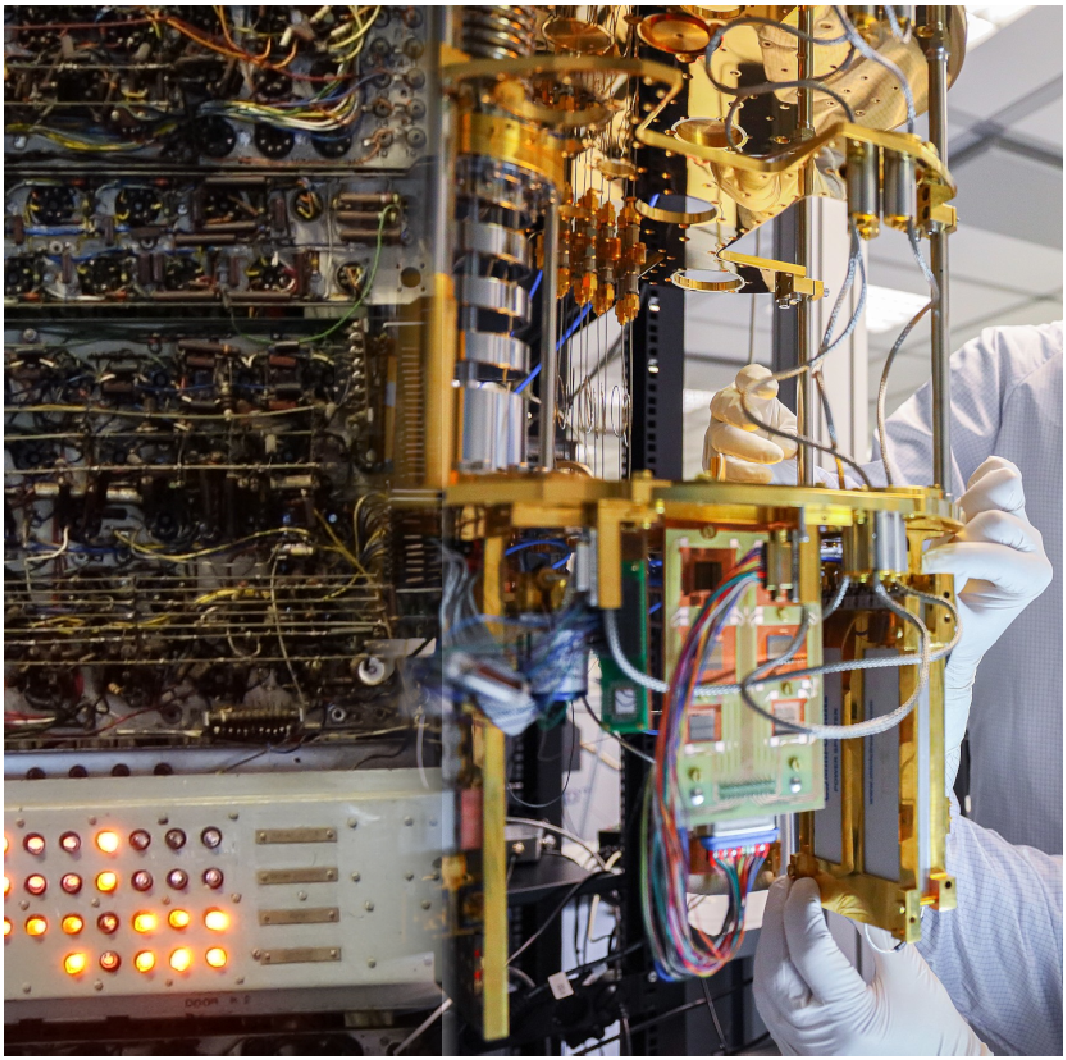
THE UNIVERSITY OF SYDNEY

Pearcey FOUNDATION

Information technology innovation in Australia, a long-term perspective

Project Report by
The University of Sydney and the
Pearcey Foundation



Left 1949: CSIRAC, Australia's first digital computer; Right 2020s: part of a quantum computer.

Foreword

The Pearcey Foundation is named after Dr Trevor Pearcey whose efforts in the 1940s resulted in Australia creating one of the very first computers of the modern age, CSIRAC.

For the past 25 years, the Pearcey Foundation has identified and honored the men and women, across Australia, who have played a leading role in IT research, industrial development, and policy formation, during the most rapid and extensive technical developments in human history.

The Foundation was pleased to join with staff of the Business School at the University of Sydney in this project which has captured, first-hand from those pioneers, insights into the factors that have inspired and encouraged or, on the other hand, impeded innovation as Australia rode the successive waves of technological change.

The oral histories gathered during this project provide an irreplaceable archive of original source material and demonstrate the nation's sustained innovative entrepreneurial skills post the CSIRAC era. They also provide a basis for further research on factors which are critical to the future well being and prosperity of the nation, as it continues to grapple with the vast range of opportunities provided by the continued digital revolution, as well as the associated challenges.

Wayne Fitzsimmons OAM

National Chair, The Pearcey Foundation

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Citation

Boell, S.K.; Philipson, G.; Thorne, P.; Riemer, K.; Peter, S.; Wang, B. (2023). Information technology innovation in Australia, a long-term perspective. Project Report by the University of Sydney and the Pearcey Foundation. Sydney, Melbourne. DOI: doi.org/10.25910/s7wf-n486

Executive Summary

This report provides insights into lasting factors that have enhanced or impeded innovations in information and communication technologies (ICT) in Australia over six decades. The study conceives of innovation as the entire process from conception of ideas to their commercial success in the market. The report summarises observations from 42 outstanding individuals in the Australian ICT sector, each admitted into the Pearcey Hall of Fame.

The Pearcey Foundation's Hall of Fame recognizes outstanding life-time contribution to ICT in Australia in business, research, the media and government. The study analyses key aspects collectively recognized by this outstanding group of individuals. It provides insights on factors that shaped ICT innovations in Australia, positive as well as negative, from the 1950s to the 2020s. Key insights into long-term strategies for a future-looking agenda supporting successful innovations in ICT in Australia are:

- Insight 1 provides an overview of key stakeholders identified as important to the landscape underpinning ICT innovation in Australia.
- Insight 2 presents a framework dissecting the interactions of four aspects important to the wider ecosystem underpinning ICT innovation in Australia: (1) education and basic research; (2) the development of novel ICT-based solutions to challenges in organisations and society; (3) the commercialisation of ideas into products and services; and (4) successful scaling up of Australian innovations in a national and global marketplace.
- Insight 3 analyses how government initiatives including tax incentives, research funding, programs, and other support mechanisms are seen as being effective or limiting in providing lasting support for the Australian innovation ecosystem for ICT.
- Insight 4 unpacks one aspect currently not sufficiently considered in policy: the role of government as customer supporting innovations in ICT in Australia.
- Insight 5 analyses the different roles that varying levels of government have in supporting ICT innovations in Australia. Notably the federal government, state governments, as well as local government all play important but distinct roles in supporting ICT innovation in Australia, that future policy will need to take into consideration.
- Insight 6 investigates in detail issues regarding the university-industry nexus, an area identified by numerous participants as requiring particular attention for strengthening ICT innovation in Australia.

