ENGINEERS AUSTRALIA

Skilling Tasmanian Engineers to compete in Global Supply Chains

Final report

"If we can't compete everywhere, we can't compete anywhere"

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Disclaimer

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Executive Summary

This report has been prepared for Engineers Australia, Tasmania. It has been funded by Skills Tasmania under a workforce development grant. The aim of this report is to build an understanding of the role of engineering in global supply chains and to pilot skills based solutions to meet identified need. The work has involved desktop research, industry consultations and focus groups and interviews with educators and other stakeholders.

There are six discreet skill sets that are required by engineers to work in global supply chains. These skills are in addition to an engineering qualification. They are:

1. A capacity for management and oversight of projects and supply chains
2. Technical and digital proficiency
3. Skills in collaboration and cooperation
4. Cross-cultural awareness
5. An ability to specialise and cater to "niche" markets
6. Adaptability, flexibility and a capacity for innovation

About this project

The Tasmanian engineering profession is competing, collaborating and supplying services to a global market, where it is integrated into sophisticated supply chains across a range of industry settings. This requires broadening and deepening of the skills of engineers to enable them to play specialist roles within a supply chain.

The objective of this project is to understand the skills issues faced by the profession in this international context and to develop a structured skills framework and associated skills related responses to assist the profession to enhance its reach into global supply chains.

Engineers Australia has engaged consultants, The Work Lab in conjunction with Stenning & Associates to assist it with conducting this project.

The first phase of the project is to understand the current and emerging environment faced by engineers and to document and validate the skills required to effectively operate in this environment. This understanding has been developed through extensive desktop research and validated through in depth interviews with leading engineering businesses in Tasmania.

What will the engineering profession look like in Tasmania in 5 years?

The engineering profession has changed significantly in the last decade. Every business surveyed (~60) during the development of the workforce development plan[1] reported significantly changing their business model post global financial crisis. Consultations would suggest that the private sector is already operating in integrated global supply chains and can forsee this model continuing to be normalised in the future. The public sector engineers are less certain of their future.

What is clear is that the... ***"old pure engineer is not valid any more. Young engineers need to be slick and adaptable with a broad knowledge of many things and the ability to jump around. Need to be able to take a brief and be involved with it to delivery.***

Where has the profession come from?

Accurate and comprehensive descriptions of the business models within which engineering expertise has traditionally been required, particularly in Tasmania, are few. Nevertheless, a number of broad trends by which engineering business models have traditionally been characterised are evident in these limited accounts.

Traditionally, firms within which engineers and engineering skillsets were required adopted business models which were labour intensive but required limited technological capital.[2] An absence of advanced technology from workplaces[3] allowed the majority of businesses' activities to be performed by a large workforce of low or semi-skilled workers with limited technical or technological capabilities.[4] "Employability skills" in management, innovation and interpersonal relations were rarely required of workers within these business models.[5]

Some level of skill variation existed between individuals with engineering expertise. Generally, engineers have been described as engineering associates, engineering technologists or professional engineers.[6] Associates require the lowest level of

1 Workforce Development Plan 2016-19, Engineers Australia
2 K. Woolley and R. Eversole, "Manufacturing Industry Innovation: Future Directions for North West Tasmania" (report, University of Tasmania's Institute for Regional Development, February 2013), 40.
3 Ibid 4.
4 Ibid 8; see also Productivity Commission, "Digital Disruption: What do governments need to do?" (research paper, Productivity Commission, 2016), 40.
5 See, e.g., The Australian Industry Group, "Progressing STEM skills in Australia" (report, Australian Industry Group, March 2015), 5.
6 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study" (report, Australian Workforce and productivity Agency, June 2014), 7; A. Kaspura, "The Engineering Profession: A Statistical Overview" (report, ninth edition, Institution of Engineers Australia, July 2012), 1-2.

tertiary qualification and tend to undertake practical tasks, often involving the use and maintenance of equipment;[7] technologists require a moderate level of tertiary qualification, and tend to focus on the development and operation of specific technologies;[8] and professionals require the highest level of formal qualification, and undertake less practical tasks such as project management and design.[9] Nevertheless, despite clear differentiation between roles within the engineering profession and skills required of these roles, business activities revolved around low-skilled labour, for example construction activity.

