ENGINEERS
AUSTRALIA

The Digital Economy

Engineers Australia submission

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Introduction

The Institution of Engineers Australia (Engineers Australia) is the peak body of the engineering profession. We are a member-based professional association with over 100,000 individual members. Established in 1919, Engineers Australia is a not-for-profit organisation, constituted by Royal Charter to advance the science and practice of engineering for the benefit of the community.

Engineers Australia views the burgeoning Digital Economy from a diversity of engineering perspectives. The organisation has multiple and varied contributions to make in relation to the Government's consultation on the Digital Economy Strategy. This submission has been developed in collaboration with the association's College for Information Telecommunications and Electronics Engineering (ITEE). The ITEE has the Digital Economy Strategy at the forefront of mind, reflecting the effect of digitisation on society and how engineers will contribute in a positive manner. The ITEE College encompasses disciplines that are integral to complex engineering products and systems, such as communications, manufacturing, information transfer and infrastructure.

From a broad perspective, Engineers Australia considerations on the Digital Economy involve:

- Technology trends, complex systems development and the evolution of the underpinning telecommunications and data processing/storage infrastructure enabling the Digital Economy;
- Continued education and skills development through Australian and overseas universities and vocational education institutions. Curriculum development, delivery mechanisms, independent regulation and quality control of engineering courses that will support the Digital Economy Strategy; and
- Continued Professional Development (CPD), Chartered Engineer and national registration programs to ensure that engineering technical expertise remains up to date and in-line with the needs articulated in the Digital Economy Strategy.

Engineers play a primary role in developing the digital strategies of both public and private sector institutions, setting the conditions for the digital economy to prosper. Engineers are the designers and implementers of the technologies and complex systems that enable and support the digital economy, participating and leading efforts from technology conception, through design, implementation, operation and environmentally sound disposal. Engineers are uniquely positioned to offer valuable ideas and identify important priorities that Australia's Digital Economy Strategy must articulate.

Engineering skills is a crucial component for the development of the complex systems that enable and support the Digital Economy. Engineering aids the empowerment of individuals, businesses, and government in fully exploiting Digital Economy opportunities.

Professional engineering input is required at many different levels, and in a multitude of ways, in order to crystallise the vision, strategy, and delivery of a robust national digital economy.

Engineers Australia is able to muster significant impartial expert professional engineers who can contribute to these processes. Government is encouraged to consider Engineers Australia a key strategic stakeholder for consultation and a reliable source of sound and impartial advice on matters of the Digital Economy, Telecommunications Infrastructure, STEM education and professional registration, skills development, and cyber and systems security.

To discuss the contents of this submission further, please contact Jonathan Russell, National Manager for Public Affairs, on (02) 6270 6565 or by email at JRussell@engineersaustralia.org.au.

Answers to consultation questions

This Chapter addresses the specific questions posed in the Government's consultation paper, "The Digital Economy: Opening up the conversation." Most, though not all, questions are addressed.

1. How are advances in digital technology changing the way you work, your industry and your community?

Engineers Australia is well positioned to address this question generically. Roles in almost every field of engineering endeavour are disrupted by productive advances in digital technology.

Applications and service platforms facilitated by core ICT technologies, network connectivity, available computation and storage technologies, are infiltrating almost every corner of engineering activity:

- Designing,
- Modelling,
- Manufacturing,
- Consulting,
- Collaborating, and
- Educating.

The engineering workplace is increasingly distributed and mobile, enhancing the capacity for global collaboration for innovation, sharing of ideas and provision of services. However, with diversity and globalisation comes variability in professional standards and the risk of reduced quality and weakened regulation and control. That could jeopardise the safety and fitness for purpose of engineered products.

With low barriers to entry for many digital technology companies globally, the risk of external disruption is high. Australia must position itself to exploit a significant proportion of the opportunities presented, to balance the volume of disruption threat our enterprises face.

