. This model could be extended beyond the current five centres, after a review of their effectiveness.

#### **Finding 4**

***Highly innovative organisations develop employees with broad knowledge bases and strong integrative skills (beyond a single discipline). The bundles of required skills vary across the innovation cycle and include technical skills (science, technology, engineering, mathematical, digital) and non-technical business skills (business, management, financial, marketing) as well as creative, design, interpersonal and entrepreneurial skills. Highly innovative organisations use sophisticated recruitment and retention practices, internal training and development, incentive systems, strong cultures and engagement. They typically take a long-term approach to investing in and building skills bundles that support their innovation strategy.***

Government, industry, and education and research institutions can assist individuals, organisations and the innovation system to build a broad base of skills and update these skills over the lifetimes of individuals and organisations.

This strategy may include broader learning opportunities within more well-defined educational pathways for individuals, as well as assisting organisations to provide training (on and off the job) to encourage the development of broad skills bases among their employees.

There are also opportunities for government, industry and education and research institutions to foster and promote longer-term approaches to innovation success.

The National Innovation and Science Agenda recognises the need for tolerating failure in entrepreneurial activities. This attitude is also necessary to support innovation in general.

Organisations can take more responsibility for developing the skills required for innovation. However, policy changes may also be required to sustain these efforts, such as grants for R&D (which can be based on specific requirements, e.g. collaborative innovation).

## Findings and implications related to individual skills mixing

### ***Finding 5***

***Innovative organisations require individuals with a range of skill sets beyond technical skills and who are willing to adopt a life-long learning approach to acquiring new skills.***

Joint action from government, industry, and education and research institutions can enable individuals to acquire and continue to develop a more holistic and integrated profile of diverse skills.

These skills profiles will typically involve integration of:

- expert skills, based on disciplinary background
- work or 'employability' skills, such as communication, teamwork, planning and organisational skills

- problem solving and higher-order integration skills
- skills that enable theoretical knowledge to be translated or applied to practice.

In particular, education institutions can extend the:

- creation of articulation pathways between vocational education and training (VET) and university-level programs
- introduction of WIL as part of undergraduate and graduate programs across disciplines, including internships and practicums, and applied or translational PhD programs
- integration of innovation skills into technical disciplines delivered at the VET, undergraduate and graduate program levels, such as design thinking and digital literacy, collaboration and teamwork, and problem solving.

Many of these initiatives place some responsibility on enterprises to participate more actively in skills development through:

- identifying opportunities for WIL, internships and graduate programs that enable 'hands on' development of work-related skills in industry organisations
- contributing to curriculum development where programs seek to develop employability or other work-related skills
- signalling the importance of broad-based innovation skills in recruitment and selection, career development and incentive structures.

The diffusion of such initiatives may require policy initiatives by government to encourage or direct industry and education/research institutions to change their practices, including reforms related to:

- extending existing institutional arrangements designed to support dialogue and collaboration between government, industry and education/research institutions
- providing tax and other incentives for organisations to invest in skills and to participate in WIL

- formulating new skills frameworks that recognise holistic and integrated skills needs within traditional trades and disciplines
- creating new pathways and incentives that encourage individuals to develop more diverse bundles of skills (for example, combining a VET certificate with an undergraduate program)
- employment regulation supporting the use of internships as part of formal training programs promoting skills for innovation in school curricula, to integrate an emphasis on entrepreneurship and coding, for example, into more holistic skill sets. The National Innovation and Science Agenda initiative 'Talent and Skills – Best and Brightest' could be broadened to embrace integrative skills for innovation
- SMEs may require assistance to facilitate graduate training programs, for example, through pooling across organisations, as done in some apprenticeship degrees.

#### ***Finding 6***

#### ***Highly innovative organisations overcome significant barriers to innovation through strengthening management and leadership capabilities.***

Government, industry, and education and research institutions can enable individuals to acquire and continue to develop high-level management and leadership skills.

Managing innovation requires skills in collecting and assessing ideas, presenting and promoting ideas and concepts, leading product/service development and testing and marketing new products and services.

Management and leadership skills can be developed through a number of mechanisms, many of which are currently in use, but not necessarily widely accessed or available. Online education platforms provide a low cost means to deliver such programs at scale to widely dispersed groups of organisations and individuals.

A wide variety of benchmarks and diagnostic tools are available for assessing leadership capabilities, such as the Leadershift platform funded by the Australian Department of Employment.

Industry has a critical responsibility to foster management and leadership capabilities. As well as directly investing in management training, organisations can:

- introduce mentorship programs with experienced managers to internally disseminate leadership knowledge and encourage and provide time for self-directed study and development
- use secondments across partner/collaborating organisations, for example suppliers or clients can provide new opportunities for new managers to build their domain-specific and management expertise.

Education institutions also need to take action in educating the future workforce. There is a need to emphasise broad relational and problem solving skills applicable across all disciplines. For tertiary education, this may require new curriculum developments that build skills mixing, by:

- integrating management subjects in non-business degrees, and embedding technical programs in business and arts degrees
- providing internship opportunities and practicum subjects within academic programs
- creating opportunities to complete more practical certificate-level programs while completing a degree program
- organising student projects that span across faculties.

#### ***Finding 7***

#### ***Higher education students can develop a more holistic understanding of the skills required for innovation through greater exposure to enterprise workplaces.***

More university programs can expose students to a holistic WIL experience, which includes longer-term projects with a range of industry organisations.

Universities and industry can work together to develop more extensive and better resourced WIL policies and practices. Such policies need to focus on exposing students to higher-order integration skills and champion those skills as a fundamental feature of successful enterprises.

## Findings and implications related to team and organisational level skills mixing

### ***Finding 8 Innovative organisations need diverse bundles of people, as well as people with diverse bundles of skills.***

Australia's 'economy in transition' can strive to build a capacity more aligned to '21<sup>st</sup> century' skills, which include higher-order integration, or holism, as a common attribute.

This will help address Australia's underperformance in research translation and collaboration between enterprises. For example:

- education institutions, especially tertiary education, can offer courses that span multiple faculties
- enterprises can cultivate organisational cultures and practices that more purposefully assemble teams with diverse skills
- government can facilitate skills diversity by promoting best practice and assisting businesses, especially SMEs, with advice and education on how to organise teams for innovation—the U.S. Small Business Administration provides an international model, and a comparable role could be built into Australia's Industry Growth Centres
- state and territory governments can extend their R&D voucher systems to cover holistic skills development and training
- Innovation Science Australia can build these insights into its program of policy development around skills for innovation.

### ***Finding 9***

### ***Innovative organisations have well-developed HR systems to enable access to diverse skills and also organise their work to support innovation.***

The Australian Institute of Company Director's diploma and other such courses can support innovation by including HR, skills diversity and skills mixing.

More managers can embrace the importance that leading companies place on 'instilling a talent mindset', and on how HR practices can be used to successfully recruit skills for innovation. This often includes a focus on attitudes rather than skills alone, and encouraging involvement in activities beyond formal education. Expertise in recruiting and retaining talent are critical factors for innovation; innovative organisations enable individual, team and 'life' skills.

## Findings and implications related to systems level skills mixing

### ***Finding 10***

### ***More third generation innovation thinking and practices will support a stronger innovation culture in Australia.***

Government plays a crucial role in facilitating collaboration and cooperation for innovation.

Governments and policy makers could, for example, balance calls for teaching coding in every Australian school with the evidence from this report. Exposure to the practical ways in which organisations mix technical and non-technical skills to meet innovation challenges is critical to prepare current students for the future of work.

Government and policy makers can also collect better information on skills needs, use and expectations in the future, for instance through expanding and optimising the Expanded Analytical Business Longitudinal Database (EABLD) survey administered through the Australian Bureau of Statistics to take into account the complex dynamics and interactions inherent in third generation innovation.

Such practices would enable better advice to students, schools and higher education institutions. Government collaboration with forecasting teams, such as those engaged with the CEDA report may be another option. There could also be better data collection and use along with greater collaboration between universities and business chambers.

**Finding 11**

***Deeper collaboration across enterprise boundaries, including integrating Australian organisations into global value chains, will significantly improve Australia's innovation performance.***

Future innovation policy could focus more on developing the skills for innovation within a broader skills development context. In addition Innovation and Science Australia could extend its role to cover holistic skills for innovation and consider:

- developing and supporting sector-specific management education and training, and related skills development, for entrepreneurs and managers in high-growth businesses
- funding 'higher apprenticeships' in Industry Growth Sectors, as agreed with Growth Centre Chairs
- encouraging co-investment in tertiary education–industry skills development programs
- showcasing careers of 'VET-trained business entrepreneurs' who become employers
- highlighting why and how employers can (or don't) take on 'learners' as graduates, interns or apprentices.

Government's major policy instrument to incentivise enterprise innovation, the R&D Tax Incentive, could be refined to more directly address the findings in this report. For example, a proportion of the incentive devoted to 'profit contingent' loans could be coupled with pre-requisites for skills development measures or for collaborative arrangements. There are two possible reasons for rethinking the basis of government subsidies in the R&D area, to move away from total reliance on grants and towards loans of this type: (i) the difficulties associated with establishing causal links between subsidies and value-added innovation behaviour implies concern with monitoring and establishing the connection between subsidies and R&D outcomes; and (ii) loans systems, particularly generously designed loan systems, have the great potential for achieving similar outcomes as grants at far less cost to taxpayers. Details on what a respective scheme could look like are in Chapter 5.

Tax incentives, for example for employing PhDs in industry, could also be deployed to address the low levels of collaboration and knowledge transfer between Australian industry and education/ research institutions which inhibit the development and diffusion of new innovations. Enterprises could be eligible to claim a tax incentive for the employment of PhD graduates. Administrative arrangements should be developed to ensure continuity of employment and protection of employee rights.

**Finding 12**

***Investment in innovation ecosystems in specific industries and regions will significantly improve Australia's innovation performance.***

Enterprises can do more to engage with local clusters and integrate themselves into networks of innovation on a national and international level. This could include investments in collaborative projects, such as joint spin-off companies.

Education institutions can also increase initiatives to become active in clusters, precincts and enterprise networks.

Also organisations need to engage more with local clusters and integrate themselves into networks of innovation on a national and international level. This could include investments in collaborative projects, such as joint spin-out companies.

Government and policy makers, however, provide the conditions that make it attractive for both

organisations and education to co-locate in clusters. Overseas, initiatives that appear to have worked include sponsoring infrastructure, such as business parks, and providing incentives for businesses to locate there through tax breaks. Government's main role is to facilitate and connect organisations. For instance, government can provide services through sub-contractors to find innovation partners. Governments can also be significant players in regional/sectoral ecosystems through their procurement practices.

The National Innovation and Science Agenda acknowledges that the Australian Government has a significant spend on procurement, but ranks only 70<sup>th</sup> out of 141 countries on how well its procurement fosters innovation. Drawing on lessons from the US Small Business Innovation Research and the UK's Small Business Research Initiative, government can apply insights developed in this report to better embed skills for innovation through procurement.



# Introduction

## Summary

**Innovation as a concept is much broader than technical breakthroughs and discoveries. It encompasses the diffusion of technologies, techniques and ideas across organisations, industries and countries.**

**While technical skills are recognised as essential for innovation, the role of non-technical skills and capabilities is not well understood. Previous *Securing Australia's Future* reports have pointed to the importance of skills mixing for innovation.**

**This report analyses skills mixing through a range of data-gathering and research activities: desk research; comprehensive literature reviews; Expert Working Group meetings; 19 interviews with senior executives in highly innovative Australian organisations; commissioned research, which included a statistical investigation of data from the Expanded Analytical Business Longitudinal Database, augmented by analyses of Australian Bureau of Statistics' Business Characteristics Survey data; and a study on the roles of government, industry, and education and research institutions for developing innovation capabilities, incorporating interviews with over 30 experts on innovation practice and policy.**



*The talent and skills of our people is the engine behind Australia's innovative capacity. We need to create an environment that attracts the world's best and brightest, while making sure Australians are equipped with the skills they need to thrive in a rapidly evolving workforce.*

Australian Government (2015), *National Innovation and Science Agenda*, December 2015

*Throughout the major U.S. tech hubs, whether Silicon Valley or Seattle, Boston or Austin, Tex., software companies are discovering that liberal arts thinking makes them stronger. Engineers may still command the biggest salaries, but at disruptive juggernauts such as Facebook and Uber, the war for talent has moved to non-technical jobs, particularly sales and marketing. The more that audacious coders dream of changing the world, the more they need to fill their companies with social alchemists who can connect with customers... Such nuances elude policymakers, who can't shake the notion that tech-centred instruction is the only sure ticket to success.*

Anders (2015), *Forbes Magazine*, July 2015

## 1.1 Objectives

Australia needs an innovative, flexible and creative workforce with the skills and capabilities to maximise its opportunities and meet its challenges. Technical and scientific capabilities are widely recognised as critical, and several Australian Council of Learned Academies (ACOLA) reports have contributed to this awareness. However, there is a growing recognition that innovation also requires people who understand business, systems, culture and the way society uses and adopts new ideas.

As noted in the *Forbes* magazine article excerpt above, the 'war for talent' has moved to non-technical jobs with organisations at the international cutting-edge realising that innovation and productivity require the interaction of a broad range of technical and non-technical capabilities.

Challenges associated with delivering successful innovation include:

- moving into, or creating, new markets and dealing with the decline of old markets
- developing, producing and marketing new products and service
- responding to technological or social change and major restructuring of service areas while retaining business sustainability and growth.

International studies have found that building innovation capabilities is a high strategic priority for governments around the world, as well as for most leading companies. However, the research literature reveals little about how diverse skills and capabilities, especially technical and non-technical skills, interact for organisations to meet these innovation challenges.

There is also limited information how Australia's leading innovative enterprises identify, manage, build and mix the skills and capabilities required to meet innovation challenges and succeed in increasingly competitive, digitally-disrupted, and globalising markets. While there have been many large-scale studies of the innovation system (Dodgson, Hughes, Foster and Metcalfe 2011; Department of Industry, Innovation and Science 2014), the role of human and organisational

capabilities have largely been overlooked.

This project aims to address this gap in understanding about the relationship between skills, skills mixing and Australia's innovation system, and to explore the implications of this new knowledge for enterprise, education, training and research, and government.

The specific objectives of this report are to:

1. investigate the extent to which technical and non-technical skills underpin the different forms of innovation (technological, operational or process, product, marketing)
2. examine how innovative Australian enterprises identify, manage and build the necessary technical and non-technical skills and capabilities
3. identify how technical and non-technical capabilities interact in innovative Australian enterprises, in the context of meeting innovation challenges
4. explore the potential for industry, education and government responses to promote optimal investment in human skills and capabilities that support the innovative enterprise, including identifying national and overseas best practice approaches.

In addressing these objectives, this report considers the problem that Australia is an 'inefficient' innovator. The Global Innovation Index (2015) measures innovation inputs and outputs of 141 countries. It ranks Australia 10<sup>th</sup> for innovation inputs and 24<sup>th</sup> for innovation outputs. This means that Australia needs to improve the way it turns knowledge inputs into innovation outputs to become a more efficient and successful innovator. More details about the Index are in Chapter 2.

This report argues that the way in which Australian enterprises use and manage skills and capabilities is a critical component of the broader strategy needed to enhance Australia's innovation performance, and it explores potential mechanisms for achieving more efficient and effective innovation outcomes.

## 1.2 Definitions

### 1.2.1 Innovation

This report uses the Organisation for Economic Co-operation and Development (OECD) *Oslo Manual* definition of innovation:

*The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relation* (OECD 2005, p. 46).

This definition captures innovations that are new or significant to an organisation, irrespective of whether they have already been applied in the same industry or other sectors. It underlines that innovation is much broader than purely technical breakthroughs. In addition, it recognises the importance of diffusion of existing technologies, techniques and ideas across organisations, industries and countries.

### 1.2.2 Skills and capabilities

Skills are defined as ‘an ability or proficiency at a task that is normally acquired through education, training and/or experience’ (Tether, Mina, Consoli and Gagliardi 2005, p. 5). In more differentiated definitions, these skills include ‘management and leadership abilities, technical, scientific and production abilities, and soft/interpersonal abilities, for which there is a demand within the formal economy (Green, Jones and Miles 2007, p. 7). The concept can also be developed further: Grugulis and Lloyd (2010, p. 92) outline three dimensions of skill—skill of the worker, skill required of the job, and the social construction of skill. This report regards skills to be the abilities embedded in individuals as they relate to completing tasks in the workplace.

In contrast, capabilities conventionally describe organisation-level enterprise capabilities, rather than individual-level human abilities, and tend to be future-focused. For instance, Teece and Pisano (1994, p. 538) point out that the ‘term capabilities emphasizes the key role of strategic management

in appropriately adapting, integrating, and re-configuring internal and external organisational skills, resources, and functional competences toward changing environments’. This report adopts this distinction in relating skills to the individual and capabilities to the organisational level.

### 1.2.3 Technical and non-technical skills and capabilities

Technical capabilities are usually associated with science, technology, engineering and mathematics (STEM) knowledge sets, while non-technical capabilities are usually associated with humanities, arts and social sciences (HASS) knowledge sets. Although the division is not always sharply defined, this report largely focuses on this distinction, as well as the interaction and mix between technical and non-technical skills and capabilities. Industry and current policy recognise that STEM skills are essential, particularly for innovation. However, the role of HASS skills in this context is not well understood, although awareness of the necessity of non-technical skills is increasing (Wilcox 2014).

Somewhat related is the distinction between so-called ‘hard skills’ and ‘soft skills’. Hard skills tend to be discipline-specific skills traditionally conveyed through formal education, while soft skills tend to describe communication, collaboration and other interpersonal skills. There are increasing calls for more emphasis on teaching these soft skills through formal education.

## 1.3 Project background

This report provides the first in-depth investigation of how many of Australia’s best-known innovative enterprises build and mix the various ‘bundles’ of technical and non-technical skills to drive and sustain the development of new products and services that address innovation challenges and capture new markets and consumers.

### 1.3.1 Previous reports

This report builds on previous reports generated through ACOLA's Securing Australia's Future (SAF) program, notably SAF 4 (Bell, Frater, Butterfield, Cunningham, Dodgson, Fox, Spurling and Webster 2014), which suggests the attributes most often identified as requirements for an innovative workforce are:

- basic reading, writing and numeracy skills
- information and communications technologies
- academic skills (including qualifications in STEM and HASS)
- analytical skills (including problem solving, critical and creative thinking, ability to learn and manage complexity)
- social skills (including the ability to work in teams, communication, receptiveness to new ideas etc.)
- management and leadership skills (including the ability to form and lead teams, negotiation, coordination and ethics).

SAF 5 (Williamson, Raghnaill, Douglas and Sanchez 2015), references findings that Australia has established a comparatively advanced capacity to acquire a broad range of new and emerging technologies—ranking Australia 13 out of more than 120 countries. However, it also identifies significant barriers to doing so, including lack of investment in skills development, education and literacy.

SAF 9 (Bell, Dodgson, Field, Gough and Spurling 2015) finds that Australia should consider developing specific measures to encourage HASS engagement and collaboration with both the public sector and industry, as developed in some countries featured in its multi-country study.

### 1.3.2 Focus of this report

The basis for innovation in a knowledge-based economy is diverse and pervasive. It is not just based on research or science and technology, or even on enterprise and ingenuity (entrepreneurial skills and knowledge). Managerial and marketing skills, organisational,

social, economic and administrative knowledge and intellectual and creative capacity (Lengrand 2002) are also required to successfully translate new opportunities, ideas and discoveries into innovation. In addition, recent changes are affecting the nature of skills needed to compete in globalised markets. These changes include the rise of the service sector, the growing impact of service industries' skills and approaches in the formerly product-oriented manufacturing sector, digitisation, and the rise of global value chains.

A major conclusion of this report is the need for Australian enterprises, and education and government institutions concerned with innovation, to move beyond a focus on technical skills alone and consider the other sets of skills needed for successful innovation in the future. Technical skills are necessary, and in many cases foundational, but they are not sufficient for sustained and successful enterprise innovation. A major aim of the report is to demonstrate why and how this is the case, and to explore the implications for enterprise, education, research and training, and government.

In developing the analysis, this report takes the approach of 'bundles' of skills for innovation, and considers skills and skills mixing on three levels:

- individuals as bundles of skills and competencies
- teams and organisations as bundles of people with complementary skills
- networks as bundles of organisations (networks, supply and value chains).

## 1.4 Methods

In addition to undertaking a review of the international literature on technical and non-technical capabilities for innovation, the Expert Working Group project team conducted and commissioned three pieces of original research.

The first was a commissioned data analytics study of a population-wide dataset of Australian businesses assessing skill-related determinants of innovation activity. This commissioned research was augmented by analyses of the Australian

Bureau of Statistics (ABS) Business Characteristics Survey data, which has followed a large panel of firms over more than a decade. The results of this research are discussed in Chapter 2.

The second study focused on organisations considered highly innovative by their peers in Australia. The Expert Working Group project team identified and interviewed 19 senior executives in innovative Australian organisations in a variety of industry sectors representative of the Australian economy. The interviews explored organisational strategies, structures and cultures used in building the technical and non-technical capabilities required for innovation. The results of this research are discussed in Chapter 4.

The third study focused on innovation policy. This included a review of the literature on international and national good practice in policies to support capabilities for innovation and skills mixing and, further, a commissioned study on the roles of government, industry, and education and research institutions for developing innovation capabilities, incorporating interviews with over 30 experts on innovation practice and policy. The results of this research are discussed in Chapter 5.

Further details of each study are in the *Evidence gathering* section at the end of this report and the commissioned research reports are on ACOLA's *Securing Australia's Future* website.

## 1.5 Structure of this report

Chapter 1 provides a brief introduction and context to the report.

Chapter 2 defines the often ambiguous terms 'skills' and 'innovation'. It examines Australia's track record in international comparison and barriers for innovation in the national context. It considers the relationship between skills and other organisational factors and different types of innovation. The discussion draws on the results of analyses using the Expanded Analytical Business Longitudinal Database (EABLD) commissioned from Professor Elizabeth Webster and her team at Swinburne University of Technology.

Chapter 3 examines the arguments underpinning the shift in innovation thinking and policy from first generation (linear) approaches to second-generation (systems) approaches to third generation (ecologies) approaches. It looks at the implications for skills and capabilities required for innovation, developing the 'bundles' of skills concept. It outlines emerging forces—including digitisation, globalisation, the continuing growth of the service sector, and the increasing impact of service industries' skills and approaches in the wider economy—and the influence of these forces on organisational structures, work organisation, and skills requirements for innovation. The chapter concludes with consideration of analyses of the future of work and its implications for skills, skills mixing and innovation.

Chapter 4 reports on the detailed case studies of leading innovative organisations. The interviewees describe factors that have been important for their continued innovative performance. Beyond the broad skill sets considered relevant for innovation, questions of leadership and leadership skills arise. Skills and skills mixing in teams and access to skills beyond the boundary of the organisation are also a central concern. The chapter discusses the skills for innovation using the bundles of skills approach (individual, organisation and network level).

Chapter 5 draws on the previous analyses as well as the commissioned research on the opinions of 34 innovation thought leaders in industry, education and government. It presents the report's findings, first discussing overarching findings relevant to industry, government and education, before delving deeper into findings at the individual, team/organisational and system level. This chapter connects the research results, discusses the respective findings and describes implications for enterprise, education, training and research institutions, government and policy development. It includes national and international examples that illustrate the skills profile needed to lift Australia's innovation performance.

# 2

## Skills and Australia's innovation performance

### Summary

**Innovation encompasses not just the conception of new ideas, inventions and discoveries, but also the development and testing of new products and services, processes or methods, and the commercialisation of those ideas and inventions.**

**Compared to other leading industrialised and emerging countries, Australia's innovation performance has been mixed at best. While Australia has been successful in generating new ideas and inventions, it has not performed well in the development and commercialisation phases of the innovation cycle.**

**Different types of skills are required for different types of innovation activity and at different phases of the innovation cycle. Difficulties in accessing skills have been the single most significant barrier to innovation for many businesses across varied sectors.**

**This mixed innovation performance has largely been due to a lack of access to the appropriate mix of technical and non-technical skills, which include entrepreneurial, business, operational, marketing and commercialisation skills.**



## 2.1 Introduction: innovation, skills and Australia's future

In its 2014 assessment of policy challenges over the next half century, the OECD concludes that:

*...future gains in GDP per capita will become more dependent on accumulation of skills and, especially, gains in multifactor productivity driven by innovation and knowledge based capital.*

Braconier, Nicoletti and Westmore 2014, p. 6

This assessment is echoed by the Australian Government's evaluation of the central role of innovation in securing Australia's future. The 2014 review of the state of innovation by the Australian Department of Industry, Innovation and Science's Office of the Chief Economist highlights this message about skills, noting that:

*...innovation and skills development, driving economic growth through productivity, will be the major counterbalance to ageing populations, climate change and rising income inequality.*

Department of Industry, Innovation and Science 2014, p. 11

Interestingly, these challenges are cultural, social and environmental, rather than technological, in nature. The Chief Economist further observes that innovation represents a major area of policy investment among both developed and developing economies. These developments are producing what Sainsbury (2007) has described as a 'race to the top' between many countries, with innovation being used to leverage future competitiveness and opportunities for growth. Without deep investment in the skills, capabilities and systems required to support sustained innovation, Australia will not maintain its current level of economic growth. These investments need to be made jointly by governments at the national and state level, industry and individual businesses, and research and education institutions.

While this report is not concerned with the broader question of how Australian governments, enterprise, and education and research institutions can drive innovation, it does address one important part of this imperative: in the context of the many factors important for innovation performance, what is the role of skills and capabilities? Skills and capabilities are just one of several inputs into the innovation process, at both the organisation and system level. Nonetheless, international evidence demonstrates that investing in human capital is a critical element in driving higher levels of innovation.

The issue, as is described in detail in this report, is not simply a matter of increasing the supply and diversity of skills at the individual level. Rather it is about how skills can be brought together within organisations, industries and innovation ‘ecosystems’. It is also about how these skills can be combined with physical capital and effective organisational systems to yield new ideas that generate new products or services, new applications of technologies in production and new ways of marketing and distributing those goods and services. Innovation-driven firms in particular face the challenge of how best to manage and integrate the output of skilled employees. Their skills are not restricted to technical skills, but encompass three broad categories of talented employees required for innovation: the *numerati*, the *literati*, and *entrepreneurial* managers (Teece 2010). The skills and talents for innovation among these different categories of employees are not limited to the skills embodied in individual workers, but also relate to how skills are combined at the team and organisational level, and how they are accessed and bundled across organisational boundaries in networks or ecosystems to drive innovation.

## 2.2 What is innovation?

The meaning of the term *innovation* is highly circumstantial and varies considerably depending on the context in which it is used, and for what purpose. It is most widely assumed that innovation is about technology and scientific

advancement. This view dominates analyses and discussions around policy and regulatory issues, such as protection of intellectual property (IP). This narrow focus on technological innovation has, unsurprisingly, placed the policy spotlight on the technical skills requirements for innovation, such as skills in STEM. As a result, to promote growth in these STEM skills, some governments have called for compulsory science education in schools and at universities, or for students to be introduced to skills such as coding from primary school (U.S. Government Accountability Office 2005; Australian Government 2015). These skills are undoubtedly critical to a great deal of new innovation, especially as new technologies disrupt established systems of producing goods and services and challenge traditional business models.

However, these technical skills are only one part of the bundle of skills required to sustain innovation and to reap the economic returns through increased productivity, growth and competitiveness. Innovation also needs to be understood through a broader lens than simply technological innovation. This report focuses on understanding innovation as it relates to *business*—the activities, processes and outcomes associated with taking new ideas to invention or application to create or capture value in a market (Department of Industry, Innovation and Science 2014, p. 12)—and the skills requirements for these innovations to occur and be sustained.

As outlined in Chapter 1, this report uses the widely accepted definition of business innovation in the OECD’s *Oslo Manual*.

Innovation is defined as:

*The implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relation*

OECD 2005, p. 46

In including new-to-the-world as well as new-to-the-organisation, the definition moves beyond the narrow focus on technological change and its application in industry, to focus on implementation and highlight the importance of diffusion of innovations.

The definition includes any activity in an *innovation process*—from the conception of new ideas, inventions and discoveries, to the development and testing, and the production, marketing and commercialisation of those inventions. These activities in the innovation cycle occur in a dynamic and complex manner, and require the firm to undertake three distinctive sets of activities (Teece 2010):

- *sensing*—identifying and assessing new opportunities for growth and profit
- *seizing*—mobilising resources, skills and capabilities to realise the opportunity and to capture opportunities for creating value
- *transforming*—ongoing efforts to improve and renew the original innovation to sustain the value creating opportunities such innovations present.

While some organisations are engaged in the complete innovation cycle to produce a new product or service, it is more common for separate organisations to take different steps in the innovation process, often in collaborative or commercial relationships. Importantly, innovation—whatever type of innovation or stage in the innovation cycle—requires organisations to access a wide variety of technical and non-technical skills. These different sets of activities require different skills and combine different types of talents and skills in different ways.

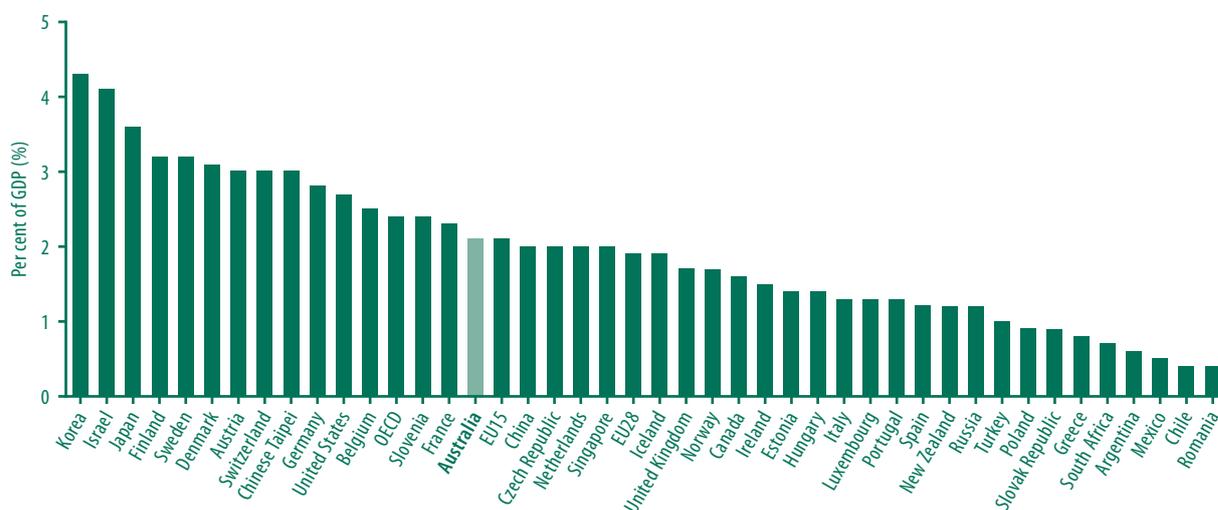
## 2.3 Australia’s innovation performance in the international context

A common measure of innovation activity that allows for international comparison is expenditure on research and development (R&D). On this score, Australia ranks comparatively well. The OECD data on R&D expenditure, both in terms of expenditure per capita and as a percentage of Gross Domestic Product (GDP), reveal Australia performs relatively well among that group of countries.

There are, however, some significant differences between Australia and the best performing countries on these metrics. For example, while Australia ranks 16<sup>th</sup> among the OECD countries on the basis of R&D expenditure per capita, it spends only approximately half the per capita amount compared to the best performing country, Switzerland (US\$991.8 compared with US\$1697.1). Similarly, compared with Korea, which spends 4.3 per cent of GDP on R&D, Australia spends just 2.1 per cent of GDP annually on R&D.

R&D expenditure is an important indicator of innovation activity because it closely correlates with the rate of technological innovation. However, R&D expenditure (like patenting activity measures) does not capture the extent to which

Figure 2.1: R&D expenditure, per cent of GDP by country (2015)



Source: OECD (2016), Gross domestic spending on R&D (indicator), doi: 10.1787/d8b068b4-en. Last accessed 25 May 2016.

industry applies technological innovations or whether there is successful commercialisation in the form of new products and services or production processes. It represents just one of a number of critical 'input' measures of the innovation process.

This assessment is consistent with other international evaluations of Australia's innovation system. The project report for SAF 5 comments on the RAND Corporation's study of technological adoption (Silberglitt, Antón, Howell and Wong 2006). This study reports the RAND Science and Technology Index, which uses a number of indicators of a country's science and technology capacity. In addition to R&D expenditure, indicators include research outputs, patents, and the number of scientists and engineers per capita.<sup>1</sup> This report concludes that Australia had established a comparatively advanced capacity to acquire a broad range of new and emerging technologies, ranking Australia 13 out of more than 120 countries. However, it also identifies a number of significant barriers to doing so, including a lack of investment in skills development, education and literacy (Silberglitt et al. 2006).

A more comprehensive understanding of Australia's innovation performance—and the role of human capital and skills in our innovation performance—can be gleaned from the Global Innovation Index (GII). This index, produced jointly by Cornell University, INSEAD and the World Intellectual Property Organization, provides the most comprehensive and robust assessment of innovation performance. The GI compares innovation activity and performance across more than 140 countries, and provides an account of both the 'inputs' and 'outputs' associated with innovation, including human capital and research inputs.

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1. See Appendix H of Silberglitt, R., P. S. Antón, D. R. Howell and A. Wong (2006), *The Global Technology Revolution 2020, Executive Summary: Bio/Nano/Materials/Information Trends, Drivers, Barriers, and Social Implications*, Rand Corporation. Retrieved 22 October 2015, from <[www.rand.org/pubs/technical\\_reports/TR303.html](http://www.rand.org/pubs/technical_reports/TR303.html)>.

Table 2.1 summarises measures that make up both the components of the GI and reports Australia's score and international rank for each. In 2015, Australia ranked 17 overall out of the 141 countries for which a GI score is available, confirming that Australia has established a comparatively healthy environment for enterprise innovation. However, a further breakdown of this index reveals some important points of weakness. Significantly, Australia shows a notable disparity between innovation inputs (ranked 10<sup>th</sup>) and innovation outputs (ranked 24<sup>th</sup>), which include technology and knowledge (ranked 39<sup>th</sup>) and creative outputs (ranked 7<sup>th</sup>). This implies a lack of 'innovation efficiency'.

While the input measures are generally adequate, Australia performs significantly below its overall ranking on measures capturing the human capital inputs into innovation systems. On the output side, low scores are particularly prevalent in the areas of knowledge impact and knowledge diffusion. Overall, the GI indicates shortcomings in the capacity of Australian enterprise to generate and, more specifically, to bring innovations to application and diffusion. The low scores in business sophistication—especially in innovation linkages (ranked 38<sup>th</sup>) and knowledge absorption (ranked 63<sup>rd</sup>)—indicate that rather than lacking skills in general, Australia lacks capacity in using these skills and other inputs for innovation.

An industry survey conducted for SAF 1: Australia's Comparative Advantage came to similar conclusions, highlighting a lack of knowledge transfer cooperation between universities and companies. Businesses also query an unsupportive political system, declining finance and credit matters and a decline in the education system over the past decade (CEDA-ACOLA 2013). The critical assessment of government support for innovation is also reported by foreigners doing business in or with Australia (Halteman, Kerle and Lerner 2015). One urgent issue to address is an overhaul of the institutional system for IP protection which requires adjustment to cater for innovation based on collaboration, development and branding of services and intangible assets (ACOLA and PWC 2015).

**Table 2.1: Australian scores in the GII 2015 (out of 100)**

Overall performance		Score (0–100)	Rank
Global Innovation Index 2015		55.2	17
Innovation Output Sub-Index		45.6	24
Innovation Input Sub-Index		64.8	10
Innovation Efficiency Ratio		0.7	72
Global Innovation Index 2014 (out of 143)		55	17

Input measures		Score	Rank
1	Institutions	89.3	11
	1.1. Political environment	87.3	13
	1.2. Regulatory environment	93.8	12
	1.3. Business environment	86.8	12
2	Human capital and research	57	9
	2.1. Education	54.3	32
	2.2. Tertiary education	52.9	13
	2.3. Research and development (R&D)	63.9	10
3	Infrastructure	63.7	4
	3.1. Information and communication technologies (ICT)	86	7
	3.2. General infrastructure	55	13
	3.3. Ecological sustainability	50.1	27
4	Market sophistication	66.7	9
	4.1. Credit	65.5	6
	4.2. Investment	46.1	36
	4.3. Trade and competition	88.5	10
5	Business sophistication	47.5	23
	5.1. Knowledge workers	66.7	10
	5.2. Innovation linkages	41.2	38
	5.3. Knowledge absorption	34.4	63

Output measures		Score	Rank
6	Knowledge and technology outputs	34.8	39
	6.1. Knowledge creation	34.9	26
	6.2. Knowledge impact	46.2	32
	6.3. Knowledge diffusion	23.2	99
7	Creative outputs	56.5	7
	7.1. Intangible assets	53.3	34
	7.2. Creative goods and services	44.8	7
	7.3. Creation of online content	74.4	6

Source: Cornell University, INSEAD and WIPO (2015).