Business activities were clearly defined and circumscribed

Firms within which engineering expertise has traditionally been required have tended to deliver one specific isolated good or service, generally within clearly defined contexts and without significant variation in tasks undertaken or the manner in which they were performed. Innovation was "not a term commonly used", although it remained "present" in business operations, with problems "researched and worked on until a solution was found".[10] Engineering professionals were skilled in "component-level modelling", but lacked an understanding of "uncertainty, integration and complex systems".[11]

Business operations were isolated and localised

Engineers have traditionally operated within "vertically integrated [business] structure[s]",[12] wherein individual firms deliver each "layer" of a particular project, good or service from conception to completion.[13] The supply chains connecting businesses' products and activities have predominantly been localised or national, with the bulk of goods produced sold within domestic markets.[14]

Collaboration between firms was limited

Firms throughout the private sector in Australia in general, and the industries within which engineering skills are required in particular, have traditionally engaged in "relatively weak levels of collaboration".[15] The localisation of supply chains and predominance of domestic markets within firms' customer bases created a perception that local stakeholders operating within similar or identical markets were competitors rather than potential collaborators.[16] Where collaboration between firms did occur, it was "mostly within existing supply chains", or with suppliers of the (limited) capital equipment required by a firm's activities.[17]

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7 Kaspura, "The Engineering Profession", 2.
8 Ibid.
9 Ibid 1-2.
10 Woolley and Eversole, "Manufacturing Industry Innovation", 9.
11 R. King, "Engineers for the Future: addressing the supply and quality of engineering graduates for the 21st century" (report commissioned by Australian Council of Engineering Deans, Australian Learning and Teaching Council, Australasian Association for Engineering Education, and Australian Academy of Technical Sciences and Engineering, October 2008), 62.
12 Productivity Commission, "Digital Disruption", 40.
13 Ibid; see also Woolley and Eversole, "Manufacturing Industry Innovation", 8-9.
14 Woolley and Eversole, "Manufacturing Industry Innovation", 9.
15 Australian Industry Group, "Joining Forces: Innovation Success Through Partnerships" (report, Australian Industry Group, September 2016), 18.
16 Ibid 21.
17 Ibid 16.

What are the emerging business models?

The business models within which engineering expertise is required are undergoing a process of "evolution" or "disruption" as a result of the development and widespread adoption of advanced digital technology,[18] with "new, digitally-enabled business models … emerging" across the industry,[19] and future engineers poised to fill roles as "specialists", "integrators" and "change agents".[20] The digitisation and corresponding globalisation of the economy have had two key effects on the operation of the markets within which engineers operate, both a consequence of the increased ease with which firms may now communicate, collaborate and trade with each other.[21]

1. Business activities are more distributed and decentralised[22] firms are better able to outsource work where it is most efficient or productive to do so,[23] and the supply chains within which they operate have accordingly become increasingly globalised.[24]
2. Partially as a result of trends towards decentralisation, firms are more regularly required and better able to work collaboratively within networks, "clusters" or consortia,[25] acting either as "organising agents"[26] or as deliverers of individual, specialised supply chain components.
3. Supply chains are globalised and industry activities are decentralised. The development of advanced digital technology and rapid internationalisation of trade have allowed businesses to develop commercial advantages by decentralising and globalising their activities. Most significant to the engineering industry is firms' increased range of choice in decisions regarding who they work with.