The partners

THE UNIVERSITY OF SYDNEY

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The University of Sydney Business School provides expertise from different groups, including the Business and Labour History Group (BLHG); the Digital Futures Research Group (DFRG), and Sydney Business Insights (SBI).

The Pearcey Foundation promotes the significance of the Australian ICT sector by recognizing and awarding outstanding achievements and its involvement in debate and public policy on critical national issues. The Foundation is named after Dr Trevor Pearcey, pioneering the world's fourth digital computer, CSIRAC, in Sydney in 1949/50.

Our expert team

Dr Sebastian Boell

Leader of the Business and Labour History Research Group at the University of Sydney Business School. Sebastian has expertise on historical research on information systems. He has attracted grants from the CRC, the University and industry. His work is published in leading international journals and conferences.

Graeme Philipson (Vale 2021)

President of the Australian Computer Museum Society and Historian for the Pearcey Foundation. Graeme has written books on high technology, business, travel, and history. He has launched and edited many business and technology magazines, and written several corporate histories.

Dr Peter Thorne

Chair of the Pearcey Foundation Heritage Committee. Former Head of Computer Science at the University of Melbourne and a Member of the Commonwealth National Procurement Board, Peter has extensive experience as a consultant, to both the private and public sector, on procurement policy and practices and as an expert witness in IT-related litigation.

Prof. Kai Riemer

Professor of Information Technology and Organisation and Head of the Discipline of Business Information Systems at the University of Sydney Business School. Kai has extensive experience with industry-funded research and leads a Linkage project initiative on managing end-user technologies, sponsored by the ARC.

Dr Sandra Peter

Sandra contributes to research, public conversations, policy, and critical thinking by working with leading experts in industry, government and community. She is also co-host of Australia's leading Business and Technology podcasts series.

Belinda Wang

Belinda is a PhD student in Discipline of Business Information Systems at the University of Sydney. Her research interests lie in areas of AI for decision making, specifically focuses on human-machine collaboration in algorithmic decision-making processes.

How we define innovation

We define innovation as follows:

> *Innovation comprises the entire process from conception of ideas to their commercial success in the market.*

This definition explicitly covers the whole process, as organisations and society ultimately only benefit from ideas that see the light of day in products and services.

Research approach

The study collected data from biographical interviews with outstanding individuals whose careers have contributed to ICT in Australia and who are recognized by national awards at the highest level.

In total 42 individuals were interviewed (for details of those interviewed see appendix 1). Due to the nature of the award many interviewees have had long careers and broad experience in contributing to, and shaping, the Australian ICT ecosystem. The awards given by the Pearcey Foundation are highly regarded for recognising life-time achievements to the ICT sector in Australia. The awardees are elected by a panel of peer industry figures and include entrepreneurs who formed successful companies, academics who developed new technologies, individuals driving the adoption and use of IT in government, as well as IT journalists.

For this project, interviewees were asked open ended questions about their career, as well as more specific questions regarding what they perceived to be innovative products, projects and services that they were involved in over their professional career. The research team followed up with more specific questions to elicit how participants perceived the role of government, aspects specific to the Australian context, access to personnel and the skill sets sought, as well as other aspects deemed important, either within or outside of their direct control.

Interviews lasted about 60-120 minutes and were generally conducted by a team of two interviewers. The interviews were recorded, and all interviews are transcribed in full. Transcribed interviews were provided back to participants to allow for additions and clarifications. With the permission of participants, approved interview transcripts are stored permanently by the Pearcey Foundation as part of an oral history collection of ICT in Australia.

Based on the interviews, we analysed common themes across interviews. Several topics recurred independently in many interviews. This allowed the research team to develop a tentative model of aspects perceived to be relevant to innovation in ICT in Australia.

A notable aspect of this project has been to capture and record the insights and experience of leading figures who have played major roles in shepherding Australia through the more than seven decades of the ICT revolution.

Timeline of ICT innovations in Australia

Australia was an early adopter in computing, with CSIR Mark 1/ CIRAC one of the first computers in the world. Today CSIRAC is the oldest surviving valve-based digital stored program computer in the world. CSIRAC is on exhibit at Science Works in Melbourne. The timeline in figure 1 captures key events in ICT in Australia, and globally from 1949 to the present.