## 2.4 Skills and innovation among Australian businesses

What are the barriers for transforming innovation inputs into outputs? It is possible to draw some indications from data collected through the Australian Bureau of Statistic's Business Characteristics Survey (BCS). It is important to emphasise up front that 'innovation active' businesses are not necessarily successful innovators (Section 2.6 analyses Expanded Analytical Business Longitudinal Database (EABLD) data, which measures the *successful* implementation of different types of innovation). Success depends on whether innovation activities can be translated and implemented into actual innovations. Innovation active organisations fail to innovate for a variety of reasons, for example, lack of access to additional capital, lack of access to skills, higher than estimated costs of development (see Figure 2.2).

In addition, the BCS shows that innovation active businesses in Australia are significantly more likely to report barriers to innovation than non-innovation active firms, but that the extent of this difference varies considerably from issue to issue. The single most often stated barrier to innovation reported by innovation active businesses is the lack of access to additional funds required to develop and implement innovation. Almost one third of all innovation active businesses report this issue, compared with less than 10 per cent of non-

innovation active businesses. Around one quarter of all innovation active businesses report that the cost of developing and implementing innovation represents a significant barrier to innovation.

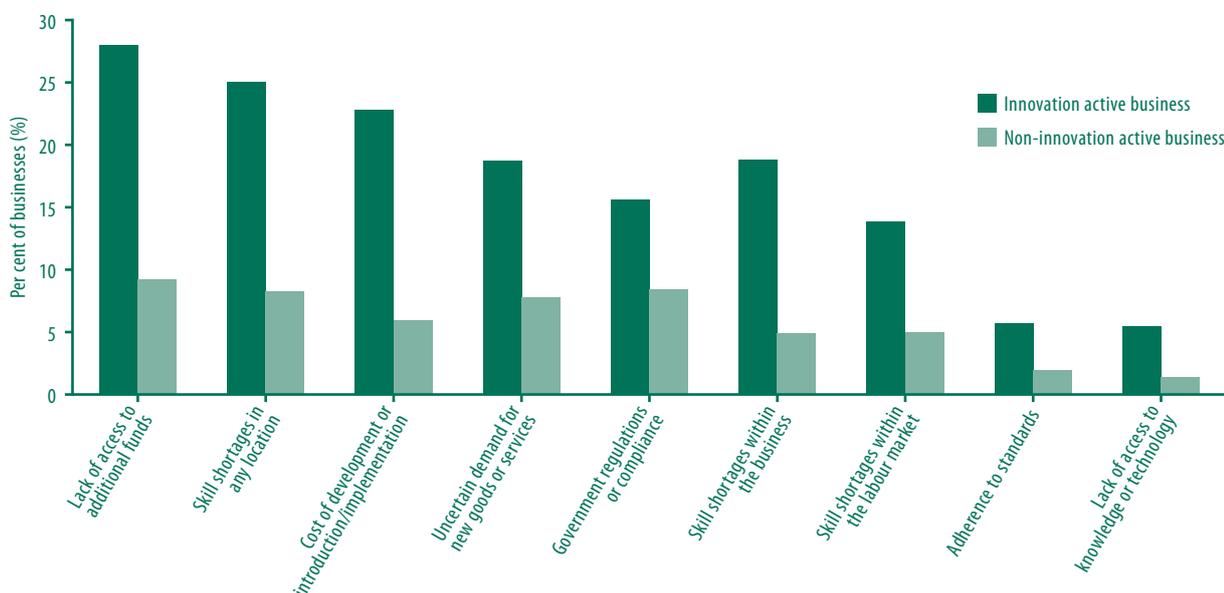
However, overall in the BCS, a lack of access to skills was the most significant barrier to innovation among innovation active businesses. Skills shortages are mentioned as barrier in different ways for different businesses:

- one-quarter of all innovation active businesses indicate that skills shortages, in any location in which they operated, were a significant barrier to innovation
- almost one in five innovation active businesses indicate skills shortages within the business were a significant barrier to innovation
- around one in seven innovation active businesses indicate general skills shortages in the labour market were a significant barrier to innovation.

The presence of these barriers to innovation, including access to skills and capabilities, is not simply a product of the characteristics of the firm. It reflects how individual organisations choose, and are able to access, resources and capabilities within their broader ecosystem.

International evidence clearly demonstrates that countries investing more in skills also report higher rates of innovation activity (Toner 2011). However, the relationship between skills and innovation is not always simple. The BCS shows this in its comparison of skills usage among

Figure 2.2: Barriers to innovation: innovative active versus non-innovation active, 2013–14



Source: ABS Catalogue Number 8167.0—Selected Characteristics of Australian Business, 2013–14, available at <[www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8167.02013-14?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8167.02013-14?OpenDocument)>. Last accessed 25 May 2016.

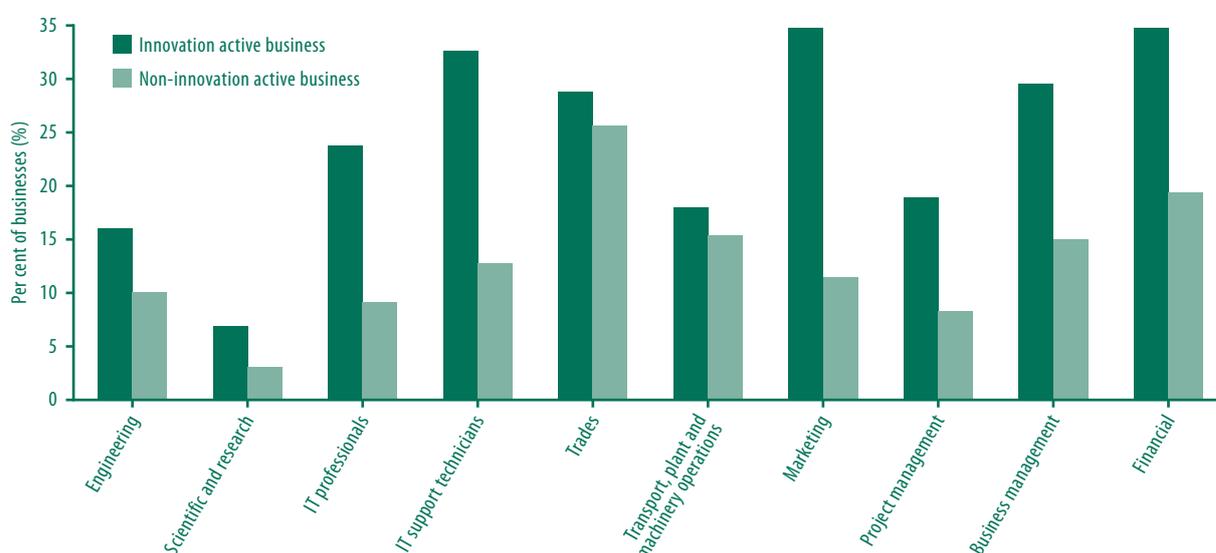
innovation active and non-innovation active businesses (see Figure 2.3). It demonstrates that innovation active businesses not only use skilled workers more extensively than their non-innovation active counterparts, but also use more of all types of skills.

The extent of this difference varies considerably by skill type, with use of relatively lower level skills (trades and transport, plant and machinery operatives) being broadly similar among innovation active and non-innovation active firms. In contrast, the most distinctive differences in skills use are evident in relation to business skills (marketing, finance, business

management, and project management), and IT skills (IT support technicians and IT professionals). There are less marked differences in relation to the other technical skills, such as engineering, scientific and research staff.

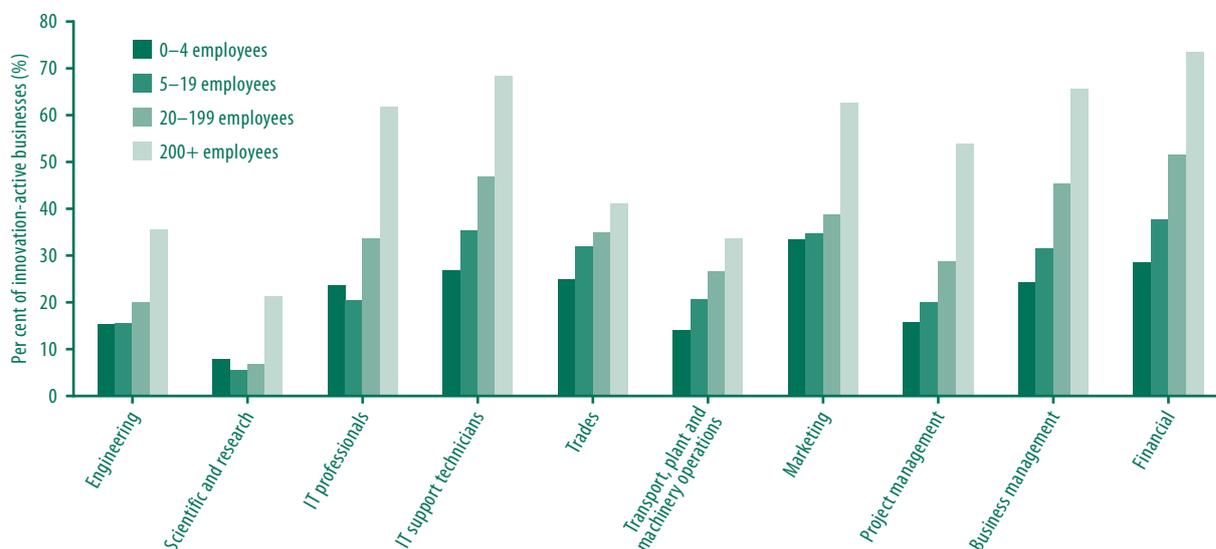
A striking feature of these data is the relative prevalence of non-technical skills (such as marketing, business management, project management and finance). More than twice as many innovation active firm report using marketing and financial management skills as those who report employing engineering skills. Less than 10 per cent of innovation active firms report employing research and scientific personnel.

**Figure 2.3: Skills use by Australian businesses: innovation-active and non-innovation active firms, 2013–14**



Source: ABS Catalogue Number 8167.0—Selected Characteristics of Australian Business, 2013–14, available at <[www.abs.gov.au/AUSSTATS/abs@nsf/DetailsPage/8167.02013-14?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@nsf/DetailsPage/8167.02013-14?OpenDocument)>. Last accessed 25 May 2016.

**Figure 2.4: Innovation-active businesses and skills use, by firm size, 2013–14**



Source: ABS Catalogue Number 8167.0—Selected Characteristics of Australian Business, 2013–14, available at <[www.abs.gov.au/AUSSTATS/abs@nsf/DetailsPage/8167.02013-14?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@nsf/DetailsPage/8167.02013-14?OpenDocument)>. Last accessed 25 May 2016.

The differences in skills use also need to be understood in the context of different firm sizes. Figure 2.4 focuses on the skills use of innovation active firms of different size as measured by the number of employees. As with innovation activity more generally, the proportion of innovation active firms that employ skilled workers of any category is significantly higher in larger businesses. Although these differences are once again less distinctive in relation to trades and operatives, innovation active firms with 200 or more employees are more likely to use business and technical skills, with the use of business skills far more prevalent than the use of technical skills overall.

While these are interesting findings, the level of granularity of data is not sufficient for complex analyses and future capabilities planning. For instance, the level of the reported skills is unclear, i.e. graduate diplomas or university degrees. It is also unclear if they relate to formal education or to the positions in which individuals are currently employed. For example, many engineers by trade move into senior management positions, but it is not known if or how this is captured in the data. If organisations only employ very low levels of scientific and research staff, is most science and research outsourced and if so to whom: universities or research institutions?

## 2.5 Skills and innovation in context: the determinants of innovation performance

The question of ‘why do some firms innovate while others do not?’ is the subject of considerable academic and policy attention over an extended period of time. This body of research is spread across a number of academic disciplines, where the variety of studies and the conceptual models and empirical strategies make it difficult to consolidate and synthesise findings. Most of this work, however, is concentrated among applied economists and management researchers. For extensive reviews of the economic and business research on this issue, see Cohen (2010) and Crossan and Apaydin (2010).

Cumulatively, this body of research on innovation activity shows that the propensity to innovate at the organisational level is associated with a wide range of factors, both internal and external to the business organisation. Many of these factors are highlighted in prior SAF projects associated with technological innovation. SAF 4, for example, emphasises stronger linkages between industry, research institutions and government in facilitating greater development and adoption of new technology. The SAF 4 report also highlights the importance of workforce skills in sustaining innovation at the level of the business enterprise. SAF 5 examines the role of new technology in securing Australia’s future and highlights a wide array of institutional and business attributes that shape technological innovation, including:

- costs associated with the development and uptake of new technology
- appropriate policies, regulatory frameworks and laws that facilitate technological innovation
- collaboration between universities, individual business and industry sectors
- open data
- privacy and security for use of wireless and cloud-based technologies
- the development of standards that ensure interoperability between competing technologies and platforms
- government willingness to maintain itself as a lead purchaser and user of new technologies
- a business culture that supports innovation and technology, as well as acceptance of risk and failure as integral to innovation
- public awareness of enabling technologies
- skills required to adopt and use new technologies.

A summary of the major determinants of innovation performance is provided in Figure 2.5. This figure highlights the difficulties associated with identifying and isolating empirically any factor, and specifically the unique role of workforce skills in driving innovation at the

organisation level. This is because skills exist at several levels—the individual, team and organisational and the inter-organisational—and because the effective use of existing skills depends on a number of ancillary conditions. These conditions, for example, include overarching organisational capabilities and culture, team structures and climate or work organisation. Moreover, the relative importance of different factors is likely to depend on the type of innovation activity and prior experience with bringing new innovation to successful application or commercialisation.

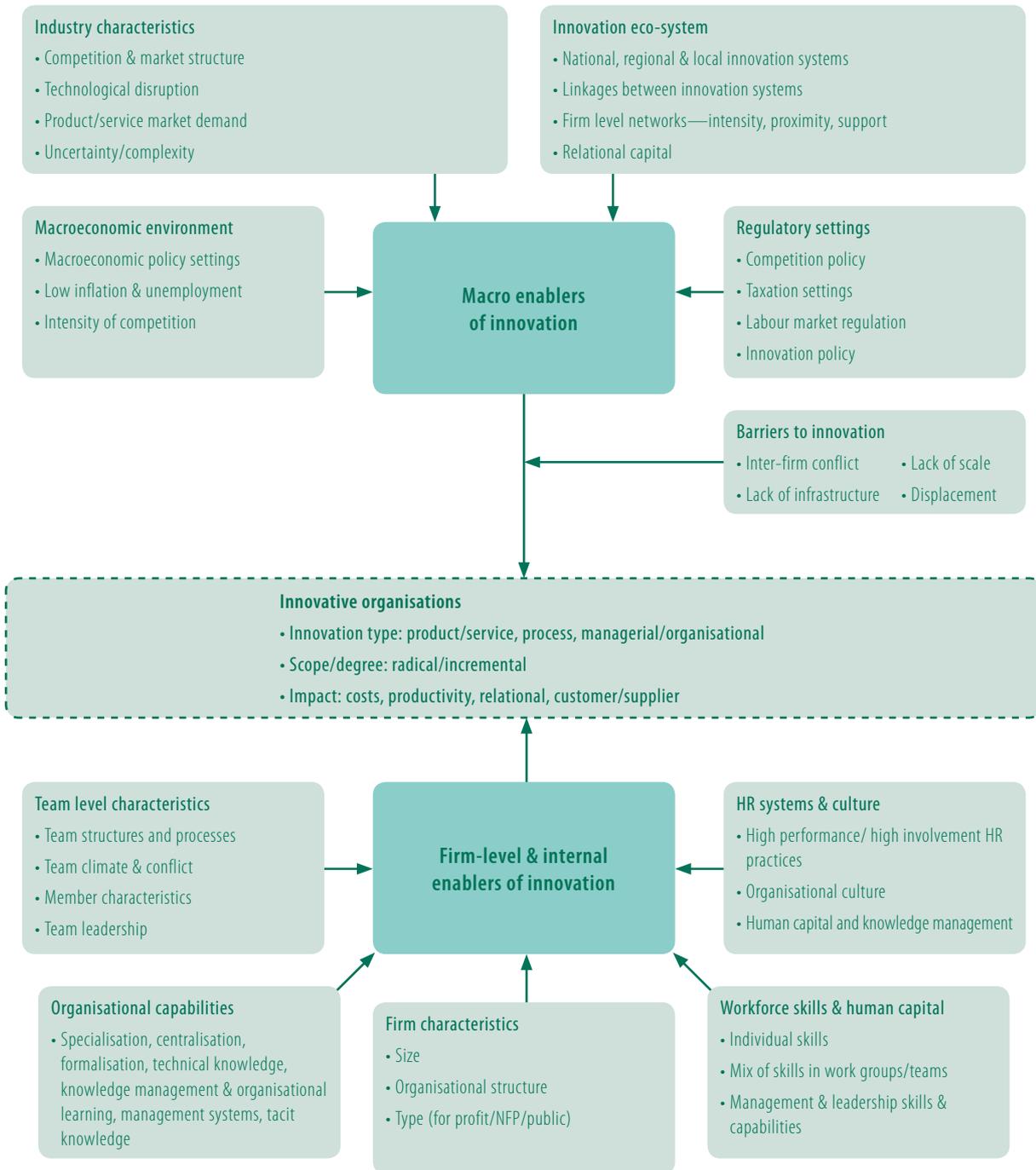
To contextualise the role of skills and capabilities, this report first gives a brief summary of research across the major determinants of innovation. Much of the foundational work on innovativeness has focused on firm size as primary factor, positively influencing the ability and propensity to innovate (Cohen 2010). The importance of firm size is generally attributed to a number of explanations. These include: the advantage of size for incumbents in capital markets when investing in R&D; the inherent economies of scale and scope associated with R&D activity; the ability to invest in dedicated R&D capabilities; and the ability to redeem R&D costs over larger sales revenues. There are clear and robust results linking firm (or business unit) size to innovation activity (notably R&D), indicating a tight linear relationship between these two variables. In many respects, however, firm size represents a somewhat 'empty' variable, in the sense that it captures a range of other, unobserved, factors that are associated with size. Firm size also offers no clear policy direction for enhancing innovation beyond pooling innovation activities across organisations to achieve size advantages (Palangkaraya, Spurling and Webster 2016). Beyond this foundational work, much of the evidence that centres on understanding industry and organisation level factors emphasises factors that are readily subject to policy manipulation.

## 2.5.1 Industry factors

While the relationship between size and innovation is robust across industry sectors, the evidence also points to the importance of a number of industry level conditions including market structure and competition. Although earlier work has demonstrated that market share and innovation activity are positively related, more recent studies using longitudinal data show that industry concentration and innovation are negatively related (Cohen 2010). Of particular interest is the relationship between the intensity of product market competition and innovation. Competition generally exerts a positive influence on innovation outcomes, or an inverse U-shape relationship, indicating the interaction between the countervailing effects of competition on increasing the incentives, but diminishing the returns to innovation (Aghion, Bloom, Blundell, Griffith and Howitt 2005). Beyond competition and market structure, economic models of innovation highlight three factors related to industry characteristics that, in part, impact on organisations' willingness to invest in building their innovation capabilities, including the skills and capabilities of employees. These three factors are: product market demand; technological opportunities; and 'appropriability' (Cohen 2010).

The first of these three factors recognises that the demand for innovative products and services leads to innovation. This line of work has also explored how significant innovations, especially general purpose innovations such as electricity or the computer, lead to diffusion through the impact on demand for innovation (adaptation) in different industry settings. The research recognises that demand for innovative products and services is likely to shape the demand for a wide range of skills associated with both product/service development, process innovations and commercialisation. While the link between the demand for innovation and skills seems obvious, the direction of this relationship appears more ambiguous.

Figure 2.5: Determinants of innovation at the organisation level



Based on Crossan and Apaydin (2010).

Similarly, it is argued that some industry settings present clear opportunities for innovations of specific types, especially opportunities for technical advances (Leiponen and Drejer 2007). How and when this arises is not clear, but these ‘natural trajectories’ within particular industry settings are likely to see different forms of innovation, and therefore, different bundles of skills emerge to support innovation activity. This line of research has also highlighted the importance of knowledge transfer and the

development of specific capability sets at an innovation cluster or industry level for these trajectories to emerge.

Finally, investment in innovation is conditioned in part by the ability to appropriate value from those investments. This outcome can reflect a number of factors associated with intellectual property rights, but also partly reflects how innovation activity of a technical nature is spurred on by factors such as a firm’s ability to

commercialise its innovations. It is therefore not surprising to find that innovation active firms make investments in a range of business skills to appropriate value from their investments in new innovations.

### 2.5.2 Firm characteristics and innovation performance

Both economics and management research have considered the importance of the characteristics of the firm in determining innovativeness, although with a focus on different characteristics (Teece 2010). Within economic research, cash flow and diversification are the two most researched determinants of innovation activity. Cash flow in particular is closely associated with higher levels of R&D intensity, although the research indicates that this may be more attributed to the development of financial markets and access to debt financing of innovation activity (Hall 2002).

Product diversification has yielded less clear cut evidence for a host of reasons, but has highlighted the potential link to skills and capabilities required for innovation activity to take place. In their review of this research, Crossan and Apaydin (2010) conclude that a number of management and organisation attributes explain why some firms are able to innovate successfully while others do not, including:

- i. attention to user needs
- ii. innovation leadership that develops a culture of innovation and facilitates innovation by encouraging personnel to connect with each other within the organisation
- iii. efficient management of the innovation, project management skills and accountability to deliver innovation outcomes
- iv. efficient business processes and internal systems and processes for running and leveraging innovation activity
- v. effective marketing and commercialisation skills

- vi. knowledge management practices within the firm
- vii. the capability to draw on skills and knowledge external to the firm, including research communities and other technology developers.

The final attribute is an important factor that links innovation capabilities and skills within the organisation to the external ecosystem within which it operates. The importance of external linkages is recognised in both the economic and management literatures. It explains why innovation performance varies across firms, even within the same industry setting, as few firms can pursue all of the activities necessary to develop and commercialise any particular technical innovation. Firms innovate through their interactions and connections within their particular innovation ecosystems, through which they can access critical skills and capabilities. This search for connection is reflected, for example, in the acquisition of small, innovative firms by larger ones, or the way in which larger firms use small innovative firms to complete specific innovation tasks using their critical skills and knowledge. This is discussed in more detail in Chapter 3.

## 2.6 Skills and innovation performance among Australian firms

As well as reviewing the evidence available from prior studies, the Expert Working Group project team commissioned an independent statistical analysis of the factors associated with innovation performance among Australian businesses. Undertaken by the Centre for Transformative Innovation at Swinburne University of Technology, this study provides one the first attempts to analyse the factors associated with innovation activity and different types of innovation, including an analysis of those variables that capture the impact of the use of different types of skill. The analyses undertaken for this report use the Expanded Analytical Business Longitudinal Database (EABLD), which integrates administrative data from the Australian

Taxation Office with collected survey data from the Australian Bureau of Statistics for all active businesses in the Australian economy from 2001–02 to 2012–13.<sup>2</sup> The analyses use data from a representative sample of 5,630 businesses for which complete data is available across the entire data collection period. The variables used in this analysis are provided in Table 2.2 in the *Statistical appendix* to this chapter.

Before further discussing the results, it is important to emphasise the inherent limitations of the statistical analysis undertaken for this project. Firstly, many of the variables associated with innovation performance (and the studies using them) need to be interpreted with some caution. As noted, a number of firm level characteristics (such as firm age and size) tend to explain a significant proportion of the variation in levels of firm innovation, but of themselves represent 'empty' variables. Second, and most importantly, the causal direction between variables used to explain innovation activity and innovation performance is likely to run both ways, even in the case of firm demographic variables such as age and size. Firms survive and grow because they are successful innovators, as much as size and age create the conditions for successful innovation.

This applies more broadly for many firm level and industry factors (Cohen 2010). As evident from Figure 2.5, skills and human capital are just two of many internal factors that determine innovative activity. Significantly for this report, many of the potential contributors to innovation closely relate to skills. Teams and team level characteristics, for instance, relate to the accumulation of different skills within groups. While organisational capabilities describe the often tacit capacity to effectively fulfil organisational functions such as marketing or R&D at the firm level, they are ultimately driven by the skills embodied in the workforce. In addition, HR systems and culture

influence how and under what circumstances employees and teams apply their skills to tasks that promote innovation.

Beyond the organisation, innovation is also determined by environmental conditions including industry type, national and global settings, and regulation. Organisations cannot directly influence many of these conditions but can position themselves to take best advantage of these environmental settings. With regards to innovation, this may be achieved through developing strategic links with other organisations, customers and regulatory institutions and, more broadly, by using partnerships to access knowledge and skills in their innovation ecosystem.

Therefore, in regard to the role of skills and capabilities, innovation can be viewed as broadly dependent on whether individual skills are available to firms, and their capacity to organise these skills through their internal systems, their organisational capabilities to connect and collaborate with other organisations and institutions, and their ability to best position themselves to exploit the conditions in the external environment. Adding to this complexity is the fact that the importance of these factors very likely varies at different stages of the innovation cycle—that is, a recurring innovation process which can be simplified to consist of ideation, development/testing and commercialisation—in different sectors of the economy.

Finally, the analysis undertaken for this report examines the relationship between simplified variables designed to capture more complex and multi-dimensional factors (inputs) and innovation activity (outputs), and assumes simple functional relationships between them. However, the relationships and interactions between variables are likely to be more complex and take more dynamic, non-linear and functional forms. Despite the proliferation of estimation techniques that seek to address these issues, the problem of identifying and estimating causes and effects, the conditions under which these effects might be moderated, and the interactions between firm level, industry level and ecosystem level factors

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2. ABS Catalogue Number 8171.0—Information Paper: Construction of the Expanded Analytical Business Longitudinal Database, 2001–02 to 2012–13, available at <[www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8171.0Main+Features12001-02%20to%202012-13?OpenDocument](http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/8171.0Main+Features12001-02%20to%202012-13?OpenDocument)>. Last accessed 29 February 2016.

remain ambiguous.<sup>3</sup> For these reasons, the results described here based on the EABLD data cannot be interpreted as causal in nature.

Table 2.3 and Table 2.4 in the *Statistical appendix* to this chapter report the main estimates from the analyses. Table 2.3 reports estimates of the probabilities that each of the factors included in the analysis will lead to any type of innovation, or each of the types of innovation individually. Table 2.4 extends this analysis by including an interaction between STEM and business skills (included as composite measures) to capture the extent to which skills mixing takes place for innovation.<sup>4</sup>

The analyses presented in these two tables provide consistent support for the conclusion that skills are critically associated with a firm's ability to innovate. As noted, however, causality remains unclear. Before discussing the influence of skill, it is useful to place the role of skills in the context of the other estimates presented here. The results demonstrate that a number of factors are significantly associated with the propensity of Australian businesses to introduce innovations, including:

- the age, size and ownership of the business (the association—negative or positive—is not consistent across all types of innovation and the magnitude is marginal)
- negative associations with the absence of market competition for organisational and marketing innovation
- positive associations with receiving financial assistance from government for product, process and marketing innovation (note Footnote 6 below with regards to the interpretation of the coefficients)

- positive associations with the integration of operational activities across supply chain partners across all types of innovation
- positive associations with engaging in collaborative research with research institutions and universities for product and organisational innovation
- positive associations with the use of working arrangements, such as flexible hours, flexible use of annual leave, selection of own roster and shifts, job sharing, ability to work from home, paid parental leave and flexible use of personal leave across all types of innovation.

While these relationships were all statistically significant, the magnitude of their impact varies greatly.<sup>5</sup> For example, the age, size and ownership of a firm all have a significant association with the probability of innovation occurring, the size of the effects, however, is marginal. Rather, the largest effects were associated with financial assistance from government: the more varied the sources of this support, the higher the relative probability that the business engaged in one or more types of innovation.<sup>6</sup> A number of variables are more closely associated with particular types of innovation. For example, foreign ownership has a significant (although not large) effect on the probability of product innovation, but not on other types of innovation. Firm age was negatively (albeit marginally) associated with the ability to engage in both product and organisational innovations.

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3. The available data are inadequate for the purpose of developing better insight into firm level innovation processes and supporting informed policy making. Most variables on which this analysis is based employ simple binary responses to capture the presence/absence of a factor or innovation outcome.

4. More extensive analyses were undertaken, along with a range of robustness checks including a random effects estimation of each model to capture unobserved firm and industry level factors. These are not reported here, but are contained in the report produced by the Centre for Transformative Innovation at Swinburne University of Technology. This report is available at on the ACOLA SAF 10 website. <[www.acola.org.au/index.php/projects/securing-australia-s-future/capabilities-for-australian-enterprise-innovation](http://www.acola.org.au/index.php/projects/securing-australia-s-future/capabilities-for-australian-enterprise-innovation)>. Last accessed 05 May 2016.

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5. A note on interpreting the regression coefficients is included with the results in the *Statistical appendix*.

6. As noted, this interpretation assumes a level of causality between government assistance and innovation outcomes, which is very difficult to establish statistically. The analyses lags the dependent variables by one year, assuming that most input factors to innovation will not immediately produce outcomes but instead will take time to have an effect. However, the time horizon for having an effect on innovation may also be two or five years. Similarly, it is, especially for government funding, likely that causality runs in the opposite direction. That is, firms that want to innovate are more likely to apply for government funding to do so. Also, the circular argument described for skills can apply to most factors with regard to innovation.

Turning to the relationship between skills used by the business and innovation outcomes, Table 2.3 reports the effects of employing a range of different skills, separately, on different types of innovation performance. While the results indicate that the relative size of the effects of skills are moderate compared with other factors associated with the probability of innovation occurring, both STEM and business skills are shown to be critical factors associated with the probability of innovating. Importantly, different types of skills appear to be significant for different types of innovation. Generally speaking, STEM-based occupations are more significant for product and process innovations, while occupations using business skills were more strongly associated with process, organisational and marketing innovations.

The research explored the hypothesis that skills mixing across different types of occupations may have synergistic effects for different types of innovation (i.e. that an interactive effect exists between STEM and business skills).<sup>7</sup> These estimates are reported in Table 2.4. This analysis confirms that different types of skills were more important for different types of innovation. STEM skills were more strongly associated with the propensity to innovate around products and processes, while business skills were associated with a significantly higher propensity to innovate around process, organisational and marketing innovations.<sup>8</sup> Finally, the interaction term included to capture additional effects of skills mixing shows no direct support for the contention that skills mixing is important for any specific type of innovation. The analyses are nevertheless useful by showing that, overall, firms require different types of skills at different points in the innovation cycle.

## 2.7 Discussion and conclusion

This chapter examines existing evidence that relates individual skills and bundles of skills to innovation activity. It places evidence in a broader understanding of the diverse nature of innovation activities, inputs, processes and outputs. The results show that advanced economies rely on innovation for growth and prosperity, and that the business enterprise is a critical economic institution through which innovation is generated and diffused. Innovation-driven firms face the challenge of how to acquire or access, manage and integrate the effort and output of a diverse set of skilled personnel in this process. Individual businesses make these choices within a wider array of supporting institutional and economic settings—the ecosystem for innovation—which provides an important source of resources, skills and capabilities required for innovations to be identified, seized and realised.

Innovation in a knowledge-based economy is not just based on research or science and technology, or even on enterprise and ingenuity. It also requires the combination of different sets, or bundles, of skills and talents: skills in sciences, technology, engineering and mathematics; marketing, organisation, management, social, economic, administrative skills and artistic creativity; as well as entrepreneurial managers with a capacity to identify opportunities for innovation and to take risks associated with seizing those opportunities.

The international evidence demonstrates that the efficiency with which innovation inputs, including skills, are transformed into innovation

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7. First, two composite measures for STEM and business skills were constructed from the individual items used in the analysis reported in Table 2.2. Then, these two composite variables were entered into the analysis as an interaction term.

8. The data and analyses presented here have some significant limitations. The data provide only a rough guide to skills at the occupational level. Moreover, the analyses do not allow for any causal inferences about the direction of the relationship between skills and innovation. Although extremely useful in providing a 'thick description' of the data, more fit-for-purpose data collection from firms would greatly assist in supporting and evaluating policy interventions designed to stimulate innovation.

outputs varies greatly, depending on the quality of the ecosystem within which individual businesses operate. Based on evidence drawn from the Global Innovation Index, and other global assessments of innovation performance, Australia's innovation performance generally compares favourably with many other industrialised economies. However, the efficiency of Australia's innovation system remains suboptimal. Table 2.1, which shows input and output measures of innovation activity drawn from the Global Innovation Index, demonstrates that a significant reason for innovation inefficiency is the way Australia currently uses skills and skills mixing. Australia ranks relatively highly on assessments of skills inputs—notably general investments in education, and the number of graduates in STEM based programs and research. However, it ranks relatively poorly in relation to the sophistication of how organisations use these skills. This issue should be a considerable concern to any government seeking to optimise policy settings to support and sustain innovation.

The Australian evidence reveals significant differences among innovation active and non-innovation active businesses in the use of skills. In general, innovative businesses in Australia employ and use all types of skills far more intensely than non-innovative firms. Yet, innovative businesses of all sizes also report that gaining access to adequate supplies of a diverse set of skills is one of the most significant barriers to their ability to be innovative. These skills shortages relate as much to expertise in business and related skills as they do to the STEM-based skills required for innovation.

This chapter also reports on an econometric analysis of the correlations of innovation activity using Australian data. This enabled the project team to assess whether, in the context of a host of other factors, skills and skills mixing were significantly related to innovation activity.

There are a number of caveats on how these results could be interpreted. The findings reveal that both technical and non-technical skills were consistently associated with innovation performance. Technical skills were most closely associated with product and process innovations, while non-technical skills were most closely associated with process, organisational and marketing innovations.

The important concluding observation from the analyses presented in this chapter relates to the impact of skills relative to other factors. As noted above, several other factors have a stronger association with innovation than skills variables. In particular, financial assistance from government, the integration of systems, and work arrangements each have a larger effect on the probability of innovating than the skills variables included in the analysis. However, skills are still critical in shaping the propensity of a business to engage in different types of innovation, as results consistently show that skills are significant across all four types of innovation activity measured. Skills and investment in skills for innovation are also one factor that individual businesses can influence and more easily leverage than other factors found to be significant. Finally, the full report commissioned from Swinburne University of Technology (Palangkaraya et al. 2016) also stresses the need to place these findings in context of the broader challenge of unpacking the complex nature of the relationships between these different factors, something that cannot be captured from the available data. Skill, working arrangements, external competitive forces and other factors are not independent of each other, and will both drive and be driven by innovation activity and success. To enable more detailed analyses of the complex and dynamic relations between skills and other factors relevant in the context of innovation (system) performance, data would have to be collected on a more granular level.

# Statistical appendix to Chapter 2

**Table 2.2: Variables used in statistical analysis**

Variable	Survey question
Introduced innovation—product	= 1 if business introduced any new or significantly improved goods; services in the last 12 months; = 0 if otherwise.
Introduced innovation—process	= 1 if business introduced any new operational processes—methods of manufacturing or producing goods or services; Logistics, delivery or distribution methods for goods and services; Supporting activities for business operations; Other operational processes in the last 12 months; = 0 if otherwise.
Introduced innovation—organisational	= 1 if business introduced any new organisational/managerial processes—knowledge management processes; major change to the organisation of work; New business practices for organising procedures; new methods of organising work responsibilities and decision making; significant changes in relations with others; other organisational/managerial processes in the last 12 months; = 0 if otherwise.
Introduced innovation—marketing	= 1 if business introduced any new changes to the design or packaging of a good or service; new media or techniques for product promotion; sales or distribution methods/new methods of product placement or sales channels; new methods of pricing goods or services; other marketing method in the last 12 months; = 0 if otherwise.
Introduced innovation—any	= 1 if Introduced innovation—product, process, organisation and marketing; = 0 if otherwise.
Captive market (0/1)	= 1 if captive market/no effective competition; = 0 if otherwise.
Years in operation	Years of operation—regardless of changes in ownership.
Working arrangements (0–1)	The average of 7 binary items measuring the presence of flexible work hours; ability to buy or cash out extra leave, or take leave without pay; selection of own roster or shifts; job sharing; ability for staff to work from home; paid parental leave; flexible use of personal sick, unpaid or compassionate leave.
Foreign ownership (0–3)	Percentage of foreign ownership: 0 = 0%; 1 = GT 0% and LT 10%; 2 = GE 10% and LE 50%; 3 = GT 50%.
Financial assistance from governments— types (0–1)	The average of 7 binary items measuring whether the business received any financial assistance from Australian government organisations—grants; ongoing funding; subsidies; tax concessions; rebates; other.
Financial assistance from governments— levels (0–1)	The average of 2 binary items measuring the whether the business received government financial assistance received from Australian Government; state/territory or local government.
Systems link automatically (0–1)	The average of 7 binary items measuring the whether the business had systems that linked automatically with Suppliers' business systems; customers' business systems; own systems—reordering replacement supplies; own systems—invoicing and payment; own systems—production or service operations; own systems—logistics, including electronic delivery; own systems—marketing operations; other.
Collaborative research (0/1)	= 1 if business collaborated for innovation; = 0 if otherwise.
Debt finance refused (0/1)	= 1 if sought but not obtained debt finance; = 0 otherwise.
Equity finance refused (0/1)	= 1 if sought but not obtained equity finance; = 0 otherwise.
Core skills—engineering (0/1)	= 1 if skills used in undertaking core business activities—engineering; = 0 if otherwise.
Core skills—scientific and research (0/1)	= 1 if skills used in undertaking core business activities—scientific and research; = 0 if otherwise.
Core skills—IT professionals (0/1)	= 1 if skills used in undertaking core business activities—IT professionals; = 0 if otherwise.
Core skills—IT support technicians (0/1)	= 1 if skills used in undertaking core business activities—IT support technicians; = 0 if otherwise.
Core skills—marketing (0/1)	= 1 if Skills used in undertaking core business activities—marketing; = 0 if otherwise
Core skills—project management (0/1)	= 1 if Skills used in undertaking core business activities—project management; = 0 if otherwise.
Core skills—business management (0/1)	= 1 if skills used in undertaking core business activities—business management; = 0 if otherwise.
Core skills—financial (0/1)	= 1 if skills used in undertaking core business activities—financial; = 0 if otherwise.
Ln (employment)	Log of employment number.