These macro changes have a number of flow on effects on the engineering labour market with employees being drawn from a broader pool of potential candidates. As "the need for workers to be co-located is reduced", firms are increasingly likely to introduce "telecommuting" or other flexible working arrangements,[27] limiting geographical barriers to employment of individuals with a desired skillset; subcontractors have also become "easier to locate and organise" as a result of digital technologies,[28] allowing firms to "work as an organising platform" for activities performed by a variety of commercial entities.[29]

Firms are also increasingly able to obtain equipment or expertise externally,[30] outsourcing tasks or aspects of projects where it is profitable to do so.[31] "Companies no longer have to rely on services, repairs, maintenance and new equipment being completed internally by employees",[32] and "supplying firms … can in principle be located anywhere".[33] This flexibility in both employment and outsourcing is global;[34] production is often likely to be outsourced offshore to locations where labour costs are low[35] or required skills are available.[36]

Collaboration between firms in different locations is also possible, and occurs between both separate commercial entities and differently located branched of the same firm, with firms tending to expand by "having more workplaces … with fewer people in each location".[37]

Firms' increased capacity to trade and communicate with external partners has led to the delocalisation, and often globalisation, of supply chains within which their products and services exist.[38] The production of goods or delivery of services is "carried out wherever the necessary skills and materials are available at competitive cost and quality",[39] with "research, development, design, assembly, production

18 See, e.g., Engineering Education Australia, "Engineering Education Australia" (2015) <http://eeaust.com.au/?utm_source=EEA-Professional-Development-homepage-banner-2016&utm_medium=EEA-Professional-Development-homep>; Australian Industry Group, "Joining Forces", 5 ; Australian Industry Group, "Tackling Foundational Skills in the Workforce" (report, Australian Industry Group, January 2016), 7.
19 Productivity Commission, "Digital Disruption", 19; see also Australian Industry Group, "Tackling Foundational Skills in the Workforce", 9; Australian Industry Group, "Joining Forces", 7, 9; Australian Workforce and Productivity Agency, "Engineering Workforce Study", 70.
20 King, "Engineers for the Future", 8.
21 See, e.g., Productivity Commission, "Digital Disruption", 53.
22 Ibid; see also
23 See, e.g., Australian Industry Group, "Tackling Foundational Skills in the Workforce", 9; Australian Workforce and Productivity Agency, "Engineering Workforce Study", 28 ; P. Langford, "Attracting and Retaining People Employed in Australia in Science, Engineering and Technology (SET) Occupations - Literature Review", (report commissioned by Department of Education, Science and Training, August 2006), 19; P. Windle, "IBISWorld Industry Report M6923: Engineering Consulting in Australia" (report, IBISWorld, November 2016), 9; Productivity Commission, "Digital Disruption", 6, 35, 47.
24 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study", 28; Productivity Commission, "Digital Disruption", 48, 54.
25 Productivity Commission, "Digital Disruption", 46.
26 Ibid 64.
27 Ibid 95.
28 A. Kelly, "IBISWorld Industry Report E: Construction in Australia" (report, IBISWorld, August 2016), 12.
29 Productivity Commission, "Digital Disruption", 48.
30 See, e.g., Tasmanian Department of State Growth, ***Advanced Manufacturing*** (29 July 2015) Tasmania – Gateway of Opportunities <http://cg.tas.gov.au/home/investment_attraction/investment_opportunities/investment_opportunities2/advanced_manufacturing>.
31 Ibid 35.
32 Woolley and Eversole, "Manufacturing Industry Innovation", 13.
33 Productivity Commission, "Digital Disruption", 48.
34 Ibid.
35 Australian Industry Group, "Tackling Foundational Skills in the Workforce", 9.
36 Productivity Commission, "Digital Disruption", 6, 48.
37 Ibid 57.
38 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study", 28; Productivity Commission, "Digital Disruption", 35, 48, 54; Tasmanian Government, "Tasmania's Place in the Asian Century White Paper" (March 2013), 17, 31, 45.
39 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 28.