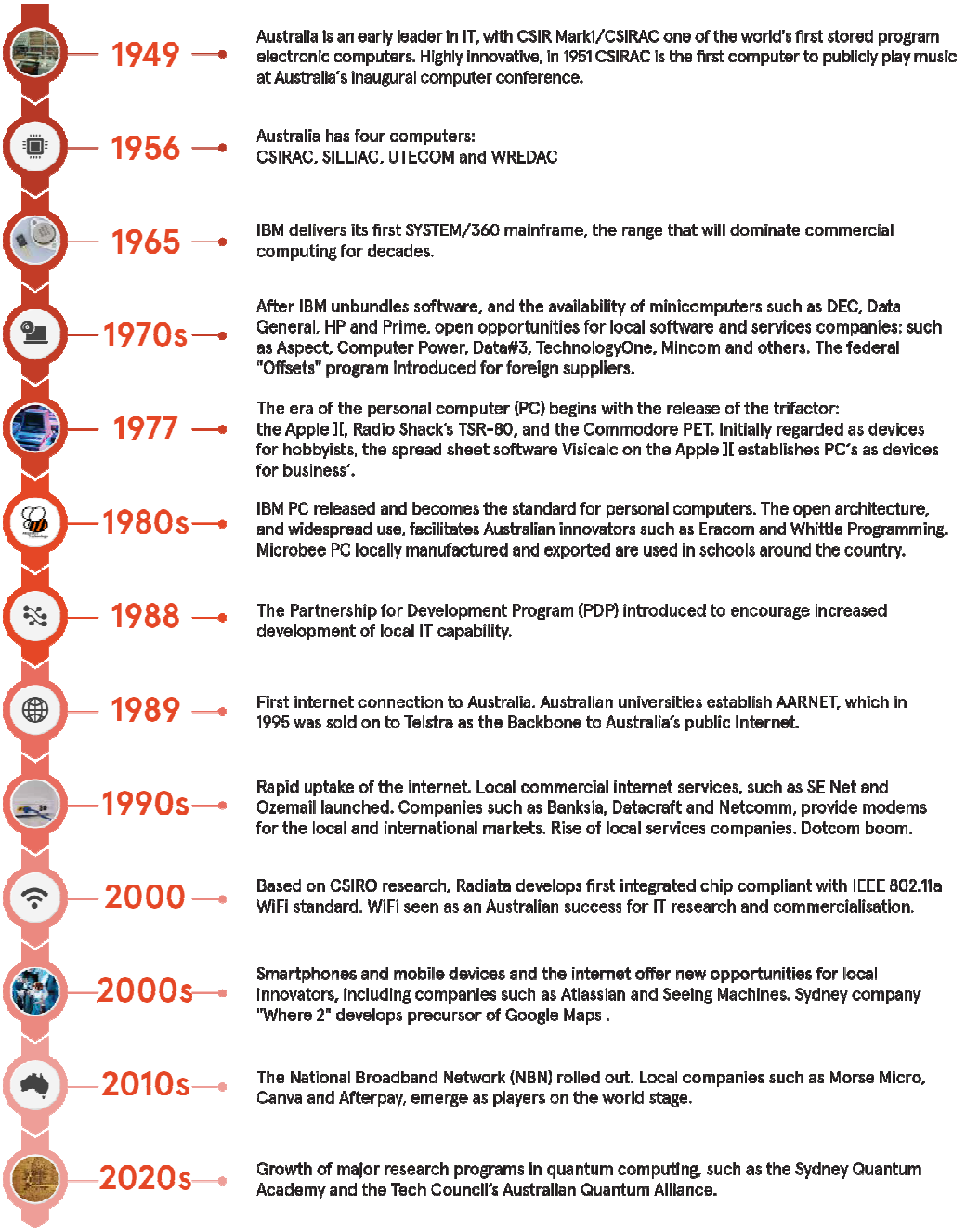

Figure 1: Timeline of key events in ICT from 1949 to the present.

Challenges then and now

The interviews surfaced a number of challenges for the commercialisation of innovations in ICT in Australia, and provided a picture of how those challenges have changed over time.

	Then	Now
Access to funding and capital	Very difficult to obtain, as investors and banks did not have good understanding of the technology sector.	Access to capital is much improved. For more details see the report 'Australian Digital Innovation on the Rise' (2020).
Access to a skilled workforce	Australian Universities produce well-trained graduates educated by world-leading researchers in ICT.	Australia produces well-trained graduates educated by world-leading researchers. Sought after graduates bring with them a problem-oriented mindset attuned to the wider context in which ICT is applied.
Inventiveness	New approaches and products are driven by a "tyranny of distance" (lack of access to overseas technology), encouraging inventiveness outside of major overseas trends.	Australians are early adopters of innovative technology, often developed overseas, making Australia an attractive place to evolve and test new technologies.
Government policy to support local IT industry	At times strong incentives for multinational companies to engage in product development and manufacturing in Australia through the Partnership for Development Program (PDP).	No current comprehensive government initiatives driving ICT innovations in Australia were identified by participants in our interviews, other than R&D tax incentives.
Government as customer	High risk aversion and long contract timeframes were seen as favouring multinational companies.	Risk aversion and long contract times are still seen as favouring multinational companies, often from outside of Australia.
Industry-Research collaboration	CSIRO, but also incentives for multinationals through the Partnership for Development Program (PDP) and Offsets program to engage in research collaborations (Button 1988).	Some successful programs exist, namely Cooperative Research Centres (CRC)[1] as well as CSIRO including Data 61. Collaboration with multinationals on research is problematic as their Australian presence is increasingly limited to sales and marketing.
Going global	Good support by Austrade for making initial contacts in the US and south and middle America were reported.	Much reduced "tyranny of distance" due to modern communication technologies makes going global easier for Australian inventors.
Established Industries for which ICT is developed	Mining, local government, accounting and other business software.	The report by the Australian Tech Council 2022 lists: Business Software, Biotech, Medical Devices, Media and Design, Pay Tech, Mining Tech, Lending, AgTech and EdTech.

[1] https://business.gov.au/Grants-and-Programs/Cooperative-Research-Centres-CRC-Grants/Current-Cooperative-Research-Centres-CRCs

Key insights

The research arrived at five key insights regarding lasting impacts on the Australian ecosystem that underpin innovations in ICT over the last few decades. Each of these insights is now discussed in detail.

Insight 1: Overview of the Australian ICT innovation ecosystem

Our research identified important stakeholders involved in Australia's ICT innovation ecosystem shaping the landscape in which ICT is developed and commercialised (Figure 2). Pearcey Hall of Fame awardees have significant, collective decade-long experience in the ICT sector, which allowed surfacing a range of notable trends for each area of the ecosystem. These will be unpacked in more detail in the insights below.

One notable change in the industry over time is the vastly improved access to funding, particularly of venture capital. Up until the 1990s access to finance was a major roadblock for the local ICT industry, meaning that entrepreneurs largely had to finance growth out of their ongoing cash-flow and personal wealth. By contrast, the past two decades saw a robust incubator and start-up scene emerging in Australia, fostering the commercialisation of innovative ideas.

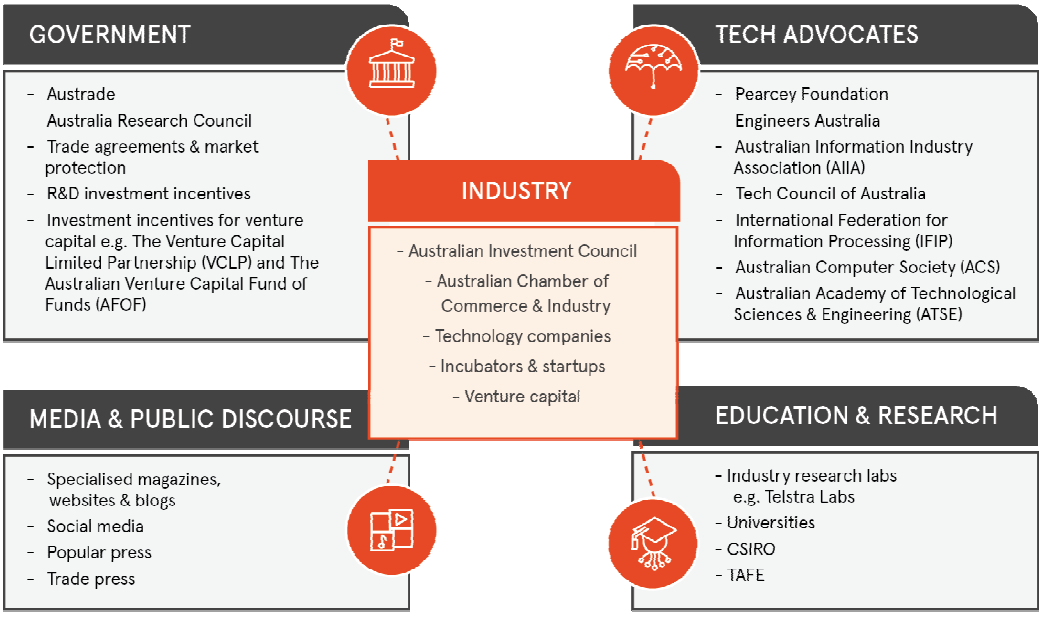

Figure 2: Overview of the Australian ICT innovation ecosystem.

Over time federal and local governments have changed their approach on protecting the domestic market and the local ICT industry. During the 1980s, to be eligible for government contracts, multinational companies were required to invest part of their profits made in Australia back into manufacturing and education locally (see insight 3 for more detail). At the same time, Australian Governments actively supported local ICT industry by sourcing locally made products such as the *Microbee* system for computer education in schools (for details on the role of government as customer see insight 4). In addition, government has been an active facilitator in helping Australian organizations to scale-up in a global marketplace. *Austrade* has supported several Australian ICT entrepreneurs in growing their business overseas.