**Table 2.3: Skills and the propensity to innovate among Australian businesses; probit estimation results**

Explanatory variables (1 year lag)	Introduced innovation				
	Any	Product	Process	Organisational	Marketing
Firm size (Ln employment) †	0.044*** (0.012)	-0.006 (0.011)	0.061*** (0.011)	0.044*** (0.011)	0.002 (0.011)
Firm age (years in operation)	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.002*** (0.001)	-0.001 (0.001)
Foreign ownership (0–3)	0.005 (0.019)	0.061*** (0.017)	-0.009 (0.017)	-0.013 (0.017)	-0.011 (0.017)
Captive market (1/0)	-0.108 (0.061)	-0.094 (0.056)	-0.074 (0.056)	-0.112** (0.056)	-0.225*** (0.058)
Financial assistance from governments—types (0–1)	0.235 (0.234)	0.736*** (0.199)	0.654*** (0.200)	0.351 (0.200)	0.394** (0.199)
Financial assistance from governments—levels (0–1)	0.072 (0.118)	0.001 (0.094)	-0.141 (0.094)	0.117 (0.094)	0.034 (0.094)
Debt finance refused (0/1)	-0.048 (0.175)	0.124 (0.160)	0.007 (0.162)	0.061 (0.163)	-0.016 (0.164)
Equity finance refused (0/1)	0.050 (0.108)	0.118 (0.094)	0.144 (0.094)	0.085 (0.094)	0.118 (0.094)
Systems link automatically (0–1)	0.415*** (0.117)	0.430*** (0.098)	0.404*** (0.098)	0.391*** (0.099)	0.401*** (0.098)
Collaborative research (0/1)	0.131** (0.065)	0.164*** (0.054)	0.076 (0.055)	0.126** (0.055)	0.043 (0.055)
Working arrangements (0–1)	0.281*** (0.080)	0.236*** (0.070)	0.165** (0.070)	0.377*** (0.070)	0.219*** (0.071)
Core skills—engineering (0/1)	-0.095* (0.051)	0.020 (0.042)	0.072* (0.042)	-0.055 (0.042)	-0.247*** (0.043)
Core skills—scientific and research (0/1)	0.236*** (0.066)	0.275*** (0.055)	0.194*** (0.055)	0.163*** (0.055)	0.089 (0.055)
Core skills—IT professionals (0/1)	0.081 (0.048)	0.134*** (0.044)	0.088** (0.043)	0.040 (0.043)	0.037 (0.044)
Core skills—IT support technicians (0/1)	-0.008 (0.048)	-0.063 (0.044)	-0.067 (0.044)	0.009 (0.043)	-0.008 (0.044)
Core skills—marketing (0/1)	0.114** (0.046)	0.197*** (0.042)	-0.024 (0.041)	-0.023 (0.041)	0.462*** (0.042)
Core skills—project management (0/1)	-0.058 (0.050)	-0.056 (0.045)	0.048 (0.045)	0.064 (0.045)	-0.100** (0.045)
Core skills—business management (0/1)	0.091* (0.050)	-0.002 (0.046)	0.110** (0.046)	0.124*** (0.046)	0.021 (0.046)
Core skills—financial (0/1)	-0.092 (0.052)	-0.103** (0.048)	0.022 (0.048)	0.045 (0.048)	-0.074 (0.049)
Intercept	0.839*** (0.263)	-0.448*** (0.044)	-0.595*** (0.045)	-0.540*** (0.045)	-0.531*** (0.045)
<b>Observations</b>	<b>5,630</b>	<b>5,630</b>	<b>5,630</b>	<b>5,629</b>	<b>5,630</b>

Notes:

1. Dependent variable: An innovation introduced during last 12 months = 1, 0 if otherwise.
2. Standard errors in parentheses. Significance: \*\*\* p<0.01, \*\* p<0.05. † Control variable only because the dependent variable is binary. This does not mean large firms are more innovation intensive.

Source: Palangkaraya et al. (2016), based on Australian Bureau of Statistics Business Characteristics Survey and Business Longitudinal Database and Australian Taxation Office Business Activity Statement data, 2005–06 to 2011–12.

**Table 2.4: Skills mixing and the propensity to innovate among Australian businesses; probit estimation results**

Explanatory variables (1 year lag)	Introduced innovation				
	Any	Product	Process	Organisational	Marketing
Firm age (years in operation)	-0.001 (0.001)	-0.001 (0.001)	0.000 (0.001)	-0.002*** (0.001)	-0.001 (0.001)
Foreign ownership (0–3)	0.006 (0.019)	0.066*** (0.016)	-0.005 (0.016)	-0.014 (0.016)	-0.013 (0.016)
Captive market (1/0)	-0.103 (0.061)	-0.098 (0.056)	-0.073 (0.056)	-0.106 (0.056)	-0.228*** (0.057)
Financial assistance from governments—types (0–1)	0.263 (0.232)	0.752*** (0.198)	0.709*** (0.200)	0.387 (0.200)	0.335 (0.197)
Financial assistance from governments—levels (0–1)	0.067 (0.118)	-0.002 (0.093)	-0.123 (0.093)	0.124 (0.094)	-0.001 (0.093)
Debt finance refused (0/1)	-0.031 (0.174)	0.136 (0.160)	0.015 (0.162)	0.064 (0.162)	0.005 (0.162)
Equity finance refused (0/1)	0.034 (0.107)	0.101 (0.093)	0.140 (0.094)	0.084 (0.094)	0.094 (0.092)
Systems link automatically (0–1)	0.419*** (0.116)	0.427*** (0.097)	0.386*** (0.098)	0.390*** (0.098)	0.435*** (0.097)
Collaborative research (0/1)	0.170*** (0.064)	0.208*** (0.053)	0.112** (0.054)	0.151*** (0.054)	0.058 (0.053)
Working arrangements (0–1)	0.276*** (0.079)	0.225*** (0.070)	0.153** (0.070)	0.378*** (0.070)	0.220*** (0.070)
Core skills—STEM (0–1)	0.252 (0.134)	0.292** (0.121)	0.297** (0.122)	0.146 (0.122)	-0.083 (0.123)
Core skills—business (0–1)	0.167 (0.088)	0.045 (0.080)	0.171** (0.079)	0.246*** (0.079)	0.447*** (0.079)
Skills mixing (business*STEM skills)	-0.243 (0.186)	-0.035 (0.164)	-0.105 (0.165)	-0.071 (0.165)	-0.213 (0.165)
<b>Observations</b>	<b>5,630</b>	<b>5,630</b>	<b>5,630</b>	<b>5,629</b>	<b>5,630</b>

Notes:

1. Dependent variable = Introduced an innovation during last 12 months = 1, 0 if otherwise.
  2. Intercept term not reported. Standard errors in parentheses. Significance: \*\*\* p<0.01, \*\* p<0.05. Includes a constant; ln(employment)
- Source: Palangkaraya et al. (2016), based on Australian Bureau of Statistics Business Characteristics Survey and Business Longitudinal Database and Australian Taxation Office Business Activity Statement data, 2005–06 to 2011–12.

Interpretation of the coefficients is as follows:

- \*\* and \*\*\* denominate levels of statistical significance, meaning that coefficients with no asterisk have little to no explanatory power. The more asterisks, the more confidence there is in the meaning and interpretation of the coefficient.
- For significant coefficients, the value of the coefficient can be interpreted as a measure of probability. For instance, collaborative research is associated with any form of innovation with a coefficient of 0.131\*\*. Since collaborative research is measured as a binary variable (have you collaborated? Yes/No), the coefficient can be interpreted as 'a firm which has conducted collaborative research is, based on this data, 13.1 per cent more likely to have introduced any innovation in the following year than a firm that has not conducted collaborative research'. At a  $p < 0.05$  (\*\*) significance level, this statement is true for over 95 per cent of the firms in the sample.
- Working arrangements are associated with any innovation with a coefficient of 0.281\*\*\*. Working arrangements are measured on a scale between 0 and 1, that is, of the seven arrangements (flexible work hours; ability to buy or cash out extra leave, or take leave without pay; selection of own roster or shifts; job sharing; ability for staff to work from home; paid parental leave; flexible use of personal sick, unpaid or compassionate leave) each accounts for one seventh of the overall coefficient. The coefficient can be interpreted as 'a firm which has all seven working arrangements in place is, based on this data, 28.1 per cent more likely to also have introduced an innovation in the following year than a firm which has none of the working arrangements in place'. At a  $p < 0.01$  (\*\*\*) significance level, this statement is true for over 99 per cent of the firms in the sample.
- The equivalent interpretations apply to any other relationship between an explanatory factor and innovation outcome variable.

# 3

## Understanding the generations of innovation thinking in policy

### Summary

**Innovation thinking in policy has evolved from linear, 'first generation' approaches through 'second generation' systems approaches to more complex 'third generation' innovation ecologies approaches.**

**Third generation thinking emphasises the importance of viewing people as bundles of skills, teams as bundles of diverse people, and organisations as resembling networked structures, that is bundles across organisational boundaries.**

**The effects of digitisation, globalisation and the rise of the service sector reinforce the complexity of the innovation system.**

**Research and discussion on the future of work, future work skills, and sources of innovation highlight the growing importance of broad and integrative (non-technical) skills.**



### 3.1 Introduction

Chapter 2 focuses on examining the relationship between skills and innovation at the firm level. The evidence discussed establishes that skills are a critical input into innovation activities of Australian businesses. Innovative firms use more skills than innovation inactive firms. They also report more intense skills shortages than non-innovation active firms. However, Chapter 2 also establishes that the relationship between skills and innovation is not a simple one. Different types of skills—and different bundles or skills mixes—are used to support different types of innovation at different stages of the innovation process. An important additional theme to emerge from Chapter 2 is the way firms seek to bundle skills at the individual level, the team and organisational level, and across organisational boundaries. This is explored in more detail in this chapter and Chapter 4. At all levels, innovation requires diverse skills, and accessing these skills is a multifaceted challenge for many organisations. Reliance on traditional ‘make or buy’ models for skills acquisition and development is only part of the story. Organisations access and develop skills bundles through a range of avenues, including partnerships with other enterprises and training and education providers, as well market mechanisms.

These observations highlight the need to consider the broader context or ‘ecosystem’ within which organisations are seeking to develop and access the skills required for innovation. This chapter’s consideration of this broader context of innovation ecosystems is framed by an understanding of how thinking about the innovation process and policy has evolved over time. This evolution is important to understand because it has implications for the role and expectations of government, industry, education and research institutions and other social actors, in shaping conditions conducive to innovation or conditions that present barriers to innovation. Another issue to emerge from this understanding is that the ecosystem matters for both the ability of individual organisations to access skills required for innovation, while also having consequences for the types of skills and capabilities that organisations will need to operate effectively within the innovation ecosystem.

This chapter therefore starts by examining the evolution of innovation policy and thinking. There are many ways to characterise this evolution, but the most influential has been to understand it as successive waves or generations of innovation policy and thinking. The focus is on understanding the shift from first to second and then third generation innovation policy, and the implications of these shifts for skills and innovation. Doing so highlights the forces that have emerged in recent times—the global financial crisis, digitisation, globalisation and the rise of global value chains, ‘financialisation’, the growth of the service sector and the growing impact of service industries’ skills and approaches in manufacturing. These forces have influenced the economy, organisational structures, the nature of work and skills requirements and, in turn, current thinking about the nature of innovation.

Understanding and analysis of the dynamics of innovation and its relationship to skills formation has developed and become more complex. A holistic, integrated view of the innovation ecosystem sees important links between expanded and expanding skills for individuals,

a central role for diverse multi-skilled teams, and networked organisations crossing the boundaries and striving for collaboration between public and private sector, and in particular with higher education.

## 3.2 Looking back: understanding the waves of innovation

Chapter 2 observed that much of the work connecting skills and innovation has focused on the role of technical and scientific skills—in science and in driving the capacity of business to develop and use technological innovations. This focus on technical skills and technological innovation has merit, especially at a time of intensifying scope and pace of technological changes. Attracting, retaining and investing in the development of technical skills should be a compulsory foundation of a firm’s capacity to develop technological innovations.

However, other skills also play a critical role in driving innovation activity. This is particularly so where innovations encompass non-technological elements, such as business models and processes, organisational and managerial systems or markets and product design. When innovation constitutes more than technological and scientific novelty, then the consideration of skills underlying innovation also needs to be broadened.

Chapter 2 briefly canvassed the scope of activities and outcomes understood as ‘innovative’. The core of what innovation is has changed over time, and along with it has evolved our understanding of what drives innovation and how innovation is treated in policy.

The evolution in innovation thinking and policy approaches has typically been characterised as passing through different phases or waves, or as generations. One of the most influential models of this process is proposed by Lengrand (2002), who describes three generations of innovation thinking in policy (see Table 3.1).

### 3.2.1 First generation

The first generation of innovation thinking in policy was developed around linear models of the innovation process: the sequence starts with research, moves through development and design to production for the market, and then on to marketing and sales, and (though these received little attention) after-sales service, consumption and product disposal. This approach to thinking about innovation has important consequences for how skills are integrated into the innovation process. From this first generation viewpoint, scientific endeavour is seen as largely autonomous from the process of developing, designing and commercialising new products or services. Consequently 'scientific breakthrough' has strong public good qualities and should therefore be invested in as a public enterprise (Teece 2010).<sup>1</sup> This first generation of thinking is also associated with the idea of the 'great innovator', heroic individuals with the vision to relate new knowledge to commercial opportunities (Lengrand 2002, p. 49). While such individuals still exist and undoubtedly play a role in innovation, individual creativity is unlikely to provide a sufficient basis for large-scale enterprise innovation.

The role of public policy for this first generation of innovation thinking was to support research, principally at publicly funded research institutions, which would then produce a flow of innovation into markets (Teece 2010). In short, the model was entirely supply-driven: firms produce products and customers will buy. This linear model of innovation, however, failed to recognise the multiple links and feedback loops that connect research activity, development, commercialisation and the uptake of innovations (Teece 2010). New research problems, for example, are often inspired by experiences with the application of new knowledge in real-world situations—that is, they are demand-driven. Moreover, commercially viable innovations have generally not been generated by scientists and technicians working in isolation (Teece 2010).

Rather, the consequence of interactions and information flows between research managers, sources of finance for R&D, regulatory agencies, entrepreneurs, marketing experts and the like, have enabled 'invention' to be translated into viable and successful 'innovations'. Innovation is rarely a matter of heroic individuals pursuing their visions. Indeed, very few innovations come 'out of the blue', and there are typically several teams working on any particular class of innovation at any moment. Equally important, innovation typically happens in networks of innovative agents, often through collaboration between firms, across the university-industry interface (Lengrand 2002, p. 51).

### 3.2.2 Second generation

In the second generation, policy focused on innovation systems (both national and regional), clusters and improving the networks within which groups of actors involved in innovation interact. Crucially, from the 1990s onwards, resource constraints became an increasingly important issue for innovation activity. Critical to innovation processes in second generation thinking and policy is the idea of deliberate and intentionally designed 'innovation systems' that connect public agencies and institutions, enterprises and education and research institutions, often in co-located precincts. Innovation in this second generation typically relies on scientific and technical knowledge bases and also relies heavily on business and marketing knowledge to uncover market demand for innovation and effectively commercialise new products and services. This approach tended to work for organisations operating in a predominantly domestic market. However, globalisation and new international competition, financial constraints and the formation of global value chains with highly specialised global organisations (see Sections 3.4 and 3.5) challenged particularly smaller and non-international organisations and skills beyond technical and business understanding became necessary.

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1. Teece notes that in the US, these public investments were also replicated in large privately owned scientific institutes and laboratories, such as the Bell laboratories.

### 3.2.3 Third generation

The third generation of innovation thinking in policy typically dates to the second decade of this century. This new approach to thinking about innovation is holistic and stresses ecologies (Lengrand 2002). Dodgson et al. (2011) characterise this generation of innovation thinking in policy as a dynamic, emergent and evolving ecosystem in which there are multiple and distributed sources of knowledge for innovation. Successful economies are those with robust but adaptable network connections or ecologies and the skills to build and maintain these. Entrepreneurial and innovative behaviour takes place in conditions of uncertainty, which brings together organisations of all sizes, new combinations of technologies, new organisational rules and new human skills to generate innovation. The biggest challenge for policy makers is how to re-design both policies, and the mechanisms for delivering policies, in the face of the uncertain and changing nature of innovation. Skills to successfully innovate in this third generation have moved beyond technology and business to now include broad diversity across a variety of technical and non-technical skills, the competencies to source and retain these skills when they are required, and the skills to position the organisation as a valuable partner in the innovation ecosystem.

Significantly, under this contemporary view of innovation, governments play a crucial role coordinating and facilitating connectivity and thus enabling complex systems to deliver new products and services. Government can adopt the role of connector in dynamic and evolving systems of institutions, as well as encouraging the development of organisational skills and capabilities. Innovation policy needs to be rooted in, and sympathetic to, the idiosyncrasies of different innovation systems, within and between nations (Dodgson et al. 2011).

Table 3.1 outlines the distinguishing features in these three generations of innovation thinking and policy, and the skills and competencies associated with each. As can be seen in the Table, the move from a linear to a more complex view of innovation includes the supporting skill sets also becoming more complex and diverse. Significantly, innovation now depends on bundles of skills that are provided by people having broader skills (technical and non-technical), by people with different skills working in teams with individuals who have diverse sets of skills, and by organisations working in alliances and networks that bring together different skills and experiences across different types of innovation, and different activities in the innovation cycle (i.e. ideation and discovery, development and testing, and commercialisation).

**Table 3.1: Generations of innovation thinking in policy**

Generations of innovation thinking in policy	Model of innovation	Skills/competencies
First	Linear Science/technology based Pre-/production based	STEM
Second	Multiple links/feedback loops Science/tech plus marketing Pre-/production and post production Networks of innovative agents Triple helix National innovation system	STEM+ STEM B T shaped careers Teams (narrow diversity)
Third	Complex, evolutionary Holistic ecologies Multiple, distributed sources of innovation	Individuals as bundles of skills: STEM and beyond Teams and organisations as bundles of skills (broad diversity) Networks as bundles of skills across organisations

Based on Lengrand (2002).

### 3.3 Looking around: individuals as bundles of skills and teams as bundles of people with complementary skills

In the analysis of skills necessary for innovation, there is an important distinction between varieties of innovation. A *radical (or disruptive) innovation* has a significant impact on a market and on the economic activity of firms in that market, while *incremental innovation* concerns an existing product, service, process, organisation or method whose performance has been significantly enhanced or upgraded. Incremental innovation is by far the dominant form of innovation (Toner 2011).

*Manufacturing innovation* is fostered by R&D of technologies that are aimed at increasing the performance of manufacturing processes. Broadly speaking, manufacturing-related R&D encompasses improvements in existing methods or processes, or wholly new processes, machines or systems. *Service innovation*, on the other hand, relates to a new or considerably changed service concept, client interaction channel, service delivery system or technological concept, leading to service functions that are new to the firm, that change the service/good offered on the market, and that require structurally new technological, human or organisational capabilities of the service organisation.

*Technological innovations* comprise new products and processes and significant technological changes to existing products and processes. An *organisational innovation* is the implementation of a new organisational method in the firm's business practices, workplace organisation or external relations.

The skills required for these types of innovation, as outlined by Green et al. (2007) are provided in Table 3.2. As the Table shows, radical and incremental innovation require contrasting skills mixes. However, in each case, the required skills go well beyond STEM.

In summary, across all types of innovation, there is a move away from a linear form of analysis with a focus on technical skills per se, to a greater focus on bundles of skills including, but not limited to, STEM. This development could be interpreted in the parlance of the debate as STEM+ or STEM B, that is technical skills with business skills added or skills beyond STEM added. It is not clear at this point whether these skills are to be embodied in employees originally qualified in STEM alone or achieved through bundles of technically qualified and non-technically qualified staff. In a major U.S. study, the U.S. National Academies of Sciences, Medicine and Engineering (2016) concluded that although significant numbers of students were graduating with STEM degrees, many lacked the right combination of technical and employability skills needed to thrive in the workplace.

In Australia, Professional Scientists Australia (2015, p. 4) concludes that:

*Greater commercialisation of research doesn't happen spontaneously—it can only be led by STEM professionals who have not only technical skills and training but also business acumen, an understanding of how IP incentivises innovation, leadership and team management skills, cross-discipline skills and the creativity and motivation to drive the commercialisation process and closer ties between industry and the research sector.*

Based on this and earlier views, there is an argument for broadening the education of STEM trained and qualified employees. Furthermore, when considering the comparison of the skills required for technological and organisational innovation (see Table 3.2), this broadening needs to involve an even greater mix of skills and competencies embodied in the teams of people at work in enterprises.

Almost all developed nations have also moved from manufacturing products, including the sale of resources, to selling products with high-value-add services. The required skills for manufacturing and service sector innovation are also compared in Table 3.2. Innovation in the service sector requires

similar but not identical skills to manufacturing, although the increasing integration of the two sectors is blurring this distinction. As discussed later in this chapter, the growing impact of service industries' skills and approaches in the manufacturing sector means that the skills expected along the whole value chain are now considered essential for an innovative organisation (although not necessarily held within any one organisation). The skills mix is both intensive and

extensive. In both cases, once again the demands of innovation go well beyond STEM.

Phillip Toner, in a much cited report for the OECD, argues that the increasingly service-oriented focus of the economy altered how the connections between skills and innovation need to be viewed. A compelling concern for Toner is to determine whether the innovation process for services, and consequent demand for workforce skills, differs significantly from that for

**Table 3.2: Skills required for different types of innovation**

Radical innovation	Incremental innovation	Technological innovation	Organisational innovation	Manufacturing innovation	Service innovation
<p>Very highly qualified expert science and technology skills (e.g. computing, medicine, biology, physics)</p> <p>Synthesising, knowledge translation and transfer skills (bringing together ideas and knowledge from disparate disciplines and domains)</p> <p>Lobbying and negotiation skills (especially where long-term development funding and social acceptance are required, and licensing agreements are in play)</p> <p>Opportunity recognition skills</p> <p>Market development skills</p> <p>Coordination skills (if distributed, complementary effort is required)</p>	<p>Science and technology skills</p> <p>Engineering skills</p> <p>Design skills</p> <p>Process management and technical skills</p> <p>Coordination skills</p> <p>Market research and analysis skills (and competitor analysis skills)</p> <p>Business and product positioning skills</p> <p>Strategic analysis skills</p> <p>ICT skills (especially in the case of services where the producer-consumer relationship is electronically mediated)</p>	<p>Science and technology skills</p> <p>Software development skills</p> <p>Systems development and integration skills (especially in the domain of technological process development)</p> <p>Engineering and design skills</p> <p>Negotiation, coordination and communication skills (especially where licensing, royalties and distribution agreements, production partnerships and outsourcing, and organisation of complementary inputs are concerned)</p> <p>Value-chain organisation skills</p> <p>Professional skills (for example, accounting and finance, marketing, sales, IP protection and legal skills)</p>	<p>Strategy development and business modelling skills</p> <p>Procurement and negotiation skills (especially where innovation involves the contracting of external consultants)</p> <p>Communication skills (especially where innovation implies major changes to work practices and impacts on employees)</p> <p>Workflow and job design skills</p> <p>Professional skills (especially Human Resources)</p> <p>ICT and systems design skills (where reorganisation is reliant on ICTs or involves relocation or off-shoring of work)</p>	<p>Engineering and design skills</p> <p>Science and technology skills</p> <p>Market and competitor research skills (and data analysis skills)</p> <p>Customer interfacing skills</p> <p>Process organisation and management skills</p> <p>Business development and positioning skills</p>	<p>Client interfacing and communication skills</p> <p>ICT skills (especially systems design and integration)</p> <p>Data management and analysis skills</p> <p>Market research and analysis skills</p> <p>Team assembly, coordination and management skills</p> <p>Ideas harvesting skills (gathering ideas for innovation from service workers, partners and service users)</p> <p>Procurement and coordination skills (especially where service development involves partnership projects, complementary innovation and technological components)</p> <p>Professional skills (legal, policy analysis and translation, Human Resources)</p>

Based on Green et al. (2007).

manufacturing. For Toner, technical skills are still acknowledged as important in the innovation process, but in the incremental innovation process that dominates innovation overall, non-technical skills are of central importance:

*...the capacity to engage in such [service] innovation has been shown to depend critically on the technological 'absorptive capacity' of the workforce, broadly conceived of as the ability to adopt, adapt and diffuse new or improved products, production processes and organisational innovations. In turn it is generally argued that the increased rate of innovation across economies requires the workforce to possess both technical competence and what are termed 'generic skills'—problem solving, creativity, team work and communication skills.*

Toner 2011, p. 8

Of considerable relevance to this report is Toner's (2011, p. 61) conclusion that today a broad range of workforce skills and occupations are involved in the implementation of innovation. These occupations are not limited to STEM-based occupations, but also include people involved in direct production, tradespersons, technicians and people involved in marketing, financial management and human resources.

### 3.3.1 Mixing skills

As these summaries of skills requirements for different types of innovation reveal, there is no universal mix of skills for innovation—rather, the skills necessary to innovate depend on the desired output as well as the industry and organisational environment (cf. Tether et al. 2005). For example, industries like the creative sector have very different skills mix needs from the highly technical automotive industry.

A wealth of research reports that technical innovation—more readily conceived as the invention stage of traditional innovation processes—is mainly related to technical skills. Yet, the need for 'skills mixing' (Gupta and Singhal 1993)— or skills distribution, skills variety or diversification (Tether et al. 2005) and skills complementarity (Watson 2013) —has gained traction in research in recent years. There are

many arguments for the integration of technical and non-technical skills, not at least the recent focus on design-led innovation, particularly in traditionally technology-oriented industries. At Apple, for example, design does not follow function, but technology is adapted to fit design specifications, often sacrificing functionality to meet design characteristics.

Some observers have suggested a need to correct a 'science and technology bias' in thinking about innovation and in the skills required for successful innovations to occur (Jaeniste 2009). Successful commercialisation of technical inventions requires more managerial and business skills that enable organisations to create new products and services, develop new markets, and appropriate value from these technical innovations. In this context, it is often skills management, not just the skills, that increase the chances of financial success from new ideas and invention (Meier, Williams and Humphreys 2000; Green et al. 2007; Watson 2013). This has more recently also been the focus of policy thinking in other countries:

- The Danish Business Research Academy (DEA), for example, points to HASS research and development as offering significant advantages for 'user-driven innovation'<sup>2</sup> by contributing to the ability to link and synthesise the varying types of understandings of customers, the market and the firms themselves (DEA 2011). In a survey of Danish firms (DEA 2007), a significant number of companies reported the need for interdisciplinary research that identifies ways to maximise creative processes.
- Similarly, a report from Sweden (Linnaeus University 2009) offers a practical analysis of the value of interdisciplinary expertise-mixing in a range of local industries of varying sizes. Drawing on case studies of the interdisciplinary practices within successful Swedish companies, it documents strategies adopted by these firms. This study found

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2. Innovation that is based on articulating and solving user problems and needs.

most businesses use mixed skills organised in interdisciplinary teams. Skills diversity within teams, based on recruiting individuals from different educational backgrounds, including young people gathered from the global workforce, are associated with a better understanding of the customer, a clear view of company purpose and business performance.

- The U.S. National Academies of Sciences, Engineering and Medicine (2016) argued that there is a growing need for students with a breadth of skills outside their core STEM discipline. The report suggests that these skills are perhaps best developed through a well-rounded liberal education that includes STEM courses, humanities courses, and experiences in the arts. The skills include problem solving, critical thinking, teamwork, collaboration, communication and creativity. Degree programs following such broad structures have been introduced in Australia (e.g. the Melbourne Curriculum since 2008), but are not widespread.

The actual and potential benefits of 'cross-sectoral collaborations' that combine diverse skills and expertise have also been examined in an Australian study investigating organisation characteristics associated with a successful collaboration (Metcalf, Riedlinger, Pisarski and Gardner 2006). Drawing on evidence from surveys with over 600 organisations, several focus groups, a two-day workshop with 185 participants and 75 structured interviews, the study concluded that:

- cross-sectoral collaboration was associated with innovative solutions to problems, development of commercial products, collaboration with community services, more diverse education opportunities, and a more engaged public and end-users
- teams and individuals involved in these collaborations also benefited from the processes, in that they broadened their social and professional networks.

Metcalf et al. (2006) draw some important policy implications from their study. In particular, they contend that the high transaction costs of collaboration imply there should be a focus on

cross-sectoral collaboration where the returns are likely to accrue to many firms. Such collaborative efforts are difficult to initiate, and require joint actions by government, funding institutions, researchers and industry. Critical factors for cross-sectoral collaborations to flourish, they argue, are removing institutional impediments, investing in cross-sectoral research, and training 'boundary spanners' (e.g. postgraduate students working across STEM and HASS disciplines).

At an organisational level, it is now more widely understood that many Australian enterprises need to develop a different type of workforce with a different type of skills profile. For instance, engineers not only need to know how to construct a statically sound apartment building, they also need to understand market conditions and customer preferences and how those might change in the future, they need to understand design and aesthetic aspects, and they require the communication and negotiation skills to 'sell' their idea to superiors. Generally, there is a requirement to increase the level of skill, whatever the area of skills in use (Roos 2014). This workforce also needs to combine technological expertise with the ability to effectively and efficiently integrate various knowledge bases and skill sets, and deploy 'soft skills' including team building capacity, emotional intelligence, strategic visioning, market analysis and cultural sensitivity. This intersection of STEM and HASS disciplinary inputs is critical to the success of Australian knowledge-based enterprises. As outlined in Chapter 1, previous SAF projects have also highlighted the importance of integrative skills to innovation. SAF 4 highlights, for instance, the role of a mix of technical and non-technical skills in driving innovation at the level of the business enterprise and illustrates the value of skills mixing in a number of cases studies, some of which are revisited later in this report.

The study of the potential role of government, industry and education and research institutions in developing innovation skills and capabilities (Howard 2016) commissioned for this report identifies a more nuanced categorisation of the skills required for innovation to occur. The research also identifies the need to

### Box 3.1: Skills for innovation

**Basic skills**—covering numeracy, reading and comprehension, written expression (literacy), active learning, oral expression, problem solving, critical thinking, self-awareness, and digital literacy. These basic skills are sometimes referred to in the business community as employability skills.

**Knowledge skills**—covering knowledge drawn from science, technology, engineering and mathematics (STEM) and the humanities, arts and social sciences (HASS). Knowledge skills lie at the foundation of ‘knowledge organisations’ (that is, organisations that create, manage, use and transfer knowledge-based products/services). These skills are now essential features of businesses in manufacturing and in the mining, agricultural and service industries.

**Technical and technician skills**—covering areas such as equipment maintenance, installation, repair, operation and control, machine programming and software maintenance, quality control, technology and user experience design, troubleshooting.

**Creativity, design and cross-cultural skills**—covering idea and opportunity creation (which may or may not be sourced from science and technology), problem solving, integrative thinking, ingenuity, and end user (customer) orientation including cross-cultural understanding within and across multiple global markets.

**Entrepreneurial skills**—abilities related to starting a business, whether as a ‘start-up’ company, or as a new venture in an established organisation, including an ability to focus on satisfying customer needs and end user wants.

**Business skills**—covering implementation and administration of critical business systems and processes including, sales and marketing, accounting and finance, materials procurement and supply, project delivery, recruitment and motivation of employees and contractors, and management of time.

**Management and leadership skills**—covering judgment and decision making, communicating and coordinating with others, emotional intelligence, negotiation, persuasion, organisation culture, training and teaching others.

Source: Howard (2016).

differentiate skills needs for start-up businesses and more established organisations at various stages of their growth cycle and operating in different contexts. This issue is addressed more systematically in Chapters 4 and 5.

Drawing on prior studies and extensive interviews with industry stakeholders and innovation experts, the commissioned study identified sets of skills for innovation (see Box 3.1). A wide range of skills, both technical and non-technical in nature, are considered relevant for innovation. Notably, the majority of skills mentioned throughout the interviews conducted for the project relate to managing oneself and others (e.g. leadership, collaboration and organisation) and are inherently integrative, both in observing and re-combining knowledge and in developing and combining skills from different disciplines. Chapter 4 explores such skills mixing—within individuals, in teams as well as through collaboration across organisations—and the mechanisms through which organisations support an innovation culture.

Based on this list, it is clear that a wide variety of technical and non-technical skills are required

for innovation, both embodied within individuals and within teams.

### 3.3.2 Teams and skills: swarming

Commenting on recruitment difficulties in the UK in the data-driven economy—and accepting the inherent limitations of individuals—the National Endowment for Science, Technology and the Arts (NESTA) concluded that:

*By and large, the problem is finding people with the right mix of skill: the data scientists who combine technical skills, analytical and industry knowledge, and the business sense and soft skills to turn data into value for employers are very hard to find—so much so that some people refer to them as ‘unicorns’. In the absence of such ‘unicorns’, businesses are building their analytical capability through multidisciplinary teams. Members of a team may have a number of core skills in common, and individuals will have specialist skills developed within particular disciplines. This underscores the need not just for multidisciplinary working, but for analysts with strong teamwork and communication skills.*

Mateos-Garcia, Bakhshi and Windsor 2015, p. 37

The conceptualisation of individuals as bundles of skills and organisations as bundles of individuals with diverse skills used in this report aligns with what Stewart, De and Cole at Deloitte (2015, p. 16) call 'swarming'. This is where a disparate group of professional experts work independently, but come together to complete a project for a period of time before dispersing and joining a new group (or 'swarm'). This is not dissimilar to a method of project-based work organisation that is common in many of highly innovative organisations interviewed for this project. See Chapter 4 for a discussion of these cases.

### 3.3.3 Teams and innovation: the lens of diversity

*A diverse and inclusive workforce is necessary to drive innovation, foster creativity, and guide business strategies. Multiple voices lead to new ideas, new services, and new products, and encourage out-of-the box thinking.*

Forbes Insights 2011, p. 19

Over time, consideration of skills diversity has expanded to consider a broader range of skills required for innovation. Consistent with first generation innovation thinking and policy, early notions of skills diversity meant little more than the mix of STEM skills needed for understanding the technological basis of innovation. Second generation innovation policy moved away from merely STEM-based diversity towards notions of STEM B or STEM+ to acknowledge the importance of business-based skills for commercialisation of technical innovations. Yet, apart from some consideration of gender diversity within technical skills domains, consideration of skills diversity has, until recently, been limited.

Writing in the *Harvard Business Review*, Hewlett, Marshall and Sherbin (2013) broadened the consideration of skills diversity for innovation. They argue that there are fundamentally two types of diversity: inherent and acquired. Inherent forms of diversity involve traits, often 'surface level', an individual is endowed with at birth. In contrast, acquired forms of diversity involve skills or traits gained from experience (deep diversity).

The authors categorise firms as demonstrating '2-D diversity' where the organisation's leadership team exhibits at least three inherent traits (e.g. gender, ethnicity, age) and three acquired diversity traits (e.g. different disciplinary backgrounds). They find that organisations with such 2-D diversity are able to outperform other organisations, both in terms of innovation output and financial performance.

