THE UNIVERSITY of ADELAIDE

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12 June 2020

**South Australian Productivity Commission Inquiry into Research and Development in South Australia – submission from the University of Adelaide**

On behalf of the University of Adelaide, please find attached a detailed submission in response to the March 2020 SAPC Research and Development Inquiry Issues Paper.

As a major partner in the South Australian research ecosystem, the University is pleased to participate in this initiative to identify opportunities to improve the State's capability to attract investment and support innovative research.

Yours sincerely

PROFESSOR ANTON PJ MIDDELBERG
Deputy Vice-Chancellor and Vice-President (Research)

Attachment: University of Adelaide submission to the SAPC Inquiry into Research and Development in South Australia.

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# South Australian Productivity Commission Inquiry into Research and Development in South Australia

## Submission from the University of Adelaide, 12 June 2020

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This submission is presented on behalf of the University of Adelaide by Professor Anton Middelberg, Deputy Vice-Chancellor and Vice-President (Research). It is structured around the twelve information requests listed in the SAPC Inquiry Issues Paper, noting that the Health and Medical Research sector is covered by a separate Inquiry. (Your attention is drawn to the separate submission to that Inquiry lodged by the University, noting the complementarity of many of the issues raised).

**INTRODUCTION**

At the highest level, the University is guided by its Strategic Plan, Future Making, which states that the Vision and Mission of the University is to:

> *realise its purpose as a catalyst of knowledge creation and innovation, as an engine of social advancement, and as an active participant in the local, national and global economy.*

The University of Adelaide has a long and distinguished reputation for sustained quality in research and its translation. As a research-intensive university with a tradition of delivering innovative research outcomes in a local, national and international collaborative manner, the University of Adelaide is highly supportive of the innovation agenda, expanding research ties with industry and working closely with different tiers of government to deliver outcomes of benefit for the community. In fact, one of the University's significant strengths has been its strong partnerships with key sectors of the State economy, providing an incredibly close fit to the scope of the SAPC R&D Inquiry which includes 'mining, agribusiness, cyber risk and other areas as appropriate'.

The University's research produces demonstrable benefits for the State, and it is one of the major contributors to State GDP. It underpins and contributes to the growth and development of key industries including agriculture, food and wine, defence, advanced manufacturing, energy and resources, and health and medicine. For example, cereal varieties developed at Waite have comprised approximately 80% of all those in production across southern Australia. Our research also informs and enriches policy-making and public debate in areas including economics, law and social well-being. The existence of world-leading research in numerous areas has helped to attract major projects and investment into the State. Less directly, the research intensity of the University contributes strongly to its global reputation as a top 1% university, which in turn attracts large of numbers of international students, contributing to a major export industry for the State. A strong, vital and growing research-intensive university makes a major contribution to the State's strategic goals.

In this context, one of the biggest shared challenges for the University and the State is attaining critical mass. We should be aiming for appropriate scale and focus in priority areas, rather than the division into non-leading units that can work across each other to create unnecessary complexity. This is about the synergy between collaboration (where it makes sense for mutual benefit) and competition (to drive innovation and build international reputation). Research institutions and the states (especially in a small State) need to be able to work together in way that optimises synergies, but allows focus on what it is they do which is excellent, specialised or niche, rather than broad-based. Recruitment should be at the highest international standard and include sufficient funding to support the work of world-class research teams; and models for sharing expensive enabling infrastructure should be developed.

The University of Adelaide is eager to build on, and further promote, engagements with the public and private sector, not only for co-investment but also to foster core teaching and research outputs, and deliver an enhanced reputation to the State.

**University of Adelaide Summary of Key Recommendations**

1. Attract and retain high-quality research teams in South Australia through collaborative State investment in people, and a strong focus on specialised or niche areas where the State can differentiate and excel.

2. The State Government to support the continuing growth in quality and volume of the University's research through co-investment and coordination of strategic research developments, e.g. via investment in the Waite Precinct, Information Capability at Lot 14, biomedical research, etc.

3. Provide collaborative State investment in enabling core research infrastructure, including the development of a long-term strategy and investment plan and a central register of major infrastructure. This includes ensuring critical base infrastructure is housed in open access, well-managed facilities that are set up for cost recovery and provide a wide range of value-add services.

4. Create a clearer governance structure for the South Australian research ecosystem which avoids duplication, clarifies responsibilities, facilitates synergies and complementary capabilities, and where helpful assists (in a non-duplicative way) with coordinated national funding initiatives.

5. Extend current State Government R&D support beyond project funding to include long-term (5+ years) strategic investment.

6. Back translation initiatives by seed funding opportunities and underlying core infrastructure, services and facilities to encourage the establishment of translation eco-systems that engage both research providers and translation partners.

7. Conduct a strong informational and promotional campaign, possibly augmented by subsidies, to convince industry more broadly of the value of engaging with research trainees and employing research graduates.