One significant area where digital technology is broadly changing work, industry, and the community, is that of Artificial Intelligence (AI) technologies. A Stanford University report, *Artificial Intelligence and life in 2030*, identifies several ways in which the future of AI will affect all areas of the community, including the following:[1]

- Transportation, including autonomous and connected vehicles.
- Home/Service Robots to deliver packages, clean offices and enhance security.
- Healthcare, such as personal monitoring devices, mobile applications, electronic health records, developments in surgical robots to assist in medical procedures, service robots supporting hospital operations.
- Education, providing personalisation for students at scale through interactive machine tutors for teaching all disciplines and online learning.
- Low-resource and at-risk communities, using data mining and machine learning to create predictive models to help government agencies address issues such as prevention of lead poisoning in at-risk children and distribution of food efficiently.
- Public safety and security, deploying AI technologies for border administration and law enforcement, including improved cameras and drones for surveillance, algorithms to detect financial fraud, and predictive policing.
- Employment and workplace, where AI is poised to replace people in certain kinds of jobs. However, in many realms, AI will likely replace tasks rather than jobs in the near term, and will also create new kinds of jobs. AI will also lower the cost of many goods and services, effectively making everyone better off.
- Entertainment, where AI will increasingly enable entertainment that is more interactive, personalised, and engaging.

[1] Artificial Intelligence and Life in 2030 - Stanford University 2017, *One Hundred Year Study on Artificial Intelligence (AI100)*, Stanford University, viewed 1 November 2017, https://ai100.stanford.edu/.

2. What is your vision for an Australia that thrives in a digital economy? Where would you like to see Australia in five, 10 and 20 years' time?

Engineers Australia would like to see a nation that fully embraces its intellectual capacity for creativity, innovation, and application development. This can only occur in significant ways in a regulatory and financial environment that is innovation and development friendly. We must strive to be a nation that spends the bulk of our intellectual effort on considering possibilities, and not setting barriers or hurdles.

3. What is the role of government in achieving that vision?

Australian governments can assist in achieving productive outcomes by helping to coordinate efforts, and ensuring that government spending is determined with strategic national interests in mind. Government can establish incentives and recognition for engineering activities and applications.

State, territory or federal governments have the responsibility for setting laws and regulations and they need to become more agile and diligent in delivering frameworks that support the changes that technology introduces in traditional business models. There is a need to protect current business models while understanding that things can and will be done in different ways in the future. In essence, governments must be able to address the impacts to the legal framework from disruptive technologies.

The Australian government can actively encourage science and engineering progress in the nation. We need to ensure that leadership of our national infrastructure is driven by board members and CEOs with strong technical credentials. Too many leaders in such positions publicly exhibit core weaknesses in their technical understanding on basic matters in what are for many highly technical fields of endeavour.

Governments have a very important role in developing the next generation of engineers who are essential to the digital economy. This includes factors such as Science, Technology, Engineering and Mathematics (STEM) in schools and harnessing the efforts of more women who currently form just 12 per cent of the profession. These issues are explored further at Question 20.

To help address concerns about the individual and societal implications of rapidly evolving (and anticipated broadly disruptive) AI technologies, there are three general policy recommendations drawn from a Stanford University report, *Artificial Intelligence and life in 2030*.[2]

1. Define a path toward accruing technical expertise in AI at all levels of government. Effective governance requires more experts who understand and can analyse the interactions between AI technologies, programmatic objectives, and overall societal values.
2. Remove the perceived and actual impediments to research on the fairness, security, privacy, and social impacts of AI systems.
3. Increase public and private funding for interdisciplinary studies of the societal impacts of AI. As a society, we are underinvesting resources in research on the societal implications of AI technologies. Private and public dollars should be directed toward interdisciplinary teams capable of analysing AI from multiple angles. Research questions range from basic research into intelligence to methods to assess and affect the safety, privacy, fairness, and other impacts of AI.