Focusing more broadly on the workforce as a whole, Professor Judy Wajcman (2014) of the London School of Economics pointed out in the case of gender diversity:

*... the kind of innovation we are getting relies on the whole on young men with narrow engineering degrees thinking about the future... I say, 'If we had a more diverse workforce, would we not be able to think of and tap talent for lots of different things?' If we want a creative industry, we need a diverse workforce.*

House of Lords 2014, p. 44

More broadly, Stephanie Hill (2014), Vice-President of Lockheed Martin Information Systems, argues in an article in *Scientific American*:

*It's a truism that the best teams are greater than the sum of their parts. I believe that is only true when those parts are diverse. When everyone looks the same, acts the same and thinks the same, is it any wonder that they often fail to embrace—or even produce—innovative and unconventional ideas?*

## 3.4 Looking forward: third generation innovation thinking and policy

Lengrand (2002, p. 10) suggests that although second generation innovation thinking and policy were not universally accepted by either by policy makers or practitioners, a third generation approach is slowly emerging. This more holistic picture is driven by a series of ideas about the ways in which economies, organisations, work, skills and innovation have become increasingly interconnected through collaboration within and across industry, the public sector and education

providers. This new generation of innovation thinking and policy emphasises the benefits of coordinating actions in policy areas, and making innovation—and innovation-friendly policies—one of its core principles. Thus, third generation innovation policy places innovation at the heart of each policy area and is itself adaptive.

In the years after the influential Lengrand (2002) study, debate developed around innovation, organisation, skills and competency in a number of different ways. This introduced greater complexity on the one hand, while demanding an integrated holistic approach on the other. However, these strands have occurred with a greater or lesser degree of interconnection. There is a growing importance and complexity of the discussion around teams and diversity. This also links to organisational restructuring and cooperation.

Stark (2009) argues that innovation, among other drivers, demands more complex organisations. This complexity is revealed through organised dissonance and through radical decentralisation and coordination rather than hierarchy within each organisational entity engaged in innovation. Stark builds on the idea that entrepreneurship exploits such uncertainty and disrupts and re-combines. That is, entrepreneurs re-combine knowledge to generate new products and services that have the potential to disrupt established markets. Because of the increasing complexity of feedback loops, coordination cannot be engineered or controlled hierarchically, while the increased levels of independence required to support innovation demand more fine-grained coordination across increasingly autonomous units. 'Lean' organisation principles as described in Chapter 4 are one result of this fragmentation. These forces drive organisations to actively construct (or deconstruct) their organisational models, the result of which is more properly described as networks. Many large organisations, such as IBM for example, continuously buy in small organisations to acquire their knowledge and spin off small organisations, often the organisation operates relatively independently but remains part of a

larger, loosely coupled network. To return to the original formulation, organisational structures are now beginning to more closely resemble bundles of units both internal and external to the formal boundaries of the firm.

Stark's concern is primarily with intra-organisational restructuring. Beyond that, the concept of *Open innovation* has promoted inter-organisational collaboration for innovation. Open innovation is defined as 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and external use of innovation respectively' (Chesbrough 2006). The approach is based on the three critical processes of knowledge exploration, retention and exploitation (Lichtenthaler 2011), and further on core processes that are:

- *outside-in*—enriching the company's own knowledge base through the integration of customers, suppliers and external knowledge sourcing
- *inside-out*—earning profits by bringing ideas to market, selling intellectual property, and multiplying technology by transferring ideas to the outside environment
- *coupled*—co-creation with (mainly) complementary partners, through alliances, cooperation and joint ventures during which give and take are crucial for success (Enkel, Gassmann and Chesbrough 2009, p. 312f).

Again, the debate tends to focus on emerging organisational structures and processes rather than the skills and expertise of those involved in them.

Another recent development involving collaboration beyond the formal boundaries of an organisation is the growth in *customer-focused* or *user-linked* innovation, also described as *hidden innovation*. This approach views customer communities as important sources of innovation. Rush, Bessant, Marshall, Ramalingam, Hoffman and Gray (2014) suggest three characteristic types of user innovation value creation:

- *spontaneous*—occurs when some users spontaneously create their own entirely novel product or service

- *orchestrated*—occurs when a firm seeks to influence the innovative behaviour of users to channel their creative energies in an outcome which will generate value for the firm
- *managed*—occurs when a firm directly manages the innovative behaviour of users.

While acknowledging the inherent potential of users for generating innovation, there is little reference to the skills users need to possess in order to do so. Most research (e.g. Von Hippel 2009) attributes user innovations to the prolonged immersion with a topic (often a hobby) and sometimes complementary skills in prototyping solutions. On the organisation level, however, such forms of innovation become dependent on capabilities in managing customers and extracting their needs and know-how.

This view is supported by the recent literature on *innovation ecosystems*. Firms today are caught up in a network of interdependencies, where change in one part can have far reaching and often unexpected effects in other parts of the system. Peter Weill, chair of the MIT Centre for Information Systems Research, argues (in Grey 2016, p. 26) that instead of seeing their business as operating in a value chain, boards and executives should instead think about being part of an ecosystem where the lines between the corporation and its partners are blurred. Organisations within the ecology work cooperatively and in competition, developing capabilities around new innovations. Zahra and Nambisan (2012) identify four different types of ecosystems:

- *orchestra*—a keystone player establishes a shared architecture around which the activities of different specialist firms can be orchestrated
- *creative bazaar*—local company searches for, integrates and exploits external technologies, products ideas etc. drawn from across the global marketplace or bazaar (has less control than in the orchestra)
- *jam central*—more organic and emergent than previous two. This involves horizontal collaboration between independent entities

- *MOD station*—similar to orchestra, in that a dominant firm provides a product or platform architecture around which communities of innovators coalesce to make modifications.

Of equal relevance to the shift in skills focus is the idea of *design thinking*, which has advanced as a bridging skills set between scientific research and consumed technology, and business ideas and the successful roll-out of innovation. In the latter case, design integration is the critically important concept that means bringing designers into the organisational processes of firms, as well as bringing design thinking to bear on all of a firm's activities. Design thinking describes the idea that the mindset, habitus, or skill sets of designers are valuable inputs into contemporary business thinking:

*Creating a design-centric culture requires understanding that the returns on an investment in design are difficult to quantify, allowing people to take chances, and appreciating what design can and cannot achieve. Design helps people and organisations cut through complexity and imagine the future, but it doesn't solve all problems.*

Kolko 2015, p. 66

These discussions about open innovation, customer-centric innovation and ecosystems highlight how bundles of organisations are becoming more complicated. Although not talking directly to the skills demanded of innovation, this view does relate to a complex division of labour not only within organisations, but crucially between them and also their customers. The important point is that the lead organisation does not need to provide all of the skills and competencies necessary to innovate. Furthermore, both government and large organisations are pushing down the responsibility for managing health, education, career and skills formation to small firms, communities and individuals (UK Commission for Employment and Skills 2014). Thus, organisational restructuring (i.e. organisational bundles) becomes a crucial determinant of the patterns of individuals as bundles and bundles of people concepts.

In the search for innovation, the connection is now being made between new organisational structures (e.g. decentralised networks) and forms of work organisation (e.g. workscape, teams, trust, knowledge management). These issues are reinforced by current changes in advanced economies. In other words, there is a connection between organisations as bundles and the necessity for innovation of bundles of skills and competencies.

By the early 21<sup>st</sup> century, the connection between innovation and skills was developing into an increasingly sophisticated understanding of what innovation itself entailed and, consequently, a more extensive and differentiated picture of the skills and competencies that might be required. Christensen and Overdorf (2000) developed the influential notion of *disruptive technology*, which is quite different from the concept of *radical innovation* examined earlier. It is based on the distinction between sustaining and disruptive technologies. The former improve performance, while the latter produce lower performance at least in the short-term but will access fringe and/or new customers.

*'Disruption' describes a process whereby a smaller company with fewer resources is able to successfully challenge established incumbent businesses. Specifically, as incumbents focus on improving their products and services for their most demanding (and usually most profitable) customers, they exceed the needs of some segments and ignore the needs of others. Entrants that prove disruptive begin by successfully targeting those overlooked segments, gaining a foothold by delivering more-suitable functionality—frequently at a lower price. Incumbents, chasing higher profitability in more-demanding segments, tend not to respond vigorously. Entrants then move upmarket, delivering the performance that incumbents' mainstream customers require, while preserving the advantages that drove their early success. When mainstream customers start adopting the entrants' offerings in volume, disruption has occurred.*

Christensen, Raynor and McDonald 2015, p. 44

However, other than stating that people tend to be flexible and that culture is vital in promoting or inhibiting innovation, Christensen's approach has little to say about the skills and/or competencies of the workforce required for disruptive innovation.

This is addressed in the following section.

### 3.5 Advanced manufacturing, digitisation, the growing impact of service industries' skills and approaches, and global value chains

In a recent report for the Committee for Economic Development of Australia (CEDA) on the future of advanced manufacturing, (Drake-Brockman 2014) observes that patterns of global production and trade have undergone significant transformations in recent years, particularly through the rise of global value chains and the associated rise of services. The World Economic Forum (WEF) describes global value chains as the economy's backbone and central nervous system. The implications for organisations are significant:

*Today's advanced goods are produced through complex interactions in fragmented value chains, with varying degrees of proximity between interdependent manufacturing and service activities performed by increasingly specialized organisational entities—either firms or parts of firms.*

Roos 2014, p. 39

The University of Cambridge's Institute of Manufacturing provides a holistic definition of advanced manufacturing (or high-end manufacturing) as being 'the full cycle of activities from research and development, through design, production, logistics and services, to end of life management'. According to Jeff Connolly (2014), CEO of Siemens Australia, digitisation is accelerating this process with design, production planning, engineering, manufacturing and services merging into one unit, instead of being sequential.

So, even in Advanced Manufacturing, innovation is focusing on the pre- and post-production areas with a significant shift in the nature of the required skills, particularly given the growing impact of service industries' skills and approaches in those processes. In short, the new bundles of organisations are demanding new bundles of skill.

Others, such as the Chief Economist in the 2014 *Australian Innovation System Report*, have started to make important connections between innovation and global value chains:

*Businesses that participate in global value chains have been argued to be more innovative, more engaged in research and development (R&D) and skills development, drive the highest productivity premium, and can support high unit labour costs... Participation in global value chains also drives a step change in business culture by challenging participants to upgrade their management, financing and technology, and encourages greater collaboration... Investing in research and innovation will be the key to maintaining a strong position in a global value chain as a price maker.*

Department of Industry, Innovation and Science 2014, p. 220

However, as a number of commentators point out, Australia is relatively under-integrated into the world economy (cf. Drake-Brockman 2014). More particularly, the 2014 *Australian Innovation System Report* argued that, according to the OECD's global value chain participation index, Australia's overall participation in global value chains is below the OECD median and well behind global value chain hub countries (p. 113).

But these changes are not just happening in manufacturing. The melding and merging of services and manufacturing, and indeed the rise of the service sector itself, allied to the rise of the global value chain has led to a situation more generally where a new organisational paradigm sees companies increasingly as 'network

orchestrators'. The skills and resources they can connect to, through activities like crowdsourcing, become more important than the skills they own (UK Commission for Employment and Skills 2014).

Significantly, the UK Commission for Employment and Skills identify 10 skills necessary for the new working environment:

- prioritisation of work
- teamwork
- organisational awareness
- problem solving
- self-awareness
- proactivity
- influence
- decision making
- learning agility
- technical expertise.

This rise of the organisation as a 'network orchestra' will mean that coordinating the partnership network by managing communication and organising knowledge networks will become highly desirable skills. Having a profound understanding of the interfaces and differences between sectors will be of major importance for future business ecosystems (UK Commission for Employment and Skills 2014, pp. 29, 51).

The UK House of Lords in a report on the UK's digital future, argues that employers are looking for an ever widening skill set. In addition to levels of literacy and numeracy, employers seek a mix of technical, creative and social skills. Crucially, the report argues, jobs based on creativity and social skills are not susceptible to automation. The report goes on to say:

*A number of witnesses suggested expanding the 'STEM' package to include art ('STEAM'), or even art, entrepreneurship and design (STEAMED) to meet this challenge.*

House of Lords 2014, p. 45

### 3.6 The future of work, skills and innovation

So far, this report has examined changing nature of the understanding of the relationship between skills and innovation from a linear approach focusing on technical skills, to a more holistic focus on bundles of skills including, but not limited to, STEM. Analysis of changes in innovation thinking and policy is also beginning to show a move beyond formal organisational boundaries towards clusters of organisations (public and private, the triple helix). However, as noted, Lengrand was hinting in 2002 at the emergence of third generation analysis. The discussion also points to a series of factors (e.g. the global financial crisis, the rise of global value chains, the growing impact of service industries' skills and approaches, digitisation) that are further complicating and accelerating emerging trends.

Hugh Durrant-Whyte (2015, p. 238) dramatically describes digital disruption as 'the fifth horseman of the apocalypse', potentially wreaking havoc in all areas of the economy and society. Durrant-Whyte and colleagues argue that:

*... current machine-learning algorithms are taking a larger share of what were once perceived skilled jobs or roles around customer engagement. These include occupations such as legal clerks (with automated search and analysis of legal documents), market research and sales (ranking and recommendation engines, credit risk and management), predictive analytics and many others.*

*Health is an especially significant area likely to be impacted—through automation in clinical data and predictive diagnostics (analysis roles), to robotics assisting in areas from surgery to nursing and from hospital logistics to pharmaceutical dispensary. Other examples include banking and legal advice—typically activities that involve a qualified professional, but where data and analysis play a large role, and where most, but not all, work is routine.*

Durrant-Whyte, McCalman, O'Callaghan, Reid and Steinberg 2015, p. 59f

This analysis suggests that STEM skills, although of continuing fundamental importance to the economy and innovation, will not be sufficient to guarantee survival in the labour market. These skills will have to be connected to creativity in order not to be codified and, at least to some extent, digitised. Indeed, the World Economic Forum (2016) report, *The Future of Jobs*, argues that many formerly technical occupations are expected to show a new demand for integrative and interpersonal skills.

When interviewed for this report, Durrant-Whyte argued that the problem is not a shortage of STEM qualified graduates per se. He argues that many STEM qualified graduates are employed in sectors and occupations where their skills are underutilised at best, if not redundant (e.g. retail). Further, many of the routine data managing jobs that employ STEM-qualified graduates will disappear as a result of the digital disruption. On the other hand, some jobs will resist computerisation. These are jobs with tasks that require a high level of perception and manipulation, where people can see and respond to circumstances in ways that robots and computers cannot. Other jobs require creativity and social skills that are not perceptible to automation (Stewart et al. 2015, p. 6).

However, Durrant-Whyte argues that current trends in digitisation will lead to a polarisation in the labour market, with jobs at the bottom of the labour market that resist computerisation being low paid and insecure. This reflects international research that has shown a growing tendency for technology to displace skilled with lower skilled jobs, leading to a hollowing out of the skills distribution of jobs (Rotman 2013). Furthermore, there is a growing geographical imperative: the higher paid, higher skilled, more secure jobs are increasingly based in metropolitan areas, particularly inner city metropolitan areas (Moretti 2012). Therefore there is a geographic as well as a wealth divide.

There appears to be broad consensus that these global changes are also reshaping future skills needs. A number of publications, such

as the CSIRO's (2015) *Strategy 2020*, the World Economic Forum's (2016) *Future of Jobs* report or the Institute for the Future's (Davies, Fidler and Gorbis 2011) *Future Work Skills 2020*, identify an array of global 'megatrends' expected to shape employee skill requirements for the future. Based on a similar list of global drivers, the U.S. National Research Council (2012) put forward three categories of skills domains required of the future workforce:<sup>3</sup>

- Cognitive skills: critical thinking; problem solving; analysis; reasoning/argumentation; interpretation; decision making; adaptive learning; executive function; information and communications technology literacy; oral and written communication; active listening; creativity; innovation.
- Interpersonal skills: communication; collaboration; teamwork; cooperation; coordination; empathy; trust; service orientation; conflict resolution; negotiation; leadership, responsibility, assertive communication, self-presentation, social influence with others.
- Intrapersonal skills: flexibility; adaptability; artistic and cultural appreciation; responsibility; continuous learning; curiosity; ability to take initiative; self-direction; responsibility; perseverance; productivity; grit; metacognitive skills; professionalism; ethics; integrity; citizenship; career orientation; self-monitoring, self-evaluation, and self-reinforcement; physical and psychological health.

In summary, innovation thinking and policy have come a long way from the first generation approach. The analysis of individuals as bundles has moved far beyond its original STEM focus to encompass a broader bundle of technical and non-technical skills. Clearly the focus on teams

as bundles of people with complementary skills has advanced. As a Science Europe (2015, p. 7) opinion paper concludes:

*As priorities shift from curiosity-based to challenge-driven research, so the urgency increases to create innovation ecologies that integrate research domains across the sciences, technologies, arts and humanities. The formation of multi-disciplinary teams is, therefore, an essential element of future research if the skills needed to solve complex challenges are to be aligned. In seeking answers for major societal and environmental challenges we need radical innovation to help propel us beyond the narrow confines of a disciplinary field.*

Cardiff University academics (Price and Delbridge 2015) suggest that societal problems and so-called 'grand challenges' need to be faced by going beyond traditional structures and driving interdisciplinarity. They suggest the formation of social science research parks (such as SPARK Cardiff, described in Chapter 5). This is an attempt to create a dedicated space for the generation of new ideas founded on those areas of human knowledge that focus on society and the way it is organised: geography, economics, law, management and organisation studies, sociology, political science and social psychology. The social science park is an experiment in social science as well as of social science. It is intended to be a catalyst for both the more innovation-oriented social science and the more socially-oriented system of innovation that is required by the problems of current times.

*A social science park therefore needs to be a platform for interaction, a space for collaboration and knowledge co-creation by researchers, students, citizens, customers and stakeholders. Where traditional science parks have often felt like corporate gated communities, a social science park has to be social and sociable: a public square of open interaction at the heart of social life, an innovation hub in a wider system.*

Price and Delbridge 2015, p. 10

3. Similar lists of skills can be found in other reports and publications, often called 21<sup>st</sup> century skills, e.g. the 2016 report of the U.S. National Academies of Sciences, Engineering and Medicine (2016), *Promising Practices for Strengthening the Regional STEM Workforce Development Ecosystem*. Retrieved 15 March 2016, from <[www.nap.edu/catalog/21894/promising-practices-for-strengthening-the-regional-stem-workforce-development-ecosystem](http://www.nap.edu/catalog/21894/promising-practices-for-strengthening-the-regional-stem-workforce-development-ecosystem)>.

For Price and Delbridge this development meshes well with the Expert Working Group project team's view of the new role for universities in these ecologies. The role of the universities is

shifting from being the monopoly producer of knowledge to the orchestrator of regional innovation ecosystems. Orchestration is a method for coordinating a diverse network of actors without top-down direction—by designing spaces, creating a culture and developing incentives that seed co-operation and channel activity along mutually beneficial lines.

### 3.7 Conclusion

Understanding the drivers for creating and sustaining innovation acknowledges the role of skills, bundles of skills and skill mixing. Current thinking around innovation presents a more complex picture of the nature and process of innovation. This better reflects the changing nature of how enterprises are responding and changing with shifts in their organisational environments, industry structures, the nature and relationships between organisations and the needs of their consumers.

Significantly, the make up of these forms of bundles and the relationships between them will continue to extend and deepen into the future. Today innovation requires individuals with bundles of skills that include, and go beyond, STEM. In addition, the complexity of the 'grand challenges' and the levels of disruption require organisations to design structures for these individuals to work within bundles as adaptive teams that maximise diversity and creativity, and which are supported by their connections to larger innovation ecosystems. In these ecosystems an organisation does not need to have all of the skills and competencies to initiate and sustain innovation. Rather organisations work cooperatively and in competition, developing and even sharing capabilities around new innovations. Furthermore, there is an intimate relationship between the three forms of 'bundle'. The emergence of complex forms of networked organisation, within holistic innovation ecologies (the third generation of innovation thinking and policy), is driving the demand for dynamic and evolutionary forms of skills content and mix. This underpins the move beyond a simple focus on STEM, both for the individual and for the team.



# 4

## Skills at work in innovative organisations: Australian case studies

### Summary

**Interviews were held with senior executives at 19 organisations, all of which are considered highly innovative by their peers.**

**All use skills mixing and access to skills outside the boundary of the organisation as a central strategy.**

**Innovative organisations spend considerable time and resources on finding and developing the right candidates. They emphasise the importance of attitudes, cultural fit with the organisation, and ‘cleverness’ or ‘emotional intelligence’ in their desired skill sets.**

**As different skills are required at various stages in the innovation cycle, skills mixing in individuals, in teams and across organisations is a chief concern for innovation.**

**Innovative organisations greatly value external ideas and viewpoints and actively increase their levels of cooperation with other organisations. Networks, partnerships and clusters are a major source to access skills required for innovation.**



## 4.1 Introduction

In the context of the overarching research aims for this report—to understand the systems, strategies and resources needed to build the mix of skills required to underpin innovation—the previous chapters provide insight into factors associated with both high and low levels of innovative activity across Australian firms.

However, the data basis available through the Expanded Analytical Business Longitudinal Database (EABLD) alone is not sufficient to draw far-reaching conclusions. The research conducted for this chapter complements Chapter 2's broad-spectrum analysis by specifically focusing on organisations that have been identified as being highly innovative over a sustained period of time. As such, the case study selection is not intended to be representative of all enterprises, but to explore differences in organising and skilling up for innovation in organisations that have successfully done so.

In presenting this information, this chapter contributes to understanding of how organisations, both SMEs and large organisations, identify, manage and build the skills and skills mix required for innovation. It outlines the human resource strategies, leadership and organisational structures and cultures that enable organisations to build these technical and non-technical capabilities. It also identifies barriers that undermine the willingness/ability of organisations to build these capabilities.

In selecting the cases, the Expert Working Group project team relied on a process of peer nominations in a number of sectors, starting with organisations recognised through innovation awards. The aim is to provide a representative selection of industry sectors, including those recognised through the Industry Growth Centres initiative, as well as a spread across small, medium and large organisations within the economy. Organisations that had won innovation excellence awards and innovative organisations identified by the Growth Centre Chairs were asked to nominate three further organisations they deem as most innovative in their industry sector. The process was repeated with the nominated organisation, and so on, to ultimately identify ‘top of the pyramid’ innovators. The project team contacted those organisations that were mentioned several times.

The final selection of cases includes well-established private, public and not-for-profit organisations, as well as some start-up businesses. This provides a mix of traditional scientific R&D innovation, service development innovation and media/creative innovation. The 19 case organisations are described briefly in Appendix A.

Following the bundles of skills approach from Chapter 3, one or more individuals were interviewed for each case study. They were asked about what they saw as the signal aspects of their journey in being recognised by their peers as innovative firms. The interview questions investigated the following themes:

1. contextualising the nature of innovation within the case organisation—types of innovation and modes for conceiving innovation
2. employees and bundles of skills—skills, qualifications, experience as recruitment criteria; use of apprenticeships, internships, secondments and other forms; lack of skills in prospective employees
3. teams as bundles of complementary skills—approaches to team building; diversity in teams and composition over time; training, rewards and performance mechanisms; organisational strategy, structures and culture to support innovation; inevitable challenges
4. networks and organisational linkages as sources of skills—use of and linkages to other organisations, research organisations,

**Table 4.1: Overview of case organisations**

Organisation	Industry sector	Staff (approximately)
Anglicare Victoria	Consumer Services/NFP	1,300
Animal Logic	Media	500
Cochlear	Manufacturing (medical)	1,400
Cotton Australia	Agriculture/	20
CSIRO	Research Institute	5,000
Envato	Technology	200
Fibrotech/OccuRX	Medical Technologies	5
George Institute of Global Health	Medical Research	550
Hatchtech	Medical Technologies	5
ING Direct	Financial Services	1,000
Keech	Manufacturing	150
Laing O’Rourke	Engineering and Construction	3,000
NOJA Power	Manufacturing	150
Pernod Ricard Winemakers	Food & Beverages	2,000
Queensland Urban Utilities	Consumer/Business Services	1,300
SEEK	Technology	6,000
SocietyOne	Financial Services	70
Southern Innovation	Advanced Manufacturing	10
Woodside	Resources	3,500

universities; nature of skills sought and nature of the relationships; challenges and barriers

5. policy environment for innovation—the role of policy to support skills formation, e.g. through training, vocational education and training (VET), government. This theme bolstered links to policy considerations in Chapter 5.

This chapter outlines major themes and comments from the case study interviews as they relate to the report’s organising framework of bundles of skills:

- Entering the firm—Skills and skills mix requirements on the individual level
- Sustaining the skills mix—Teams as bundles of skills
- Meeting innovation challenges over time—The enterprise as part of an innovation ecology

The skills, capabilities and tactics outlined below do not necessarily make organisations more innovative directly. Rather, each enterprise also creates structures, internal environments and systems that often more subtly increase the capacity for innovative thinking and behaviours. The examples give an account of how organisations set up and act for increasing their innovation capacity. As NOJA Power’s R&D Director states, ‘Innovation is not just the product, it’s all sorts of ideas that go into creating an organisation as well’.

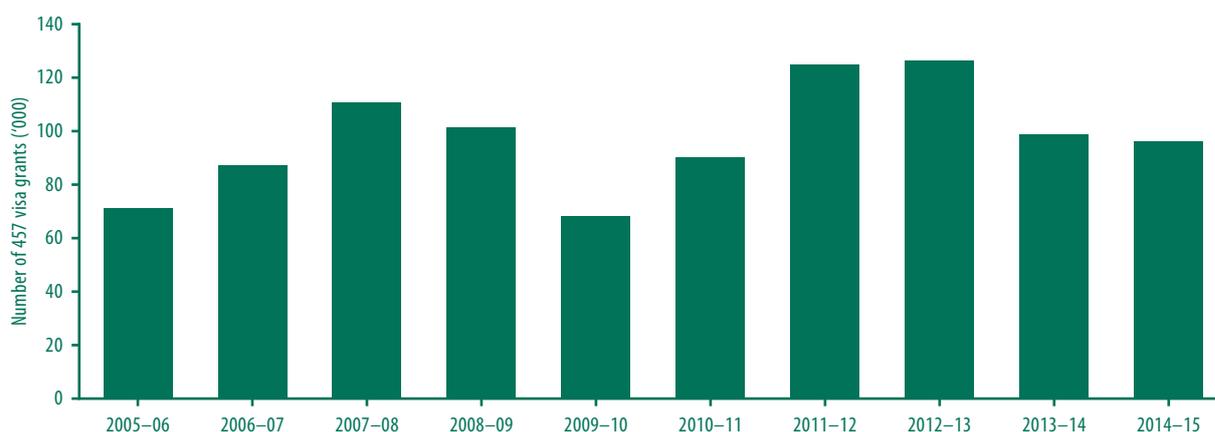
## 4.2 Entering the firm: skills and skills mix requirements for individuals

### 4.2.1 Recruiting talented and skilled employees to drive and sustain innovation

As mentioned in Chapter 3, there is a widespread opinion in Australian businesses that job-seekers, most pertinently graduates, often cannot find jobs due to their lack of ‘employability skills’ (e.g. collaboration and teamwork, communication, problem solving). These are the types of skills acquired through experience in a working environment, but also often associated with the processes in driving and sustaining innovation. In many instances, this leads to firms taking up alternative options, such as hiring trained and experienced workers from overseas. Particularly in highly technical areas, employers often see the technical skills as a ‘given’ and their major attention is on finding new employees who have workplace skills, the right attitudes, or are ‘clever’.

As background, there are claims in Australia and elsewhere of a shortage of STEM personnel, along with competing claims of high rates of STEM graduates who cannot find work (e.g. Norton 2015). One strategy to address this skills deficit is apparent in the growing use of 457 visas by organisations in Australia (see Figure 4.1). However, rather than responding to a shortage of technical staff, various analyses ‘show that the primary goals of employers in hiring foreign workers are to reduce labour costs and to obtain “indentured” employees’ (Matloff 2013).

Figure 4.1: Number of 457 visa grants 2005–06 to 2014–15



Source: Department of Immigration and Border Protection (2016).

Most of the innovative companies reported reasonably low levels of difficulty in finding and attracting the right employees. Also a recent report for SAF 1 which provides a global perspective on doing business with Australian organisations found that Australia is viewed as on par with other countries in scientific research and has the capacity to be a world leader in innovation (Halteman et al. 2015) and the quality of universities and research institutions, and Australia's educational qualifications are generally seen as a strength (ACOLA and PWC 2014). This is in contrast to the general rhetoric of vast skills shortages, particularly in STEM areas (AiGroup 2015b). The recruiting success in the case organisations may be due to their recruitment, training and retention strategies. Many case organisations apply non-traditional tactics to attract talented individuals with the skills they require for sustained innovation, and often focus more on attitudes and 'organisational and cultural fit' than on formal qualifications per se. SEEK, for instance, focuses on skills in the application of technical capabilities by inviting applicants to perform common tasks during job interviews. Beyond those skills, however, appointment decisions are driven by job applicants' experience, including student project work or co-curricular work, and, most importantly, the 'cultural fit' with SEEK's value system. SEEK admits that its strategy is not based on finding and developing suitable graduate students, but builds on accessing highly specialised and highly experienced people. Such high expectations are not always easy to meet.

*We are challenged to find really strong and experienced performers in certain areas, particularly around technology. We work really hard to try and find the right people, because there is just not that capability in Australia that is easily obtainable. Everyone's fighting over the same handful of people.*

SEEK

Echoing third generation thinking (see Chapter 3), ING Direct and Woodside use less traditional approaches to meet their skills needs in new recruits, seeking recruits who are curious rather than those who believe they know the answers. ING Direct's CEO is a strong proponent of creating a mix of imaginative people, those

who see the world differently, are courageous and, importantly, are prepared to fail. Woodside also looks for new talent with broad skills.

*The only people who never fail are superman, people who have failed but don't tell you the truth, or people who have never tried anything.*

ING Direct

#### Box 4.1: Recruiting—focusing on 'emotional intelligence'

*One of the biggest questions asked in interviews for our graduate program is 'what else did you do?'—'Oh I'm into sports, I'm into community volunteering, I've done humanitarian aid work, I've done...—it doesn't matter what, but they have done something else and that's what is becoming of interest to our recruiters. We are trying to ascertain their emotional intelligence.*

Woodside

To alleviate perceived skills gaps in terms of work skills, some organisations bank on early identification of talent at different levels. NOJA Power, for example, nurtures talent through its youth sponsorships (sponsoring undergraduate degrees of two Engineering and two Administration Cadets) and through internships (currently a relatively high six interns in a location with about 110 employees).

*We're finding that if we get those really best of the best students [regardless of their area of specialisation], they do clever things for us. It is about bringing young clever people into the organisation to actually keep it young and growing.*

NOJA Power

NOJA Power, Laing O'Rourke and the George Institute also collaborate with universities in joint PhD programs. Such forms of early involvement with potential candidates filter a large talent pool and establish connections to the 'best and brightest'.

*The young people that join us quite often do PhDs and learn work skills while they are here. It might, if they're good or enjoy it, kick-start a research career while others might move on and do something else.*

George Institute

This, and other examples in this report, are good illustrations of the value of translational PhDs, a potential strategy considered in Chapter 4.

Laing O'Rourke is upfront about the issues the construction industry faces in attracting the best talent.

*When the very best engineers graduate from Sydney they get poached by management consultancies, investment banks, a bunch of them go off to the professional consultancies like KPMG. Then, next down on the traditional hierarchy are the consulting engineers and finally at the bottom you get the ones who actually want to go and do proper engineering. So the industry doesn't get its fair share of the talent that comes out of the universities.*

Laing O'Rourke

In response Laing O'Rourke, known as one of the most innovative construction firms in Australia, uses other ways to attract and retain talented employees. This includes accessing universities that provide internships and PhD programs known to be more focused on generating innovative ideas and new technologies that attract the best talent from a variety of scientific disciplines. In the UK, Laing O'Rourke seconds PhD students from a number of elite universities (e.g. Cambridge, Imperial) to work on their applied projects for several months. Significantly Laing O'Rourke creates and nurtures a workplace culture that mirrors the environment these were working in at their universities.

#### Box 4.2: Recruiting—creating a stimulating environment

*I have an extraordinary team, they're outstanding but that's largely the environment that we've created. It's an interesting intellectual space; so they're well paid but we give them other things. This [innovation hub] office is a living lab for Laing O'Rourke as a business; we test things here that the business is still not totally comfortable with.*

Laing O'Rourke

Animal Logic is clear about the importance of the work environment for innovation.

*We need to first of all provide great projects for people to work on. We need to provide a great work environment to work in. We need to have a really smart recruiting strategy and execute it well because we need to draw from around the world.*

Animal Logic

Commitment to developing talent is also embedded through internal training programs and career progression.

Laing O'Rourke used its 'Guns' and 'Young Guns' programs designed with UK universities (Imperial) and Australian universities (University of Queensland) to develop their best and equip them with essential non-technical skills required for quick career progression. These skills are especially around leadership, building high performing teams and strategic thinking.

Keech has a similar emphasis. As an example, Keech trained an employee initially hired as an order taker to be a lead manager within three months.

#### Box 4.3: Recruiting—recognising existing talent

*Most companies are ignoring some of the talent right in front of their eyes. And that was clearly the case here.*

Keech

Cochlear manages and develops talent in a highly structured and strategic way to develop internally the skills mix required for their team leaders. Talent pools around its senior, middle and emerging leadership talent are reviewed in regular meetings to determine if there are enough people with the right skills given the projected work in the future. Head counts and investments are aligned with Cochlear's revenue to determine recruitment numbers within its development budgets to avoid under or over-investment in the right skills. The prime message from Cochlear is the importance of skills management rather than the availability of skills.

Many of the innovative organisations interviewed also push the boundaries to attract and retain specific groups of employees, or to achieve a diversity of employees critical to building a culture that fosters innovative thinking. Envato, for example, specifically seeks to attract women into the ICT field, and the firm recently won the title of Australia's Coolest Company for Women.

*We offer pay equity, flexible working hours, maternity leave, equal opportunities for promotion and development, and the less obvious: eye contact with respectful exchanges, and the face to face. Colleagues to work with who demand the best and don't tolerate complacency, the ability to bring your whole self to work—imperfections, passions, quirks—to feel at home.*

Envato

Another important and recurrent theme for Envato is the need to hire staff with the broad set of skills required to operate in a global environment. As a global business with clients around the world, Envato seeks people who can work in this environment. Five years after its inception, the company employs 180 people permanently and works with another 80 contractors around the world to ensure 24-hour availability of its systems.

*If we're not doing a good enough job for our employees and contributors they'll leave and we'll have nothing to sell. So we're constantly conscious that we need to be providing a better experience for them and a better livelihood. That might mean making less profit in the next year but it buys goodwill in the long term.*

Envato

NOJA Power, a global producer of advanced electrical equipment, also strives to create an environment that employees do not want to leave. This supports the positive influence of working arrangements on innovation as shown in the analyses results in Chapter 2.

#### Box 4.4: Recruiting—Looked-after employees are more innovative

*We provide an annual health check with a doctor on site for personal appointments. Last year we identified two men in their forties with early stage cancer, both of whom have been cured, and we have to chase them out of here at night as they're so grateful to us.*

*We have the flu immunisation shot, we have lectures on healthy eating, healthy cooking, how to pack a healthy lunchbox. We provide two pieces of fruit for every staff member every day. We have on-site showers, everyone gets a locker, so they can ride their pushbikes to work, or jog to work.*

NOJA Power

Although not directly related to skills, many companies realise that cared-for employees are better workers, not only in terms of productivity, but also in terms of innovation.

*I suppose another example for where we're a little bit ahead is—in normal companies career progression is based on very set criteria around performance reviews, people can get promoted and can accelerate their salary once a year. It's all very formulaic and 'tick-the-boxes'-based. We think progression should be happening on a very periodic basis, could be monthly, quarterly, doesn't matter, if you're good, you're promoted—you should be promoted!*

SEEK

#### Summary 4.2.1: Recruiting

**Most organisations interviewed have few problems finding the right employees, and attribute their recruitment success to using non-traditional HR approaches and to providing a desirable work environment.**

**Rather than following traditional HR tactics, innovative organisations tend to spend considerable time and resources on finding and developing the right candidates. As noted, these organisations also emphasise the importance of attitudes, cultural fit with the organisation, 'cleverness' or 'emotional intelligence' in their desired skill sets.**

**For these organisations, technical (professional) skills are necessary but not sufficient for hiring. Candidates need to possess additional skills (people skills, adaptability and problem solving skills, leadership), which often make the technical skills and disciplinary fields a secondary consideration.**

**The 'right' work environment often includes non-traditional review and progression arrangements, provision of social spaces and amenities, flexible work conditions or health checks. As employers, these organisations view their organisation ideally as a social community that needs to empower its members to unfold their innovative capabilities.**

#### 4.2.2 Using HR to build the skill sets to support innovation

In the smaller innovative firms, attitudes about the use of HR departments and HR practices are shaped by their flatter structures, smaller number of employees, and willingness to outsource for skills. Many SMEs and start-up organisations do not have the financial resources to operate dedicated ancillary functions including HR, marketing and process management unless and until they reach a critical mass or level of organisational complexity.