Australia has a track record of providing strong education and research that drive ICT innovations, with one of the first computer science conferences in the world convened in Sydney as early as 1951. Interviewees reported that Australian graduates are well trained, making them attractive hires for ICT companies domestically as well as abroad. One notable change in the Australian ecosystem over the last few decades is the declining role of industry-run research labs, such as *Telstra Research Laboratories*, in driving the development of new products and services.

The role of key publications spanning the whole ICT industry has also declined over time. This change in media has been significant for public discourse and understanding. For instance, the IT section in *The Australian* used to offer a common ground for following developments in the local ICT industry including a major job market for qualified personnel. In line with other industries, specialised magazines or sections on major newspapers have largely disappeared as current news and events are shared via social media and specialised blogs, which offer individuals a more personalised information sphere with news relevant to them.

Technology advocates in Australia comprise professional societies and more traditional lobby groups. There are multiple important societies, associations, and groups that represent different interests of the Australian ICT industry to the public, government and education. However, some associations, such as AIIA as a major industry advocacy body, were regarded in several interviews as having an overrepresentation of international or multi-national ICT companies. Recently, new players are emerging, most notably the Tech Council of Australia.

Insight 2: A dynamic national innovation framework

Besides having various different actors involved, creating the right conditions for successful innovation at the national level requires the interplay of a number of different factors. This study identified four main factors, with key interactions between them (Figure 3): (1) building of *intellectual capital* through training and education; (2) *identification of opportunities* where ICT can be used to address organizational and societal needs; (3) the ability to *commercialize ideas* into products and services; and (4) the ability to *scale up* products and services for success in the national and global marketplace. Each of these four factors, as well as their interactions, contribute directly to a well-functioning national innovation ecosystem.

Education and training are at the heart of the creation of new intellectual capital. They lay the foundation for evolving technical expertise and producing graduates with a problem-oriented mindset who are able to identify novel approaches to use ICT for addressing organisational and societal needs. Importantly our participants stressed that problem-oriented thinking driving innovation in ICT goes beyond just STEM education. It explicitly also includes the humanities, social sciences, and business schools. Graduates with relevant technical ICT skills have to be complement by a cohort of graduates that are able to identify and understand relevant problems from a dedicated customer perspective, as summarised in the following quote:

> *"I put ads in the paper for nurses and teachers because I just knew they'd be really good in the business … quite frankly we got people that were good managers, terrific managers, good project leaders, could go in and analyse a problem and come up with a solution, even if they didn't cut the code."*
>
> *(Lyndsey Cattermole AM, Founder and Managing director of Aspect Computing)*

While the interviews revealed healthy levels of interaction between most of the four factors, as shown in figure 3, some weak points were also identified. In particular, the university-industry nexus remains an area of concern for Australia (see insight 5 for further details). A second weak point relates to the demise of industry research labs,

which was said to weaken the ability of organizations to work on novel "blue sky" ideas with a view to quickly scale up into products.

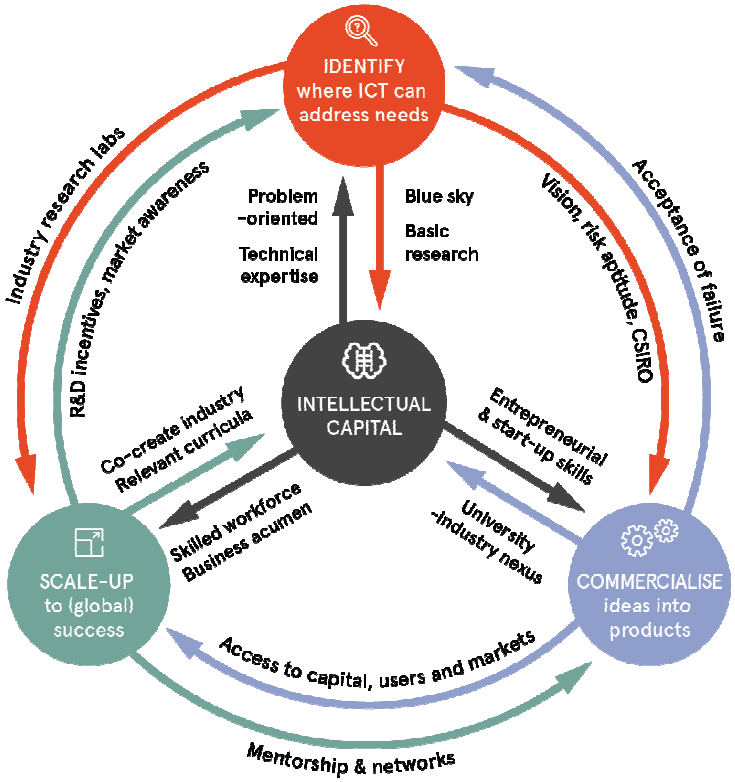

Figure3: Elements of Australia's ICT innovation ecosystem and their interactions

As shown in figure 4, a different way to understand Australia's ICT innovation ecosystem is to foreground the temporal-causal relationships between the four factors, in a process model that stresses the transition points between them. Our research identified several aspects for each of the four factors that underpin and strengthen the national innovation ecosystem. For instance, the "tyranny of distance" – the relative distance of Australia from the rest of the world – is seen as potential driver of innovation, as it necessitates local innovation with an unfettered perspective encouraging tinkering and novel approaches.

Looking at transition points in figure 4 also reveals potential roadblocks and exit points where progress towards successful innovation of ICT may be hindered. For instance, a perceived risk aversion and a "glee club" attitude in Australia is seen as reducing the probability that novel ideas, of which there are many, progress towards successful commercialisation. Low risk attitude reduces the likelihood individuals pursue the commercialisation of ideas, particularly if investment of personal capital is required. Moreover, a "glee club" attitude, where success is celebrated and failure is regarded as a weakness, discourages entrepreneurship built around a culture of learning from setbacks. As a result, the opportunity to pursue commercialisation of novel ideas for products and services remains underutilised.

As shown in figure 4, our research also indicates that commercialisation of innovations in ICT requires a solid market to build and maintain a strong enough customer base. Innovation in ICT thus leverages existing strengths in the Australian economy. Entrepreneurs are well positioned in scaling-up their products and services when they have ready access to users of their products. It is thus no surprise that several leading mining-related ICT products achieved a world leading position.

