Preparing for Australia's Digital Future

A Strategic Plan for Information and Communications Sciences, Engineering and related Technology

SUMMARY REPORT and RECOMMENDATIONS

February 2018

1 Introduction

Digital disruption is already here. The economic and social impact of digital technology is already pervasive, and is only set to grow. For example, PwC recently valued the economic contribution of artificial intelligence (just a subset of the many technologies considered here) at 15.7 trillion by 2030: more than the current total output of China and India combined[1]. Closer to home, digital technology is expected to add $139 billion to the Australian economy by 2020[2]. Despite the impressive numbers, the imperative to proactively manage the ongoing digital transformation is not purely economic: societal well-being, cultural growth, accessing, using and creating knowledge, and many other parts of our complex lives are equally prone to transformation in a way that will leave no Australian unaffected.

It is tempting to describe a single transformation, or to talk of a post-transformation world, yet digital transformations are not likely to end. They are continuously and rapidly evolving, driven by aggressive technology progress and accelerating uptake—and Australia is not driving. It is not realistic to expect Australia to lead in all aspects, but it is essential that, through strategic actions outlined in this plan, we are able to chart our own course.

The digital economy in Australia has been steadily growing as a proportion of GDP (up 2.2 percent over the last 6 years), and is increasingly important to enable both domestic commerce and international trade. It is clear that research investment in digital technology is only a tiny fraction of their potential contribution to Australia's future prosperity.

Despite broad and now longstanding acceptance of the importance of digital technology to Australia, we lag most developed—and developing—countries in both business awareness and plans for the future[3]. Our international standing as a forward-looking digital nation is not only at risk; it is in active decline. Notable exceptions to this picture include headline successes such as Technology One[4] and Altassian[5], yet countless others such as Vitalcare[6] and VPI Photonics[7] (to arbitrarily name only two of many) also serve as reminders that Australian researchers and businesses *do* have what it takes to succeed. Recognising Australian success is an important step towards normalising it[8].

This strategic plan draws attention to an opportunity hiding in plain sight. It points to the importance of an overarching strategic understanding of the capabilities and priorities that will shape our digital future, and outlines how Australia can do better. We have not fulfilled our potential in turning our excellent science and research into commercial technologies and services that benefit Australia, yet it is definitely possible to recognise, act and derive benefits from our research and innovation sector. Similarly, meeting our changing capability requirements into the future will need astute and perhaps courageous planning.

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[1] PwC 2017, Sizing the prize: PwC's Global Artificial Intelligence Study: Exploiting the AI Revolution. https://www.pwc.com/gx/en/issues/data-and-analytics/publications/artificial-intelligence-study.html

[2] Deliotte Access Economics, 2015: https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-connected-continent-ii-2015-300315.pdf

[3] For example: InfoSys 2017: Amplifying Human Potential: https://www.infosys.com/aimaturity/pages/index.aspx

[4] Technology One: https://www.technologyonecorp.com
See also https://pearcey.org.au/2015-hall-of-fame

[5] Altassian: https://www.atlassian.com

[6] Vitalcare: http://vitalcare.com.au

[7] VPI Photonics: http://www.vpiphotonics.com

[8] Organisations such as the Pearcey Foundation play an important role in celebrating the success of Australian ICT leaders across industry, research and government. See: https://pearcey.org.au

Australian successes

Technology One

Technology One was founded by Queenslander Adrian Di Marco in 1987 and has grown into one of Australia's largest enterprise software companies. It has 14 international offices and has achieved steady domestic and international growth: roughly doubling in size each four to five years. It listed on the ASX in late 1999. Technology One has continued to reinvest 20 percent of its annual revenue in R&D and recently committed to the Pledge 1% movement[9].

Vitalcare

Self-declared 'specialists in nana-technology[10]', Vitalcare develops and manufactures leading technology to make independent living safer and more enjoyable for the elderly. It has approximately 1000 installations nationally covering 50,000 hospital and aged-care beds in low- and high-care environments. It invests in Australian-based R&D with its own engineering workforce and collaborations with Australian universities, and assembles its devices in Australia.

1.1Objective

This strategic plan intends to help position Australia as a successful, forward thinking digital nation.