Also many innovative firms are designed around lean management principles. The core focus is on running the operational side of the organisation using continuous improvement and incremental changes in processes to improve their efficiency and quality over time. This focus on operational effectiveness means that HR departments are not formally put in place until later stages in the growth of firms.

*When the business has grown into a small to medium sized business it has to deal with the fact that you can't just multi-task everything. We've developed some really great support structures in human resource management, in training, in recruiting, in communications to make sure there's a really great infrastructure to support that growth.*

Animal Logic

Many organisations also continue to outsource staffing needs to consulting firms, their industry partners or suppliers to get access to employees with skills sets that currently do not exist internally.

Many interviewees highlight the need to seek outsiders for skills sets critical for the firm's growth. A frequently cited case was the need to bring into the business more senior managers and leaders with specific skills sets and track records that best suit the current stage in the firm's growth. Keech's turnaround from a struggling steel castings manufacturer to a thriving supplier for the global mining sector, for instance, is attributed to the business owners' employment of an externally sourced CEO with broad business experience across several sectors and in a number of functional positions.

*His career has included international operating responsibility extending from sales and marketing management and general management to Managing Director roles in the industrial, professional and consumer products industries. He encouraged the company to set up new distribution channels, positioning the organisation for sustainable growth and launching new products, as well as developing strong business links with key distributors, suppliers and end users.*

Keech

One of the CEO's first calls was to build internal HR expertise to establish the firm's internal skills base for its future requirements.

#### Box 4.5: HR for innovation—building HR capability to foster skills for innovation

*We used to have one part-time person in HR, now we've got three full-time. There is no argument about it. One of them is also responsible for occupational health and safety, one also covers environmental issues, and of course I've got the HR Manager. So across the three of them, they're involved in every aspect of the business one way or another.*

Keech

Broad business knowledge and skills are especially important for start-ups and SMEs, where founders often aim to take the responsibility themselves for building these skills. Fibrotech's CEO, a scientist with a PhD in translational medicine, for instance, states:

*I did an executive diploma of business management to get some of the required skills. I learned a lot of things on the road, basically. I had to go out and do everything: set up a company, file my own intellectual property, go around the world and raise funding for the company and bring in my own international consultants. And still, in areas where I was deficient, I had to go and find those skill sets.*

Fibrotech

His view is that existing PhD programs, especially in the sciences, must include more development in business skills. However, he also reiterates the value of starting a company like Fibrotech with people who have strong and specific life-sciences skills and well-developed networks to supporting scientific organisations. The benefits of cluster and network integration are discussed in more detail in Chapter 3.

#### **Summary 4.2.2: HR for innovation**

**Lean operating principles, particularly in smaller and younger organisations, see HR considerations embedded with general leadership positions. This means that leaders need to have the skills to recruit employees and assemble appropriate project teams.**

**As noted, innovative organisations often access skills from outside the organisation.**

**Specialised degrees (e.g. in scientific research) would benefit from the addition of management and business skills.**

**In the absence of such combined programs, many innovative organisations attach themselves to networks and clusters of likeminded and complementary organisations (bundles of organisations).**

**As organisations grow, so does the need for effective and strategic HR processes without which enterprises cannot innovate effectively.**

### **4.2.3 Selecting employees to achieve the vision to be a successful global innovation firm**

Except for a few enterprises operating only domestically (Anglicare Victoria, Queensland Urban Utilities), the innovative firms interviewed for this project are designed to operate beyond national borders. This is to overcome size restrictions of the Australian domestic market and also exposes those organisations to global competition and best practice. In particular, many firms attribute their success to being 'born-global'. Their vision from the start was to develop and sell goods and services to a global audience, and in doing so they needed to select staff with the diversity, experiences and skills to allow the firm to compete successfully in highly competitive international marketplaces.

The majority of organisations interviewed believe their desire to be global from the start-up stage is a major reason for their success as an innovative organisation. NOJA Power, Envato, the George Institute, Animal Logic and Cochlear, have built their success on pursuing a global market from the start, in part motivated by the relatively small size of the domestic market.

*From the very beginning we started as a global company. We could never have made Cochlear a successful business just in Australia as the market just isn't big enough. The product was approved by the FDA [U.S.], received the CE Mark [Europe] and was approved in Japan all relatively early.*

Cochlear

This is not only the case for the private businesses. Since its recent restructuring, CSIRO has taken up this global mantra.

*Our vision is about global outlook, national benefit, about delivering connectivity to the global science, technology and innovation frontier, as well as access to new markets for Australian innovation.*

CSIRO

#### Box 4.6: Global outlook—skills to operate in a global market

To compete in a global environment, these organisations employ staff with the skills to operate in this changing and challenging context. NOJA Power is proud of its multi-cultural workforce, with employees from more than 50 different cultural backgrounds. The founders believe their success is strongly linked to this fit between global skill sets for designing and selling products to a global market. ING Direct uses its global parent company (ING Group) to give its Australian employees international experience and, in turn, receives staff from other countries to work in Australia. This transfer and rotation of staff across different countries has generated new ideas and business solutions, including successful pilot projects.

ING Direct is a 'direct' bank (operating entirely online, without legacy infrastructure and associated costs), and has succeeded due to its high level of ICT skills and focus. Despite this, the CEO regards technical skills as a second level issue. He argues that ING Direct tends to contract someone to program a solution, with technology being a tool to make banking easier for customers. He believes that the more significant challenge for employees is developing knowledge and skills to understand and interpret how markets, customers, competition, culture and societies operate in order to influence the financial services the company needs to deliver now and in the future.

Diversity is important but also broadly defined in the case study organisations. All firms stress the benefits to innovation of diversity of gender, age, national culture and skill sets. The development of greater workforce diversity is especially important in industry sectors that traditionally have a more homogeneous workforce. SocietyOne, for instance, stresses the importance of having older employees work in a firm that provides financial technologies, even though the customers are dominantly younger people. A more age-balanced workforce allows the firm to better think of ways to also attract older customer groups to their services. The idea is to represent (potential) customer groups internally to better cater to those customers' needs.

Similarly, Laing O'Rourke emphasises a gender balanced workforce in the traditionally male-dominated construction sector.

Envato's co-founder plans to change the gender balance.

*I was frustrated by the shortage of female developers when hiring for Envato and the shortage of female entrepreneurs more generally. I have now committed to be more present in the start-up scene to try to inspire other women.*

Envato's co-founder

For Animal Logic, the visual effects company that has animated the LEGO movies and many other blockbusters, diversity is a necessity to operate as a global business. To enhance employee diversity, the company is recruiting globally. Animal Logic has hired from the US, Canada, the UK and other European countries, and India.

Envato supports the push for more diversity by introducing more flexible work practices. Flexible working arrangements were shown to be strongly associated with all types of innovation in the statistical analyses in Chapter 2.

#### Box 4.7: Global outlook—attracting a diverse workforce

*We've found incredible talent in Melbourne. There is a diversity to Melbourne and a diversity to our team, so we are more able to deal with the nuances of having an international community. Staff are free to work from anywhere in the world for up to three months of the year. This has helped us to attract staff, especially staff with boutique skill sets.*

Envato

The organisations interviewed also exhibit diversity in the skills mix promoted in teams, reflecting their focus on teams as bundles of skills. Many of the case organisations deliberately place employees into cross-functional teams.

Queensland Urban Utilities, for example, attributes its innovativeness to the mix of disciplines present in the organisation and its teams, ranging from chemistry and engineering to marketing, finance and procurement disciplines.

Although an engineering and construction enterprise, Laing O'Rourke's cross-functional integration brings together experts from a wide variety of countries, cultures and disciplines.

#### Box 4.8: Global outlook—combining disciplines

*I've taken a music student; I truly don't care. Music and maths are pretty much the same, so no argument from me; I just want smart kids.*

*We find the best innovations come about where you manage to get individuals who are experts in their little area rubbing up against each other. It's the interfaces of disciplines where the value is created. I'm constantly surprised that not more people understand that.*

Laing O'Rourke

Pernod Ricard Winemakers uses its diverse teams, and skills within those teams, to develop new products for a challenging wine market that is conservative and not as open to innovation as many other food and beverage categories. Although the business is focused on producing and marketing premium wines, a lot of time is devoted to new product development. To develop these new products the company use a variety of diverse teams and structured small group processes to promote new product ideas that build its innovation pipeline globally.

#### Summary 4.2.3: Global outlook

**A global orientation requires staff with the competences to operate in a global environment—that is, staff with an understanding of global markets and competition, but also staff that represents the diversity of the world market.**

**Diversity in its various forms is crucial in all innovative organisations. Skills diversity is an important component. The need for skills diversity is based on the realisation that much innovation happens at the intersection of different disciplines and ways of thinking about problems.**

## 4.3 Sustaining the skills mix: teams as bundles of skills

### 4.3.1 Building teams for innovation

Organisations vary in how they structure their teams that lead innovation. At ING Direct, there is no prescribed way to form teams. Rather they are put together on the spot based on the skills required for the project and adapted over time. By letting employees decide who they want to work with, a number of CEOs are promoting core cultural beliefs about the importance of trust, openness and diversity in sustaining innovation.

#### Box 4.9: Innovation teams—combining different ways of thinking

*When I recruit my core team, I surround myself with people who think differently to me, people who know more. I think strategically, I like ideas, so I need people around me who can execute, otherwise I'd be a failure. And I try to make sure the organisation looks like that, too.*

ING Direct

CEOs who let employees decide who they want to work with also advocate allowing teams to adapt over time as the organisation and its customers mature. While individual and specialised skills are critical to empower people to use their technical skills, creating a workplace culture that promotes openness to new ways of thinking and new mindsets is also indispensable to innovation. The development of these 'innovation attitudes' and 'innovation mindsets' is seen as a skill in itself, and has, at its foundation, a willingness to build a broad understanding across a range of disciplines.

#### Box 4.10: Innovation teams—self-forming teams

Envato has institutionalised the idea of self-forming teams in regular innovation challenges (called Idea Sprints). Twice a year, teams form around self-generated ideas on how to improve the business. Within a two-week period, the teams spend time (while maintaining their everyday work) to advance ideas and propose methods of implementation. This approach not only generates rich solutions but also challenges employees to sell their idea to other team members, to form a coherent team and to organise when and how to work on these new ideas.

The development of a more general skills base among employees is most apparent among the founders of start-ups. Hatchtech is a pharmaceuticals spin-off from the University of Melbourne, whose scientific basis was the essential driver for discovery and product testing. However, with the formation of the firm, knowledge of intellectual property protection, attracting venture capital investment, regulatory requirements, manufacturing, business, marketing and project management became increasingly important. Hatchtech brought some of these new skills in-house by hiring a CEO with a science background and an MBA. It hired other senior staff either directly or through temporary contracts. Southern Innovation, a Melbourne-based start-up producing advanced radiation detection technologies for use in medical, defence, resource exploration and materials analysis, had a similar experience.

*If you think about successful engineering start-ups, they usually develop from a range of different disciplines. You need lawyers, accountants, tax professionals, bookkeepers, and all those are only auxiliary roles to the core engineering. On top of that you need business development, sales, marketing, and some knowledge of production techniques.*

Southern Innovation

On a larger scale, the adaptive cycle continues as organisations grow and mature. Cochlear reports that as a business it continuously adapts and changes the skills represented in its workforce. In the beginning phases, Cochlear was strongly based on its core technology, but more

recently the focus has moved to understanding customer needs. An example is the company's development of automatic adaptation to different ambiances and wireless control of the Cochlear device. Cochlear now employs more 'user experience' people, more employees in software, technology, human design factors, and most recently it has also hired data scientists. At Cochlear, these may often be individuals with a technical background, but many firms are opting for specialists in consumer behaviour. Intel, for instance hired a trained anthropologist as Director of User Experience Research (*The New York Times* 2014).

#### Box 4.11: Innovation teams—cross-disciplinary representation

*We've invested in the design and development and in the marketing spaces. The project teams that bring products to market are becoming more diverse in order to bring that about. There is a lot of clinical and regulatory input into bringing products to market as well, and those skill sets are very hard to find. You have to build them, as well as go into the market for them.*

Cochlear

CSIRO is also pursuing diversity in its vision to be Australia's innovation catalyst.

*Inclusion, trust and respect—to fully enable and support the innovation capacity of our creative people and teams to take risk and deliver to customers, we will promote inclusion and diversity as a driver of innovation, specifically increasing gender and cultural diversity in middle and senior leadership positions, and the number of Aboriginal and Torres Strait Islanders in CSIRO over the strategy period.*

CSIRO

Woodside echoes this diversity focus.

*Our leaders are very diversity aware, for the lack of a better term. 'Too much group think?— Break that team up, bring in cultural and gender diversity, bring different thought in...' That I see as the leadership of the future—knowing how to get that right mix of talent onto a problem.*

Woodside

Woodside also emphasises the role of emotional intelligence in the make up of innovative teams.

*The team minus the hard-core math person will define the problem, but without 'emotional intelligence' in that room, the problem will not be defined very well. Once the problem is defined very well, it's handed off almost to a single contributor. And Mr Hard-Core Math takes over, plugs head phones in, sits on a bean bag, 'leave me alone'... Four hours later s/he comes back, 'done'. Then the rest of the team takes over and then completes the solution so that everyone else can understand it, and make use of what that solution is.*

Woodside

### Summary 4.3.1: Innovation teams

**There is a high degree of trust, openness and flexibility in innovative enterprises' approaches to team formation to support innovation.**

**Trust, openness and flexibility are very important in the formation of 'innovation attitudes' and 'innovation mindsets', with a willingness to build a broad understanding across a range of disciplines as the foundation.**

**Teams are diverse and dynamic with skills and characteristics established both within and beyond the boundaries of the particular organisation.**

### 4.3.2 Accessing external sources of technical and non-technical skills

To maintain their external focus, cross-functionality and adaptiveness, many of the case organisations are very willing to use external expertise to promote innovation. This includes a willingness to hire staff from outside their own sector, as well as to use contractors and partners to complement their internal skills base. It also includes creating more skills mix on projects through strategic alliances with other firms.

The interview partner at Anglicare Victoria, who herself entered the not-for-profit sector after working in corporate businesses for many years, emphasises the usefulness of 'business skills', such as negotiation and contracting,

which are not necessarily as prevalent in the not-for-profit world as they are in the corporate sector. The accountability and sustainability pressures on the not-for-profit sector are such that Anglicare Victoria recognises the value of skills from the for profit/corporate sector and therefore, where appropriate, looks to attract staff from that sector to complement skills currently available in the organisation. Likewise, when faced with a major restructure when several local government service departments were folded into one organisation, Queensland Urban Utilities consciously hired several executives from outside its core engineering capabilities. These were managers who had worked in sectors traditionally more customer-focused, such as telecommunications and energy providers.

Keech and SocietyOne show similar ambitions. At Keech, the focus is on recruiting employees with extensive knowledge about its customer business sectors. Keech is developing 'product engineers' who have both the technical expertise and marketing skills relevant to mining and construction. SocietyOne is seeking greater diversity of thought, by sourcing talent from industries other than finance to bring new ideas into the firm.

#### Box 4.12: Accessing external skills—different mindsets foster innovation

*We are aggressively looking to recruit all kinds of people from other industries. Those are always attractive because they have a cross-display of skills that can help you think differently about problems where a lot of finance people bring a traditional mindset—they can only think in terms of a banking problem, a funding problem or a credit problem.*

SocietyOne

Cotton Australia applies a similar approach to seeking a mix of internal and external appointments to fill senior leadership roles. It complements this strategy with the use of consultants with technical and non-technical expertise from outside the sector, including from economics, energy, water, and from other industry organisations.

*We specifically bring in people from outside the cotton industry such as chemical engineering to push for radical innovation. Expertise from outside the cotton industry is highly valuable.*

Cotton Australia

The liberal use of contractors is another common theme in complementing the internal skills for innovation and commercialisation. In particular, resource-constrained start-ups and smaller organisations locked into their ‘lean thinking’ mindset rely heavily on the temporary inclusion of external expertise.

#### **Box 4.13: Accessing external skills—contracting for lean operations**

*We had consultants in the US, Europe and Australia, and we had other people everywhere doing bits and pieces for us. When you suddenly need something done, you go and find someone who can do it. It might take some more time, but you don't have someone sitting on the payroll.*

Hatchtech

The focus on ‘lean’ in many of the organisations interviewed for this project means building networks and collaborations beyond the confines of the organisation. Anglicare Victoria, SEEK and ING Direct use external contractors to fill short-term technical and non-technical skills gaps. ING Direct’s use of external programmers is discussed earlier. SEEK uses externals to, for example, run innovation contests (called Design Sprints).

*Get someone who has done it before, is impartial and able to keep the group motivated and on-track for the duration of the sprint. An external person is more likely to fit the bill.*

SEEK

It is notable that several organisations, including technically-focused firms such as ING Direct, observe a ‘commoditisation’ of technical skills. This is in line with the comments (for example those by Hugh Durrant-Whyte) on the future of work described in Chapter 3.

At ING Direct programming is frequently outsourced because it is not seen as one of the core competences of the organisation. But it is important that employees have ‘digital literacy’, that is, they know how to use technology and, more importantly, think in technological terms and know what and how solutions can be achieved through the use of technology. While a solutions designer does not need to know how to program every aspect of a software solution, this does not negate the need for highly specialised technology skills.

For visual effects at Animal Logic, there is a need for advanced coding skills, yet those skills are seen as one part of a more complex mix of skills required in the company’s development teams.

Laing O’Rourke relies on mixing permanent staff with interns on short-term contracts to bring technology and ideas from outside into the construction space. The innovation hub office in Australia has only 14 permanent staff but doubles or triples this number with the appointment of university interns and consultants on different projects around its core focus on disruptive innovation.

Another approach is the use of long-term collaborations with partners firms. Rather than incurring the salary costs through hiring staff, partnerships give the case study organisations access to the technical and non-technical skills of others. Even large and well-established firms like Cochlear use partner organisations for advanced technical work. Chip design work, for instance, is done using skills brought in through Cochlear’s partnering with specialised firms. More mid-sized groups like The George Institute talk openly of their alliances in the delivery of world-class, high-impact health care research. The George Institute accesses the skills of over 550 staff across its four main global offices and network of collaborators and partners in over 50 countries.

At the start-up stage, Fibrotech relies on its network in Australia to further develop its pharmaceutical discoveries, but during the process also lamented the lack of business expertise that meant going outside Australia for commercialisation.

*The group of founders were a diverse group of disciplines being researchers in medicine, biology and chemistry but they were lacking the business skills necessary for setting up the company. We later closely involved the director of MRCF (Medical Research Commercialisation Fund), who brought a lot of business expertise to the group. I think access to people is a big problem in Australia. We don't have enough expertise in this area of pharmaceuticals commercialisation, which means you have to go to the US to contract these skills.*

Fibrotech

### Summary 4.3.2: Accessing external skills

**To maintain their external focus, cross-functionality and adaptiveness, many of the case study organisations show great willingness to use external expertise to promote innovation. This includes a willingness to hire staff from outside their own sector, as well as using contractors and partners to complement the internal skills base. It also includes creating a skills mix on projects through strategic alliances with other firms.**

**Accessing skills both internally and externally is an essential element of third generation innovation thinking.**

**It is notable that several organisations observe a 'commoditisation' of technical skills.**

### 4.3.3 Building an innovation culture supportive of skills sharing

A willingness to collaborate externally goes hand in hand with a desire to share and mix skills internally. Underlying sustained high performance in the case study organisations is the view that individuals are driven by the same values. Many of the organisations are actively investing in and promoting their own forms of innovation culture.

Queensland Urban Utilities promotes to all staff its core values about being innovative, seeking engagement and creating employee buy-in. SEEK's values promote inclusiveness, diversity and equality—values that allow SEEK to continue

to transform itself from an online job search provider to a human capital company. Making this successful transformation will allow SEEK to operate in new and larger markets that it will need to open up through innovative ideas and technologies.

Attitudes, time and culture are actively aligned to promote sustained innovation. Cochlear removes barriers to its employees' personal creativity by focusing less on the completion of everyday tasks and more on achieving activities that are another step towards fulfilling well-articulated significant organisational goals. In similar ways, NOJA Power provides regular presentations and seminars to keep its people informed about bigger picture developments in new technologies and other developments influencing the longer-term strategic objectives of the business.

Cultural fit is important to all firms, especially to the smaller innovation firms. NOJA Power lowers its sights on skills in exchange for the right attitudes. At NOJA Power this means people have to be enthusiastic, willing to learn and broaden their skills along the way.

Keech looks for a sense of imagination when hiring new employees.

#### Box 4.14: Innovation culture—capacity to think outside the square

*We are trying to listen to people and to see if those people have imagination, have the capacity to imagine outside the square. In a small and innovative business, it is absolutely important to us not to have people that you have to sit with every minute of the day and say 'Do this, do that'. We're following a 'Here is a problem—solve the problem' type approach.*

Keech

As a young business, SocietyOne is taking advantage of recent shifts in employee mindsets. Start-ups, which often were perceived as risky employers, are now gaining more traction with the general workforce. SocietyOne reports that many of its employees come from large corporates and are taking a step outside that world 'to try some time on the wild side—that is the spark of passion we are looking for'.

Another common theme in these organisational cultures is the strong support for sharing and combining different skills at various stages in the innovation cycle. The nature of skills that individuals and teams require will develop and change over time. Third generation thinking around innovation ecologies stresses the dynamic and evolving nature of the systems. Although SocietyOne and Pernod Ricard Winemakers are in different industry sectors—being finance and wine making/global marketing respectively—both organisations share very similar views about not only combining the talents of technical and non-technical staff, but also selecting employees with a mindset and willingness to broaden their skills over their time in the organisation.

*We focus on bringing the mix of skills together in teams to solve problems. If Jacob's Creek needs a new product for market 'X', we'd have a diverse cross-functional team with a representative of the market, global brand team, insights, winemaking as well as innovation creativity and commercialisation.*

Pernod Ricard Winemakers

#### Box 4.15: Innovation culture—sharing skills across disciplines

*There is the combination of people who are building the technology and the people who are from all those other disciplines such as customer service, sales, marketing, design, and they are working together in small teams. We're very big on trying to structure those teams and support those them through ongoing training and mentoring so they can be really effective and productive.*

Society One

#### Summary 4.3.3: Innovation culture

**Skills mixing occurs across organisations and disciplines, and over time. Innovative organisational cultures exhibit strong support for sharing and combining different skills at various stages in the innovation cycle.**

**The nature of skills that individuals and teams require will develop and change over time. This are consistent with third generation thinking around innovation ecologies, which stresses the dynamic and evolving nature of the systems.**

#### 4.3.4 Building a broader skills set 'on the job'

Supported by cultures that promote and reward skills mixing and sharing, employees in these innovative organisations are encouraged to build and extend their skill set on the job. This includes a preference for individual development plans, the use of challenging tasks and assignments, rotations, internships and access to expert mentoring. Less attention is given to formalised training, although it still occurs.

SEEK follows a plan of using more seasoned employees to mentor new entrants especially to instil the company's core culture and values around collaboration between individuals and teams. Although Envato has increased its training efforts, the company does not follow a formalised structure or impose training in specialised fields. One reason is its view that many of the specialised skills, especially in programming languages, are changing at too fast a pace. Rather, Envato allows employees time to develop individual plans that identify a broad set of technical and non-technical skills that will support self-development.

*Instead of going and doing an MBA, employees might do a performance marketing piece. They can do this online, just by reading publications or classroom based. This will allow them to move into a part of the business that does that type of work which is more important to them in their future than an MBA.*

Envato

At ING Direct, the focus is on challenging people to broaden their skills through learning new skills on the job. The CEO strongly encourages his managers and team leaders to challenge and open up employees skills through new projects that take them beyond their current levels of expertise.

A level of more structured formal training still occurs in these types of firms. Again the overall aim is to broaden skills rather than provide more specialised technical training.

Woodside follows a structured approach that rotates graduates through different parts of the business to diversify their skills base.

**Box 4.16: On the job learning—broadening skills through job rotation and in-house creativity training**

*Our graduates are on a three year program. They are rotated every year and have to do a minimum six months in those three years outside of their discipline. So an engineer might do a year in commercial or corporate. This way they are forced to also get to know different parts of the business.*

Woodside

Pernod Ricard Winemakers follows a structured approach that is less focused on specialised functions. Interestingly, the company uses an in-house creativity training program that brings together all types of staff. The goal of the program is to develop skills in each employee in how they can apply deliberate creative problem solving in all areas of their jobs. The training teaches a system and processes that can be applied beyond new product innovation to support employees to more confidently tackle everyday problems at work, to make business improvements and to improve efficiency. The training brings together sales and marketing, viticulture, production, finance, and HR—so that staff from every department in the business are trained in a process ranging from asking the right questions, visioning, clarification, ideation, development through to implementation.

Another interesting feature of the program is that staff have to focus on two different sets of problems. As might be expected, they have to apply the creative process to an internally identified business problem and come back with a solution. In addition, they are also asked to focus on generating solutions to real issues faced

by an outside client who might have nothing to do with the wine industry. These creative solutions are presented back to this client.

**Box 4.17: On the job learning—in-house creativity training**

*We are in our third year of using creativity training. The creativity program that we run internally challenges people to think about how to think differently about business challenges. The program is designed for everyday applicability and enables employees to step outside their functional areas to think about problems from different perspectives. It thereby seeks to break down some of the mental barriers and learned views that can develop over time.*

Pernod Ricard Winemakers

**Summary 4.3.4: On the job learning**

**Innovative organisations do not rely on new people being simply ‘work ready’.**

**Job development and rotation within the organisation to develop a whole of organisation mindset is important.**

**This involves an emphasis on individual development plans, the use of challenging tasks and assignments, rotations, internships and access to expert mentoring. Less attention is given to formalised training.**

**4.3.5 Internal vs external training and rewards around innovation**

The focus of training is, overall, on technical skills, as those are outdated frequently. The majority of training is managed internally. There are not strong or very active partnerships with VET or higher education institutions.

As noted by the Australian Industry Group (AiGroup), different training models do occur in the SMEs and the larger organisations to build employee skills. Well-established internal training systems in the larger firms use apprenticeships, graduate programs and internal job rotation programs. However, such systems are difficult to maintain for smaller organisations with their

smaller numbers of new recruits and smaller firm size. According to the AiGroup there is some pooling of apprentices across organisations for training, but this is not frequent. AiGroup argues that innovative businesses would prefer greater levels of collaboration with educational institutions such as VET and universities to achieve better development of the connections between theory and practice in their new recruits.

#### **Box 4.18: Training for innovation—job rotation and internal training measures**

As an example of a large organisation and its approach to training, Laing O'Rourke relies on its graduate programs combined with job rotations to diversify the skills sets of new entrants. At the more senior levels, Laing O'Rourke extends this idea by engaging its executives in training and learning about developments in new technologies through its Engineering Excellence Centre. Laing O'Rourke believes that a key to its success is how well it promotes and integrates new ideas across all parts of its global business. The major objective is to make all of its local operating businesses successful through access to the best training and latest ideas.

At the other end of the scale, Keech builds on the technical skills of current employees through in-house training that focuses on 'skill sets' delivered as standardised blocks that are aligned to formal VET qualifications. Keech uses an integrated occupational health and safety and HR system to track, control and mandate training and education for its diverse group of employees.

One of the businesses partnering with universities for its training is Fibrotech. Fibrotech's attention is on improving research training, in particular to increase industry collaboration. Its CEO, for instance, is discussing science PhD training schemes with universities that will not only be more translational but also include training for business and entrepreneurship.

*You could do your three year research project, but maybe we could include a few business projects, learn about IP, finance and start-up companies. People could come out with a different flavour of PhD.*

Fibrotech

In some firms training is motivated by financial rewards but in the vast majority of cases motivations and rewards for training are more intrinsic. Employees are more motivated by firms providing challenging work, attractive work environments, regular recognition and progression, and good programs that support new talent.

SocietyOne uses training to promote core values around internal co-creation through collaboration and trust in and across teams, particularly between technical and non-technical personnel.

Many firms find that a mix of intrinsic and extrinsic rewards works best. Southern Innovation has staff with backgrounds in engineering and mathematics who are intrigued with the problem solving around the technology that they are developing. This in itself is compelling for many staff to train and stay, but the firm also provides bonuses and days off.

ING Direct has evolved its reward system to incorporate additional ways of recognising employees, in addition to remuneration. These include greater accountability and decision making, career development through secondments and business education, flexible working, and the opportunity to continuously learn, grow and develop.

#### **Summary 4.3.5: Training for innovation**

**There is some pooling of apprentices across organisations for training, but this is not frequent.**

**Training is a valued activity in innovative organisations, although it is often not through formal means but rather viewed as development. Often this includes providing seminars or internal dissemination of research findings, such as at Laing O'Rourke. It also often involves the direct development of employees by trusting them with more demanding projects, such as at ING Direct.**

**Reward systems incorporate additional ways of recognising employees, in addition to remuneration.**

## 4.4 Meeting innovation challenges over time: the enterprise in context

### 4.4.1 Collaboration, clusters and networks as bundles of complementary skills

A clear pattern that emerged is that the case study firms are highly focused on increasing their levels of cooperation, primarily to access skills required for their next stages of innovation. As noted, a major source of skills is through the networks, partnerships and clusters they belong to. Beyond these relationships most often in the same industry, they increasingly favour collaborations with universities and the CSIRO to foster access to a broad knowledge and skills basis in other organisations. The viewpoints and ideas from other organisations, often outside the firm's own sector, are greatly valued in advancing innovation. Often this is at a personal level that allows mentoring and ongoing support.

*The deeper our intra-connectivity, the bigger is the support network to keep us self-sufficient and motivated. At monthly 'leadership lunches' we sit the new CEOs next to those who know the ropes to create a strong support network.*

Fibrotech

*The BioMelbourne network provided us with some best practices applicable to pharma-related organisations around the world. Summed up as: you need to plan for business success, not continued funding; connect internally, but focus externally; accept that small support can go a long way; and the greater good of the region helps the locality.*

Fibrotech

Cotton Australia has established long-term strategic research partnerships towards its objectives to better manage crops. Research partners include CSIRO, Cotton seed distributors (Monsanto, Syngenta, Bayer), the Cotton Research and Development Corporation, the Australian Cotton Growers Research Association, New South Wales Agriculture, the Queensland Department of Primary Industry and the Department of Agriculture Western Australia. These alliances, networks and partnerships, including the Cotton

Innovation Network, allow industry leaders to develop a 20-year vision (Vision 2029) for positioning the industry and ensuring the future of the industry. Cotton Australia also draws on the skills of staff from other industry organisations when necessary, mainly through informal relationships.

*We are a member of the National Farmers Federation and number of irrigator groups. So we accept the need to work together. They have particular staff with particular skills and experience that we draw on.*

Cotton Australia

Many of the innovative firms use similar informal connections to complement their existing skills, especially in initial stages. Fibrotech's CEO used his close connections to a number of mentors who had successfully led start-up businesses. These firms also use more formal mentoring for building skills and skills mixes in firms. SocietyOne, which promotes the importance of collaboration between its technology and non-technology teams, organises collaborations and training with individual mentors.

#### Box 4.19: Collaboration—developing teamwork through mentoring

*We bring collaboration coaches on site and they continue to provide coaching and mentoring with our teams on a functional basis. So there are experts available to help us think about how to structure our teams and deal with trade-offs. It's a big investment to this use of a formal mentoring program that we make and we are pretty committed to it.*

SocietyOne

SocietyOne is also building and using its close relationships to regulatory bodies in the finance sector. A strategic partnership with a credit score provider is the foundation of its business. Keech and the CSIRO are collaborating to advance 3D printing on the materials side, and this has led to the formation of a new company acting as a commercial arm of CSIRO (Keech 3D). Cochlear continues to make good use of the access to technical and non-technical skills through its location at the Macquarie Park business and education precinct in Sydney.

The grants offered by the Cooperative Research Centres (CRCs) and Australian Research Council (ARC) provide another way of joining research efforts and skills. Southern Innovation recently partnered as Linkage Partner Organisation with a professor at the University Melbourne to receive an ARC Linkage Grant—a research collaboration they see as critical in their innovation pathway.

#### Box 4.20: Collaboration—business-university partnerships

*It's very, very important because we need to continue to invent around ourselves because otherwise someone else will do it. So as a resource, the University has been important.*

Southern Innovation

Some of the case organisations are cooperating directly with universities through joint PhD research programs. These alliances offer opportunities for research translation into application and an inexpensive way for organisations to trial and advance new ideas. Woodside collaborates with a range of universities—seeing the mutual benefit of their projects not only helping to translate research into the business, but also encouraging universities into new and less-explored research areas. Keech cooperates with Deakin University, working on metal properties. SocietyOne is planning internships, Hackathons and PhD research in collaboration with universities. Also on the table are project practicums such as pursued at the University of Melbourne. The University host the Melbourne Business Practicum where cross-disciplinary teams of students are partnered with a company to work on a business problem for two weeks. Students are located in their company for two weeks where they work with the team and a mentor to come up with a solution. As a side benefit for the company, such collaborations also allow exposure to future talent.

On the down side, partnering with universities has its challenges. Laing O'Rourke, which partners with many Australian and UK universities, is critical of various structural and cultural barriers.

#### Box 4.21: Collaboration—understanding the roles of business and university

*There's a structural disconnect between universities and industry. Industry needs to start to understand that blue sky research is not a bad thing and universities need to start rewarding behaviour that industry finds valuable, instead of basing promotion only on publishing academic research.*

Laing O'Rourke

Cotton Australia and Envato also report difficulties in collaborating with universities. In particular, this appears to be based on changes to university funding arrangements through the ARC. One of the factors according to which universities are rated and funded is the amount of direct funding received from other sources, e.g. industry partnerships. As a result, universities tend to focus on the amount of funding received for projects rather than the quality of the partnerships with industry in doing applied research. Envato has found it challenging to work with the bureaucratic structures in universities.

*We talked to universities about joint training programs and got to a point where it was just too hard. There is little trust or flexibility to trial things. What we would have liked to see was the university saying 'You set the program, and we'll accredit based on what you set'.*

Envato

Finally, Laing O'Rourke, ING Direct and others emphasise the need for change in university education. They wish to see a move away from teaching facts to teaching students how to think, learn, and to create new knowledge.

#### Box 4.22: Collaboration—changing demands for university education

*I think the problem with universities is that they build highly educated people, but few innovative thinkers and leaders. The education system is focused on awarding fantastic academic qualifications, but the world has moved beyond that. We can't keep educating people based on the same standards we used in the past. The world is moving too fast for that.*

ING Direct

#### Summary 4.4.1: Collaboration

**The case study organisations are highly focused on increasing their levels of cooperation. They use such cooperation and partnerships to access skills required for innovation.**

**A major source of skills is through the networks, partnerships and clusters that these organisations they belong to.**

**The viewpoints and ideas from other organisations, often outside the sector, are greatly valued in advancing innovation.**

#### 4.4.2 Leadership for innovation requires a technical and non-technical skills mix

To remain high-performing innovators, the case study organisations need skilled leaders to drive performance and create a culture that allows new thinking. The AiGroup see it as a primary role for leaders in firms to create new ideas and risk-taking that challenges the status quo.

Significantly, the leadership of innovation firms requires individuals with skills that go beyond their often specialised qualifications. As shown in a number of research studies (e.g. Custódio, Ferreira and Matos 2014), leaders with a deep knowledge in one field, but a broad understanding across many other fields (referred to as T-shaped), tend to run more innovative organisations. This is the case across the case study organisations.

There are many cases at the start-up phase where one person among the founder group chooses to lead. At Fibrotech, the former CEO took it upon himself to learn 'the whole thing'.

##### Box 4.23: Leadership skills—challenges in the start-up phase

*There were a huge number of various business skills that I had to learn. With my scientific education there was a big gap there, but I was also doing absolutely everything back then. In my new role at OccuRX I've grown a little and am probably a bit less hands-on and more strategic.*

Fibrotech

Animal Logic's CEO recalls how he developed skills beyond his training as an artist by taking up opportunities that moved him to the role of group general manager of Colourfilm (Australia's largest post-production company group at the time) so that when Animal Logic was started:

*I had the experience as a hands-on creative person, but also as a very senior level business manager. I think that if we had only had experience in technology, that would have been a risk but between Chris Godfrey, who was a very capable video editor at the time, and my experience in film and in management, it was like bringing all the skills together.*

Animal Logic

Other firms access the more general skills of their board or hire externally. At Cotton Australia, a smaller organisation, it is the board that provides this broadly-based set of skills in leadership. The board members push the boundaries towards blue sky innovation, bringing along the CEO and the entire team.