of parts, marketing and branding stages of goods … each taking place in a different part of the world";[40] one finished product or service may contain component elements from all over the world.[41] Firms are accordingly more likely to operate within a "horizontal structure" wherein individual firms provide components of a good or service than within traditional, "vertically integrated" structures.[42] They are also more likely to provide value adding services "pre- and post-production" – these have become more important.[43]

Notably, trends towards the globalisation of production and of resulting supply chains are not universally observable within the industry. Within some sectors, such as building and construction, international trade makes "only a minor contribution to total revenue or domestic demand",[44] and globally observable patterns of firm distribution, including trends towards firms operating out of several small, separately located offices, "have yet to be observed in Australia".[45] Nevertheless, the consistency of global trends towards these new business models, coupled with their existing significance to other sectors,[46] means they are important.

More firms are participating in integrated service delivery

Firms providing engineering services are increasingly likely to participate in some form of end-to-end service delivery,[47] "a model where the contractor delivers the project from start to finish, including design, engineering, construction, operations, risks and project management".[48] This "provision of single-service solutions" has come to be "expected" of firms in the industry,[49] and allows firms to develop competitive advantages associated with the operation of an economy of scale.[50] Participation in traditional end-to-end service delivery is generally undertaken by larger firms which have better resources. However, smaller firms are often increasingly likely to participate in some form of integrated service delivery, either in active collaboration with others in a consortium, or within a horizontally integrated supply chain.[51]

The market is dominated by large firms

Traditional end-to-end service delivery, wherein projects are coordinated and completed in-house by one firm, is undertaken predominantly by large, (often) multinational corporations. These firms' prominence within domestic markets has increased significantly over the past five years,[52] as the result of a process of market consolidation driven by larger firms "increasingly looking to forge strategic alliances or mergers with global partners",[53] and a growing prevalence of "foreign acquisition of domestic firms".[54] This market consolidation appears likely to continue.[55]

Significant size and a ability to compete internationally have a variety of commercial advantages for firms in the engineering industry. An international parent company renders firms better able to "access advanced technology … [and] increased financial resources",[56] rendering their domestic operations more competitive;[57] it also allows firms to access a larger and more diverse client base,[58] enabling them to "generate a steady income stream" and thereby "withstand periods of economic uncertainty".[59] Significantly, operation on a larger scale grants firms the capacity to provide end-to-end-service delivery in-house and to access a variety of corresponding commercial benefits.[60] "Large, multistage projects … are highly profitable",[61] but are generally only able to be designed and managed by "large firms with sufficiently diverse capabilities",[62] which are able to "integrate the necessary engineering disciplines under one roof".[63]

40 Ibid.
41 Ibid 29; see also Tasmanian Department of State Growth, ***Advanced Manufacturing***; Woolley and Eversole, "Manufacturing Industry Innovation", 14.
42 Productivity Commission, "Digital Disruption", 40.
43 Ibid 5, 37.
44 Kelly, "Construction in Australia", 18.
45 Productivity Commission, "Digital Disruption", 57.
46 See, e.g., Kelly, "Construction in Australia", 18.
47 Windle, "Engineering Consulting in Australia", 7.
48 Ibid 30.
49 Kelly, "Construction in Australia", 33.
50 Windle, "Engineering Consulting in Australia", 10.
51 See, e.g., Kelly, "Construction in Australia", 33.
52 Windle, "Engineering Consulting in Australia", 5, 7.
53 Ibid 21.
54 Ibid 16, 21.
55 Ibid 9.
56 Ibid 21.
57 Ibid 21.
58 See, e.g., Windle, "Engineering Consulting in Australia", 9.
59 Ibid 19.
60 See, e.g., Windle, "Engineering Consulting in Australia", 11, 14, 19.
61 Ibid 19.
62 Ibid 14.
63 Ibid 8.