Note that a focus on AI in the above paragraph should be read in terms of a key example, and not a suggestion of exclusive focus on this area of potentially disruptive technology. Many other areas of emerging technology also need to be fully considered from a government policy perspective. Machine vision technologies, Internet of Things (IoT), quantum computing and communications, financial exchange technologies, augmented and virtual reality environments, and robotics and automation, are other notable examples.

[2] Artificial Intelligence and Life in 2030 - Stanford University 2017, *One Hundred Year Study on Artificial Intelligence (AI100)*, Stanford University, viewed 1 November 2017, https://ai100.stanford.edu/.

4. What key disruptive technologies or business models do you see? What do you predict is on the horizon in five, 10, 20 years' time?

Engineers Australia anticipates accelerating change, with conventional digital technologies and quantum computing technologies becoming increasingly embedded in the fabric of our society. Education and employment are likely to see major changes, verging on disruptive technology introduction.

The Internet of Things (IoT), including the technologies that support it is already being accepted by many organisations for what it promises to deliver in every aspect of our daily activities; work and personal. This is only the beginning and it involves connecting machines in addition to 'things'. The next step is to connect processes and people.

Artificial Intelligence (AI) technologies, including Robotics Process Automation (RPA) are likely to provide broad-based disruption to a large number of industry and social sectors. Within the 5-year timeframe we are likely to see such technologies gain momentum in routine daily business tasks.

Financial technologies including distributed ledger technology (blockchain) are likely to reach further into the structure of our society over the 10-year timeframe. The effects could be dramatic in terms of disruption to many processes which might effectively exploit distributed ledger technology outside of the financial industry.

On a 20-year timeframe we might expect that technology development results in larger scale adoption of work from home practices. This in turn may imply widescale downscaling and dispersal of corporate and government offices. It is possible to envision major changes to governance of corporate entities and national, state, and local governments, via the adoption of intelligent democracy platforms and systems.

5. What communication services, and underlying data, platforms and protocols, does Australia need to maximise the opportunities of the digital economy?

At a fundamental level Australia requires robust and highly capable fixed and wireless national network infrastructure (a capable NBN and wireless infrastructure such as 5G which serves multiple needs, including that of IoT systems). At a higher level we require reliable systems and secure environments. Cyber security factors are explored further at Question 9.

We must ensure that storage and processing facilities are available in locations where they can be relied on to deliver low-latency and practically continuous operation. To achieve this aim, a coordinated system architecture for a county-wide Data Centre Infrastructure interconnected by substantial, resilient and reliable fibre optic networks, and using clean energy, would be highly desirable for the overall optimisation of resources.

The nation must foster and facilitate software and systems development activities, much of which is likely to occur via innovative start-up enterprises. We should attempt to take a lead in collaboration technologies which can help facilitate Industry 4.0 ideals.

6. What opportunities do we have to accelerate the development of technologies that will underpin Australia's digital economy?

Australia will be well served if information and communications systems are developed following established architectural techniques creating an ecosystem of standard building blocks. Such building blocks would possess security, reliability, scalability and performance qualities, allowing for repeatable solutions to provide the most common services. At a granular level, this has already been provided by "Cloud Environments". Adoption by industry has been sluggish due to lack of standardisation and awareness in the wider business community.

Engineers Australia recommends that cooperation, aligned with Industry 4.0 principles, can drive significant benefits for the nation. Towards this direction, a stronger collaboration between industry and research in academic institutions would accelerate significantly the development of technologies that will underpin Australia's digital economy. Engineers Australia is already helping by facilitating such collaborations with some of the major

universities across the country. Much greater focus and effort is required to achieve broad outcomes at the volume the nation requires to obtain and maintain competitive advantage.

7. What opportunities do we have in standards development and regulation to, (a) enable digital entrepreneurship, innovation and trade, and (b) mitigate the risks associated with digital disruption?

As many platforms will be dominated by international standards, Engineers Australia encourages a well-considered strategic approach to standards development and regulation.