As they grew beyond being start-ups, others sought leaders from outside. Keech hired an outside CEO after experiencing 'misguided innovation'—the family business was struggling with increasing national and global competition externally and high failure rates in production internally. Hiring an outside CEO assured more focused and effective innovation. Queensland Urban Utilities used a restructure to hire external executives with experience in more customer-centric companies in telecommunications and energy. Anglicare Victoria found that a new CEO brought in externally provided a different way of thinking about its services and instilled a culture that more strongly supports employees proposing and using new ideas.

Cochlear takes a very structured approach to develop the management and leadership of its personnel. It uses the concept of learning pathways where future leaders and managers are equipped with the more non-technical skills they need to do their work over time. They are supported by ongoing learning and encouraged in particular to learn through their experiences managing cross-functional teams that bring together a range of different expertise. As noted,

Cochlear has appointed a marketing expert as CEO to take the company on the next stage of its journey centred on the creation of new markets.

Woodside follows a similar concept of learning to lead by managing diverse teams.

#### Box 4.24: Leadership skills—leading and managing diverse teams

*Leaders at Woodside are 'diversity aware'. We get them to observe and reflect as they build their teams. Too much group think, break that team up, bring in cultural or gender diversity, bring in different thoughts. That's leadership of the future where you know how to get the right mix of talent for a problem. And making sure that there's the right calibre in the room as well, that everyone is pulling their weight in driving innovation.*

Woodside

#### Summary 4.4.2: Leadership skills

**The innovative organisations studied for this report support the findings of a number of research studies (Hansen and Von Oetinger 2001) that show leaders who are 'T-shaped'—with a deep knowledge in one field, but a broad understanding across many other fields—tend to run more innovative organisations.**

**Leadership for innovation often requires stepping outside traditional core competencies of the company. Innovative leaders do this by encouraging diversity of skills at all levels of the organisations.**

#### 4.4.3 Founder's values, culture, teamwork and skills sharing

The founders of these innovation firms have a significant impact on establishing the values, behaviours and cultures that drive the passion to innovate. They are often the major agents not only in determining the skills and teams required at the start-up stage, but they also continue to influence changes in skills requirements and skills mixing over time as the firm grows and changes. Hatchtech's founder, a university researcher for more than 15 years, made the choice to devote effectively all of his time and efforts

to his growing firm. He believes his risk taking and passion has driven the culture in his team, and continues to attract the right people at the right time in the development of the business. Similarly he moves between different roles and skills as required.

*I never lost my passion for doing what I wanted to do, and it was pretty tough I'll tell you. That's really what's driven us through. We've had people come and go, we've had a number of CEOs, the board has changed, I've been on the board, off the board, I've been company secretary, finance guy, I manage all the company's IP—I have been involved in virtually all of the company's operations at some point in time.*

Hatchtech

Southern Innovation began with two brothers, one an electrical engineer and the other an accountant. The firm's culture continues to be built on the trust within its core group of people, which has expanded over time by accessing individuals to fill important positions from personal and business networks. Cotton Australia was founded by a group of cotton farmers with a vision for changing a relatively traditional agricultural industry into an industry that adopts new technologies across all of its activities. Today Cotton Australia has a strong culture for innovation from its board through to the farmers at the grass roots level.

At NOJA Power and Envato, the founders' values translate into distinct business practices that give both firms competitive advantages in sustaining innovative thinking. Envato promotes values around trusting its employees to 'work from anywhere, anytime' to support their ability to innovate. NOJA Power focuses on creating an environment in which employees want to stay to create a consistent team culture, while its investment of 10 per cent of annual turnover in R&D supports this culture.

Anglicare Victoria's CEO attributes its innovation on products and services to the use of flexible multi-disciplinary team structures that can connect members of the technology team into conversations with those who deliver their products and services.

SocietyOne's founder has a similar attitude, mixing staff in potentially unusual ways to generate new ideas or solutions. A common feature is the use of engineers who have all the attributes of team participation and collaboration and are given considerable autonomy. However, 'finding those is like finding that mythical butterfly'. (Society One)

Although well beyond the riskier days of the start-up stage, large successful organisations continue to tell stories about the role of their founding figures in instilling a culture and values that are critical to their organisational DNA. SEEK's continued openness to change, to remaining agile and flexible, is a critical feature of its success in being able to operate in very different locations like South America and Asia.

#### Box 4.25: Founder values—openness to change

*Much of SEEK's culture goes back to the co-founder CEO Andrew Bassett who is very open to new ways of doing things. There is an active innovation culture, a mindset of wanting to do things better rather than just doing business in a specific space. Having a group of individuals who are open to new ideas, keen to collaborate and work together is critical. We use our great product design team as a cross-functional team to great impact. To illustrate the point, a team of 12 can include product managers, developers, a marketing communications manager, strategy, designers, a sales lead, a researcher and a business analyst.*

SEEK

Laing O'Rourke was founded by two brothers who, as owners, continue to stay heavily involved in this worldwide construction business. They motivate the company's leaders to challenge and disrupt in the construction industry, which they believe is still very old-fashioned in its methods in design and construction. Innovation is supported by the mix of skills around the firm's financial systems, business processes, design, and lessons learned about the potential applications of new technologies.

#### Box 4.26: Founder values—The Engineering Excellence Group at Laing O'Rourke

In 2011, Laing O'Rourke initiated a new division, the Engineering Excellence Group (EEG), to lead innovation in its disciplines of heavy civil, structural, mechanical, process and electrical engineering. The EEG has launched a broad range of innovations including augmented reality technology for interaction with virtual site models, 3D printing to improve prototype design, and remote workers monitoring devices which are now used on construction sites around the world.

Laing O'Rourke's global perspective and diversity of culture and thought is also visible in the people employed at the EEG. Although the group only consists of 14 permanent staff in Australia, there are as many university interns contracted to work on different projects, largely focused on disruptive innovation. The EEG is also engaged in internal development and training of both graduates and executives, mainly for spreading knowledge about new technologies and approaches relevant to their business.

To sustain its cutting edge status, Laing O'Rourke invests heavily in research and development activities, both internally and through collaborations and partnerships with universities, funded with several million dollars annually. Research has included wireless distributed sensors in system commissioning (with Imperial College London), phase-change materials for energy storage in buildings (with the University of Oxford) and fibre-optics in tunnelling and deep excavations (with the University of Cambridge).

Founders' views about the links between physical space, skills and innovation are also important. Animal Logic puts considerable effort into the design of its physical spaces, using an extremely modular form of office layout to connect people with different skill sets. Its use of space and technology, combined with business savvy, are critical for its success.

#### Box 4.27: Founder values—striking a balance

*We're always doing the balancing act between technology, creativity, and commerce. You can be making a lot of money for a short period of time but if you're not breaking new ground you'll be overtaken by the competition. It's finding a balance of investing in the future, surviving on the day, but also always breaking new ground.*

Animal Logic

There are similarities here with the views of Marek Kowalkiewicz, the PWC Chair of Digital Economy at QUT, who insists on the need to balance 'desirability, feasibility and viability'.

#### Summary 4.4.3: Founder values

**The role of founders in particular and the senior executives in general is vital. Broad, diverse experience and being open to change are centrally important.**

**Founders have often been involved in virtually all of the organisation's at least initial operations at some point in time.**

**Where necessary, innovative enterprises invest heavily in research and development activities, both internally and through collaborations and partnerships with universities, with a continuous balancing act between technology, creativity and commerce.**

#### 4.4.4 Building knowledge and skills to support the full range of firm products and services

As mentioned previously, in the smaller innovation enterprises in particular, employees are more likely to develop knowledge and skills across a variety of other fields, beyond their technical specialisations. This knowledge often relates to understanding the markets the firm operates in, while the skills are more to do with leading teams, building networks, and general business and finance skills. The AiGroup emphasises the growth in 'applied STEM skills', where a mix of technical basis and business skills is now required for successful operations in many manufacturing markets.

NOJA Power, for instance, expects all staff to develop knowledge of its full range of products and changing market needs, so that irrespective of discipline training they can assist in developing new products and specifications. There is a similar expectation at Keech where the focus is on all staff developing an understanding of markets and competition. The firm has developed the role of 'product engineers', rather than marketing specialists, to propose new products, identify new markets and look for opportunities to expand existing markets. Cochlear has established 'global launch teams' that bring new products to market. These teams have representations from the regions, the markets in targeted countries, the regulators and marketing. Together, the teams work through core issues around the scope and product features for new markets. Like Cochlear, Laing O'Rourke operates globally and uses the wide range of disciplines in the firm to its advantage, to generate new ideas that might be taken up in its innovation program.

#### Box 4.28: Market and business knowledge—supporting innovation across the firm

*The innovation program we've designed is deployed across the entire business for anyone in any function. It could be the finance team, the treasury, the commercial managers. Any of those could have ideas and we have mechanisms for collating those ideas, sorting them, ranking them, resourcing them and getting them deployed.*

Laing O'Rourke

#### Summary 4.4.4: Market and business knowledge

**Innovative organisations highly value employee skills beyond technical specialisations. In particular, an understanding of markets and competition is often regarded as essential to understand the organisation's offerings in context.**

**Together, the different disciplinary components of global launch teams work through the core issues around the scope and product features for new markets.**

## 4.4.5 Innovation, lean management and skills

Lean management promotes running an organisation on the principles of continuous improvement, and adopting a long-term approach to achieve incremental changes in processes to improve efficiency and quality. Lean is centred on making obvious what adds value by reducing everything else, including waste. It also has implications for the technical and non-technical skill sets of employees and teams.

Nearly all of the firms in these case studies apply lean principles to manage waste and free up time and very limited resources for innovation tasks (e.g. thinking about new products/service or new ways of doing things). Keech, for instance, used lean principles to first 'clean up' its basic business and production processes before embarking on innovation.

### Box 4.29: Lean management—'cleaning-up' to free resources for innovation tasks

*Building skills in process innovations, such as lean processes, the systematic reduction of error rates in production was the first step to becoming more innovative. Once the processes were cleared up, there was more room for product innovation. We implemented manuals and routines and around working processes, products and problems which meant documenting every product and production process to the infinite—we took photos, produced step-by-step guides on how we make everything.*

Keech

During Fibrotech's start-up phase, all operations were run on the lean approach due to the lack of volume in funding. Skills not required daily were only bought in when needed. The firm had to make best use of its limited \$7 million investment, which it argues would have been \$25 million to \$30 million for a US company at the same stage of pharmaceutical development.

NOJA Power produces its products using lean and just-in-time principles especially for keeping inventory costs as low as possible. It

also finds that lean thinking requires different skills. NOJA Power has difficulty finding people who understand not only the technical side of a product, but also are on top of world-class production techniques. The company expects their employees to be willing to develop new skills over time, so a desire to be open to learning is fundamental.

As a not-for-profit organisation, Anglicare Victoria has no option but to operate in a lean way. However, for Anglicare Victoria the impact of lean principles is not on systems and processes, but on the organisation's attitudes towards skills and resourcing. Employees need to possess skills across different domains including the ability to be responsive to changes in the environment. It means some skills that are not available internally are sourced from outside.

Cochlear has encountered problems around skills and its focus is on retaining a lean systems culture. Employees need strong technical skills, but also need to understand the non-technical and management side of doing business. While staff are increasingly using more technology, there needs to be effective management of people in these lean systems to complement the engineering improvements. Much of Cochlear's productivity increases are attributed to enhanced skills in the manufacturing and management disciplines, but also through good management principles that increase the engagement of their workforce.

### Summary 4.4.5: Lean management

**Lean management requires different approaches to thinking about skills. Beyond understanding their technical or non-technical specialisation, employees also need to understand organisational and supply chain processes in order to see their actions in context.**

**Employees need to possess skills across different domains including the ability to be responsive to changes in the environment. It means that some skills that are not available internally are sourced from outside.**

#### 4.4.6 Adapting skills to retain competitiveness

These organisations are adapting their skills to sustain and increase their competitive position. Across the case organisations, the transition is from tackling technical challenges at the initial stages, to being totally focused on understanding the value of innovations from the customer perspective today. These firms are thinking about how innovations in their products, services and processes will add value that customers are willing to pay for, and to pay even more than for a competitor's product.

According to the AiGroup, the major implication of more customer-focused innovation is the need for employees to understand customers and be able to apply their technical knowledge in customer terms. The AiGroup argues that the lack of such skills is one reason for the discrepancy between the STEM skills shortage and the high number of STEM graduates not able to find work.

##### Box 4.30: Adapting skills—more application-based skills

*The data suggests that we're turning out fewer students in school in STEM-related subjects and less graduates from STEM-related disciplines in universities. That is a pretty strong, clear story. Having said that, people who graduate with those skills often find it hard to get jobs, so we have got a disjuncture in the labour market. I think one thing we need to do, particularly at the university level, is have a better conversation about the application of STEM skills rather than just developing them for their own sake. The application might then start helping transition some of the labour market issues more effectively.*

AiGroup

The transition by innovation firms to a stronger customer-focus requires different skills sets around building effective alliances, customer focus, relationship marketing, co-creation of products and commercialisation. Fibrotech has adapted its clinical trial design to work with pharmaceutical companies who are prospective clients, to speed up the development process,

decrease costs and facilitate commercialisation once the product is in the final stages of approval. SocietyOne and Envato are striving to develop more customer-focused skills around innovation in their employees. At SocietyOne, employees must think about new products from a customer perspective.

##### Box 4.31: Adapting skills—inquisitiveness

*The best employees, the ones that are likely to come up with an innovative and useful customer-value proposition, are the ones that are inquisitive and intrigued by how things work. 'Why do things work this way, I find it irritable or just strange' or, 'Why couldn't they work some other way? I've already come to some version of a formed hypothesis but it's got to be much better'. They're the ones that you want.*

SocietyOne

Envato thinks in similar ways, using staff who are close to customers to feed ideas into the company. Envato reports that some of its most innovative ideas come from their customers and 'authors'. These 'authors' (effectively suppliers) are very vocal about the value of their ideas to improve the business. Teams collect these ideas and turn them into working products. Envato is also applying features of 'crowdsourcing ideas', which is relatively straightforward for Envato given a business model focused on selling digital content provided by its 40,000 plus 'authors'.

Cochlear's size means that it has a large and strategically-minded HR group actively adapting the skills sets required for innovation in response to changes in customers' needs. Cochlear's HR processes identify gaps in the organisation's capabilities that might limit delivery of its business strategy. It addresses these gaps either through training or buying in those skills through hiring or engaging contractors.

A specific example of this continuous process of aligning a firm's skill sets with the capabilities required in the future is how Cochlear is actively managing skills in its software and connectivity area—the enterprise has recognised changing

customer needs for increased software integration and device interaction with other technological products, including remote controlling of sound levels and ambiance modes. As a set of strategies around people and training, since 2006 the company has invested substantially in its graduate program, while using a highly competitive internship scheme to get initial interaction with future job candidates. On employment, graduates rotate through different areas of the business for 18 months. Other actions include growing the number of staff in marketing and IT to measure changing customer preferences and facilitate contact and feedback from customers, often via the internet at all points of their hearing journey.

**Box 4.32: Adapting skills—taking a customer perspective**

*What we've done was to really define the customer experience. We need to figure out the capabilities needed to support customers at each stage of their hearing journey, including partnering with healthcare professionals to support them. We used to be much more focused on products; now we've got the focus on customers.*

Cochlear

At Woodside, the focus of innovation is on problems that people want to be solved. To achieve this, Woodside reports the need for employees with improved skills and mindsets to think of solutions as they apply to the business

context of their customers. A major change was connecting the firm's technologists with others in the business to give solutions that (internal) customers valued. In the past, few people in the company, other than those in technology, knew what the technology group was working on. Today technology is connected and collaborating internally with other disciplines and with other companies. The business side is now also involved in discussing what the technology group are doing.

Queensland Urban Utilities has gone through similar major structural and cultural changes to deliver innovations valued by its customers. The organisation chose to deliver an economical 'green infrastructure' solution rather than the traditional sewage treatment plant upgrade. One example is its approach to regenerating and rehabilitating two reaches of riverbank to reduce upstream pollution and, in turn, offset treated effluent discharges from a sewage treatment plant. Queensland Urban Utilities restored 500 metres of severely eroded river bank, installed rock revetment to protect against low-flow erosion, and planted over 8,000 trees and shrubs to prevent further sediment runoff into the waterway. This program of activity required the organisation to shift its thinking about solutions to sewage and water issues from a purely technical engineering perspective to a mix of engineering and non-engineering type solutions. Again, this transition required a shift in, and broadening of, the underlying skills and capabilities available in the organisation.

#### Box 4.33: Adapting skills—broader issues need broader skills

CSIRO continues to undergo structural and cultural change to support the development of mindsets to solve 'bigger issues'. The organisation is very conscious about how this shift is changing the skills required to develop according solutions. As CSIRO reports, if the objective is to find an application for an invention and to create a business, it believes that STEM skills plus business skills will work. However, if the challenge is to solve climate change (or other larger societal issues), it needs to bring together a larger and more diverse group of people with skills in technology as well as society, culture, psychology, business etc. who are empowered to collaborate, cooperate and share their knowledge.

#### Summary 4.4.6: Adapting skills

**One necessary concept to successful innovation is to understand what innovation is in the eyes of customers and users of products and services. Innovative organisations are developing skills that help them make sense of customer information and deduce what customers want next.**

**Innovative companies make sure that their innovative efforts, such as technology development or research activity, are well connected with their business experts to avoid developing innovations with limited application potential.**

**Innovative companies practice bringing technical engineering and complex stakeholder-centric thinking together, and actively prepare for future workforce requirements.**

## 4.5 Conclusion

This chapter has drawn extensively on the experience of leading innovative organisations to investigate the links, as these organisations see them, between skills and innovation. At a general level, Animal Logic talks of the essential links between technology, creativity and commerce. Similarly, in an interview, Professor Marek Kowalkiewicz stresses the inseparability of desirability, feasibility and viability.

Successful innovative enterprises approach individual talent as a bundle of skills, never only as narrowly technical in nature. Recruitment practices, along with rewards and retention initiatives, reflect a broader view of skills and skills mixing.

On the level of teams as bundled of complementary skills, innovative organisations reflect third generation innovation thinking by assembling their teams to include a broad diversity of backgrounds, skills and experiences. These organisations also liberally use contractors and partners to access skills that are not available internally.

In addition, innovative organisations focus on integrating their operations in wider networks and clusters, reflecting the concept of networks as bundles of organisations. Connections and collaboration allow ready access to complementary skills and expose these organisations to a more global perspective on innovation. This means that leading innovative organisations have to walk a complex tightrope, balancing multiskilling of individuals and teams with organisational repositioning and restructuring into complex network forms.

# 5

## Findings and implications for enterprise, education and government

### Summary

**Skills shortages for innovation are more nuanced than headline claims suggest, and are more related to 'employability' skills rather than specific disciplinary areas.**

**Diversity in teams and organisations—both in terms of established indicators such as gender, age or ethnicity and in terms of skills and disciplinary backgrounds—is imperative for innovation.**

**Joint and coordinated actions is needed by government, education and industry to address and overcome inhibitors in the Australian innovation system.**



**The overarching findings as well as more detailed findings related to the individual, team and organisational and systems level are presented along with implications for industry, education, training and research, and for government and policy.**

**The constant theme in the findings and implications is the potential to broaden yet complement the current policy focus on science and technology, enabling a more holistic approach to tackling Australia's innovation challenges that teams humanities, arts and social sciences (HASS)-based skills with science, technology, engineering and mathematics (STEM)-based skills.**

## 5.1 Introduction

This chapter brings together the findings from previous chapters and the voices of policy, industry and education analysts on practical ways to improve Australia's focus on technical and non-technical skills mixing to meet the country's innovation challenges. It draws on evidence from statistical analyses, national and international studies and case interviews with leading innovative enterprises as described in the previous chapters, as well as on international and national good practice and policies.

In addition to the project team undertaking a review of developments in innovation policies in other countries, John Howard and Associates was commissioned to compile a report outlining issues for government, industry and education/research institutions in addressing skills challenges for innovation. This report draws on a review of international evidence, as well as insights gathered from industry representatives and experts in the area of innovation systems and innovation policy. A total of 34 interviews involving 37 people, were undertaken. See the *Evidence gathering* section of this report for a list of interviewees. The full report is available on Australian Council of Learned Academies (ACOLA) Securing Australia's Future website<sup>1</sup>.

The evidence drawn from these sources, together with the project's Expert Working Group input, forms the basis for the findings and implications for enterprise, education/research/training, and government. Importantly, the analysis emphasises that building both the technical and non-technical skills requirements for an innovation economy can best be achieved through actions taken jointly by enterprise, education and government. Moreover, simultaneous attention is needed on skills development and skills bundling at the individual ('individuals as bundles of skills'), team and organisation ('teams/organisations as bundles of people with complementary skills'), and system levels ('networks as bundles of organisations').

For each finding, implications are outlined for skills, and suggestions provided about how these issues could be addressed through actions taken by government, industry and education and research institutions.

## 5.2 Critical issues in relation to skills at the individual, team and systems level

Chapter 4 presents case study information from a number of highly innovative firms. Across these cases there is considerable agreement about the issues that need to be tackled. These organisations largely operate within the framework of third generation innovation thinking, as outlined in Chapter 3. The views of these organisations also resonate with feedback from industry leaders who were interviewed as part of the policy review conducted for this project, by John Howard and Associates and by the Expert Working Group project team. Indeed, most innovation leaders are thinking in 'systems' and 'ecological' terms already, or are well on the way. Rather, the issues relate mostly to implementing and applying this type of thinking effectively and broadly throughout organisations, education systems and government.

### 5.2.1 Issues on the individual level

Looking at the skills embedded in and required by individuals, the major issues related to matters of skills shortages and lack of, or inappropriate, training. Many of the organisations, industry representatives and experts interviewed indicate that skills required for innovation (especially STEM and 'digital' skills) are in short supply. More importantly, most interviewees felt that skills and training did not extend sufficiently beyond STEM to meet the needs of innovation in a rapidly changing world. Specifically, this relates to 'employability' skills in graduates, which are not discipline-specific but relate to skills picked up through exposure to a work environment. This theme also resonates with the international evidence.

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1. <[www.acola.org.au/index.php/projects/securing-australia-s-future/capabilities-for-australian-enterprise-innovation](http://www.acola.org.au/index.php/projects/securing-australia-s-future/capabilities-for-australian-enterprise-innovation)>

The issue of skills shortages is particularly interesting. Reports produced by consultants and policy makers, both in Australia and internationally, suggest significant STEM skills shortages, as noted above, particularly in the digital technology area. For example, the *Australian Digital Skills and Salary Survey* reported in April 2015 that around one-quarter of all Australian businesses have difficulty sourcing adequate supplies of 'digital employees' (Chief Scientist 2013). A recent survey of 150 small to large Australian businesses reveals that 70 per cent agree that the digital skills gap is taking a moderate or heavy toll on their business (Slade Group 2015). Similarly, a 2014 survey by the AiGroup found that almost 44 per cent of employers continue to experience difficulties recruiting STEM qualified technicians and trade workers. The main barriers are a lack of qualifications relevant to the business (36 per cent) and a lack of employability (softer skills and workplace experience (34 per cent) (AiGroup 2015a). This finding is also reported in prior Securing Australia's Future (SAF) reports, in particular SAF 4, *The role of science, research and technology in lifting Australian productivity* and SAF 5, *Technology and Australia's Future: New technologies and their role in our security, cultural, democratic, social and economic systems*.

Other reports, however, have pointed out that while many applicants have these technical and functional (STEM) skills, graduates still cannot find jobs (Norton 2016). This is also the view of many of the case study interviewees. These interviewees typically indicate that the challenge was less about a shortage of technical skills in general, but more to do with a lack of candidates in highly specialised areas, such as advanced computer science, software engineering or data analytics. The perception of a skills shortage is based more on shortcomings, particularly in graduates, in the 'softer' skills required in the workplace and the absence of other non-technical skills.

Almost unanimously, interviewees with business backgrounds referred to the need for basic skills (literacy and numeracy), 'employability'

(communication, teamwork, problem solving, initiative, self-management, and willingness to learn), and an understanding of the nature of business (business and entrepreneurial acumen). Also, given the potentially rapid redundancy of particular specialised skills in digital and programming, many organisations commented that they are less interested in employing people based on their high level technical skills, but are more concerned with applicants' willingness and ability to learn and adapt to changing circumstances.

The matter of shortages of skills for innovation is far more nuanced than headline claims might suggest. Clearly, however, there are implications for the way that organisations source skills, their expectations of 'employability' and their willingness to invest in training and development. There are related implications for how tertiary education needs to embrace changes in skills demand to better prepare graduates for their future in a rapidly changing work environment.

## 5.2.2 Issues on the team and organisational level

As complex knowledge across multiple technical and non-technical areas becomes more integral to innovation, the skills mix—at the work team level and more broadly at the organisation level—is more critical to the process of innovation. Different types of skills and different bundles of skills are required for teams involved in different stages of the innovation process. Moreover, this relates to the skills available both within and outside the organisation for innovation activities. It also relates to skills required to manage and lead in the diverse and complex team environments required for innovation to occur. A recent report by Deloitte (2016) which surveyed more than 7,000 executives in 130 countries, suggests that the use of teams has reached a new high. More than half of the executives stated that their organisations were in the middle of, or about to embark on, restructuring—which for the most part meant putting more emphasis on teams.

These teams are gaining authority to run their own affairs and spending more time working within and across multiple teams rather than reporting upwards. This, according to Deloitte, marks the rise of new organisational forms where a network of teams is replacing conventional hierarchies—the beginnings of which are described in Chapters 3 and 4. However, the Deloitte report also states that only 12 per cent of the surveyed executives feel they understand the way people work together in networks and only 21 per cent feel confident in their ability to build cross-functional teams. This emphasises the importance of leadership and team management skills, as outlined in Chapter 4.

Cross-functionality and diversity within teams is well established in the management and organisational literatures as an input for creating innovative teams (see for example Hülshager, Anderson and Salgado (2009)). It is important that diversity refers to both established indicators, such as gender, sexual identity, age, ethnicity, race and culture, as well as indicators of 'skills diversity', which include skills based on disciplinary backgrounds, value orientations, a 'problem-opportunity' (or 'reactive-active') focus and other sources of cognitive differences that generate diverse capacities to address common issues.

Diversity, however, is a two-edged sword: it generates diversity of ideas, but also potentially creates conflict within teams and organisations. To be an effective driver of innovation, diversity therefore needs effective HR management. The case study organisations reported in Chapter 4 demonstrated this principle across a wide range of organisational settings. These organisations recognise the critical role that strategic HR systems and practices play in supporting and sustaining innovation. A high performing HR system drives recruiting and retaining the 'best and brightest', the ongoing professional development and training of individuals, setting benchmarks and managing performance, and the continued re-aligning of internal practices to meet changes in the expectations of external markets.

As well as developing and integrating skills mixes within the organisation, innovative organisations typically access skills externally, through their collaboration and partnerships. This finding is corroborated across the case study organisations, the industry interviews and many international studies. Innes Willox, Chief executive of AiGroup, for instance, suggests that, generally, Australian firms have not been successful at being innovative. In his view:

*The businesses that have done well tend to be the foreign owned companies, who take their experience from overseas and imbed it in the Australian context. They readily go out to find partners and look to take the next steps and the advances. Part of the reason is that they operate in international competition which creates a competitive culture within their business framework. Accordingly, they are much quicker to address innovation, much more ready and able to do it.*

AiGroup

This view is in part supported by the study commissioned to Swinburne University of Technology for this report, which is summarised in Chapter 2. However, as that study suggests, the path to higher and more sustainable levels of innovation may require interventions that create not only a stronger ecosystem to support a culture of innovation but also interventions that enable Australian enterprises to overcome a number of different barriers to being innovative.

### 5.2.3 Issues on the systems level

Innovation leaders interviewed for this project frequently commented about a general lack of an innovation and collaborative culture in Australian enterprise. Even among the organisations that do innovate, innovation is related more to adopting and modifying rather than being the original source of the innovative idea or product. Across most industry sectors in Australia, and specifically in manufacturing, organisations are preoccupied with low value-add activities. It has been argued for many years that Australia must move away from its commodity approach to industrial

development and towards a higher 'value added' strategy. Australia's economic complexity has declined over the last 25 years. In 2012 Australia ranked 53 among all countries (Roos 2015). The top three were Japan, Switzerland and Sweden, countries with a very low natural resource base.

The Advanced Manufacturing Industry Growth Centre points out that for some time the value generated by 'making things', or production, has been recognised a decreasing source of value for organisations, and the economy. The higher order sources of value are in research and new product development and in the sales, marketing and branding, packaging and distribution and other services areas. The production component is often outsourced to domestic contract manufacturers or overseas.<sup>2</sup> Moreover, the processes are becoming increasingly complex, calling for a wide range of skills and capabilities, or skills mix, across different organisations.

There is a view that Australia needs to achieve a much higher level of complexity to lift productivity growth. Leading technologist and businessman Göran Roos, for instance, points out that 'countries with high economic complexity have a highly diverse portfolio of firms all producing and exporting offerings few other nations are able to produce. These offerings require *a multitude* of capabilities (Roos 2015). Extending complexity in manufacturing creates growth opportunities across the broad industrial base.

In turn, this multitude of capabilities calls for a broad 'skills mix'. This skills mix adds value on the supply side by including more knowledge-based inputs, and adds value on the demand side by understanding and responding to growth and shifts in end user needs, changing preferences, and expectations of service content—in keeping with third generation innovation approaches.

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<sup>2</sup> For example, large companies specialising in preparing tax returns on a high volume basis contract with overseas accountants to prepare the returns. Established suburban and regionally based accountants can only compete by offering more value added and personalised services, requiring a broader mix of skills.

The wine industry is one sector that has achieved success through this 'value added' approach. However, the value-added argument also applies in food, composite and fibre materials, and products that originate from minerals. One step in this direction is the Industry Growth Centres Initiative (Department of Industry, Innovation and Science 2016). Andrew Stevens, Chair of the Advanced Manufacturing Growth Centre, for instance, indicated its focus on:

- improving engagement with international markets and access to (almost universally digital) global supply chains
- improving managerial and workplace skills
- increasing engagement between research and industry, and within industry, to achieve commercialisation outcomes
- removing unnecessary and over burdensome regulations.

This systems perspective is identified as an integral part of third generation innovation approaches. Across all interviews there is a clear demand for system-wide thinking and a need to break down silos within and between industry, government and higher education. Strategic collaborations rather than short-term, profit-driven considerations are needed.

Some of these issues have specific implications that are more relevant for the way organisations are managing training, and for the content of education programs. Yet, in line with third generation thinking, government is seen as the system-wide connector and facilitator for collaboration and innovation, whose role is to facilitate 'flow' among the 'stock', or institutions, in the innovation system. The next section briefly outlines a broad rationale for actors, whether government, industry or education/research, to invest in skills that support innovation, and broad public policy options that may flow from these rationale.

### 5.3 Broad policy options

First, there is a need to briefly frame a rationale for the consideration of policy options, focusing on the conditions that go to developing skills for innovation. Innovation may suffer from a lack of strategy and investment. This reflects a range of market and system-level imperfections. In turn, these produce a lack of investment in R&D, lack of collaboration among and across actors in the industry, lack of investment in human knowledge and skills, information asymmetries, and lack of awareness about technological developments or lack of demand for innovations.

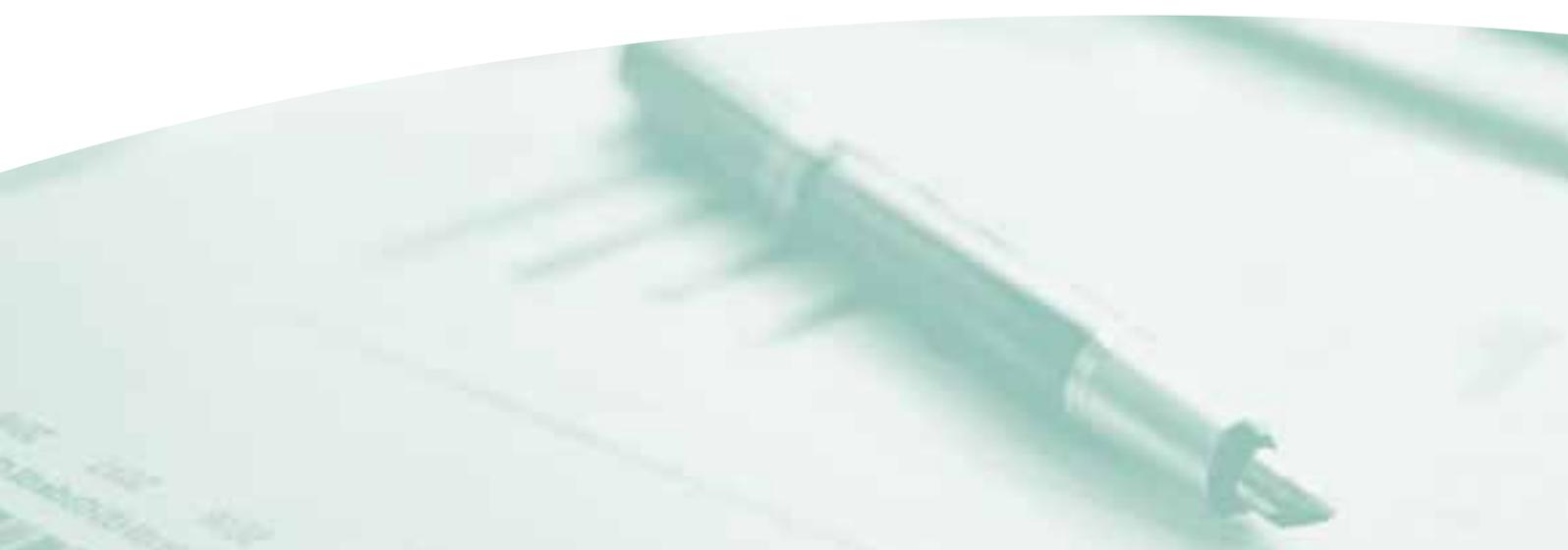
Human capital theory assumes that innovation is, in part, determined by the knowledge, skills, competences and experiences of individuals. Despite this, individuals and firms tend to under invest in skills and training because the returns are not necessarily captured by those who make the investments. For example, employees may leave firms and render the received training irrelevant for the firm or indeed provide a competitive advantage for rival firms. Or the quality of training provided may not be effective given the firm's objectives.

Policy initiatives can be designed to create incentives for investment in skills and training and the development of higher-skilled employees. This may also include creating incentives for skilled migrants to enter the workforce.

In addition, innovation suffers from significant information asymmetry. Lack of awareness, information and resources further contributes to barriers, especially for entrepreneurs to form businesses. Beyond providing means for funding, including through the formation of favourable conditions for venture capital, there is a need for effective policy strategy to maximise access to expertise and advice for actors in the innovation system.

In order to know which instruments to apply, it is necessary to know the causes of the problems in the innovation system. This depends on the activities performed in an innovation system. These activities are divided into four groups, many of which focus specifically on the skills for innovation:

- The provision of knowledge to the innovation system through the provision of R&D results for the creation of new knowledge, and competence building through the provision of education and training of the current and future labour force and through organisational learning.
- Demand-side activities including the formation of new markets, or the articulation of quality requirements for products/processes.



- The provision of constituents through creating and changing organisations (e.g. research organisations) to develop certain fields of innovation, networking (i.e. integrating new knowledge elements developed in different fields with elements already available to innovating organisations), and creating and changing institutions that influence innovation processes by providing incentives or removing obstacles to innovation (e.g. patent and tax laws, environmental and safety regulations).
- Support services for innovating organisations such as incubation activities which provide access to facilities or administrative support for innovators, and financing innovation processes or activities that facilitate commercialisation and adoption of knowledge, or provision of consultancy services (e.g. technology transfers or legal advice).
- improving access to expertise, e.g. through measure for exploiting intellectual property, support of entrepreneurship policy, or technology advisory services
- generating and exploiting connections and complementarities, e.g. through programs to support collaboration or providing investment in or incentives for network and cluster formation
- improving and increasing demand for innovation, e.g. through supporting private demand for innovation, or public innovation procurement
- improving framework conditions, e.g. through regulation and standardisation that favours innovative activity
- facilitating exchange and dialogue about innovation, e.g. through publicising results of foresight and scenario analyses.

Based on these activities, policy can use a number of options to influence innovative activity. The National Endowment for Science, Technology and the Arts (Edler, Cunningham, Gök and Shapira 2013) suggests that the major goals for innovation policy are:

- increasing input for innovation and R&D, e.g. through direct substitution, tax incentives, profit contingent loans and/or venture capital schemes
- improving and increasing the supply of skill, e.g. through skills development in education and training, or skilled international migration

In Australia, the newly established authority, Innovation and Science Australia (ISA), will play an important role in improving 'flow' in the system. It will provide strategic whole-of government advice to government on all science, research and innovation matters. In particular ISA is charged with advocating reforms on matters such as:

- innovation investment
- innovation collaboration and skills
- delivering and operating research infrastructure
- better planning and use of Australia's investment in research and development.