These companies either provide services required by large projects themselves or engage a variety of subcontractors, often in lower cost countries,[64] to provide them.[65]

Smaller firms are increasingly likely to work collaboratively

Unlike their larger, multinational counterparts, smaller firms lack the capacity to provide end-to-end service delivery in-house. Small firms face a variety of obstacles to competitiveness and endurance within the engineering industry,[66] arising in large part from the increasing prominence of large, internationally owned or operated enterprises within domestic markets.[67] These firms tend to employ staff with a range of qualifications significantly more limited than that found within a larger firm,[68] and unable to do everything in-house as a result. In contrast to large firms' "monolithic capability to 'do it all'",[69] smaller firms accordingly find it difficult to "acquire and retain internally all the knowledge, skills and resources" required of the large-scale project delivery that grants firms of more significant size a competitive advantage.[70]

Instead, smaller firms with the individual capacity to deliver specialised services[71] are increasingly likely to collaborate actively with each other in the process of service delivery, effectively "combining with other firms and [thereby] expanding their [collective] capabilities".[72] This collaboration is often formalised in "project consortia" wherein "engineers, financiers and construction firms … bid together" for tenders and are thereby able to "win contracts … on substantial projects" which would otherwise remain inaccessible.[73] Sometimes they also do subcontracting.[74] Small firms are significant within the industry, with approximately 96% of consultancy firms employing fewer than 20 people;[75] these trends are accordingly likely to be relevant to engineers working into the future.

Collaboration is inherently beneficial to the development of firms' competitive advantage

Cooperative activity, particularly collaborative efforts towards innovation, provides inherent benefits for firms. In isolation, however, innovative practices appear to be more difficult to develop.[76] "Collaborative innovation is associated with higher performance",[77] as it allows for the development of efficient business practices by permitting companies to "invest in and focus on what [they are] good at",[78] and "provides a mechanism for sourcing the widest possible range of ideas and resources to build a firm's competitiveness."[79] Additionally, healthy collaborative relationships are likely to lead to "a stream of further projects",[80] resulting in a multiplication of cooperative innovation's initial positive effects.

Tasmanian firms face unique challenges

In general, "it is more difficult for small-to-medium-sized enterprises … to partake in global supply chains", as "many international businesses do not wish to deal with [firms of this size] … and [these firms] may find themselves vulnerable to decisions by larger firms in the chain".[81] These obstacles are of particular significance to Tasmanian firms,[82] which tend to be small; for example, over 80% of North West Tasmanian manufacturing businesses are "micro-enterprises".[83] At the same time, a capacity to compete globally is often critical to these firms' survival, as the local market for engineering expertise is relatively small, with Tasmania home to only 1.4% of Australia's total of engineering consultancy firms, rendering it an industry "cold zone".[84] "Many of the state's largest businesses compete globally, and will only stay in Tasmania if they remain globally competitive".[85]

Tasmania's geographical distance from significant engineering markets also gives rise to unique challenges for firms operating within the state.[86] Despite the increasing viability of technologically enabled collaborative and globally distributed

64 See, e.g., Windle, "Engineering Consulting in Australia", 9.
65 Ibid 9, 20; see also Kelly, "Construction in Australia", 12, 33.
66 See, e.g., Windle, "Engineering Consulting in Australia", 22.
67 Ibid 11, 21.
68 King, "Engineers for the Future", 5.
69 Australian Industry Group, "Joining Forces", 7.
70 Ibid.
71 See, e.g., Windle, "Engineering Consulting in Australia", 14.
72 Ibid 11.
73 Ibid 22.
74 Ibid 20.
75 Ibid 19; see also Woolley and Eversole, "Manufacturing Industry Innovation", 27.
76 See, e.g., Australian Industry Group, "Joining Forces", 7; Woolley and Eversole, "Manufacturing Industry Innovation", 27.
77 Australian Industry Group, "Joining Forces", 5; see also Woolley and Eversole, "Manufacturing Industry Innovation", 27.
78 Australian Industry Group, "Joining Forces", 22.
79 Ibid 8.
80 Ibid 20.
81 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 29.
82 See, e.g., Tasmanian Government, "Tasmania's Place in the Asian Century White Paper", 17.
83 Woolley and Eversole, "Manufacturing Industry Innovation", 1.
84 Windle, "Engineering Consulting in Australia", 17; see also Kaspura, "The Engineering Profession", 18.
85 Tasmanian Government, "Tasmania's Place in the Asian Century White Paper", 21.
86 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study", 29.