It will achieve this by informing policy development, helping identify future investment needs in research, infrastructure, and education aimed at increasing Australia's scientific impact in the digital realm and its translation into skills, innovation, public benefit and commercial success. It will also be useful to research funding bodies such as the ARC and MHMRC and provide guidance to strategists and planners in a variety of organisations, including state departments of industry and innovation, state and federal education departments, federal agencies, university research policy managers, and research organisations such as CSIRO and the DST Group.

The consultative process of developing the plan, jointly led by two independent Learned Academies, developed a shared, sector-wide understanding of the challenges and opportunities that Australia's digital futures present. Coupled to a shared, sector-wide commitment to actions, this in itself would be a considerable success.

It is essential that Australia better aligns its research, industry and governments to unlock the potential of the digital transformations that are gathering pace. This strategic plan intends to:

- Improve Australia's track-record of translating research into industry innovation that builds skills, commercial profits and public benefits for Australia. It does this by:
  - Identifying areas in the innovation system that could function more effectively, and recommending actions accordingly
  - Providing a framework to help guide primary research into areas that are more likely to be translatable and less likely to come across barriers to uptake.
- Improve collaboration, equity and diversity at all levels and across all sectors. All stakeholder sectors identified this as key barrier to progress in Australia and expressed the need—and desire—for change. The plan does this by:

[9] Pledge 1%: http://pledge1percent.org

[10] A playful pun on the better-known, but unrelated in this case, field of nanotechnology.

  - Highlighting the inherently integrated nature of information and communications science and technology endeavours and enabling all stakeholders to identify appropriate collaborators, including those who may not be recognised in current paradigms.
  - Identifying a shared set of national priorities around which to marshal resources and establish new or strengthen existing collaborative initiatives.
- Improve literacy in the information and communications sciences and technologies from both a technical and social policy perspective, by:
  - Providing a consistent set of messages around the current priorities and desirable future directions of digital transformation.
  - Identifying ways to improve and extend the education and science systems, as well as engaging with governments.
  - Providing an integrated framework to assist the development of consistent and effective public policy.

This strategic plan covers the full extent of the digital revolution: information and communication sciences and engineering, their sub-disciplines, and related technology. It also extends to the supporting environment that will shape our digital future: infrastructure, education and training, business, public policy and the innovation system.

By its nature, information and communication has always underpinned human endeavours: there are exceedingly few people today who are unaffected in some way by the ongoing digital revolutions. Yet this document is not aimed at the general public. It is aimed specifically at:

- Research planners and managers, including universities and funding agencies: not limited to those with ICS, engineering or technology programs because of the far-reaching implications for the future of research.
- Forward-thinking researchers in all disciplines.
- Public policy setters in all fields: progress in information and communications technology is an inescapable part of policy context, regardless of the field.

We do not make predictions about the future, but offer guidance on strategic considerations for future planning, and possible actions to help capture the benefits of technology progress while avoiding drawbacks.

This plan recognises the massive volume of recent work by many organisations, each examining aspects of Australia's digital transformations and their impact on our economy, our research and education system, or our culture. There is a growing number and range of initiatives in the digital sector (and indeed the wider STEM sectors) addressing a large and growing number of issues, led by many players across industry, governments, research and education.

However, while single issues or clusters of related issues can be addressed relatively comprehensively, there does not yet appear to be an agreed approach, method or framework that can help prioritise the many complex issues that have multiple drivers and many players. It is those complex issues—often at the interfaces between science, society, government, industry and economics—that present persistent friction to progress and have limited our ability to (for example) translate basic research into commercial successes, or to bridge the science-policy interface at the rate and frequency that is often required. As a result, some of these shortcomings in our systems seem to be persistent and feature regularly in commentaries, reviews and even public policy interventions.

Many of the metrics[11] used to establish the need for the various initiatives that are underway can effectively view one part of the system from one angle. It is however possible, as in other complex systems, that integrated approaches could more efficiently shape Australia's digital futures in ways that are less likely to encounter unexpected barriers. In developing this plan, an overarching framework for the whole of the 'digital space' was used to help identify linkages and guide thinking around strategic interventions.