The following findings are placed into these broad contexts, as outlined in the previous chapters.

## 5.4 Overarching findings and implications for enterprise, education and government

### Finding 1

**Innovation policy-makers, industry leaders, and innovative organisations increasingly recognise the complex ecosystem required to support enterprise-level investment in skills and innovation.**

This theme was a pervasive element associated with the empirical findings based on Australian data reported in Chapter 2, the international evidence reported in Chapter 3, and the case study evidence presented in Chapter 4.

Innovative organisations are not islands of innovation activity, but are embedded within a larger ecosystem of co-dependence. Innovation clusters and networks are critical, in that they contribute to creating a culture of innovation, increase competitive pressures to be innovative and provide many of the necessary resources and skills required to become innovative in co-location.

As one of the important features of third generation innovation thinking, this project found that highly innovative enterprises extensively mix technical and non-technical skills. These enterprises recognise the necessity for mixing skills based on STEM and HASS discipline knowledge do so to a markedly greater extent than this practice is understood and executed in education and research institutions and policy practice. Both education and government policy processes tend to work within disciplinary and portfolio boundaries, as exemplified by the lack of research on skills mixing in the academic business literature. Educationists claim the 'crowded curricula' allows little space for spanning boundaries or higher-order integration of skills, and there is a strong and in some respects exclusive STEM focus in innovation policy formulation.

Australia's myriad businesses, public and not-for-profit enterprises, government departments, and education, training and research institutions

make up the 'stock' of its innovation system. But there can be no dynamism in the system without 'flow'. 'The essential criterion for innovation policy is the extent to which it encourages and facilitates the flow of ideas across the economy and within national innovation systems and enhances the chance of them being successfully combined together and implemented' (Dodgson and Gann 2010, p. 72).

In this context, governments cannot rely on traditional policy instruments to create ecosystems, but must assume a broader role as facilitators, connectors and enablers of the system-level collaborations that are required for innovation. Government's primary role should be to facilitate collaboration and cooperation for innovation to provide conditions and support that encourage enterprise and education to mix and use skills beyond their organisational and sectoral boundaries.

### Implications

*Government, industry, and education and research institutions can tackle Australia's innovation challenges by adopting holistic system-level approaches to innovation policy settings.*

*This involves integrating and aligning policy responses designed to influence investments in skills and capabilities for innovation, at the individual, enterprise and system level. There is a crucial role for Innovation Science Australia to refine and target Australia's performance in skills mixing for innovation.*

### Finding 2

**By international standards Australia has an average track-record of innovation, reflecting issues across all levels of the innovation ecosystem. In particular, Australia could more effectively turn innovation inputs, such as investments in human capital and research, into knowledge and technology innovation outputs.**

The international comparative measures of innovation activity demonstrate that Australia has a good track record of developing a range of 'inputs' into innovation systems, and innovation activity at the organisation level.

This is evident from the Global Innovation Index (GII), in which Australia scores highly on most accounts. However, some gaps in the quality of these inputs are evident: Australia scores low on business sophistication (23<sup>rd</sup>) and even lower on basic education (32<sup>nd</sup>) which, in turn, adversely influence innovation outputs, especially knowledge and technological outputs (39<sup>th</sup>). The GI scores suggest that at the *organisational* level, many Australian organisations do not have the requisite management skills to turn knowledge inputs into innovation outputs. Reports have consistently pointed to shortcomings in management capacity in Australia (ACOLA and PWC 2014). At the *system level* there is also a distinct absence of innovation linkages in the form of collaboration across firms, government and education/research institutions. This is also associated with a lack of 'knowledge absorption' from international best practice, a sub-optimal level of knowledge diffusion across firms or investment in the intangible organisational capabilities required for innovation.

This general outcome is in marked contrast to the experience reported among highly innovative organisations interviewed for this project. These organisations overcome obstacles to innovation through activities designed to improve their recruitment of appropriate skills. They focus on broad skills rather than single discipline knowledge, invest in developing technical and other skills internally, but also access skills and information related to innovation through their networks. Markedly, almost all of these innovative organisations are embedded in global supply chains and clusters that enabled growth to support innovation.

### Implications

*Government, industry, and education and research institutions can more efficiently turn innovation inputs into outputs.*

*While the Industry Growth Centre initiative has prompted some changes to research and commercialisation in specific industries, further incentives could increase collaboration for innovation, dissemination of outcomes, and*

*the general external focus of organisations. A National Innovation and Science Agenda initiative, Australia's Global Innovation Strategy, will promote links with leading international bodies. Future innovation policy could place a heightened focus on collaboration in general, with higher-order skills integration for innovation built into this collaboration model.*

### Finding 3

**Highly innovative organisations are embedded within strong innovation ecosystems that enable access to skills bundles. As well as internal skills development, they use external labour markets, and collaborative relationships with other organisations and networks.**

The innovative organisations interviewed for Chapter 4 report a strong focus on acquiring and developing the skills they need for being innovative. Some organisations bank on early recruitment of 'best of the best' candidates, others strive for innovation by using multi-disciplinary and diverse team setups, and others provide structured creativity training for their employees. These organisations also seek employees with the right 'fit'. This goes beyond defining their mission and values statements, to include how work is organised (often focusing on flexibility and autonomy), the nature of their incentive structures, clear career pathways, and providing seminars, training and other knowledge opportunities for sharing knowledge internally or externally. Where the required skills are not available internally, or are only required temporarily, these organisations readily use contractors and their relationships with other firms, suppliers and others to achieve their goals. These practices are particularly relevant for smaller organisations with potentially limited resources to attract and retain talent.

Aside from providing access to skills and knowledge when needed, their outward orientation also provides exposure to other innovative organisations. This external focus aids the adoption and diffusion of innovative practices and contributes to a general culture of innovation in these firms.

## Implications

*Government, industry, and education and research institutions can support innovation by encouraging the formation and integration of networks and clusters.*

*This includes government investment in regional infrastructure (e.g. business parks) and co-location with universities and research institutions. While tax incentives to locate in specific regions can accelerate cluster formation, it is also important that this proximity of complementary enterprises provides sufficient long-term benefits. The Industry Growth Centres are a ready mechanism to support such developments. This model could be extended beyond the current five centres, after a review of their effectiveness.*

### Finding 4

**Highly innovative organisations develop employees with broad knowledge bases and strong integrative skills (beyond a single discipline). The bundles of required skills vary across the innovation cycle and include technical skills (science, technology, engineering, mathematical, digital) and non-technical business skills (business, management, financial, marketing) as well as creativity, design, interpersonal and entrepreneurial skills. Highly innovative organisations use sophisticated recruitment and retention practices, internal training and development, incentive systems, strong cultures and engagement. They typically take a long-term approach to investing in and building skills bundles that support their innovation strategy.**

Analyses of Australian data reported in Chapter 2 show how different types of skills are associated with different types of innovation. Specifically, engineering, scientific and IT skills are significantly related to product and process innovation, while business and marketing skills are more related to process, organisational and marketing innovation. It is not surprising that the skills required for research and development, in most sectors, differ largely from those required to commercialise new products or services. To be a successful innovator, organisations require a sufficient mix of these skills. Chapter 3 provides more detailed lists of skills bundles required for

innovation activities, based on the international literature as well as interviews with experts. These bundles encompass a wide variety of skills, including technical and non-technical skills as well as integrative, entrepreneurial, design and digital skills.

These findings regarding skills are corroborated in the case study evidence presented in Chapter 4, where highly innovative organisations were asked about the skills expectations and requirements to sustain their innovation activities. Interviewees were outspoken about the need to develop employees with broad knowledge bases and strong integrative ('beyond discipline') skills. Skills and skills mixing requirements for individuals and teams also vary across the lifetime of organisations. Particularly in start-ups, individual leaders need broad skills, while additional variety around skills is often achieved through contractors. Larger organisations can invest more in specialised individuals and achieve a skills mix through specifically assembled teams.

The commissioned research for this project (Howard 2016) highlights a need for more focus on design skills. Prominent business entrepreneur Glenn Keys emphasises that design is 'possibly even more important' than skills relating to IT and manufacturing needs (for example, with 3D about to revolutionise 'how you buy stuff from shops'). He says design is a critical feature which 'we have no concept of, or even value, in the innovation skills mix around service delivery'.

These skills requirements set expectations not only for the design of undergraduate and postgraduate curricula, but also where companies need to invest in training and development, and what government needs to consider in designing frameworks for national strategies around skills development.

Also relevant is the fact that innovation and related activities are characterised by a high degree of uncertainty. Investments that contribute to innovation often do not pay off immediately, but require a long-term approach. Contrary to this, shareholder and business expectations drive many organisations to value short-term profits over long-term sustainability and reinvestment. To sustain innovation,

organisations need to take steps to balance these competing demands and time horizons.

Many of the organisations interviewed actively shielded their business from profit-driven short-termism. Laing O'Rourke, for instance, remains privately owned and its two owners drive much of the firm's innovative behaviour. At SEEK, the founder-CEO steers the board towards more long-term thinking. A number of the start-up enterprises such as Envato report a willingness to sustain a slower growth trajectory than might otherwise be possible, to protect the business from the pressures of a short-term view.

As these observations suggest, a longer-term orientation not only relates to capital investment in innovation, but also to the investment in skills. While the ways to reach it are diverse, the goal is to build and develop the broad skills base that is required for sustained innovative performance.

### Implications

*Government, industry, and education and research institutions can assist individuals, organisations and the innovation system to build a broad base of skills and update these skills over the lifetimes of individuals and organisations.*

*This strategy may include broader learning opportunities throughout more well-defined educational pathways for individuals, as well as assisting organisations to provide training (on and off the job) to encourage the development of broad skills bases among their employees.*

*There are also opportunities for government, industry and education and research institutions to foster and promote longer-term approaches to innovation success.*

*The National Innovation and Science Agenda recognises the need for tolerating failure in entrepreneurial activities. This attitude is also necessary to support innovation in general.*

*Organisations can take more responsibility for developing the skills required for innovation. However, policy changes may also be required to sustain these efforts, such as grants for R&D (which can be based on specific requirements, e.g. collaborative innovation).*



## 5.5 Findings and implications related to individual skills mixing

### Finding 5

**Innovative organisations require individuals with a range of skill sets beyond technical skills and who are willing to adopt a life-long learning approach to acquiring new skills.**

As the empirical results in Chapter 2 show, different skills are relevant for different types of innovation and for different phases of the innovation process. This is not only the case for the different skills required for inventing and commercialising a new product or service—tasks likely to be completed by different teams or individuals—but is also relevant for the skills embodied in individual employees. As revealed in the list of skills for innovation in Chapter 2, and the recruitment and development practices of innovative organisations discussed in Chapter 4, individuals need to broaden their skills basis beyond their disciplinary specialisation. This is particularly relevant at the intersection of technology and business, and also applies to employability and general work skills, and the notion of bringing skills from different fields together for innovation.

As part of their focus on ‘beyond disciplinary’ skills innovative organisations expose their employees to considerable training and seminars, encourage self-directed learning and other forms of continuous development. Especially in areas where skills are outdated very quickly, organisations focus on learning abilities and more fundamental skills. Organisations, as well as individuals, can no longer expect their formal education to provide a sufficient skills basis for the rest of their working lives. However, these developments not only call on individuals and organisations to direct skills development, they also require universities and other teaching institutions to teach more broadly across disciplines and focus on teaching transferable skills alongside specialist knowledge.

### Box 5.1: Example—Innovation and Business Skills Council

Patricia Neden from the Innovation and Business Skills Australia refers to ‘soft skills’ as covering leadership, entrepreneurship, and developing innovation. She says employers, almost universally, and particularly when they are talking about recruiting higher-level employees, would rather have someone with those skills than the technical skills for the job. Employers view having the right mindset as more important than having a high level of sophistication in technical skills—the right mindset meaning someone who has the capacity to demonstrate leadership, proactivity, creativity and the capacity to embrace innovation.

These particular skills requirements relate more to senior level employees than entry level positions, for which employers emphasise the skills that make graduates ‘ready to go’. Yet, even for a reasonably junior level, employers are emphasising the importance of ‘soft skills’ over technical skills. If the soft skills are there, the technical skills can be taught quite easily.

This change has occurred as technical skills requirements are changing so quickly. A person may have highly developed skills today which are out of date in two years’ time. But if a person has a mindset that exhibits a hunger for learning, an ability to be flexible and agile, and a willingness to take on new things, then as Patricia Neden asserts, ‘you are across the new technical skills without even noticing the change’. If a person does not have those soft skills and technology changes, the employer and the employee often find it very difficult because the employee does not change.

### Implications

*Joint action from government, industry, and education and research institutions can enable individuals to acquire and continue to develop a more holistic and integrated profile of diverse skills.*

*These skills profiles will typically involve integration of:*

- expert skills, based on disciplinary background
- work or ‘employability’ skills, such as communication, teamwork, planning and organisational skills
- problem solving and higher-order integration skills
- skills that enable theoretical knowledge to be translated or applied to practice.

*In particular, education institutions can extend the:*

- *creation of articulation pathways between vocational education and training (VET) and university-level programs*
- *introduction of WIL as part of undergraduate and graduate programs across disciplines, including internships and practicums, and applied or translational PhD programs*
- *integration of innovation skills into technical disciplines delivered at the VET, undergraduate and graduate program levels, such as design thinking and digital literacy, collaboration and teamwork, and problem solving.*

### **Box 5.2: Example—Melbourne Business Practicum**

One frequently discussed model is the Melbourne Business Practicum (University of Melbourne). Students receive preparation and mentoring through both academic supervision and an industry mentor towards solving a business problem for their partner organisation. In the final two weeks of the practicum, the student team is located with the organisation to work on their problem and, at the end, present a solution. Reports and presentations are graded and flow into the students' degrees. The program is available to graduate students who have completed a minimum number of points in their degree and have completed foundational business subjects or previous experience. The program is generally very well received by both students and partner firms. Students are exposed to organisational practices, while partner firms receive a low-cost solution to an issue relevant to their business.

*Many of these initiatives place some responsibility on enterprises to participate more actively in skills development through:*

- *identifying opportunities for WIL, internships and graduate programs that enable 'hands on' development of work-related skills in industry organisations*
- *contributing to curriculum development where programs seek to develop employability or other work-related skills*

- *signalling the importance of broad-based innovation skills in recruitment and selection, career development and incentive structures.*

*The diffusion of such initiatives may require policy initiatives by government to encourage or direct industry and education/research institutions to change their practices, including reforms related to:*

- *extending existing institutional arrangements designed to support dialogue and collaboration between government, industry and education/research institutions*
- *providing tax and other incentives for organisations to invest in skills and to participate in WIL*
- *formulating new skills frameworks that recognise holistic and integrated skills needs within traditional trades and disciplines*
- *creating new pathways and incentives that encourage individuals to develop more diverse bundles of skills (for example, combining a VET certificate with an undergraduate program)*
- *employment regulation supporting the use of internships as part of formal training programs promoting skills for innovation in school curricula, to integrate an emphasis on entrepreneurship and coding, for example, into more holistic skill sets—the National Innovation and Science Agenda initiative, 'Talent and Skills—Best and Brightest', could be broadened to embrace integrative skills for innovation*
- *SMEs may require assistance to set up graduate programs, for example, through pooling across organisations as is done in some apprenticeship degrees.*

### **Finding 6**

**Highly innovative organisation overcome significant barriers to innovation through strengthening management and leadership capabilities.**

Skills requirements for innovation relate as much to the capacity of management and leaders as to the employees directly involved

in innovation activities. Over the course of the last two decades, a consistent finding from a number of government and industry reports is that many Australian business organisations do not have the managerial talent required to meet critical innovation challenges. This theme goes back to the Karpin report of the mid 1990s, through to the *Management Matters* report produced by Green (2009). This latter report shows that compared with similar businesses in other countries, fewer Australian businesses have the managerial skills and acumen to support high performance workplaces. Similar findings are reported by the AiGroup in its review of the evidence (AiGroup 2015a) and in a commissioned study for SAF 1 (ACOLA and PWC 2014).

Innovative organisations consciously develop expertise managing and leading their employees through investments in recruitment, setting up and using graduate programs and job rotation, providing internal development or offering appropriately designed jobs and work-life balance initiatives. Many of these practices are found used extensively in the case study organisations discussed in Chapter 4. A related concern is that these leadership and management skills, as well as practices associated with innovation activity, are less evident in SMEs, including entrepreneurial start-ups.

### Implications

*Government, industry, and education and research institutions can enable individuals to acquire and continue to develop high-level management and leadership skills.*

*Managing innovation requires skills in collecting and assessing ideas, presenting and promoting ideas and concepts, leading product/service development and testing and marketing new products and services.*

*Management and leadership skills can be developed through a number of mechanisms, many of which are currently in use, but not necessarily widely accessed or available. Online education platforms provide a low cost means to deliver such programs*

*at scale to widely dispersed groups of organisations and individuals.*

- *A wide variety of benchmarks and diagnostic tools are available for assessing leadership capabilities, such as the Leadershift platform (Centre for Workplace Leadership 2016) funded by the Australian Department of Employment.*

*Industry has a critical responsibility to foster management and leadership capabilities. As well as directly investing in management training, organisations can:*

- *introduce mentorship programs with experienced managers to internally disseminate leadership knowledge and encourage and provide time for self-directed study and development*
- *use secondments across partner/collaborating organisations, for example suppliers or clients can provide new opportunities for new managers to build their domain-specific and management expertise.*

*Education institutions also need to take action in educating the future workforce. There is a need to emphasise broad relational and problem solving skills applicable across all disciplines. For tertiary education, this may require new curriculum developments that build skills mixing, by:*

- *integrating management subjects in non-business degrees, and embedding technical programs in business and arts degrees*
- *providing internship opportunities and practicum subjects within academic programs*
- *creating opportunities to complete more practical certificate-level programs while completing a degree program*
- *organising student projects that span across faculties.*

### Finding 7

**Higher education students can develop a more holistic understanding of the skills required for innovation through greater exposure to enterprise workplaces.**

WIL constitutes one way of building workforce capability with more holistic and higher-order integration skills and entrepreneurial expertise. Chapter 4 contains numerous examples of the importance placed on workplace exposure while studying. Recent research finds that only one in 20 Australian science undergraduates experience WIL placements during the course of their studies, and just over 10 per cent have any sort of industry exposure (Edwards, Perkins, Pearce and Hong 2015). There is evidence that WIL is highly uneven in the undergraduate university experience.

There have been wide-ranging suggestions to increase the exposure of post graduate students to business operations. The former Commercialisation Training Program was highly regarded by students, although science and technology academics had concerns about 'time being spent away from the lab'. Interviewees commented that it should be easier for PhD students to take time out from their Australian Postgraduate Awards and other scholarships to undertake work for industry.

Universities Australia and peak industry organisations have developed a *National Strategy on Work Integrated Learning in University Education* (Universities Australia, ACCI, AiGroup, Business Council of Australia and Australian Collaborative Education Network 2014). There is a strong view that WIL should not only address technical and professional skills, but also workplace/employability skills. From an enterprise perspective, WIL requires a strong resource commitment. Otherwise WIL placements can become just 'work watching'. Highly innovative organisations embrace opportunities to include and exchange knowledge with students at any time of their education through e.g. cadetships, internships and joint PhD projects. WIL is seen to generate exposure to potential future employees, to expose the organisation to new ideas, and to provide an inexpensive way to approach ideas and projects that would otherwise be neglected.

From a whole-of-sector perspective, Universities Australia advocates for the need to work with business peak bodies to significantly scale up WIL. There are a number of disciplines where WIL has been a core business for decades. For example, there is a long history of clinical, teacher, and engineering placements. However, universities report that, with the growth in student numbers, placements are becoming more difficult to find, and are becoming more expensive.

As part of the Colombo Plan, Australia is encouraging the countries receiving students to give them an opportunity for a WIL placement to develop their cultural understanding. Australian international students from those countries will also have an expectation of WIL experiences in Australia to develop their cultural competencies.

### Implications

*More university programs can expose students to a holistic experience, which includes longer-term projects with a range of industry organisations.*

*Universities and industry can work together to develop more extensive and better resourced WIL policies and practices. Such policies need to focus on exposing students to higher-order integration skills and champion those skills as a fundamental feature of successful business enterprise.*

## 5.6 Findings and implications related to team and organisational level skills mixing

### Finding 8

**Innovative organisations need diverse bundles of people, as well as people with diverse bundles of skills.**

Different types of skills drive different types of innovations. This is a consistent finding from the international research and analyses undertaken for this project (discussed in Chapter 2), the

international evidence on the skills requirements connecting different fields of knowledge for innovation reported in Chapter 3, and the case studies and interviews with experts and industry representatives reported in Chapter 4.

The highly innovative organisations discussed in Chapter 4 are, without exception, drawing innovation capacity from actively diversifying the skills, backgrounds, experiences, and cultures in their work teams, and through accessing skills externally by means of collaboration and network integration. These enterprises have also found that innovation is easier to achieve through partnerships, integration and alliances with like-minded partners.

### Implications

*Australia's 'economy in transition' can strive to build a capacity more aligned to '21<sup>st</sup> century' skills, which include higher-order integration, or holism, as a common attribute.*

*This will help address Australia's underperformance in research translation and collaboration between enterprises. For example:*

- *education institutions, especially tertiary education, can offer courses that span multiple faculties*
- *enterprises can cultivate organisational cultures and practices that more purposefully assemble teams with diverse skills*
- *government can facilitate skills diversity by promoting best practice and assisting businesses, especially SMEs, with advice and education on how to organise teams for innovation—the US Small Business Administration provides an international model, and a comparable role could be built into Australia's Industry Growth Centres*
- *state and territory governments can extend their R&D voucher systems to cover holistic skills development and training*
- *Innovation Science Australia can build these insights into its program of policy development around skills for innovation.*

### Box 5.3: Example—state voucher system also for skills mixing

Commonwealth, state and territory governments have a range of business development programs, including the Entrepreneurs Program and State based business enterprise centres. A range of Commonwealth and state business websites also offer advice about how to set up and run a business. However, these tend to reflect a culture of management by checklist—a list of things to be done, often without context or how to develop capability.

The Business.gov.au Advisory Services launched in February 2016, aims to assist businesses find advisory services. This is a welcome initiative and cuts through the plethora of advisory services on offer. It includes links to providers offering skills and training services. (See <<https://beta.business.gov.au/advisory-services>>, last accessed 15 March 2016.)

Several states and territories access skills and capabilities through Innovation Vouchers. These focus mainly in access to research and development capability, although some do provide for access to skills training and development.

*State and territory governments could be encouraged to extend their R&D voucher systems to cover holistic skills development and training.*

### Finding 9

**Innovative organisations have well-developed HR systems to enable access to diverse skills and also organise their work to support innovation.**

Many of the case study organisations in Chapter 4 have a strong track record in 'holism' in their HR approaches. This often includes a focus on developing employees' attitudes and supporting activities beyond formal education, driven by the understanding that technical skills are necessary but not sufficient for employment in these organisations. These firms also seek to provide more than just a workplace for their employees, and see themselves as enablers of the development of individual, team and 'life' skills.

However, lean management principles focusing only on core competences can lead to a narrowing of skills sets. Lean management is also linked to the hollowing out of middle management positions and the tendency for

HR departments to be undervalued and under pressure. The data from Chapter 2 reveals that innovative firms invest in a broad range of skills across the board, much more than non-innovative firms. The Australian Bureau of Statistics data show that the availability of a variety of different skills and skills mixing has significant consequences for innovation performance. The evident also suggests that, on average, firms are under investing in the types of skills, the level of skills and mix of skills required to be innovative (see Chapter 2).

In contrast, innovative organisations recognise the value and importance of HR and skills considerations, irrespective of the size of the enterprise or formality of the HR function. How critical this is can be gauged from the following analysis by Cliff Rosenberg (2016)<sup>1</sup>, managing director of LinkedIn Australia and New Zealand:

*In some roles, workers need to change or augment their skills. Many occupations that were once purely technical now require creative and interpersonal skills. Traditional functions that once worked in silos are becoming more integrated. The aim to get a single view of the customer's driving marketing, product and IT functions to work collaboratively. To be successful in the workplace a good balance of specialist and soft skills is required. These skills shifts are happening fast and on two levels: the workforce lacks some of the skills needed for today's economy and it isn't being prepared for our future economy.*

### Implications

*The Australian Institute of Company Director's diploma and other such courses can support innovation by including HR, skills diversity and skills mixing.*

*More managers can embrace the importance that leading companies place on 'instilling a talent mindset', and on how HR practices can be used to successfully recruit skills for innovation. This often includes a focus on attitudes rather than skills alone, and encouraging involvement in activities beyond formal education. Expertise in recruiting and retaining talent are critical factors for innovation; innovative organisations enable individual, team and 'life' skills.*

## 5.7 Findings and implications related to systems level skills mixing

### Finding 10

**More 'third generation innovation' thinking and practices will support a stronger innovation culture in Australia.**

As stated previously, government's primary role should be to facilitate collaboration and cooperation for innovation. It can promote conditions and support and encourage enterprise and education to mix and use skills beyond their organisational and sectoral boundaries. Government's role is to establish the conditions under which the innovation system can function optimally. A fundamental element of this role is to set the tone for, and the shape of, debate around innovation. This can be enhanced by a more consistent expression of positions such as the then Chief Scientist, Professor Ian Chubb, in his *Strategy for Australian Science, Technology, Engineering and Mathematics (or STEM)*: 'The social sciences and the humanities will underpin a creative and innovative Australia; and it is only in this context that STEM can be effective' (Chief Scientist 2014). Or the view from then Minister for Education and Training Christopher Pyne: 'Australia's future competitiveness depends on increasing collaboration across disciplines and sectors, and on turning our ideas and research into real goods and services, technologies and life improvements' (Pyne 2015).

There are significant imbalances in the capacity of the disciplines that train Australia's next generation in non-technical skills for innovation, even as they currently provide major input into the skills base. The HASS disciplines teach 65 per cent of Australia's students with 52 per cent of the staff. HASS fields of research generate only 16 per cent of the nation's research income, and received 28 per cent of higher education R&D investment, but generate 34 per cent of research outputs. There are also structural impediments to HASS disciplines' full participation in Australia's research system. Business R&D based on these disciplines is currently excluded from the R&D tax incentive (Turner and Brass 2014).

## Implications

*Government plays a crucial role in facilitating collaboration and cooperation for innovation. Governments and policy makers could, for example, balance calls, for teaching coding in every Australian school with the evidence from this report. Exposure to the practical ways in which enterprise mixes technical and non-technical skills to meet innovation challenges is critical to prepare current students for the future of work.*

*Government and policy makers can also collect better information on skills needs and expectations in the future—Edler et al. (2013) describe the benefits of forecasting and scenario analysis for skills needs in some countries. A first step could be to expand and optimise the Expanded Analytical Business Longitudinal Database (EABLD) survey administered through the Australian Bureau of Statistics to take into account the complex dynamics and interactions inherent in third generation innovation.*

*Such practices would enable better advice to students, schools and higher education institutions. Government collaboration with forecasting teams, such as those engaged with the CEDA report (Durrant-Whyte 2015) may be another option. There could also be better data collection and use along with greater collaboration between universities and business chambers.*

### Finding 11

**Deeper collaboration across enterprise boundaries, including integrating Australian organisations into global value chains, will significantly improve Australia's innovation performance.**

Collaboration fosters innovation, and the lack of integration in global value chains is a major barrier to optimising the benefits of innovation. All enterprises in the case studies (apart from public and third sector enterprises) are globally connected.

The National Innovation and Science Agenda intends to stimulate collaboration between researchers/academics and enterprise, but does not address the need for improved collaboration between enterprise and the tertiary education

sector in general.<sup>3</sup> Higher certificate, diploma and degree holders, graduates that make up 54 per cent of the labour force, are not addressed through the new Agenda. Collaboration in the Agenda also does not include measures to increase business-to-business collaboration for innovation.

## Implications

*Future innovation policy initiatives could focus more on developing the skills for innovation within a broader skills development context. In addition, the newly established authority, Innovation and Science Australia, could extend its role to cover holistic skills for innovation and consider:*

- *developing and supporting sector specific management education and training, and related skills development, for entrepreneurs and managers in high growth businesses*
- *funding 'higher apprenticeships' in Industry Growth Sectors, as agreed with Growth Centre Chairs*
- *encouraging co-investment in tertiary education-industry skills development programs*
- *highlighting careers of 'VET-trained business entrepreneurs' who become employers*
- *highlighting why and how employers can (or don't) take on 'learners' as graduates, interns or apprentices.<sup>4</sup>*

*Government's major policy instrument to incentivise enterprise innovation, the R&D Tax Incentive, could be refined to more directly address the findings in this report. For example, a proportion of the incentive devoted to 'profit contingent' loans could be coupled with pre-requisites for skills development measures or for collaborative arrangements. There are two possible reasons for rethinking the basis*

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3. See Craig Fowler, Managing Director, NCVET, 'What the National Innovation and Science Agenda (NISA) Didn't Say About Skills and Jobs', <[www.ncver.edu.au/about/news-and-events/opinion-pieces/what-the-national-innovation-and-science-agenda-nisa-didnt-say-about-skills-and-jobs](http://www.ncver.edu.au/about/news-and-events/opinion-pieces/what-the-national-innovation-and-science-agenda-nisa-didnt-say-about-skills-and-jobs)>.

4. Several of these points draw on Craig Fowler, Managing Director, NCVET, 'What the National Innovation and Science Agenda (NISA) Didn't Say About Skills and Jobs', <[www.ncver.edu.au/about/news-and-events/opinion-pieces/what-the-national-innovation-and-science-agenda-nisa-didnt-say-about-skills-and-jobs](http://www.ncver.edu.au/about/news-and-events/opinion-pieces/what-the-national-innovation-and-science-agenda-nisa-didnt-say-about-skills-and-jobs)>.

#### Box 5.4: Example—incentivising collaboration with contingent loans

Two prominent Australian academics have proposed a scheme that would help high growth potential SMEs finance innovation.<sup>5</sup> The arrangement involves modest or even zero net imposition on the public purse, and it is very likely to be administratively straightforward. The proposal builds on the successful design and application of income contingent loans in financing arrangements for domestic university students, and now emulated in many other countries.

The idea is to link research grants to university teams that have developed their plans in conjunction with industry, and which are designed with profits to the business as a major motivating factor. It is motivated in part by the view that collaboration between university researchers and the private sector has potential to advance the interests of both sectors, and in ways that can be instituted with negligible longer-term budgetary costs.

Projects would be suggested, promoted and explained, and costs estimated, through interactions between university and business partners (in much the same way that Australian Research Council Linkage grants operate). If successful, projects would receive grants to finance the university activities and contingent loans for the business partner. Repayment of the loans is a critical aspect of the arrangement.

Enterprises benefitting from the research funding would be required to repay some (or all) of the loan, but only when they are in a viable future position. This can be ensured by having the obligation depend on future profits, as explained in a similar policy scheme. For example, this could be handled with an additional two percentage points being added to company tax, with the amount/proportion of the loan to be recovered set as a policy parameter by government. The transactional efficiency from government collection of debts through the tax system is a major advantage of the scheme.

A further advantage of such arrangements is that they provide insurance to the agents assisted: insurance against repayment difficulties and, critically, insurance against default. If the organisation is not in a position to repay, no repayment is actually required. Capacity to repay, as with all contingent loans, is the defining characteristic of such schemes.

Applications for support would need to be vetted by the same sort of process now used in the awarding of ARC/NHMRC grants plus the extra element of business assessment too. This joint approach would ensure projects have both university and industry merit and some industry financing is also likely to be required as 'skin in the game'.

A way forward may be to allocate some part of the R&D tax incentive budget outlays to a pilot program involving profit contingent loans, and in the first instance this could be around 20 per cent of planned annual budget costs in this area. The design parameters of the loan are a matter for government, but for purposes of discussion the initial pilot could involve a requirement that the enterprise repays 60 per cent of the present value of the loan, and this could be addressed through the imposition of several additional percentage points to company tax for debtor businesses until this is reached.

*of government subsidies in the R&D area, to move away from total reliance on grants and towards loans of this type: (i) the difficulties associated with establishing causal links between subsidies and value-added innovation behaviour implies concern with monitoring and establishing the connection between subsidies and R&D outcomes; and (ii) loans systems, particularly generously designed loan systems, have the great potential for achieving similar outcomes as grants at far less cost to taxpayers.*

*Profit contingent loans, or R&D tax incentives and other forms of grants, can be designed in ways consistent with the goal of promoting more holistic skills mixing (technical and non-technical) in enterprises' deployment of human capital. In the example above there could be an explicit link with*

*a university partner, and in this case the sorts of decisions related to the allocation of government financial support of innovation investment would rest in the main with the business/university partners and not be determined by any pre-ordained view about what are and what are not appropriate skills mixes for projects. After all, the partners should know much more about what is needed for their specific innovation needs than a government would.*

5. Bruce Chapman and Glenn Withers, *Innovation Financing: A different way of thinking about university research and industry linkages*, September 2015, <[https://submissions.education.gov.au/Forms/RRPFA/\\_layouts/SP.Submissions/ViewDoc.ashx?id=%7B2eef3278-6e45-4a78-af7b-e0792a3bb7d9%7D](https://submissions.education.gov.au/Forms/RRPFA/_layouts/SP.Submissions/ViewDoc.ashx?id=%7B2eef3278-6e45-4a78-af7b-e0792a3bb7d9%7D)> last accessed 02 May 2016.

*The low levels of collaboration and knowledge transfer between Australian industry and education/research institutions, which inhibit the development and diffusion of new innovations, could be addressed by tax incentives, for example, for employing PhDs in industry.*

*Tax incentives, for example for employing PhDs in industry, could also be deployed to address the low levels of collaboration and knowledge transfer between Australian industry and education/research institutions which inhibit the development and diffusion of new innovations. Enterprises could be eligible to claim a tax incentive for the employment of PhD graduates. Administrative arrangements should be developed to ensure continuity of employment and protection of employee rights.*

#### **Box 5.5: Example—tax incentives for PhDs in industry**

Industry could be encouraged to employ PhDs, from any discipline, through a specific tax deduction. It would be expected that PhD graduates with good people skills will rise up the management ladder. These managers are expected to readily approach universities to find or collaborate for innovation.

The PhD is one of the only training universities provide that gives people the mindset to break new ground. A PhD student is required to develop an idea that has not been thought of before in a way that proves to every conservative professor, who is trying to hold the boundaries of their discipline, that the idea is a new addition to knowledge. This mindset is what innovation leaders require.

To encourage this, organisations could be given a tax concession for employing a PhD. Employing a PhD would become as inexpensive as an undergraduate. There is already a mechanism for a tax concession. A PhD would be employed whether or not they are doing research. Employing PhDs would be expected to lift the innovation capacity of the company by capturing an 'innovation mindset'. One interviewee argued that this would be the cheapest way to transform the country in a generation.

#### **Finding 12**

**Investment in innovation ecosystems in specific industries and regions will significantly improve Australia's innovation performance.**

The Industry Growth Centres are a major step toward improvements in Australia's innovation performance. As an enterprise and education institution, being part of a cluster or network has clear positive effects on innovation. This is corroborated by the results described in Chapter 1. That is, organisations with systems that are automatically linked to partner (supplier) organisation, and organisations that do not operate in a captive market, tend to be more innovative. Also the case study organisations discussed in Chapter 4 emphasise the value of being connected to external partners. The re-elevation of CSIRO's role in innovation transfer between research and industry, as described in the National Innovation and Science Agenda, is a first necessary step towards optimising partnerships across the innovation system.

Advanced Manufacturing Industry Growth Centre Chair Andrew Stevens comments in his interview that there has been too much focus on the availability of skills, which is only one element of skills and capabilities for enterprise innovation. An understanding of *entrepreneurship*, skills *quality* not quantity, and *demand* not supply, are aspects that are not well understood.