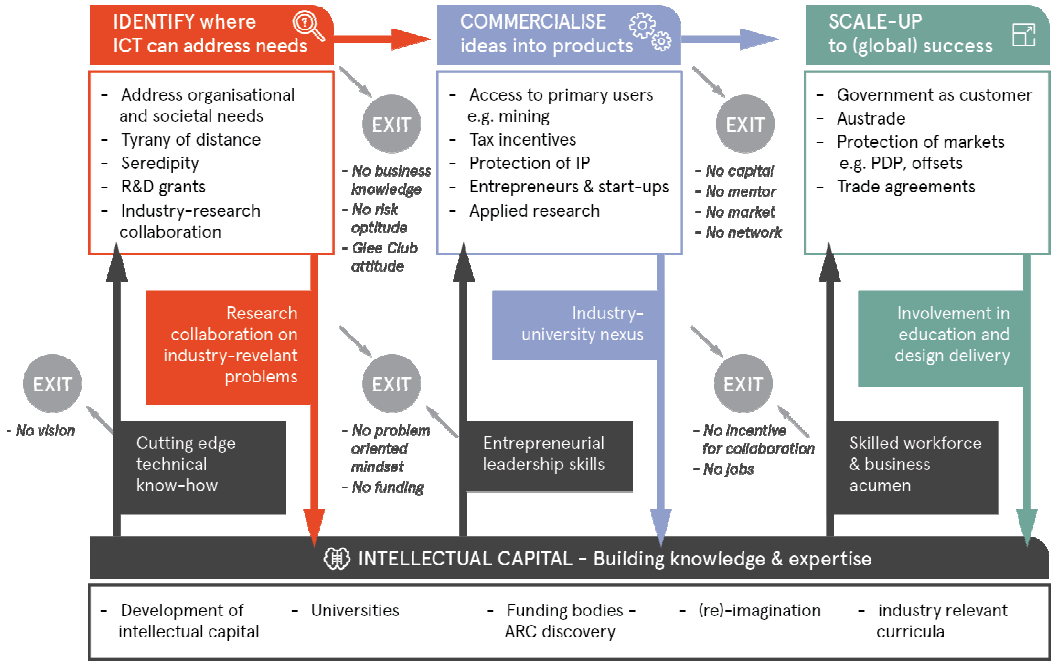

Figure 4: A process model of Australia's ICT innovation ecosystem and transition points

> *"In fact, I've often said that if you talk to a mining engineer anywhere in the world, if they haven't heard of Whittle they've been living under a stone, they really have. It's used, the stuff we sold is now used in hundreds and hundreds and hundreds of mining companies worldwide. I'd guess at least half the mines in the world have been designed using that software. … Well, 'Whittling', yeah, the mining engineers invented that, we didn't invent that, that's quite early days they'd talk about Whittling their pit. … One of the big international banks we talked to the guy … stated that they would not lend money to a mining company unless they were using the Whittle software. One of the huge international banks, that sounded nice."*
>
> *(Geoff Whittle AO, Founder of Whittle Programming)*

Future ICT innovations in Australia might well be related to industries such as mining, agriculture, education, tourism, as well as business and finance (see also Tech Council 2022). Innovations in these sectors will find an existing market in Australia, thereby laying the foundation for further growth overseas by having sites where companies can demonstrate that their products or services are already successfully implemented. On the other hand, Australia is not as well placed to capitalize in other, less industry-specific areas, such as e-commerce, as the local market is small in comparison to international markets like the US, Europe, or Asia.

Insight 3: Government as a facilitator of innovation

Many interviewees pointed out that government plays an important role in supporting the national innovation ecosystem for ICT. Over the last few decades, government approaches have varied from hands-off to more hands-on attitudes. An example of a hands-on approach was the Partnership for Development Program whereby the Commonwealth actively encouraged multinational ICT companies to re-invest parts of their earnings nationally (see example box for details):

> *""the Partnership for Development program, and that's a critical subject in Australian innovation, and it … deserved much more recognition than it obtained. And the close down of that program I think was a severe loss to Australian innovation. … because of that Fujitsu …*

had an obligation to spend considerable sums of money on R&D in Australia, and they did that by close collaboration with CSIRO. And we did it by setting up a whole range of centers, research centers, education centers, ... there's no question that Partnership for Development generated the role that technology companies used to play, the manufacturers and software development companies was huge. ... the closing down of the Partnership for Development program means now that involvement in research in Australia is entirely voluntary ... if you have no compulsion the big companies are going to do the bulk of their research in areas where they're dominant, where the bulk of their staff are."

(Neville Roach, Former Chairman and CEO of Fujitsu Australia))

Other successful approaches comprise tax incentives and grants that encourage organizations to investment in research and development (R&D). However, some participants noted that R&D funding might have limited benefit for ICT innovation in Australia. In some instances when R&D funding is effectively used for 'D' not 'R', the benefits for the national ICT innovation ecosystem are limited. Typically, a development may address an existing organizational need instead of funding research that lead to novel products and services.

"R&D and the innovation in Australia I think the R&D grants are totally exploited and are wrong. Now I do know that the Tax Department is starting to cut down on it, I know of enterprises that get quite significant refunds for doing absolutely doing nothing innovative at all. They've written a spreadsheet that connects SAP to Microsoft and they're claiming it and getting it, because they bring in a Deloitte or they bring in a KPMG who puts a really good case together, in some cases for a share of the gains, in some cases for a fixed fee, and they're getting, and this is outrageous. And it's very hard to say support genuine innovation and R&D when that's happening, and the money is being syphoned."

(Lyndsey Cattermole AM, Founder and Managing director of Aspect Computing)

The Offsets Scheme and the Partnership for Development Program (PDP)

Several interviewees referenced the Offsets scheme and the associated Partnerships for Development Program (PDP). These schemes were introduced by the Federal Government in an endeavour to encourage local investment by transnational suppliers and to induce them to collaborate with local companies when providing goods and services to the public sector.

The Offsets scheme was introduced in the 1970s and revised in 1986. In September 1987 the Government announced a new status of Partnerships for Development (initially for the IT sector only) under the Offsets scheme.

To be eligible for contracts from the federal government these programs, introduced under the Labor government, required multinational companies to re-invest part of their earnings made in Australia back into local product development, manufacturing and education. The programs were criticised on the basis that they were a counter to free trade. They were generally complied with, reluctantly, by transnational suppliers, with some participants arguing for flow on effect cross the wider innovation ecosystem.

Some interviewees claimed that the PDP, although intended to assist local SMEs, in practice had the opposite effect, and was responsible for the demise of many local small suppliers as they were pushed into the role of mere local subcontractors for multinationals.

In addition, our participants pointed out that bureaucracy surrounding R&D funding could have a detrimental effect on new products and services developed by start-ups. While established organizations often have the resources and expertise necessary to go through an extensive application process for R&D funding, start-ups gen-

erally are less able to take advantage of R&D grants when the application process is overly complex.

> *"there was some Australian government R&D grant award scheme through the Tax Office. And it required very substantial documentation. A lot of companies just thought, you know, why bother? ... I sat down and did these applications. And they were very, ... you know it was like writing a mini thesis to get the money."*
>
> *(Fiona Balfour, Former CIO of Qantas)*

As a result, there is a perceived structural disadvantage for start-ups, who generally focus their resources on developing their products and services, with limited expertise and aptitude to engage with lengthy and uncertain grant funding applications.

> *"The Government currently has R&D grants. These R&D grants we can get them, and CBA and multinationals can get them. And it doesn't make sense that CBA can get R&D grants. They need to stop this. The R&D grant needs to go to the start-ups. That's where the money needs to go. All of it needs to go to start-ups. And they need to get rid of all the red tape and all the bureaucracy. They just increased, about 12 months ago, the bureaucracy that's required to get the R&D grants. We have all the systems and the processes in place, so it doesn't impact us. For a start-up, it makes it almost impossible now to get an R&D grant."*
>
> *(Adrian Di Marco, Founder and CEO of TechnologyOne)*

A further issue that was identified is a lack of aptitude by government to back innovations in ICT, often because of the limited time-horizons in which politicians make their decisions.