2 Draft Recommendations

In proposing strategic priorities for Australia's digital future, we combined expert analysis by the Steering Committee with stakeholder feedback, together with priorities identified in recent, related reviews and reports, within an overarching framework of technologies, applications and issues. Among the myriad opportunities and challenges for the digital and digitally-enabled sectors in Australia, four broad priorities emerged:

- Fostering research and industry partnerships
- Safeguarding and strengthening our workforce pipeline
- Whole-of-government leadership
- Research sector reforms.

2.1 Fostering research and industry partnerships

Australia's research strengths are not necessarily aligned with our industry needs. Tellingly, *serendipity* was offered during consultation workshops as a common explanation for the areas in which there is good alignment.

2.1.1 Visibility of Australia's digital strengths

Lack of information on researchers and their strengths became immediately apparent in the early stages of consulting on this report. Some areas of relative strength in Australia are quite small so personal networks can be effective, but our isolated pockets of strength are hard to identify and connect with from the outside. Breaking down the 'visibility barrier' would be a useful first step towards a number of other priorities.

Recommendations:

1. Develop and maintain a readily accessible, up-to-date map or directory[12] of Australian ICS and ICT research expertise, strengths and capabilities, including international benchmarking[13].
2. Universities and other research organisations should increase visibility to industries and government agencies by holding multi-organisation communication events that are relevant to specific capability areas[14].

[11] Metrics include, for example, student interest surveys, the proportion of women in senior management roles, innovation translation rates, numbers of patents, or the number and value of business-university partnerships.

[12] The NSW Chief Scientist and Engineer provides an easily navigable example for NSW that could be extended to meet the specific needs of the digital sector: http://www.chiefscientist.nsw.gov.au/nsw-science-and-research-map

[13] Such a project may be suitable for AAS and ATSE to undertake jointly with state governments and the Australian Government.

[14] This may include, among other options, extension of existing initiatives such as the Australia 3.0 roundtables (https://australia30.wordpress.com) or the DST Group's Partnership Week, or running more events with more specific scopes.

3. Conduct regular round-tables between technical leaders in industry (CTOs) and technical leaders in academia (DVC-Rs) to build a sense of shared understanding amongst Australia's technical leadership.
4. Formalise research-industry brokerage activities in Australia to help match research capability with industry needs and foster research-industry partnerships focussed on developing future capabilities [15].

2.1.1 Using our comparative advantages

Australian universities need to recognise and maintain Australia's comparative advantages in the international landscape, to capitalise on the enduring value of our education system, our research sector and our small but potentially powerful industrial base.

Recommendation:

5. Universities[16] should develop impact statements relevant to their research activities derived from an external review process. This will serve as a mechanism for highlighting the value of the research to stakeholder groups.

2.1.2 Improving collaboration

Considering the dispersed and relatively isolated nature of the Australian digital sector(s), we need to make the most of the industry and research capability that we have. Clusters of activity help maintain critical mass, and collaboration between industry and academia strengthens both.

Recommendations:

6. Universities should actively pursue opportunities to become focal points for businesses involved in using, and developing and commercialising digital technology to cluster around particular capabilities. This may include, but not be limited to, co-location.
7. University researchers should use sabbaticals in industry to gain industry experience and create personal links between industry and research. A target of one in three sabbaticals placed in industry may be appropriate.

2.2 Safeguarding and strengthening our workforce and capability pipeline

2.2.1 Professional mobility

Professional mobility between research, industry and government is considered to be an important but currently missing link in the research, innovation and translation ecosystem. Well-rounded professionals—beginning with a well-rounded education and continuing into a range of roles throughout the career course—are the people most likely to turn creative links into successful leaps.

Recommendation:

[15] Recommendations 2 and 4 could both be achieved by a scheme similar to the former ARC Research Networks scheme (http://www.arc.gov.au/legacy-schemes), which among other successes seeded the Australian Nanotechnology Network. It is noted that there are several excellent but isolated schemes already operating, such as the NSSN (NSW: http://www.nssn.org.au), the Defence Network (national: https://www.defenceconnect.com.au), the Cyber Security Network (NSW: http://sydney.edu.au/arts/research/cybersecurity) and the Defence Innovation Partnership (SA).
[16] This could be extended to multi-organisation alliances or collectives of research organisations as proposed in Recommendation 2.