## Implications

*Enterprises can do more to engage with local clusters and integrate themselves into networks of innovation on a national and international level. This could include investments in collaborative projects, such as joint spin-off companies.*

*Education institutions can also increase initiatives to be active in clusters, precincts and enterprise networks.*

*Notable among international models, Cardiff University is building a Social Sciences Research Park, dedicated to the translation of research 'into innovative and effective solutions to pressing, global, societal problems'.*

*Also organisations need to engage more with local clusters and integrate themselves into networks of innovation on a national and international level. This could include investments in collaborative projects, such as joint spin-out companies*

*Government and policy makers, however, provide the conditions that make it attractive for both organisations and education to co-locate in clusters. Overseas, initiatives that appear to have worked include sponsoring infrastructure, such as business parks, and providing incentives for businesses to locate there through tax breaks. Government's main role is to facilitate and connect organisations. For instance, government can provide services through sub-contractors to find innovation partners. Governments can also be significant players in regional/sectoral ecosystems through their procurement practices.*

*The National Innovation and Science Agenda acknowledges that the Australian Government has a significant spend on procurement, but ranks only 70<sup>th</sup> out of 141 countries on how well its procurement fosters innovation. Drawing on lessons from the US Small Business Innovation Research and the UK's Small Business Research Initiative, government can apply insights developed in this report to better embed skills for innovation through procurement.*

### Box 5.6: Example—Cardiff University SPARK

Cardiff University is building a social science research park (SPARK) within the Innovation Campus at Cardiff, 12,000 square metres in size, scheduled for completion in late 2018. This is an attempt to create a dedicated space for the generation of new ideas that are founded on areas of human knowledge that focus on society and the way it is organised: geography, economics, law, management and organisation studies, sociology, political science, and social psychology. SPARK is an experiment in science as well as social science. It is intended to be a catalyst both for the more innovation-oriented social science and for the more socially-oriented system of innovation that is required by the problems of our times. The role of the university thus shifts from being the monopoly producer of knowledge to the orchestrator of regional innovation ecosystems. (Adam Price & Rick Delbridge 2015, Social Science Parks: Society's New Super-Labs, Nesta, November 2015)

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# Expert Working Group

## Professor Stuart Cunningham AM FAHA

Stuart Cunningham AM is Distinguished Professor of Media and Communications, Queensland University of Technology. He directed the ARC Centre of Excellence for Creative Industries and Innovation, the first Centre of Excellence based in the humanities, from 2005 to 2014. His most recent honours include admission into the fellowship of the UK-based Academy of Social Sciences in 2013, the award of a Fulbright Senior Scholarship for 2014–15, and the award of Member of the Order of Australia in 2015 for 'significant service to higher education, particularly to the study of media and communications, as an academic and researcher'. He was elected as an inaugural fellow in Cultural and Communication Studies in the Australian Academy of the Humanities, and has served in several leadership roles in advocacy, advice and governance in research and higher education, and in the screen and library sectors. His most recent books are *Digital Disruption: Cinema Moves Online* (edited with Dina Iordanova, 2012), *Key Concepts in Creative Industries* (with John Hartley, Jason Potts, Terry Flew, John Banks and Michael Keane, 2013), *Hidden Innovation: Policy, Industry and the Creative Sector* (2014), *Screen Distribution and the New King Kongs of the Online World* (with Jon Silver, 2013), *The Media and Communications in Australia* (edited with Sue Turnbull) and *Media Economics* (with Terry Flew and Adam Swift, 2015).

## Professor Peter Gahan

Peter Gahan is Professor of Management and Director of the Centre for Workplace Leadership at the University of Melbourne. He has previous held academic appointments at Monash University, UNSW, the University of Southern

California, and the European University Institute. He also headed the Workplace Innovation Branch in the Victorian Department of Industry, Innovation and Regional Development between 2001 and 2004. He has published widely in the areas of human resource management, workplace innovation, high performance work systems, employment relations, labour law and trade unions.

## Ken Boal

Ken Boal is Vice President of Cisco Australia & New Zealand (ANZ). He has a twenty-year plus track record in the IT and Communications industry, supporting organisations in the public and private sector achieve transformational change powered by technology. Ken's responsibility is to lead Cisco in ANZ to achieve growth and technology market leadership. Ken and his team support customers and partners implement new digital business innovations leveraging the Internet of Things and Fast IT, whilst addressing cyber security.

Ken is passionate and committed to working with business and the higher education sector to enhance Australia's role in the knowledge economy, and the shift to the digital economy. Ken is the President of the Business/Higher Education (B/HERT) Roundtable and was appointed to the Commonwealth Science Council in October 2014.

Prior to joining Cisco, Ken spent 10 years at Anixter Inc/NetStar, an Asia Pacific network systems integrator as Southern Region General Manager. Ken graduated from the University of Queensland in 1991 with a Bachelor of Electrical Engineering (Communications & Electronics).

## Professor Victor Callan FASSA

Victor Callan is Professor of Management and Leadership at the University of Queensland Business School, and Faculty Associate Dean (Research) at the University of Queensland. He has published in the world's leading academic journals, and is one of the most cited management Professors in Australia. Based on these academic achievements, he was elected as a Fellow of the Academy of Social Sciences in Australia and has won the University's Award for Excellence in Higher Degree Research Supervision. Victor has strong links with industry through his research, teaching and consultancy, having completed over 100 projects for numerous Federal, State and local government departments including major reviews on workforce skills, training, service delivery and workforce development.

## Professor Tam Sridhar AO FAA FTSE

Professor Tam Sridhar AO is the Sir John Monash Distinguished Professor Emeritus at Monash University. He previously served as Head of Chemical Engineering and as Dean of the Engineering Faculty at the same institution. He was also Academic Vice President for India and China Research Institutes. He is a Fellow of the Australian Academy of Technology and Engineering and a Fellow of the Academy of Science. He was created an Officer in the Order of Australia for services to Higher Education. He has published widely in the areas of reaction engineering and polymer rheology.

## Christine Zeitz

Christine Zeitz joined Lockheed Martin in August 2015 and is Vice President & Managing Director of Information Systems and Global Solutions (IS&GS) business in Australia and Asia. She is responsible for IS&GS' performance and delivery of programs, as well as strategic growth. Prior to joining Lockheed Martin, Christine was President of BAE Systems' North East Asia region. Appointed to this senior executive position in 2013, she carried sole responsibility for government, customer and industry relationships for the region with annual orders of \$US600M per annum. For the last 15 years of her 25-year tenure at BAE Systems, Christine was part of the management board and held senior positions in logistics, strategy, business development, commercial, procurement, government relations and communications. Christine was also Director of Defence Logistics in Australia (2010–13) and Business Development Director in Australia (2008–10), responsible for corporate strategy, business development, government relations and communications at a time when BAE Systems in Australia acquired Tenix Defence.

Christine was born and raised in Adelaide where she graduated with a Bachelor of Economics (Accounting) from Flinders University. She has also completed post-graduate business administration, management and marketing courses with the Australian Institute of Company Directors, Harvard Business School and the University of South Australia.

Christine has been very active on a number of industry councils, boards, forums and committees. Currently, she is a member of the Defence Council of Victoria and a council member of Flinders University (South Australia) and the South Australian Premier's Council for Women. She's also championed the diversity agenda of BAE Systems focusing on gender equity and in 2009 was a Telstra Business Woman of the Year Finalist.

# Evidence gathering

## Case studies with highly innovative organisations

The Expert Working Group project team conducted interviews with 19 organisations that are recognised as being particularly innovative in their sector, as well as interviews with further key informants, in December 2015 to discuss the skills and capabilities seen as relevant for innovation.

In selecting the cases, the project team relied on a process of peer nominations in a number of sectors, starting with firms recognised through innovation awards. In addition, the selection of firms aimed to provide a representative selection of industry sectors, including those recognised through the Department of Industry, Innovation and Science's Growth Centres Initiative, as well as a spread across small, medium and large organisations within the economy. The selection process started with asking organisations that had won innovation excellence awards, and a list of innovative firms provided through the Growth Centre Chairs, to nominate three further organisations they deem as most innovative in their industry sector. The process was repeated with the nominated organisation, and so on, to ultimately identify 'top of the pyramid' innovators. Firms mentioned several times were contacted as potential case study candidates.

The interviews were between 45 and 120 minutes long, and averaged 70 minutes. The interview questions investigated the following themes:

1. Contextualising the nature of innovation within the case organisation—types of innovation and modes for conceiving innovation.
2. Employees and bundles of skills—skills, qualifications, experience as recruitment criteria; use of apprenticeships, internships, secondments and other forms; lack of skills in prospective employees.
3. Teams as bundles of complementary skills—approaches to team building; diversity in teams and composition over time; training, rewards and performance mechanisms; organisational strategy, structures and culture to support innovation; challenges to be overcome.
4. Networks and organisational linkages as sources of skills—use of and linkages to other organisations, research organisations, universities; nature of skills sought and nature of the relationships; challenges and barriers.
5. Policy environment for innovation—the role of policy to support skills formation, e.g. through training, VET, government.

All interviews were recorded and transcribed. In analysing the interviews, the project team engaged in a thematic analysis, with at least three members of the research team reading the transcripts independently and identifying themes to pursue. This process identified and verified a number of core themes.

The project team is grateful to have had the opportunity to consult widely with many experts and stakeholders during these consultations, including:

- Diana Holmberg, Anglicare Victoria
- Megan Lilly, AiGroup
- Zareh Nalbandian, Animal Logic
- Anne-Marie Leslie, Cochlear
- Angela Bradburn, Cotton Australia
- Nicola Cottee, Cotton Australia
- Ian Taylor, Cotton Research and Development Centre
- Kathy Dunn, CSIRO
- Ben Chan, Envato
- James Law, Envato
- Darren Kelly, Fibrotech/OccuRX

Tim Regan, George Institute of Global Health  
Vern Bowles, Hatchtech  
Vaughn Richter, ING Direct  
Herbert Hermens, Keech Australia  
Andrew Harris, Laing O'Rourke  
Neil Sullivan, Noja Power  
Paulina Larocca, Pernod Ricard Winemakers  
Tony Constantini, Queensland Urban Utilities  
Sarah Macartney, SEEK  
Matt Symons, SocietyOne  
David Scoullar, Southern Innovation  
Paul Scoullar, Southern Innovation  
Shaun Gregory, Woodside  
Hugh Durrant-Whyte, The University of Sydney  
Marek Kowalkiewicz, Queensland University of Technology

## Consultant reports

The Expert Working Group engaged two consultants to gather background information for this project. The consultants produced the following reports.

*What drives firm innovation?*, Alfons Palangkaraya, Thomas Spurling, Elizabeth Webster, Centre for Transformative Innovation, Swinburne University of Technology, December 2015.

Professor Elizabeth Webster and her team at Swinburne University of Technology analysed data from the Extended Analytical Business Longitudinal Database (EABLD) hosted through the Australian Bureau of Statistics. The consultancy built on prior work by Dr Palangkaraya, Professor Webster and Professor Spurling and focused on investigating the antecedents of different types of innovation

activity based on evidence contained in the EABLD that relates to the availability or lack of different types of occupations and skills.

*The role of government, industry and education and research institutions in developing innovation capabilities: key informant interviews*, John Howard. John Howard Partners and UTS Business School, February 2016.

Dr John Howard of Howard Partners and UTS Business School conducted interviews with experts on innovation and policy in industry, education and government. The primary focus of the interviews was on examining current innovation policy initiatives implemented in Australia (and other jurisdictions) and on exploring additional options for how policy instruments may foster optimal investment in, and dynamic mixing of, technical and non-technical capabilities of Australian enterprises. The list of interviewees is provided below.

## Business enterprises

Glenn Keys, Aspen Medical, Chair Canberra Business Chamber

Russell Rankin, Director of Food Innovation Partners Pty Ltd

Neville Sawyer, Ampcontrol, former Chair ACCI

Andrew Stevens, former MD of IBM Aus, Chair, Advanced Manufacturing Growth Centre

## Business incubators, innovation advisers, regional innovation ecosystems

Brenton Caffin, Director Innovation and Skills, NESTA, UK

Hamish Hawthorn, CEO, ATP Innovations

Todd Williams, CEO, Hunter RDA

## Business and industry associations

Angus Armour, Megan Kirchner, Mike Hubbard,  
Business Council of Australia

Kate Carnell, CEO, ACCI

Tim McKay, ICT Skills and Education Manager,  
Australian Information Industry Association

Innes Willox, CEO, AIGroup

## Technology investors

John Dyson, CEO, Starfish Ventures

## Tertiary education institutions

Mark Dodgson, Professor, University of  
Queensland, and Imperial College London

Malcolm Gillies, former VC, London Metropolitan  
University and City University London

Roy Green, Dean, UTS Business School, UTS

Swee Mak, Director Design Research Institute,  
RMIT University

Stephen Parker, Vice Chancellor, University of  
Canberra

Arun Sharma, DVC Research and Innovation, QUT

David Sweeney, HEFCE

Jim Watterston, Queensland DET  
(written response)

## Tertiary education peak bodies

Belinda Robinson and Anne-Marie Lansdown,  
Universities Australia

Sharon Winocour, CEO, B/HERT

Patricia Neden, CEO, Industry and Business Skills  
Council

## Tertiary education research

Craig Fowler, NCVER

Peter Noonan, Professorial Fellow, Mitchell  
Institute

Todd Davey, Professor, Munich Business School

## Research organisations

Jack Steele, General Manager, Science and  
Government, CSIRO

## Government

Ian Cox, Director Economic Development, ACT  
Government

Geoff Garrett, Queensland Chief Scientist

Luke Hendrickson, Manager Innovation Research,  
Department of Industry, Innovation and Science

## Policy analysts and advisers

Mark Evans, Director, Institute for Governance and  
Policy Analysis, University of Canberra

Mark Matthews, Science, Technology and  
Innovation Policy Consultant, Sheffield University

Richard Snabel, Chief Strategy Officer,  
Designed4Growth and former Chair OECD  
Committee on Industry, Innovation and  
Entrepreneurship, Chief Economist, Department  
Industry, Innovation and Science

Glenn Withers, Bruce Chapman, Crawford School,  
ANU

# Peer Review Panel

This report has been reviewed by an independent panel of experts. Members of this review panel were not asked to endorse the Report's conclusions and findings. The Review Panel members acted in a personal, not organisational, capacity and were asked to declare any conflicts of interest. ACOLA gratefully acknowledges their contribution.

## Dr Genevieve Bell

Dr Genevieve Bell is an Australian-born anthropologist and researcher. She has responsibility for corporate sensing and insights at Intel Corporation. She leads a cross-discipline foresights community at Intel that delivers insights into significant societal, technical and global trends. This market-inspired view helps guide product development and enables meaningful experiences for customers and end users of Intel solutions.

## Emeritus Professor Malcolm Gillies AM FAHA

Malcolm Gillies is a retired vice-chancellor of two universities in London, where he was also chair of the mission group, London Higher, during 2010–14. He is a former vice-president of the Australian National University, president of the Australian Academy of the Humanities, and during 1998–2002 was chair of the National Academies Forum (now, ACOLA). A musicologist, linguist and educator, he has published widely, particularly about eastern European culture and higher education policy. He is now a Visiting Professor of King's College London and Mathias Corvinus Collegium in Budapest, and a Foundation Board member of Nyenrode Business University in The Netherlands.

## Dr Graham Mitchell FAA FTSE

Graham Mitchell is a veterinary graduate and University gold medallist of the University of Sydney. At The Walter and Eliza Hall Institute of Medical Research (WEHI) he made discoveries in immunology and obtained a PhD in 1969. After post-doctoral experience in California, England and Switzerland, he returned to Australia in 1973 and established a new program on the immunology of parasitism at WEHI.

In 1990 Mitchell was appointed Director of the prestigious Royal Melbourne Zoological Gardens where he introduced a number of new initiatives in local and regional conservation. In 1993 he returned to biomedical research as Director of Research in the R&D Division of CSL Limited.

Mitchell is recognised as one of Australia's leading biological scientists. He is an author of more than 350 publications, has received numerous awards for scientific achievements and, in 1993, was appointed an Officer in the Order of Australia for services to science. He is a non-executive director of several companies and has been involved with the World Health Organisation for many years.

Mitchell is an advisor on innovation to the Victorian Government. In another government role the Principals of Foresight (Mitchell, Nossal, Stocker, Penington Taylor and Turvey) jointly act as Chief Scientists for the Victorian Departments of Economic Development, Jobs, Transport and Resources (DEDJTR), and Environment, Land, Water and Planning (DELWP).

## Dr Chris Roberts BE, MBA, PhD, DSc (hc), FTSE, HonFIEAust, FAICD

Chris Roberts was CEO Cochlear Limited (ASX:COH) for 11 years to August 2015. He is a non-executive director of ResMed Inc (NYSE: RMD) and OncoSil Medical Limited (ASX: OSL).

He is a PLuS Alliance Professor at UNSW, King's College London and Arizona State University.

He is a board member of: Innovation Australia, Jobs For NSW, Monash University Industry Advisory Council, UTS VC's Industry Advisory Board; UNSW Medicine Advisory Council, the Health Innovation Advisory Committee (an NHMRC principal committee), and Centenary Institute. He is an Honorary Fellow of the Australian Institute of Business and Economics (UQ).

## Mr Raymond Spencer

In 2009, Raymond Spencer returned to Australia following 35 years of living and working in the USA, India and Europe.

During this time, Raymond led a couple of lives. He spent the first 20 years overseas in the non-profit world working with the Institute of Cultural Affairs a United Nations-recognised private voluntary organisation focused on worldwide rural and community development.

In 1989 he had a major career shift and started Kanbay International an IT services company focused on serving the financial services industry. As Chairman and CEO he led Kanbay from its inception through its acquisition by Capgemini in 2007 for Aus\$1.7 billion. At that time, Kanbay had over 7,500 associates in fourteen cities across eight nations. Following Kanbay's acquisition Raymond was CEO of Capgemini's Global Financial Services Business Unit, which he launched for the Group. He was a member of the Group's General Management Board and reported to the Group CEO.

Raymond was appointed Chairman of the South Australian Economic Development Board on 1 January 2011. Raymond is Chairman of the South Australian Health and Medical Research Institute (SAHMRI). Raymond is also Chairman or a board member of a number of private and public companies in Australia and the USA.

In 2013 was awarded an Honorary Degree of Doctor of Humane Letters by the University of Arizona.

# Appendix A

## List and short description of case study organisations

### Anglicare Victoria—community services

Anglicare Victoria is a leading provider of not-for-profit services including foster care, food and material aid, care for children with disabilities, family and financial counselling, assistance for victims of child abuse and neglect, parenting advice and support, residential and crisis accommodation for young people and advocacy for the vulnerable in our community.

During 2014–15, Anglicare Victoria has grown its programs and introduced a number of service innovations to address difficult social problems. To manage its growth past the 1,000 employee mark, the organisation has implemented a comprehensive induction tool for new staff and is expanding its professional development opportunities for staff. A total of 35 new courses across the organisation are aimed at building skills and widening vocational pathways.

Through collaborations with the Bouverie Centre, the Australian Childhood Foundation and The University of Melbourne, the organisation has taken conscious steps to support its middle and senior managerial levels in leading and managing staff and programs, and is continuing its course to re-invent the-for-profit sector with practices commonly associated with the commercial sector. Embracing reform and restructure in the

community services sector and responding to growing demand for human services, the current CEO is actively seeking to foster management and leadership expertise in its employees towards creating a nimble and athletic organisation.

### Animal Logic—visual eEffects and animations

Animal Logic is Australia's largest and most successful visual effects and animations company. Since 1991, the organisation has continually proven its capabilities and is today a partner to major film projects around the world with offices in Sydney, Los Angeles and, recently, Vancouver. Some of the projects the company was involved in include *Moulin Rouge*, *The Matrix*, *House of Flying Daggers*, *Planet of the Apes*, *Harry Potter and the Goblet of Fire*, *300*, *Knowing* and *Australia*. Later entirely animated films included *Happy Feet*, *Legend of the Guardians: The Owls of Ga'Hoole* as well as the LEGO movies.

Innovation in media and entertainment is almost by definition underpinned by the interrelationship between technology and creative design. Animal Logic provides an excellent example for organisation that has successfully grown its operations—from 10 staff in 1991 to over 500 in 2013.

## Cochlear—hearing implants

Cochlear specialises in developing electro-acoustic implants to restore hearing to the deaf, providing a lifelong commitment in upgrading and servicing its technology as well as facilitating engagement with support communities. Since its establishment in 1978, Cochlear has expanded to 70 per cent of the market share, with operations extending all over the world including in the US, Europe, Korea and Japan. Through innovation and internationalisation, Cochlear has also given autonomy to regional operations, creating local engagement programs through an understanding of cultural diversity.

Cochlear has long been the poster child of Australian innovation. With many consumers recently demanding more technological integration, the company has invested heavily in marketing and consumer services programs. These investments have led to a new generation of products including wireless accessories for hearing aids to improve the interaction with other devices, as well as improved sound quality through automatic adjustment to different ambiances. Cochlear is embedded in the Macquarie Park also provides a good example of the organisation accessing a wide range of skills and expertise to foster its innovative capacity.

## Cotton Australia—peak industry body

Since 1972, Cotton Australia has been the peak representative body for the Australian cotton growing industry, led by a Board of 10 cotton growers and ginners. The industry is underpinned by a significant research effort funded by cotton growers in partnership with the Australian government, through the Cotton Research and Development Corporation (CRDC). This covers the business of farming, soil health and water management as well as human capacity (attracting, training and retaining the workforce) and the value chain. In 2012, the Cotton Innovation Network was formed to coordinate the cotton industry's research and development

activity and ensure a collaborative and cohesive approach to achieving the industry's long term goals. It drives R&D by mapping the current investment in research and determining the research requirements for the next 10 years.

Cotton Australia's many success stories include genetically modified cotton varieties developed in collaboration with CSIRO, custom-bred cotton varieties for Australian conditions which have resulted in a net value to Australia of \$4.9 billion, within five years of their introduction. The organisation provides an excellent example for a traditional industry sector that continually operating at the forefront of research to generate economic value through innovation, through coordinated and collaborative effort across all levels, from farmers over research organisations to government.

## CSIRO—Australian Government agency for scientific research

Since its beginnings in 1916, CSIRO has delivered hundreds of innovations to Australia and the world, ranging from today's global WiFi standard, to vaccines and Aerogard, and from dieting programs to extra-nutritious BARLEYmax. In recent years, however, the organisation has struggled with funding cuts and a poor performance in collaborating with businesses.

In 2015, CSIRO appointed a new entrepreneurially-minded CEO, renewed funding arrangements and promoted a new vision of being Australia's innovation catalyst. The mission is to accelerate the pace of innovation and disruptive change driven by science and technology, by connecting and transferring solutions from research into business.

CSIRO's new vision is translated into a number of strategic actions to boost innovative performance. These include putting customer-value first, driving national benefits through a global outlook, collaborating across research and business and driving breakthrough innovation, all while retaining a culture of inclusion, trust and respect.

## Envato—digital creative ecosystem and platform, including a marketplace

Envato's ecosystem of sites includes Envato Market, a marketplace for images, themes, project files and creative assets, Envato Studio, connecting clients with freelance talent, and Tuts+, providing tutorials and video courses related to digital media. Since starting operations in a Melbourne garage in 2006, the company has grown to be a leading digital marketplace, today employing over 180 staff and working with about 40,000 contributors around the world.

Much of Envato's success (over \$50 million revenue per year) is attributed to its founders' vision building an innovative, community-centric organisation without any external funding. Envato has over the years introduced numerous innovations in its service provision, many of which relate to ideas raised through employees and their community of contributors. The company's commitment to organisational innovation is evident in its constant effort to provide a more flexible, diverse and inclusive work environment. For example, one recent change was to allow all employees to work three months of the year from anywhere in the world.

## Fibrotech/OccuRX—biomedical research start-up

Fibrotech is a Melbourne-based biopharmaceutical company that has developed a new class of drugs for the treatment of the fibrosis prevalent in conditions as chronic kidney disease, chronic heart failure, pulmonary fibrosis and arthritis. After successfully completing phase 1 trials, the company was acquired by a US pharmaceuticals company, for around US\$600 million. Fibrotech's CEO has since established OccuRX, a company focused on the development of innovative therapeutic strategies for the

treatment of ophthalmic disorders associated with retinal fibrosis (scarring of the retina leading to blindness).

Both organisations were established with venture funding from the Medical Research Commercialisation Fund, Brandon Capital Partners and Uniseed, a venture fund operating at the Universities of Melbourne, Queensland, Sydney and New South Wales. Fibrotech and OccuRX are excellent examples for the commercialisation of scientific research through collaborative arrangements and integration in a local innovation cluster environment.

## George Institute of Global Health—health and medical research institute

The George Institute is a global, not-for-profit medical research institute, affiliated with leading academic partners including the University of Oxford, University of Sydney, Peking University Health Science Center and many others. With projects in more than 50 countries, the Institute has raised over \$550 million for global health research since 1999 and has been ranked among the top 10 research institutions in the world for scientific impact.

Unlike other medical research, the George Institute emphasises large-scale, practice-based research aimed at finding the causes of common, serious diseases and ill-health, as well as studies that identify how best to prevent and manage these conditions. The focus is on finding innovative low-cost solutions to improve the delivery of evidence-based healthcare, particularly for populations in resource-poor economies. Once research results are published, the George Institute also engages in translating its work into policy guidelines and practice in the primary health care setting.

## Hatchtech—pharmaceutical research start-up

Hatchtech is a Melbourne-based specialty pharmaceutical company that has developed Xeglyze™ Lotion, a proprietary next generation head lice treatment. Unlike other lice treatments, Xeglyze™ is a topical lotion that impedes a number of physiological processes involved in all stages of the louse lifecycle from egg to adult, making one application sufficient for treatment of head lice.

The product has recently completed phase 3 clinical trials in the US and submitted a New Drug Application (NDA) to the U.S. Food and Drug Administration in September 2015. In that same month Hatchtech announced a commercialisation deal with an Indian based pharmaceutical company for total potential milestone payments up to \$279 million. Certain aspects of the related body of intellectual property are still held by Hatchtech. Hatchtech's story is an inspiring example of entrepreneurial commitment of its founder who has, over 15 years, taken considerable financial risks and worked in numerous roles in the company. It exemplifies the changing and broadening of skills requirements to bring scientific discovery to a state of commercialisation.

## ING Direct—'direct' bank

Although a relative newcomer, ING Direct is continually stirring the 'big four' dominated banking market in Australia. ING's approach is based on simplicity: providing a limited number of products, but providing the best products in each category across the market. The awards won for many products, company's status as Australia's most recommended bank, and a 65 per cent growth of customers who use ING Direct as their main bank demonstrate that the strategy is working.

Over the years, ING Direct has tackled ATM fees on everyday transactions, introduced no-fee superannuation options and no-fee savings accounts for their customers. But innovation is not only the credo externally. To enable innovative products and service provision, the bank emphasises its purpose of enabling its customers to get ahead. This way of thinking has led to business model innovations such as 'bank-in-a-box', a software-based representation of the entire system which is accelerating testing and implementation of new applications enormously. The system, based on a collaboration with Cisco, Microsoft and NetApp, is used to test new software solutions in a real-world environment within ten minutes, a process that before took three months to complete.

## Keech Australia—steel castings manufacturing

Keech is located in Bendigo, Victoria, and designs and manufactures high integrity steel castings providing a comprehensive range of ground engaging tools and equipment for agriculture, mining and excavation. Today, Keech castings are supplied not only to Australian companies but exported to international markets including Japan, Russia, North America, South America, Indonesia and Papua New Guinea.

Keech provides an excellent example of a traditional manufacturing business that has faced the challenges of global competition and risen to the task. One of its important inventions is the VYPR lip system for ground engagement tools. Traditionally damaged teeth needed to be welded on, creating downtime for the machine for often several days. Keech's system of slide-on wear caps and replacement teeth requires no welding and can be achieved in 20 minutes during refuelling.

Process innovations at Keech have included the completion of an automated fast loop moulding line, which has tripled its foundry productivity. Moulds are now multi-cavity, saving wasted steel, sand and energy to re-process, and standardisation means one setup for the day no matter what size castings are being produced. With the automated system in place, Keech is redeploying some of its factory staff into other areas of operation.

### **Laing O'Rourke—construction, engineering**

Laing O'Rourke is global engineering, construction and asset management company headquartered in the UK. Its dedication to the company values—client focus, innovation, responsible behaviour and people management—and the founders' vision is driving innovation in every aspect of the business. University partnerships, internal talent development programs and employee idea management processes are only some of the means that drive innovation in the organisation.

In 2011, Laing O'Rourke established an internal innovation division—the Engineering Excellence Group based in Sydney—to bring radical innovation from other fields into the construction business. Laing O'Rourke exemplifies a large organisation in a relatively traditional industry that has made innovation one of their guiding objectives. The company has continuously been recognised for its innovative performance for projects including a construction-scale 3D printing technology for concrete moulding. The technique produces unique moulds at a fraction of the cost of a traditional mould, making one-off moulds competitive and allowing greater expression in both form and function. Designs can now be based on the structurally optimal arrangement of material for the element, rather than having to focus on the most labour-efficient method of creating formwork.

### **NOJA Power—medium voltage switchgear**

NOJA Power researches, develops, manufactures and supplies low and medium voltage switchgear specialising in auto reclosing circuit breakers for industrial, infrastructure and electricity distribution utilities. The company's vision is to be the world leader in medium-voltage outdoor switchgear, a goal which it has moved towards with the installation of more than 35,000 Automatic Circuit Reclosers in over 84 countries worldwide. NOJA Power's product quality and innovative performance have been recognised through multiple awards across several years from Australian Government authorities and various international bodies such as the Latin America Business Council.

NOJA Power provides an interesting example of a 'born-global' enterprise. Their innovative performance is underpinned by a global orientation and a conscious focus on diversity in skills and over 50 cultural backgrounds. Following the ethos behind its core product, an innovative safety device, NOJA Power is committed to occupational health and safety with various patents and innovations that make the maintenance and repair of equipment safer. This commitment is also visible internally, since the introduction of an employee health program, NOJA Power has experienced a visible reduction in sick leave and staff turnover as well as an increase in productivity.

### **Pernod Ricard Winemakers—wine and spirits**

Pernod Ricard Winemakers is the premium wine division of Pernod Ricard, the world's co-leader in wine and spirits. Headquartered in Sydney, Pernod Ricard Winemakers is responsible for the strategic direction, production, new product development and marketing of a global portfolio of premium wines.

Founded in 2010, Pernod Ricard Winemakers boasts one of the world's most diverse portfolios of premium wines featuring brands such as Jacob's Creek in Australia, Brancott Estate and Stoneleigh from New Zealand, Campo Viejo from Spain and Graffigna from Argentina. The business also owns and administers several other wine brands worldwide, including Kenwood Vineyards and Dead Bolt in the US and Helan Mountain in China.

With over 2,000 employees based across five continents, Pernod Ricard Winemakers is dedicated to producing high-quality, premium wines and setting the benchmark for innovation in the winemaking world.

### Queensland Urban Utilities—water distribution and retail

Queensland Urban Utilities is a distributor-retailer/service provider for water in South East Queensland. The organisation is responsible for delivering drinking water, recycled water and sewerage services to over 1.4 million customers in South East Queensland. Operational excellence at Queensland Urban Utilities demands innovation to achieve outcomes at the lowest long-term cost, a goal that led to the opening of an Innovation Centre, a dedicated space to trial emerging technology and collaborate with R&D partners such as the University of Queensland.

Queensland Urban Utilities is an example for how an organisation has used a team of experts from different disciplinary backgrounds to develop an innovative and cost-effective solution outside the traditional engineering space. Rather than performing a traditional sewage treatment plant upgrade, the project reengineered 500 metres of waterway, controlling the sediment and nutrient loads through a green infrastructure solution that enabled Queensland Urban Utilities to manage increasing discharges from the

Beaudesert Sewage Treatment Plant. To prevent further sediment runoff, the project also included planting over 8,000 trees and shrubs along the riverbanks. Performed in partnership with the Department of Environment and Heritage and SEQ Catchments, the project costs of \$1 million were by far less than the traditional upgrade, which would have cost \$8 million.

### SEEK—technology

SEEK is a group of companies with a unified purpose to help people live more fulfilling and productive working lives and help organisations succeed. Over its employment marketplaces—including Australia, New Zealand, China, India, Brazil, Mexico, Indonesia, Nigeria, Bangladesh, Philippines, Vietnam, Thailand, South Africa, Kenya, Malaysia, Hong Kong and Singapore—SEEK receives more than 375 million visits to its sites every month and has over three million job opportunities available at any given time. Over its 17 years of operation SEEK continues to innovate in its products and services, and provide a culture of excellence and acceptance in its workplaces that celebrates the diversity of employees who contribute to the success of the organisation.

A recent example is a weekly Round-Up Email targeted at passive job-seekers, those not actively looking for work but open to the right opportunity. SEEK uses data analytics to scan more than five million user profiles every day to form an accurate view of each person's career intentions and likeliness to switch roles. The weekly Round-Up Email lets users know about highly relevant job opportunities, regardless of whether they are actively looking or not. For hirers, this surfaces the most relevant candidates to their jobs. For passive job seekers it generated an excess of 2.5 million extra job ad views and more than one million candidates who would otherwise not have found their new jobs.

## SocietyOne—peer-to-peer lending

SocietyOne is one of the most successful businesses in the new 'fintech' sector and Australia's largest peer-to-peer lending marketplace. The company connects investors and borrowers through an online platform to 'get a better deal for both sides'. Its lower operating cost in comparison to traditional lenders, like banks, means it can share significant savings, giving borrowers better credit rates and investors better returns.

Described by some as 'the Uber of banking', SocietyOne evaluates loan requests from individuals and lists those that meet their credit criteria on their platform, with any personal identifiable information removed. Private and institutional investors can browse these loan requests and build a diversified portfolio through investing in (parts of) individual lending requests. The salient innovation lies in how borrowers and investors are connected: investors effectively bid their rates for a given loan request. SocietyOne provides a representative example of a new generation of online-powered and community-centred businesses, such as Uber or AirBnB, which are stirring up many traditional markets.

## Southern Innovation—radiation detection technology

Born out of a university research project, Southern Innovation develops, markets and licenses patented pulse processing technologies, under the name SITORO®, for the rapid, accurate detection and measurement of radiation. Its original purpose was the rapid detection of legacy landmines but provides a much wider field of application in areas such as airport baggage screening, oil exploration, mineral analysis and the early detection of cancer. The company provides an example for a highly technology-driven start-up business and its journey of commercialisation in different areas of application.

Southern Innovation's technology is currently used in many world-class synchrotron facilities worldwide, including the Australian Synchrotron, the Cornell High Energy Synchrotron Source, the Canadian Light Source, Synchrotron Soleil, the European Synchrotron Radiation Facility, and the National Synchrotron Light Source. Southern Innovation has also launched a joint venture, LSI Scanning, with the Little Group using the technology for air cargo scanning and is developing enhanced radiation-based sensing capabilities for the mining and mineral processing industries, working with both OEMs and mining companies.

## Woodside—oil and gas

Woodside is an Australian-based oil and gas company with a global presence, recognised for its world-class capabilities—as an explorer, developer, producer and supplier.

Woodside is Australia's most experienced LNG operator and largest independent oil and gas company, with world-class liquefied natural gas assets in the north-west of Australia, including the North West Shelf Project and Pluto LNG.

The company's exploration portfolio includes emerging and frontier provinces in Australia and the Asia-Pacific region, the Atlantic margins and Latin America and Sub-Saharan Africa and significant interests in high-quality development opportunities.

Technology and innovation are essential to unlocking future growth and commercialising assets. Woodside's technology strategy is focused on gaining competitive advantage through innovative solutions to business problems. The company is pioneering remote support and the application of cognitive computing, artificial intelligence and advanced analytics in its operations.

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# About Securing Australia's Future

In June 2012 the Australian Government announced *Securing Australia's Future*, a \$10 million investment funded by the Australian Research Council in a series of strategic research projects. Projects are delivered to the Commonwealth Science Council by the Australian Council of Learned Academies (ACOLA) via the Office of the Chief Scientist and the Australian Chief Scientist.

*Securing Australia's Future* is a response to global and national changes and the opportunities and challenges of an economy in transition. Productivity and economic growth will result from: an increased understanding in how to best stimulate and support creativity, innovation and adaptability; an education system that values the pursuit of knowledge across all domains, including science, technology, engineering and mathematics, the humanities and social sciences; and an increased willingness to support change through effective risk management.

Six initial research topics were identified:

- i. Australia's comparative advantage
- ii. STEM: Country comparisons
- iii. Smart engagement with Asia: leveraging language, research and culture
- iv. The role of science, research and technology in lifting Australian productivity
- v. New technologies and their role in our security, cultural, democratic, social and economic systems
- vi. Engineering energy: unconventional gas production

Five further research topics have been identified:

- vii. Australia's agricultural future
- viii. Delivering sustainable urban mobility
- ix. Translating research for economic and social benefit: country comparisons
- x. Skills and capabilities for Australian enterprise innovation
- xi. Business diasporas in Australia: maximising people to people relationships with Asia

The Program Steering Committee responsible for the overall quality of the program, including selection of the Expert Working Groups and the peer review process, is comprised of three Fellows from each of the four Learned Academies:

Professor Michael Barber FAA FTSE  
(Chair)

Mr Dennis Trewin AO FASSA  
(Deputy Chair—Research)

Professor James Angus AO FAA

Dr John Burgess FTSE

Professor Bruce Chapman AO FASSA

Professor Ruth Fincher AM FASSA

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