> *"We have always needed more savvy politicians who might have taken the leap when it comes to innovation. That's what's been missing. Anyhow, I don't want to play too much on government - it's not the be-all and end-all, but unfortunately the technology industry has to operate within an environment in which governments rarely see longer than the three-year political cycle. The time-lines can be long for innovation and even legislating to create a suitable framework and the conditions needed to support R&D takes too long."*
>
> *(Helen Meredith, IT journalist and Former Editor for The Australian)*

Finally, the Australian Research Council and Cooperative Research Australia play an important role for funding research and the creation of intellectual capital. In particular, the Cooperative Research Centres (CRC) are seen by participants as an effective approach in encouraging collaboration across industry and academia (see insight 5).

Insight 4: Government as a customer

Governments, at all levels, play an important role as a customer of ICT-related products and services, which was identified by our participants as a major factor supporting the Australian ICT innovation ecosystem. Several entrepreneurs report that, at key points, government contracts offered a boost to their business, facilitating necessary growth trajectories, and offering signalling crucial for winning overseas contracts.

> *"If there was one thing that sort of goes right back through my time is trying to commercialise R&D, that's possibly to me the biggest factor that I can think of. That the biggest impediment of, if you go in and try and sell something to: I suppose an aerospace company in Europe or something like that, it's the first question you get asked: 'Who's using it in Australia, why isn't your government using it?'."*
>
> *(Dennis Cooper Head of CSIRO Radiophysics)*

Government contracts bolster a company's reputation and standing. Government as customer thus underpins the transition from commercialisation to scale-up in our

model (figure 4). Purchases by the government provide important points of reference when competing in a global marketplace, thereby assisting national companies in achieving economies of scale, which are ultimately only attainable by growing beyond Australia.

> *"The first question any other market will ask our companies is: does your government buy from you? And so having a range of opportunities for local companies to be procured, their services procured by a government agency, becomes a critical element in not only the ability to attract investment capital at whatever level, but it's critical to securing export opportunities as well, are formative, and necessary, for the scale for the business to continue to grow, because the Australian market is not big enough for Australian businesses to grow to scale."*
>
> *(Kate Lundy, Former Shadow Minister for IT)*

However, there is a tension in government procurement between the long-term benefits of encouraging local development and the short term, risk adverse, approach of only buying existing products from established multinationals. In particular, purchasing practices at the federal and state level frequently favour purchases from large multinational corporations over local start-ups. Moreover, tender processes and contract negotiations are often seen as too complex to encourage smaller, local companies to engage in the bidding process, thus leaving such contracts to transnationals backed by sophisticated sales teams with strong lobbying networks.

A second structural challenge regarding government as a customer are long contract lifetimes, restricting the opportunity to apply frequently for government tenders. This applies especially to tenders sought by federal and state governments which tend to have longer contract periods. Once a contract is awarded it can be several years before local companies again have the chance to break into existing service arrangements.

> *"The biggest disappointment was to see government let long term supply contracts to Oracle and to SAP that pretty much freezes out a lot of the local IT industry. … It's not good for the taxpayers, it's not good for the department. It's not good for the local industry. You see that in Canberra. They're not good, those long-term supply contracts. They've really frozen out the local industry for a long time. Contracts should be put back to tender on a regular basis, every five or six or seven years, but they don't do that. So that's probably one of the biggest disappointments. Government could have played a big role in nurturing more for the local IT industry, but they didn't do that. And they're not changing. They've still got these long-term supply contracts and they don't put them out to tender."*
>
> *(Adrian Di Marco, Founder and CEO of TechnologyOne)*

On the other hand, partnerships with local governments are often seen as easier to obtain by domestic ICT companies. The role of local governments as supporters of innovation was emphasised not only in terms of purchasing and injecting funding, but more so for creating an environment that fosters the productive exchange of ideas, thus benefitting the development of new ICT. This points to opportunities for start-ups to partner and work closely with their local government in developing novel approaches for products and services.

Strategies and policies to increase the chances of Australian start-ups in tender processes also have a beneficial flow-on effect for the wider ICT scene in Australia. This does of course not imply that inferior Australian solutions should be chosen over more mature overseas products, but that perceived risks of using smaller local companies should be balanced with the wider flow-on benefits for the Australian ICT landscape. One suggestion made was that during the tender process it should be required to explicate the degree to which the offered product or service is linked to domestic development, education and training as well as production.

Insight 5: Roles of different levels of government

In addition to their role as purchasers, federal, state and local government all serve important but different roles as part of the national ICT innovation ecosystem (figure 5). For effective policy it is essential that the multiple roles taken by government in supporting the innovation process are understood.

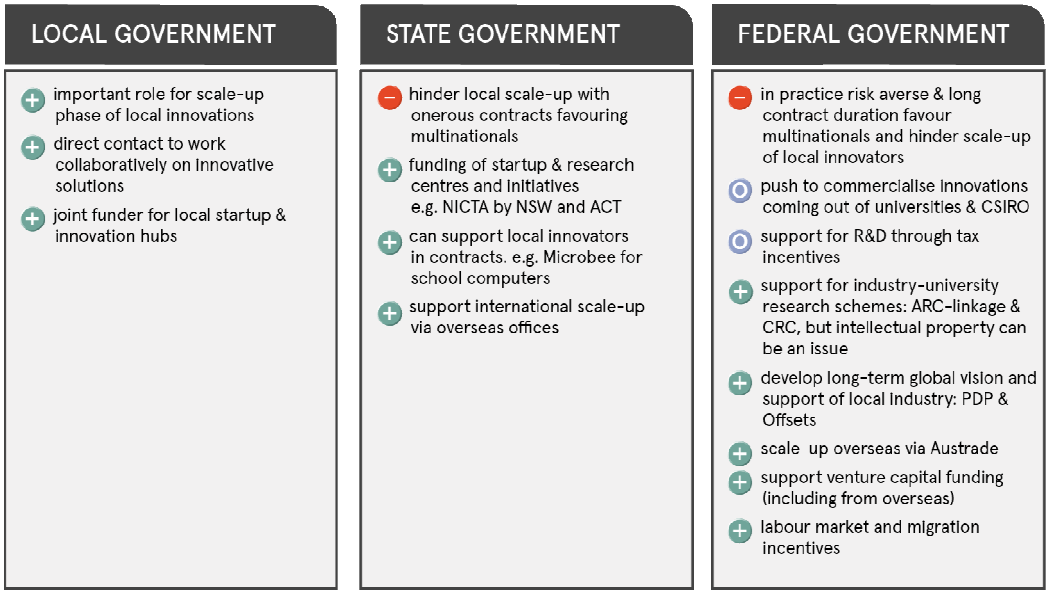

Figure 5: Roles of different levels of government

The **federal government** has an important role in early-stage research through its support for basic research in universities and organisations such as the CSIRO, but also through the building of intellectual capital through support for universities and other education institutes. It also can influence product development and commercialisation through development grants, tax incentives and Collaborative Research Centres (CRC). What is seen as problematic is when both these roles of the federal government are mixed. In particular, in recent years a push towards commercialisation of ideas by the CSIRO is perceived as potentially conflicting with the need to engage in blue sky thinking and engagement in basic research. An argument is made that while the CSIRO engages in basic research that has potential for commercialisation, the financial stability of the organisation should not depend on generating revenue through commercialisation.