It is important that highly capable professional engineers from a range of backgrounds and including those with commercial experience are involved in standards development and regulation processes. There is potential for negative effects on standards outcomes if the make-up of standards development committees is unbalanced, with undue influence from any one sector. Engineers Australia is working with Standards Australia to improve the standards development process to ensure that organisations with significant vested interests do not have inappropriate levels of influence. Government support for, and participation in, the standardisation process is essential for achieving this outcome, especially with regard to referencing of standards in regulations and adoption of standards in government policies.

Artificial Intelligence (AI) technologies, in particular, provide many concerns related to digital disruption. A Stanford University report, *Artificial Intelligence and life in 2030*, identifies some risks and issues that AI tends to raise in various contexts, as follows:[3]

- Privacy - private information about an individual can be revealed through decisions and predictions made by AI. Can people continue to enjoy the prospect of solitude in a world permeated by apparently social agents "living" in our houses, cars, offices, hospital rooms, and phones?
- Innovation policy - striking the proper balance between incentivising innovation (through freeware and software reuse) in AI while promoting cooperation and protection against third party harm and IP will prove a central challenge.
- Liability (civil) – to do with tort law and product liability for foreseeable harm —and the responsibility that falls to companies manufacturing these products— will likely grow when human actors become less responsible for the actions of a machine. The prospect that AI will behave in ways designers do not expect challenges the prevailing assumption within tort law that courts only compensate for foreseeable injuries.
- Liability (criminal) - criminal law goes further to expect that harms be intended. As AI applications engage in behaviour that, were it done by a human, would constitute a crime, courts and other legal actors will have to puzzle through whom to hold accountable and on what theory.
- Agency – can an AI system operate as the agent of a person or corporation. Authorities are setting up the conditions under which software can enter into a binding contract.
- Labour - people who find their employment altered or terminated as a consequence of advances of AI may seek recourse in the legislature and courts. Some legal firms are gearing up to specialise in addressing labour displacement due to robotics and artificial intelligence.
- Taxation - AI applications could increasingly shift investment from payroll and income to capital expenditure.
- Politics - AI can and has had a significant role within democratic society politics, through social media bots and denial of service, etc. Thus, administrative and regulatory laws regarding AI can be designed to promote greater democratic participation or, if ill-conceived, to reduce it.
- Guidelines for the future - promote a regulatory environment which combines broader goals with tough transparency requirements and meaningful enforcement to promote corporate responsibility, rather than compliance measures. Regulators can strengthen a virtuous cycle of activity involving internal and external accountability, transparency, and professionalisation, rather than narrow compliance (as has been enforced in Europe for privacy, strangling innovation). As AI is integrated into cities, it will continue to challenge existing protections for values such as privacy and accountability.

[3] Artificial Intelligence and Life in 2030 - Stanford University 2017, *One Hundred Year Study on Artificial Intelligence (AI100)*, Stanford University, viewed 1 November 2017, https://ai100.stanford.edu/.

The above short description of AI risks and issues should motivate the need for considered expert technical input to standards development and regulation processes.

8. What digital standards do we need to enable Australian businesses to participate in global supply chains and maximise the opportunities of the digital economy?

Engineers Australia suggests that this question will necessarily derive evolving answers over time. Attention to this question, including sufficient impartial expert engineering input, is recommended on a regular basis.

The necessary standards will emerge as a result of performance and commercial imperatives and will be informed by academic, customer and vendor interests over time. Achieving the right balance of interests requires independent influence in relevant standards bodies. Digitisation-linked standards will be subject to rapid change as technologies mature and develop through commercialisation cycles.

Rather than identifying numerous contemporary and prominent standards herein, EA would advocate Government establishing mechanisms to routinely seek guidance from national Standards bodies, and independent industry peak bodies, on digitisation-linked standards issues and developments.