8. Encourage joint appointments between government, research agencies and industry. Research organisations should consider revising employment contracts to assist researchers to take simultaneous employment with businesses.
9. Universities should take steps towards reshaping research culture by placing substantially higher emphasis on industry experience and collaborations in hiring and promotion criteria for research staff.

2.2.2 Life-long and work-integrated learning

As the pace of progress increases, jobs in the digital sectors are very likely to involve a substantial proportion of life-long-learning. Developing the soft-skills to work effectively in teams, as well as the meta-cognitive skills to continue learning and development throughout the working life, is becoming increasingly important, especially in undergraduate and post-graduate education. Work integrated learning, undertaken at scale in Australia, would assist with work-skill development and also offer positive cultural changes in both workplaces and the education system.

Recommendations:

10. Place a greater emphasis on metacognitive skills[17], soft human skills and teamwork in ICT- and ICS-related teaching at all levels.
11. Integrate work-integrated learning as a core element of undergraduate courses that relate directly to ICS, ICT and related engineering subjects.

2.2.3 Skills of teachers

Out of field teaching, especially in mathematics but also in most sciences, is having a slow-burn effect on our whole education system—the decline being gradual enough as to never warrant attention as an acute crisis, but the effect being just as profound. Academic qualifications are the primary measure of teacher suitability, but valuing industry experience in teachers would help them pass on a greater sense of usefulness or relevance of ICT to students. At a higher level, PhD supervisors are also often ill-equipped to foster awareness of the human skills and broader context of research in society that is often missing from ICT PhDs.

Recommendations:

12. Australian governments, schools and universities should urgently increase their provision of professional development for existing out-of-field school teachers of digitally-related subjects and enhance their commitment to the recruitment and retention of new, properly qualified staff[18].
13. Foster greater awareness of the human skills and the broader impact and implications of ICS and ICT research and applications in society that is often lacking in the research community.

2.2.4 Equity and diversity

Realising that Australia cannot reach its full potential unless it can benefit from the talents of all, we have a two-fold responsibility: to increase the participation of minorities—particularly women—and

[17] In this case, we take a broad meaning of metacognitive skills as 'skills that help a person learn to learn'.
[18] The wording of this recommendation is deliberately consistent with Recommendation 2.1 of the Decadal Plan for Mathematical Sciences, which this plan fully supports: https://www.science.org.au/support/analysis/decadal-plans-science/decadal-plan-mathematical-sciences-australia-2016-2025

to remove structural barriers that cause the loss of knowledge, talent and educational investment from the ICT and engineering sector.

Recommendations:

14. All research organisations should accelerate their efforts to address gender imbalance through programs such as Athena Swan and SAGE. Organisations should develop and track equity and diversity targets or consider focussed hiring practices to drive significant and sustained workplace diversity.

2.2.5 STEM education

STEM education is of course a key priority for Australia's digital future. The current focus on STEM education in Australia is a positive development that will take time to propagate throughout the system. It must however be protected, evaluated and improved over time.

Recommendations:

15. State and federal governments develop, define and align mechanisms to monitor, evaluate and optimise their ongoing investments to continuously improve Australian STEM education.
16. Investigate potential models that would broaden professional accreditation in Australia to recognise competence rather than solely the completion of a defined training pathway. This can apply for both ICT professionals, as well as STEM teachers.

2.3 Whole-of-government leadership

2.3.1 Leadership

A whole-of-government commitment to strengthen Australia's digital future is urgently required, including support for the capabilities that are required, and the research and expertise to support them. Australian governments are uniquely placed to provide leadership in a way that multinational companies will not and universities and SMEs cannot.

Recommendations:

17. Undertake a comprehensive national future-readiness review for the Australian digital research sectors, including its links with industry and opportunities to harmonise state, territory and Commonwealth initiatives.
18. Promote, support and strengthen the Digital Transformation Agency as a whole-of-government initiative, including support for analogous agencies in all jurisdictions.

2.3.2 Proactively owning our challenges

Australia needs to be much more proactive about adopting and owning the ICT-driven transformations that are currently permeating the whole economy. This is also required to place Australia in a position of strength ahead of subsequent waves of change.

Recommendations:

19. Strengthen public commitments around the 'Government as an Exemplar' pillar of the National Innovation and Science Agenda[19].