In terms of supporting R&D the majority of the interviewed experts advocate for tax breaks for start-ups as an approach that is perceived to be less bureaucratic than R&D grants which are perceived to be labour intensive and lengthy.

> *"You know, these young people who are doing very innovative things. They haven't got a clue about bookkeeping and accounting, and how to fill forms, not a clue, it's anathema to them. What does Government want them to do? It wants them to fill in forms. We had this in the Innovation Centre, I tell you it used to drive me nuts. All they want to know is, you know, what have you done? How many customers have you gotten."*
>
> *(Brian Finn AO, Former CEO of IBM Australia)*

The Commonwealth also plays an important role in supporting the scaling-up of Australian companies overseas. Several participants report that they received support from Austrade helping them with growing their operation overseas through contacts, product fairs and loan arrangements.

"We basically decided to go ahead and opened our office there because it was a much bigger marketplace, and the costs were ameliorated through the various support schemes from Austrade. When we went to South America … Austrade had to deal with a lot actually lending you money to start up operations overseas. So, we opened an office in Chile helped by a million dollar low cost loan from Austrade. And we did the same thing in Singapore for the Asian marketplace."

(David Merson, Founder of Mincom)

By contrast **State Governments** play an important role in supporting start-ups through innovation hubs, research centres, and similar projects. The incentive from a state government perspective is to promote local industries, but support towards the commercialisation of ideas has a flow on effect strengthening the national ecosystem underpinning innovations in ICT as a whole. Research centres also strengthen the building of knowledge and expertise that underpins the creation of ideas for new products and services.

Taking such ideas to innovation hubs start-ups are provided with the opportunity to learn from each other and tap into existing networks of potential investors and business mentors:

"Anyone could come and apply to be part of that Centre and we would help them with their business cases and help them get their businesses up and running."

(Brian Finn AO, Former CEO of IBM Australia)

State governments are, therefore, well placed in fostering and supporting mentorship networks among researchers, entrepreneurs, venture capital and local businesses. They can also facilitate the commercialisation of research outcomes produced by universities or collaboration across industries. In particular, as innovations in ICT occur in relation to existing industries innovation hubs offer points of contacts where expertise in ICT can underpin the creation of products and services for other sectors in the Australian economy.

The role of **local governments** as part of Australia's national innovation ecosystem for ICT is predominantly as a customer and as promoter of products and services in local trade shows and fairs. Particularly the role of customer was emphasised as less bureaucratic than tender processes by state and federal governments, which can be tedious and challenging particularly for small organisations and start-ups.

"State and federal very much are risk-averse, IT-led decisions. They love the big brands, if it's not Oracle and SAP, there's a lot of that attitude, the difficult contracting terms. Local governments are the opposite. Local government is very much driven by efficiencies. They are dealing face to face with ratepayers all the time, they are at the coalface. And they're very complex businesses. And they run very, very efficiently. So, we found them to be the opposite, the brands didn't really matter. They just wanted a good cost-effective solution that are very practical, down to earth organisations typically run by business people."

(Adrian Di Marco, Founder and CEO of TechnologyOne)

For all levels of government there is an ongoing pressure to stay up to date and understand changing markets and technology. In particular, at the level of the federal and state government engaging with technology advocates (figure 2) offers an effective way to cope with this changing situation.

Insight 6: Importance of university-industry nexus

A key weakness in the Australian ICT innovation ecosystem that was identified during our study is the lack of strength of what we term the university-industry nexus. For example, participants identified only a very limited number of successful initiatives and programs, but pointed to numerous issues. One such issue is that industry

and academia operate on very different project timelines. Whereas industry is generally interested in seeing tangible outcomes within weeks or months, the academic research process often unfolds over multiple years. Other issues include concerns around intellectual property, as well as a lack of day-to-day exchange between the two worlds. Compared to companies abroad, Australia has only a limited presence of academics in organizational boardrooms. This has consequences not only for co-creating industry relevant curricula but also limits the ability for collaboration on industry-relevant research.

> *"Well, we do tend to put down eggheads, we tend to be a bit rude about academia, senior bureaucrats where some are, I've tried desperately over the years on my boards to have them look at senior academics that I know are, principal of schools, as board members, because these people run really complex businesses. Do you think I can get the average businessperson to take any notice? No. It's just really sad."*
>
> *(Lyndsey Cattermole AM, Founder and Managing director of Aspect Computing)*

Existing programs such as the Australian Research Councils (ARC) linkage grant scheme, while providing much needed funding, also have to contend with an imbalance in the incentives for collaboration, as it is academics who are often more interested in and incentivised for engaging in, and driving, such collaborations, than industry. Cases where industry seeks to collaborate with academia are sparse by comparison, and often driven by a need to improve education rather than the creation of new knowledge or inventions. From an industry perspective, collaboration on curriculum, and engaging in student projects, offer a more immediate area for building stronger ties. Here, industry can bring its problems, while facilitating the development of problem-oriented mindsets in graduates.

Example: Co-operation for Excellence

The program was a cooperation involving industry-based learning to address the shortfall of IT graduates with knowledge in business during the late 1980s. The initiative was conceived by Brian Finn at IBM and involved the federal ministry for education, the University of New South Wales (UNSW), Monash University, Swinburne and UTS. In an effort to support closer links between industry and educational institutions, IBM and other corporations sponsored scholarships for students in a degree that combined elements of IT with information systems at business faculties and involvement in day-to-day work at corporate program sponsors.

For further details see: O'Hanlon, S. (1999). *Co-operating for excellence: Monash University Bachelor of Business Systems, the first ten years, 1988-1998*. Monash University, School of Business Systems, Faculty of Information Technology, Monash University.

At the same time, improved collaboration between business and University in education can lead to positive flow-on effects for research, as collaborations often result from individuals establishing personal contacts across boundaries. Schemes that foster academic sabbaticals in industry or encourage industry experts in residence at Universities might offer much needed exchange between the two worlds.

Another issue that troubles applied research by publicly funded institutes, such as CSIRO's Data61, is that funding is often insecure or time-limited, in an effort to encourage the development of industry relevant applications of ICT funding. The result is uncertainty of the funding necessary to sustain ongoing support of large research programs. While desirable, commercial success of new products and services is, however, only one aspect of a healthy national innovation ecosystem for ICT. A lot can also be learned from failure and from basic, foundational research.

There are of course notable exceptions that provide success stories of commercialisation of academic inventions, as listed in the box 'Examples of successful commercialisation of Australian Research'. Most such initiatives emerged from universities as research outcomes, which were later developed into commercial products. However, existing reward structures and publication-centric KPIs in universities increasingly favour those academics who pursue a traditional academic career, instead of taking the more risky route towards working on the commercialisation of research outcomes.