Just one example of ongoing standards development of considerable applicability to the Digital Economy are international standards that promote socially responsible development of Artificial Intelligence (AI). The IEEE-Standards Association (SA) initiative "Ethically Aligned Design" has a goal to provide a "key reference for the work of AIAS technologists in the coming years", and "to provide recommendations for IEEE Standards based on Ethically Aligned Design". Three projects have been initiated for this aim:[4]

- IEEE P7000™ – Model Process for Addressing Ethical Concerns During System Design,
- IEEE P7001™ – Transparency of Autonomous Systems, and
- IEEE P7002™ – Data Privacy Process.

The British Standards Institution (BSI) is involved in related standardisation activities, indicating the breadth of relevant standards activities: BS 8611 (2016) Guide to the ethical design and application of robots and robotic systems.[5]

9. What opportunities do we have to build trust and community confidence through resilience to cyber threats, online safety and privacy?

Engineers Australia acknowledges the critical matter of building trust and community confidence in digital economy systems.

Security must be consciously and actively designed (engineered) from the highest architectural levels to the minutest details. Risk-based policies and governance must ensure the right level of protection, commensurate to the value of the information asset or system being protected.

The government agencies with responsibility for cyber security, such as the Australian Signals Directorate (ASD) and Computer Emergency Response Team (CERT), must be well funded and inter-agency cooperation for these and other relevant agencies should remain a priority for governments. To that end, the Australian Cyber Security Centre (ACSC) is an important organisation.

Standard approaches for cyber security can be derived from readily available and mature security standards at national, regional and international levels. For government agencies, the Information Security Manual (ISM) should be regularly updated to ensure that emerging threats are adequately protected against. Expert engineers should be involved in these routine processes to ensure they are completed with the right level of technical advice.

[4] IEEE Standards Association 2017, *IEEE Global Initiative for Ethical Considerations in Artificial Intelligence and Autonomous Systems*, viewed 10 October 2017, http://standards.ieee.org/develop/indconn/ec/autonomous_systems.html.
[5] British Standards Institution (BSI): BS 8611 (2016) *Guide to the ethical design and application of robots and robotic systems,* viewed 2 November 2017, https://shop.bsigroup.com/ProductDetail/?pid=000000000030320089.

Faced with the profound changes that technologies such as Artificial Intelligence (AI) can produce, pressure for "more" and "tougher" regulation is inevitable. Misunderstanding about what AI is and is not, especially against a background of scare-mongering, could fuel opposition to technologies that could benefit everyone. Regulation should not stifle innovation, but principles that guide successful regulation of current digital technologies can be instructive.

It is illustrative to consider a recent multi-year study comparing privacy regulation in four European countries and the United States, which yielded potentially counter-intuitive results. Those countries, such as Spain and France, with strict and detailed regulations bred a "compliance mentality" within corporations, and had the effect of discouraging both innovation and robust privacy protections. Rather than taking responsibility for privacy protection internally and developing a professional staff to foster it in business and manufacturing processes, or engaging with privacy advocates or academics outside their walls, these companies viewed privacy as a compliance activity. Their focus was on avoiding fines or punishments, rather than proactively designing technology and adapting practices to protect privacy. By contrast, the regulatory environments in the United States and Germany, which combined broader goals with tough transparency requirements and meaningful enforcement, were more successful in catalysing companies to view privacy as their responsibility.

Broad legal mandates encouraged companies to develop a professional staff and processes to enforce privacy controls, engage with outside stakeholders, and to adapt their practices to technology advances. Requiring greater transparency enabled civil society groups and media to become credible enforcers both in court and in the court of public opinion, making privacy more salient to corporate boards and leading them to further invest in privacy protection.[6]

10. What roles should government, business and individuals play in protecting the community in a digital economy?

Government should establish the overall long-term strategy to ensure that ICT resources are deployed in an optimised manner across the country, ensuring availability, resiliency, security, clean power consumption, work opportunities, education, training and development for an extended period.

Business must elevate their level of awareness regarding the opportunities presented by the digital economy as well as the risk. The government can and should facilitate this where business direction is perceived as being sluggish.