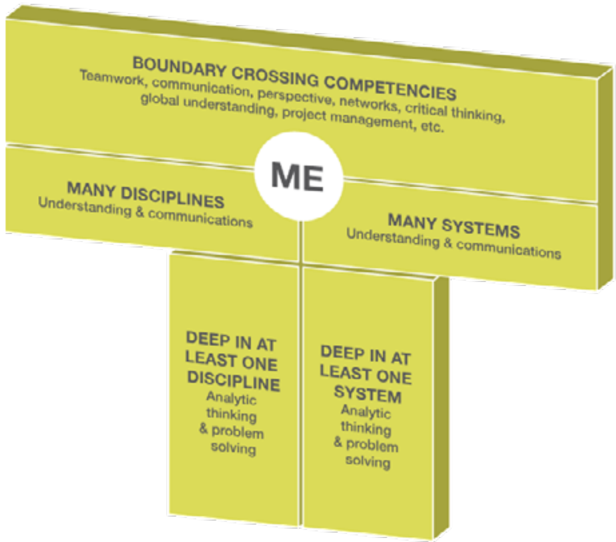
business operations, "physical co-location networks continue to matter".[87] A variety of engineering services and projects "continue to require on the ground attention",[88] with "proximity to rapidly developing communities" generating unparalleled commercial opportunities for firms in the industry.[89] Firms operating in similar fields are also more likely to "cluster",[90] working collaboratively with others in their region in the process of production or innovation.[91] Tasmanian firms, geographically unable to behave in this way are likely to be required to develop a competitive advantage in other areas.

What new or updated skills are required?

"Ultimately, Australia's competitiveness as a producer of high level and advanced engineering products and skills … will be shaped by the ability of its enterprises, educators and engineers to anticipate and effectively meet the engineering skills demands of the future."[92]

In order to remain competitive within global supply chains, Tasmanian engineers require a depth and breadth of knowledge and skills that enables them to engage productively with stakeholders in a globalised industry and to meaningfully value-add to the delivery of goods and services. These tasks necessitate the development of several key skills, including a capacity for management and oversight of projects and supply chains, skills in collaboration and cooperation, an ability to specialise and cater to "niche" markets, cultural sensitivity, specialised technical and technological skills, and a capacity to adapt, innovate and be flexible.

This is commonly referred to as a 'T Shaped' professional.[93]



A capacity for management and oversight of projects and supply chains

The evolution of horizontally integrated engineering supply chains is likely to require the development of advanced skills in management and oversight within the engineering profession.[94] As supply chains globalise, larger firms are more likely to provide the entirety of a particular good or service in house, with small to medium sized firms taking on specific, niche roles within a globalised supply chain; skills in project management are accordingly likely to increase in significance to engineers employed within both the former, as they are overseeing all components, and the latter, as they are collaborating with others in the supply chain. These capabilities are of particular importance to individuals working within firms acting as a supply chain's "organising platform", but are also likely to be valuable to firms engaged at other points of the supply chain, affording them an understanding of the structure within which their operations occur and the relationship between their work and that of other supply chain members. Although these skills are unlikely to be required of every professional engineer, it is important that these skills are evident within the team environment.