Examples of successful commercialisation of Australian Research

WiFi

The development of WiFi is an Australian success story, where initial basic research by CSIRO was successfully commercialized. Key to the success of this research was the development of commercially ready integrated circuits by Radiata that combined processing and radio transmission on a single chip design. This success was enabled by individuals crossing the university-industry nexus, working in both fields throughout their career. Notably, in this instance the open transition between academia and industry was a result of careers spent in the US.

Seeing Machines

The most successful commercialization of research at the Australian National University (ANU) is related to monitoring operators of machinery in real-time. Seeing Machines is located in Canberra, but listed at the London Stock Exchange. During the early 2000s raising venture capital (VC) in Australia for ICT was difficult and other VC offers would have required a relocation to Silicon Valley. It is predominantly the founders desire to reside in Australia that underpins this Australian success story.

Future research

The dataset collected for this project is extensive and provides insights into many aspects of the history of ICT in Australia, and from the perspective of many relevant stakeholders, including, entrepreneurs, investors, academics, government and the press. Interviews capture relevant observations for a timeframe of more than six decades, from the 1950s to 2020.

The analysis in this report focuses on salient aspects related to the role of multiple stakeholders in the Australian ecosystem underpinning innovations in ICT. We offer an analysis of government as major stakeholder influencing policy. However, the dataset offers more potential for analysis including around aspects such as support for growing overseas interactions and commercial opportunities by Austrade and others, changing perspectives on gender, access to funding, and deeper analysis of possible trigger events, such as the Partnership for Development Program (PDP). Future analysis of these aspects will offer insights into the changing landscape underlying the history of ICT in Australia.

One particular area for further research is the exit points identified in our model in figure 4. These exit points indicate potential areas where innovation in ICT is currently hamstrung. A better understanding of such exit points has the potential to support a longer-term vision for government policy with a view to foster the next waves of ICT innovations in Australia.

Acknowledgement

We thank our participants for their time in supporting this research. We also like to acknowledge Jennifer Leonard and Barbara Ainsworth for their support in conducting individual interviews. Finally, we are grateful to Wayne Fitzsimmons for his support of the research.

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Appendix 1: The Pearcey Hall of Fame

The following Table lists all individuals interviewed for the project. Interviews had an average length of 87 minutes.

Year of Hall of Fame	Interviewee	Career Summary
2000	George Kepper	Entrepreneur, Government policy advisor, Founder and Chairman of Datacraft
2002	Bill Caelli	Entrepreneur, Security Expert, Researcher, Founder of ERA-COM
2003	David Hartley	Entrepreneur, Software developer for accountancy profession, Industry advisor
2003	Lyndsey Cattermole	Entrepreneur, board and membership positions in governments, adversary and associations
2004	Bob Bishop	Entrepreneur, Engineer, Researcher, Consultant, Chairman & CEO of Silicon Graphics
2005	Ashley Goldsworthy	Computer pioneer, Federal executive, University Dean
2005	John O'Collaghan	Researcher, Expert in high-performance computing and information Technology, Educator, Chief of IT Division of CSIRO
2006	Fiona Balfour	Executive, CIO Qantas
2007	John Puttick	Entrepreneur, Banking software pioneer, Queensland industry leader, Founder of GBST
2007	Roger Allen	Entrepreneur, Investor, Founder of Computer Power Group
2008	Neil Weste	Entrepreneur, WiFi chip designer, Researcher, Founder of Radiata, Author of CMOS VLSI Design
2008	Neville Roach	Executive, Social policy advisor, Honoris Causa, Chairman and CEO of Fujitsu
2010	Brian Finn	CIO and Chairman IBM Australia 1980-1998
2010	John Grant	Entrepreneur, Government advisor, Co-founder and CEO of Data#3 Chair of the Australian Information Industry Association (AIIA)
2011	Ann Moffatt	Entrepreneur, Author, Champion of Women in IT, Executive at AMP, Co-founder of Technology Solutions
2011	Brand Hoff	Entrepreneur, Software developer, Founder TOWER software
2011	Dennis Moore	Entrepreneur, Pioneer in computing WA, Executive Director of Government Computing WA

2012	Craig Mudge	Educator, Entrepreneur; Head of Xerox PARC, Founder of Austek
2012	Gregory Clark	Academic, Corporate Executive
2013	Alex Zelinsky	Researcher, Engineer, Entrepreneur, Vice-Chancellor University of Newcastle, Founder of Seeing Machines
2013	Rod Tucker	Optical Fibre Expert, Laureate Emeritus Professor
2014	Bob Frater	Radio Astronomer, Researcher, Scientist, Deputy Chief Executive CSIRO
2014	Mary O'Kane	Automatic speech processing field pioneer, Go8 Chancellor
2014	Peter Vogel	Entrepreneur, Computer designer, Co-inventor of Fairlight CMI
2015	Adrian Di Marco	Entrepreneur, Software developer, Champion of Australian industry
2015	David Merson	Entrepreneur, Doctor Honoris Causa, Founder or Mincom
2015	Geoff Huston	Australian Internet pioneer, Researcher, Author; Founder of AARNet
2016	Jim Ellis	Entrepreneur, Adjunct professor, Founder and Former Chair of WAITTA
2016	Robin Eckermann	Entrepreneur, Adjunct Professor, ICT consultant
2016	Steve Baxter	Entrepreneur, Angel investor, Start-up mentor, Founder SE Net, Founder and CEO of TEN13, Founder of River City Labs
2017	Helen Meredith	Journalist, Editor The Australian and Australian Financial Review, Commentator
2017	Kate Lundy	Politician, Honorary Doctor of Letters
2018	Dennis Cooper	Researcher, Engineer, Head of CSIRO Radiophysics
2019	Bob Beaumont	Entrepreneur, Venture capitalist, Government program advisor, Founder of VECCI Business Angels Services and Tech Angels Australia
2019	David Abramson	Researcher, Expert in High-Performance Computing, Educator
2019	Sonja Bernhardt	Entrepreneur, Champion of women in IT, Author and commentator, Founder of ThoughtWare
2020	Jeff Whittle	Creator of Whittle mining software series, Entrepreneur, Founder of Whittle Programming, later Whittle Consulting
2020	Jenny Seberry	Researcher, Educator, Cryptography Expert
2020	Owen Hill	Entrepreneur, Computer engineer; Co-Designer of the Microbee System
n/a[1]	Graeme Philipson	Writer, Editor, IT analyst, Computer historian, President of Australian Computer Museum Society

n/a[1]	Malcolm Turnbull	Politician, Technology entrepreneur, Lawyer, Investor, Co-founder of OzEmail
n/a[1]	Wayne Fitzsimmons	Entrepreneur, ACS Fellow, Engineers Australia Fellow, Investor, Chairman Pearcey Foundation

[1] In addition to people honoured in the Pearcey Hall of Fame, we interviewed a few selected individuals of significance to this study.

Appendix 2: Reports 1975-2022 relevant to Australia's IT innovation ecosystem

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