11. What integrity and privacy measures do we need to ensure consumers can protect their data?

Security governance, awareness, system architecture, and ongoing attention to detail, are the main ingredients that provide sufficient privacy and security of any system. Securing an information system can be expensive and the level of security should be determined using a risk-based approach.

Consumers should be provided with a measure of security and privacy when engaging service providers. When engaging information services, consumers will need basic indicators of the level of security and privacy risks they are exposed to, not too different to the indicators of calories, nutrients or additives found in food products which may pose risks to the consumer.

Data needs to be identified as private within the context of the particular system and communication sources and destinations. Where data is intended for private transmission from person to person, copies of data, including meta data, should be reviewable by third parties only on appropriate legal demand.

Consumers should be able to expect that there is consistency in treatment of their private data by enterprises. Consistency in key wording of agreements entered into between consumers and organisations would be of substantial benefit to both consumers and enterprises, if frameworks are intelligently developed.

[6] Artificial Intelligence and Life in 2030 - Stanford University 2017, *One Hundred Year Study on Artificial Intelligence (AI100),* Stanford University, viewed 1 November 2017, https://ai100.stanford.edu/.

12. What are barriers for business, particularly small business, in adopting cyber security and privacy practices?

The first barrier is lack of security and privacy risk awareness, especially with regard to the potential effect of security breaches to their own business. For example, the loss of consumer confidence in the business associated with breaches of data security.

Secondly, the complexity of the problem and its solution escapes the capabilities of most business. Expert advice is required, in a simplified and highly accessible fashion, to allow for secure systems to be implemented and maintained.

The need for smaller enterprises to access tailored legal advice on privacy matters is a significant barrier to improvement. Solid accessible guidelines can provide a way for SMEs to bridge the gap in a structured fashion.

SMEs generically face serious constraints in all of the factors of: cost, awareness, time, knowledge/skill, and resources. The size and complexity of the task can be a significant barrier to SME progress. Availability of ready-made solutions (to the extent possible) can be fostered to aid in overcoming these barriers.

13. What integrity measures do the Australian Government and the private sector need to take to ensure business–consumer transactions are secure?

There are many evolving security threats, many of which target financial transactions for financial gain by threat actors, mostly organised crime. Using established cyber-security terminology, “integrity” is a technical term which is probably not the most commonly violated when dealing with commercial transactions. It is the “confidentiality” aspect that is breached in a way that makes what appears to be a secure transaction one that is actually fraudulent by way of the threat actor having access to the encryption keys or impersonating one of the parties in a fake transaction.

There are many techniques to reduce the risks of success of such attacks. Attackers, however, have continually evolving tools which require evolving counter-measures. Targeted attacks are virtually impossible to protect against, hence detection and recovery processes are imperative.

The government can establish and participate in ongoing standards and service improvement programs, and certification by appropriate government/standards bodies may be a central part of the overall security package.

15. What would help Australian businesses to embrace digital technologies?

A culture of innovation is fostered by ensuring access to funding, support services, and early business opportunities, on a fair and equitable basis. Innovative technology companies will often start with a small idea, sometimes within a larger corporate parent, but more often within a start-up environment. Australian businesses are prepared to be innovative and will drive to capture market competitive positions if their risks are mitigated by government support mechanisms and funding support.

Providing an environment where the survival chances of innovative Australian (start-up) companies is increased significantly will ensure that more pervasive adoption of digital technologies is achieved over time.

16. What efforts are you or your organisation making to respond to digital transformation? Why?

Engineers Australia at its core is the profession’s peak organisation attempting to channel the impressive raw talent of the Australian engineering community. It is the profession's formal face to government, to society as a whole, and to individuals.

The Engineers Australia organisation realises an essential part of being an engineer is to respond to the engineering changes of our time. Digital transformation is clearly the single most influential transformation in contemporary society, akin to splitting the atom or the discovery of genetics.