Emerging roles in project management and oversight are likely to require a set of skills that are reasonably specific, albeit difficult to quantify. This set of managerial capabilities includes "formal leadership skills in a technical context",[95] project management skills and tools,[96] "time, financial, labour and

87 Productivity Commission, "Digital Disruption", 54.
88 Kaspura, "The Engineering Profession", 85.
89 Windle, "Engineering Consulting in Australia", 18.
90 Productivity Commission, "Digital Disruption", 54.
91 See, e.g., Woolley and Eversole, "Manufacturing Industry Innovation", 25.
92 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 10.
93 From Michigan State University, ***What is the "T"?***, T-Summit 2016, <tsummit.org/t>
94 See, e.g., Langford, "Attracting and Retaining People Employed in Australia in Science, Engineering and Technology (SET) Occupations", 26; Australian Workforce and Productivity Agency, "Engineering Workforce Study", 70, 71.
95 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 71.
96 See, e.g., Construction Industry report 21, 33

consortium management skills",[97] skills in "planning, organising, controlling leading, directing, allocating resources, communicating and coordinating",[98] an ability to maintain a cross-disciplinary overview of the various components of complex "mega projects",[99] and general "people-skills".[100]

Technical and digital proficiency

The evolution of a digitised and globalised economy and industry firms' resulting reliance upon advanced, often digital technology require an "increasingly … sophisticated" skillset of individuals operating within the engineering profession.[101] The technical proficiencies required of engineers competing within global supply chains include both general competency in the use of digital technology, and specific, practical skills pertaining to the operation of particular technology and equipment.

General digital literacy is required of every individual working in the profession,[102] with computer technology a "necessary [asset] for even the smallest players in the industry."[103] Although business models within which engineering expertise is required remain labour-intensive, "capital intensity is expected to have increased … over the past five years", as result of the introduction of "sophisticated modelling and communications technology".[104] The capacity to productively utilise this technology is essential to every individual working in the industry.

Deeper, more specific technical skills, although not required of every industry professional, are likely to be necessary to the development of "strong and integrated engineering teams".[105] Individuals employed in the para-professional roles of engineering technologist and engineering officer, positions "described as … more 'practical' and 'hands-on' … than those of professional engineers",[106] are likely to be best placed to meet this demand.

Skills in collaboration and cooperation

The development of globally integrated supply chains is increasingly rendering "the social and technical … intertwined, inseparable realities of practice"[107] for individuals operating within the engineering profession. Collaboration on both a person-to-person and firm-to-firm level has become more achievable and more commercially beneficial, with firms more likely to work in consortia to deliver projects or to participate in global supply chains. This cooperative work is often technologically enabled or focusing on highly technical work. Professional engineers will accordingly require a generalised capacity to communicate and to "work well with others",[108] as well as a more complex skillset including the ability to operate within digital and technical frameworks for collaboration and communication.[109]

Cross-cultural awareness

Increasingly, the business models within which engineering expertise is required bring together stakeholders in "[a] variety of geographical areas",[110] encompassing several distinct cultures. In order for cross-cultural collaboration to be productive and mutually beneficial, firms require an understanding of both hard laws and soft cultural rules in operation in the locations in which they seek to work.[111]

Hard laws with which firms seeking to engage in cross-cultural collaboration must comply include both local standards, such as laws pertaining to "workplace relations and corporations",[112] and international accreditation standards, which "large, international engineering consultancy firms" are already able to leverage in order to access global tendering opportunities.[113]

Compliance with softer social standards, while more difficult to define, is likely to entail general cultural awareness and understanding, as well as an appreciation of the requirements of a social licence to operate within particular cultures.[114] If successfully developed, this type of softer cultural awareness will aid firms in the establishment of a "cultural fit" essential to the success of business partnerships.[115]

An ability to specialise and cater to "niche" markets

Increasingly, both individual engineers and the firms within which they are employed require "a depth of