[19] National Innovation and Science Agenda: https://www.innovation.gov.au/page/agenda

20. Monitor, evaluate and optimise the ICS and applied ICT elements of the National Innovation and Science Agenda, including identifying opportunities for its expansion where appropriate.

2.4 University and research sector reforms

2.4.1 Intellectual property management in research

IP protections were more widely seen as a hurdle by both researchers and industry than as an opportunity. University administration was most commonly cited as the main reason, along with the observation that this issue is uniquely Australian. There is a case for standardising some aspects of IP management across all universities as a prerequisite for national solutions that could be uniformly effective. This may include opening some types of IP by default.

Recommendations:

21. Develop a common IP framework across all Australian universities, to simplify and standardise IP licencing and management arrangements, and to remove a barrier to research uptake by business.
22. Where appropriate, universities should be encouraged to promote open IP policies.
23. Develop a national 'go-to guide' to help companies engage efficiently with each Australian university IP department. This may also provide public, competitive pressure on universities to improve.

2.4.2 Redefining interdisciplinary research

Inter- and cross-disciplinary research can sometimes be taken less seriously by practitioners in the 'pure' disciplines. Yet as digital technology sweeps across the research sector, the early pioneers developing 'digitally transformed research' will change what is currently considered as interdisciplinary work into 'business as usual' research practices. Australia has an opportunity to lead some aspects of this transformation, and to reap the resulting research leadership rewards.

Recommendations:

24. Recognising that tomorrow's research leaders will be digitally-enabled, Australian universities should seek global leadership by proactively seeking digital research expertise across all disciplines.
25. Reform academic performance metrics used by ARC and NHMRC such that interactions with industry also contribute to performance against academic metrics in ICS and ICT-related fields.
26. Further examine how to quantify the potential of digital technology to accelerate future research across all disciplines, and to underpin inter-disciplinary research. This will require projections of what the future of science will look like, and how to position Australian research accordingly.

3 Actions: setting a prosperous course

This section summarises the recommendations, identifies who could implement them, and suggests timeframes for each. Preliminary timings and implementation responsibilities are given at Attachment A.

Actions focus primarily on the Australian university sector for two main reasons:

- The majority of the ICT research in Australia occurs in universities and publicly funded research agencies[20]. While it is imperative that Australia grows the amount of ICT-related R&D undertaken by Australian industries, the immediate gains are to be made in the sector that currently has the greatest momentum.
- The focus of Australian research would be more useful to our innovation system if researchers had a deeper understanding of Australian industries. Two Learned Academies led the development of the plan and are uniquely placed to reach deep into the research sector.

[20] This is not necessarily the case internationally, especially in the US. This fact is sometimes neglected in comparisons between the Australian and US ICT sectors.

ATTACHMENT A

For easier reading, this table is also provided as a spreadsheet in the supporting information section of the website.

Priority	Recomm-endation	Target sector	Description	Short	Med	Long	Proposed leader	Proposed active contributor
Improving research and industry connection	1	Universities	Develop and maintain a readily accessible, up-to-date map or directory of Australian ICS and ICT research expertise, strengths and capabilities, including international benchmarking.				Council of Deans	Academies (LASP project?)
	2	Universities	Universities and other research organisations should increase visibility to industries and government agencies by holding multi-organisation communication events that are relevant to specific capability areas.				Council of Deans and DVC-Rs	Academies
	3	Universities	Conduct regular round-tables between technical leaders in industry (CTOs) and technical leaders in academia (DVC-Rs) to build a sense of shared understanding amongst Australia's technical leadership.				DVC-Rs	Academies
	4	Governments	Formalise research-industry brokerage activities in Australia to help match research capability with industry needs and foster research-industry partnerships focussed on developing future capabilities.				Cth Dept Industry, Innovation and Science	Universities Australia
	5	Universities	Universities should develop impact statements relevant to their research activities derived from an external review process. This will serve as a mechanism for highlighting the value of the research to stakeholder groups.				Individual Universities	Universities Australia
	6	Universities, industry	Universities should actively pursue opportunities to become focal points for businesses involved in using, and developing and commercialising digital technology to cluster around particular capabilities. This may include, but not be limited to, co-location.				Individual Universities	Industry
	7	Universities, industry	University researchers should use sabbaticals in industry to gain industry experience and create personal links between industry and research. A target of one in three sabbaticals placed in industry may be appropriate.				Individual Universities	Industry
Safeguarding and strengthening our workforce pipeline	8	Universities, governments, industry	Encourage joint appointments between government, research agencies and industry. Research organisations should consider revising employment contracts to assist researchers to take simultaneous employment with businesses.				Government Agencies, PFROs, DSTG	Individual Universities
	9	Universities	Universities should take steps towards reshaping research culture by placing substantially higher emphasis on industry experience and collaborations in hiring and promotion criteria for research staff.				Individual Universities	Universities Australia
	10	Universities	Place a greater emphasis on metacognitive skills, soft human skills and teamwork in ICT- and ICS-related teaching at all levels.				Cth Dept Employment, Education and Training	Individual Universities
	11	Universities	Integrate work-integrated learning as a core element of undergraduate courses that relate directly to digital technology.				Individual Universities	Industry
	12	Governments, universities	Australian governments, schools and universities should urgently increase their provision of professional development for existing out-of-field school teachers of digitally-related subjects and enhance their commitment to the recruitment and retention of new, properly qualified staff.				Cth Dept Employment, Education and Training	Individual Universities