To this end, Engineers Australia has established an 'Engineering Futures' committee of its Board. This committee will work to understand the likely effects of the digital transformation for the profession, and the educational pathways and skills development changes needed to build a strong pipeline of engineers ready for the digital transformation.

Central to the development of an engineering skills pipeline is Engineers Australia's promotion of engineering as a profession and therefore Science, Technology, Engineering and Mathematics (STEM) as the foundation skills required, and accreditation of engineering courses. The gender diversity of the profession is particularly poor and, amongst other actions, in 2017 the association committed to a target of 30 per cent of its board, leadership, staff and member committees to be female by 2020.

One further example of work being done by Engineers Australia to help its members prepare for the digital transformation journey is the creation of community groups that encourage the contribution and sharing of knowledge around key new technologies. One such group explores the emerging field of the Internet of Things (IoT).

Engineers Australia is prepared to work closely with government policy makers to structure the nation's Digital Economy Strategy, and the current consultation is viewed as a positive step.

17. What opportunities do we have to use digital technologies to improve linkages into export markets and global supply chains?

There are many and varied opportunities, but progress depends on the digitisation direction taken in the particular market. Australia is potentially best served by ensuring there is a culture of support for innovation fostered within the nation.

18. What opportunities do small and medium-sized businesses have to embrace digital innovation to drive customer value, improve their services and unlock their potential?

There is a risk of limited competition in key services that SMEs require to fully embrace digital innovation. While the digital age reduces distances to global markets, time-zone and language barriers ensure that Australian SMEs are not as readily served by the support ecosystem that exists in many other areas of the world.

Many niche areas exist where SMEs can provide innovative solutions and be competitive on a global scale. The government must look to support the growth of the innovation ecosystem that enables this SME activity. Government can ensure that SMEs are not locked out of government tender opportunities, allowing SMEs the room to innovate and grow to target other opportunities, many global.

19. What are the key new growth industries that Australia should be tapping into? In what technologies and sectors should Australian businesses take the lead, and where should we be a 'fast follower' of international trends?

Innovative engineering is likely to deliver competitive advantage in a large range of niche areas. Australia should be cautious of the desire to pick winners or pursue large funded programs where innovative global niche players are likely to provide external disruption.

Australia should ideally provide a reliable environment in which innovation of all types can prosper. Start-up innovation is a key component of this, as is innovation from larger industry incumbents. It is noted that protectionism of one sort or another can often be a disincentive to meaningful innovation by established industry participants.

20. What opportunities do we have to equip Australians with the skills they need for the digital economy, today's jobs, and jobs of the future?

Australia has an almost unlimited opportunity to equip all Australians, especially younger generations, with the skills they will require for decades ahead. However, basic Science, Technology, Engineering and Mathematics (STEM) education outcomes are in serious and prolonged decline. Arresting this decline will require innovative programs and support.

Australia is excessively dependent on skilled migration. This has meant that engineering is predominantly comprised of overseas born engineers (57.3 per cent), which is in stark contrast to other professions (40.9 per cent).

Continuation of this reliance is not risk free: Australia's skilled migration program does not contribute to building our engineering capability efficiently because selection emphasises entry level qualifications but does not assess capacity to practice engineering. This leads to overseas born engineers being less likely than Australian-born peers to work in engineering-related roles.

If Australia is to become an innovative nation and ready to embrace the digital economy, our engineering capability must expand. This should be done by reducing reliance on skilled migration and producing a greater number of home-grown engineers.

STEM education

Mathematics and science are the tools used by engineers to solve real world problems. For engineering, participation in high school STEM subjects is a vital means to an end. However, there is a looming crisis in STEM participation, with the percentage of students studying STEM still dropping. The 2016 Engineers Australia report, *Engineers Make Things Happen*,[7] showed that just six per cent of girls study advanced maths or physics to year 12. The numbers for boys is not much better, at 12 and 9 per cent respectively.