97 Ibid 21.
98 King, "Engineers for the Future", 71.
99 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 70, 7.
100 See, e.g., King, "Engineers for the Future", 72.
101 Australian Industry Group, "Tackling Foundational Skills in the Workforce", 4; see also Productivity Commission, "Digital Disruption", 80; Woolley and Eversole, "Manufacturing Industry Innovation", 32.
102 See, e.g., Productivity Commission, "Digital Disruption", 82.
103 Windle, "Engineering Consulting in Australia", 26.
104 Ibid.
105 King, "Engineers for the Future", 12.
106 Ibid.
107 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 71.
108 Ibid 7.
109 Ibid 71.
110 Windle, "Engineering Consulting in Australia", 28.
111 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study", 70.
112 Productivity Commission, "Digital Disruption", 48.
113 Windle, "Engineering Consulting in Australia", 28.
114 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 71.
115 Ibid 27.

specialist knowledge and skills"[116] and an ability to fill a particular "niche" in the market within which they operate.[117] This trend towards specialisation is a result of the "increasing technological complexity" of projects requiring engineering expertise[118] and the development of globalised, horizontally integrated supply chains, within which each component product or service is produced by one firm. It is particularly significant for smaller firms, which are unable to "exploit economies of scale" in order to provide end-to-end service delivery in-house,[119] and are also more likely to be "aware of niches or emerging markets than are larger firms".[120]

Firms, particularly those of smaller size, are accordingly likely to be providing "niche, high-value products" or services,[121] such as "logistics and transport design, chemical processing, engine design, and building design".[122] To work within their business models, professional engineers will require "a depth of expertise in at least one particular field"[123]. Notably, trends towards specialisation are accompanied by a need for broader, cross-disciplinary capabilities,[124] as specialist operations are generally conducted either directly collaboratively or within a supply chain. "The educational preparation of the next generation of professional engineers [thus] needs to be both deeper … and contextually broader".[125]

Adaptability, flexibility and a capacity for innovation

The rapid evolution of skillsets required by professional engineers and the contexts within which those skills will be most frequently applied is likely to continue as technology continues to develop.[126] Engineering professionals and the firms within which they operate are accordingly likely to apply their skills within an increasing variety of contexts,[127] in collaboration with a broadening range of partners.

Tasmanian engineers are accordingly likely to be required to work within a variety of contexts, with evolving tools and technology, and in collaboration with a range of partner enterprises and agencies, over the course of their professional lives. Both this evolving business environment and the inherent commercial benefits of innovative practices require professionals with a range of skills, including "adaptability, flexibility, resilience, creative and design thinking",[128] an ability to "define and solve problems elegantly and cost-effectively",[129] the capacity to "[tackle] unseen tasks",[130] and "some level of commercial acumen and flexibility".[131]

116 Ibid 70.
117 See, e.g., Windle, "Engineering Consulting in Australia", 21, 27; Woolley and Eversole, "Manufacturing Industry Innovation", 13.
118 Windle, "Engineering Consulting in Australia", 10.
119 Ibid 26.
120 Woolley and Eversole, "Manufacturing Industry Innovation", 24.
121 Windle, "Engineering Consulting in Australia", 26.
122 Ibid 14.
123 Productivity Commission, "Digital Disruption", 81; see also Australian Workforce and Productivity Agency, "Engineering Workforce Study", 7.
124 See, e.g., Australian Workforce and Productivity Agency, "Engineering Workforce Study", 7; King, "Engineers for the Future", 9.
125 King, "Engineers for the Future", 9.
126 See, e.g., Productivity Commission, "Digital Disruption", 84.
127 See, e.g., Productivity Commission, "Digital Disruption", 84; King, "Engineers for the Future", 9.
128 Australian Workforce and Productivity Agency, "Engineering Workforce Study", 29.
129 Ibid 7.
130 King, "Engineers for the Future", 62.
131 D. Edwards and T. F. Smith, "Supply, demand and approaches to employment by people with postgraduate research qualifications in science and mathematics: Final Report" (report, Department of Education, Employment and Workplace Relations, December 2008), 13.

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