Continued next page

Priority	Recomm-endation	Target sector	Description	Short	Med	Long	Proposed leader	Proposed active contributor
Safeguarding and strengthening our workforce pipeline	13	Universities	Foster greater awareness of the human skills and the broader impact and implications of ICS and ICT research and applications in society that is often lacking in the research community.				Individual Universities	Universities Australia
	14	Universities	All research organisations should accelerate their efforts to address gender imbalance through programs such as Athena Swan and SAGE. Organisations should develop and track equity and diversity targets or consider focussed hiring practices to drive significant and sustained workplace diversity.				All organisations	
	15	Governments	State and federal governments develop, define and align mechanisms to monitor, evaluate and optimise their ongoing investments to continuously improve Australian STEM education.				Cth Dept Industry, Innovation and Science	Cth Dept Employment, Education and Training
	16	Governments	Investigate potential models that would broaden professional accreditation in Australia to recognise competence rather than solely the completion of a defined training pathway. This can apply for both ICT professionals, as well as STEM teachers.				Cth Dept Employment, Education and Training	Industry
Whole of government leadership	17	Governments	Undertake a comprehensive national future-readiness review for the Australian digital research sector, including its links with industry				DTA	PM&C
	18	Governments	Promote, support and strengthen the Digital Transformation Agency as a whole-of-government initiative, including support for analogous agencies in all jurisdictions				PM&C	DTA, State governments
	19	Governments	Strengthen public commitments around the 'Government as an Exemplar' pillar of the National Innovation and Science Agenda				Cth Dept Industry, Innovation and Science	
	20	Governments	Monitor, evaluate and optimise the ICS and applied ICT elements of the National Innovation and Science Agenda, including identifying opportunities for its expansion where appropriate				Cth Dept Industry, Innovation and Science	DTA
Research sector reforms	21	Universities	Develop a common IP framework across all Australian universities, to simplify and standardise IP licencing and management arrangements, and remove a barrier to research uptake by business				All universities (COOs)	
	22	Universities	Where appropriate, universities should be encouraged to promote open IP policies				All universities (COOs)	Cth agencies
	23	Government, universities	Develop a national 'go-to guide' to help companies engage efficiently with each Australian university IP department, and to provide public, competitive pressure on universities to improve				Cth Dept Industry, Innovation and Science	Universities Australia
	24	Universities	Recognising that tomorrow's research leaders will be digitally-enabled, Australian universities should seek global leadership by proactively seeking digital research expertise across all disciplines				All universities	PM&C
	25	Government	Reform academic performance metrics used by ARC and NHMRC such that interactions with industry also contribute to performance against academic metrics in ICS and ICT-related fields				ARC and NHMRC	Universities Australia
	26	Government, universities	Further examine how to quantify the potential of digital technology to accelerate future research across all disciplines, and to underpin inter-disciplinary research. This will require projections of what the future of science will look like, and how to position Australian research accordingly.				DTA	All universities

End