Until now, the falling rates have been offset by improvements in high school student retention overall. This counterweight has had the effect of stabilising raw numbers of STEM students, but retention gains will soon stop. The window of opportunity to reform STEM in schools is closing.

Engineers Australia is one of many organisations that promote STEM in schools and the professions that rely on those skills. Together with the Office of the Chief Scientist, Engineers Australia led development of the new "STARportal"[8]. It offers a comprehensive collection of STEM activities and providers and acts as a go-to place for families to discover local STEM activities for the children in their lives and for providers to find partners with which to collaborate.

Providing these school outreach opportunities is one thing, but government can do more to assess the effectiveness of these activities in order to develop a national program of actions that are proven to help raise the percentage of students studying STEM subjects at school.

Gender diversity

The statistics noted above for young women studying STEM subjects is particularly alarming, especially in the context of any efforts to raise the proportion of women in the engineering profession above its current rate of 12 per cent.

Of those qualified as engineers, women are less likely to work in engineering roles. While 64 per cent of male engineers are employed in engineering roles, the same is true of just 51 per cent of female engineers. There are many factors that may influence the low number of women entering the profession and remaining in engineering-related employment:

- access to flexible working practices
- actual or perceived prevalence of on-site workplace harassment
- conscious and unconscious bias regarding the role of women in the workplace

[7] Kaspura, A, *Engineers Make Things Happen: The need for an engineering pipeline strategy*, 2017. Available at: https://www.engineersaustralia.org.au/Government-And-Policy/Policy-Reports
[8] Learn more about the STARportal here: https://starportal.edu.au/

- a lack of support for engineers with family caring responsibilities (this is usually in the context of care for children but elder care is another significant factor)
- a lack of visible and meaningful leadership to support women in engineering by (predominantly male) senior managers
- a significant gender pay gap

Achieving gender diversity and inclusion in the workplace takes effort and commitment by employers, employees, governments, and the engineering profession-at-large. It is not something that can be done by any one organisation or sector of society alone—every little bit counts.

Government has a strong role to play by setting policy and creating regulatory frameworks to positively influence appropriate behaviour and outcomes, setting anti-discrimination legislation and business reporting requirements, providing incentives such as the Employer of Choice for Gender Equality citation and showing strong political leadership.

But the bigger responsibility lies with industry which can, for example, make big differences by:

- setting targets for diversity in recruitment, promotion and leadership
- undertaking pay equity reviews and adjustments
- ensuring the availability of flexible work practices that benefit all employees with a range of needs
- creating meaningful policies to setting expectations
- providing training to help staff understand the issues
- showing exemplary leadership by sector leaders to set the example for behaviour.

The Male Champions of Change STEM is a great example of government and industry partnering to develop meaningful action to attract and retain women in the workplace.

For its part, Engineers Australia provides guidance to its members, encourages good practice within the industries that employ engineers, uses its magazine and social media channels to show the general community that engineering is a role for everyone. In 2017, the association set a gender target of 30 per cent women by 2020 at all levels of the organisation and its volunteer committees.

Until more women are drawn to engineering and the STEM-related professions and, importantly, retained within them once qualified, a digital economy will always be operating at half-speed. Unless Australia involves women in the careers on which a digital economy depends, the nation will be less globally competitive.

21. What opportunities do we have to bridge the ‘digital divide’ and make the most of the benefits that digital technologies present for social inclusion?

Affordable, secure and highly capable communications services, including fixed line and mobile, are an important element of reducing the digital divide.

Younger generations are typically capable adopters of digital technologies, and are often technology champions for members of older generations. However, not all members of older generations have such support networks, and additional strategies aimed at inclusion for more technology isolated individuals are likely to be required.

22. What opportunities do we have to ensure digital technology has a positive impact on the cultural practices and social relationships of Australians?

Digital technologies facilitate cultural practices and social relationships which can be highly positive but, if there are underlying negative drivers, then technology can certainly produce enhanced negative impacts. It is not clear that this might be a problem for technology to attempt to address, versus other social processes.

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