8. Support the expansion of joint appointments between industry, government agencies and universities.

9. The State Government could introduce a Fellowship scheme replicating those currently funded by the Federal Government (e.g. ARC Future Fellows), or like the Veski Fellowships in Victoria. This might include a series of bridging scholarships for early career researchers.

10. To promote industry engagement, establish a research accelerator network for select individuals which could offer seed funding, industry mentoring and connections to relevant industry networks, as well as exclusive development opportunities for members.

11. To support growth in the area of research training, make efforts to increase business investment and philanthropy supporting Higher Degree by Research (HDR) stipends, for example by means of State Government initiative offering incentives for businesses to fund jointly HDR students on collaborative projects, e.g. in line with Danish industrial PhD program.

12. To develop further an innovation and innovation collaboration culture in the State, undertake more extensive communication and celebration of SME R&D and R&D collaboration.

13. Review State regulatory agencies (e.g. Consumer & Business Services, SafeWork SA and the EPA) to identify efficiencies and resources needed to improve responsiveness to queries.

14. Facilitate extensive data linkage activities across South Australia via a partnership between SA Government departments and agencies, community stakeholders, as well as researchers from SA universities.

15. Implement funding at scale for locally-developed research breakthroughs to reach the point of further investment by companies and/or investors to commercialise these outcomes and deliver new products to market.

16. Encourage local industries to create a career market for research graduates, as part of the virtuous cycle of building critical mass to deliver research and development outcomes.

**Information request 5.1 - Defining and measuring research and development output**
The Commission seeks further information on:

- What are the sources of value created by R&D?
- What definitions and data could be used for measurement of inputs, outputs, productivity and impacts of R&D?
- Where and who use these measures?
- What are the limitations of these measures?
- Does the current R&D funding model allocate funding to areas which have the greatest benefits?
- How aligned are SA's research strengths with existing and future opportunities for growth in the SA economy?
- What regulatory barriers impede the translation of SA research into new products and services? How material are they compared to best practice?

***Measures of R&D output and their usage.***

From the perspective of the university sector, R&D measures such as publications, grant funding, and Higher Degree by Research (HDR) completions are essential:

- in attracting Research Block Grant funding from the Federal Government (a time-lagged, performance-based measure to supplement the cost of research);
- to building the necessary skills and expertise to expand fields of research ('success leads to success'); and
- in creating and maintaining a reputation for research excellence (necessary to attract external investment, high-quality researchers and students).

It is also worth noting that publication metrics in general have had an important impact on the attraction and retention of talented academic staff, such as those on the Clarivate Highly-Cited Researchers; a list which recognises the world's most influential researchers of the past decade, demonstrated by the production of multiple highly-cited papers that rank in the top 1% by citations for field and year in the Web of Science.

While the methodology differs from scheme to scheme, those measures above (amongst others) are utilised in international ranking programs which can have a considerable impact of the perception of an institution, affecting its ability to attract the necessary inputs to grow and thrive. The most recent results for the University of Adelaide of three of the most significant schemes are as follows:

**Table 1: University of Adelaide – 2019 Global Rankings**

| Ranking Scheme | World Ranking |
|---|---|
| Times Higher Education | 120 |
| QS World University Rankings | 106 |
| Academic Ranking of World Universities | 137 |

In considering funding performance, it is important to recognise the importance of all research income types whether competitive or non-competitive, public or industry-funded. Due to past funding models and peer review selection processes, Category 1 (nationally competitive) research schemes continue to be correctly perceived as the most prestigious for reputation building, which has not helped institutional attempts to diversify income streams, even though the various sources of income are not mutually exclusive. The challenges of perception and measurement can be seen with industry-focused research which is typically performed within a contract or series of contracts with industry partners. While the value of such contracts provides a measure of the direct output of the researchers involved, it does not necessarily capture the flow-on effects to the economy of that work.

Performance monitoring of university research is currently exemplified in this country by the Excellence in Research for Australia (ERA) initiative, which attempts to assess research quality using a combination of indicators and peer review. There have now been four iterations of the scheme, with the latest results released in March 2019. While not without its flaws, ERA does provide a useful snapshot of research strength, albeit on a delayed timeline. For example, the results of the 2018 ERA

exercise were based on research output measures for the period 2011-2016, and for other measures (income and applied) from 2014 to 2016. Table 2 shows all of the 2-digit Fields of Research which received at least one '5' (well above world-standard) rank in a SA university.

**Table 2: ERA 2018 – SA universities – 2-digit Fields of Research – '5' rankings**

| Description | Adelaide | Flinders | UniSA |
|---|---|---|---|
| Mathematical Sciences | 5 | n/a | 5 |
| Physical Sciences | 5 | 4 | n/a |
| Chemical Sciences | 5 | 3 | 4 |
| Earth Sciences | 5 | 3 | n/a |
| Environmental Sciences | 4 | 3 | 5 |
| Biological Sciences | 5 | 4 | 4 |
| Agricultural and Veterinary Sciences | 5 | 3 | n/a |
| Engineering | 5 | 3 | 5 |
| Medical and Health Sciences | 5 | 4 | 4 |
| Psychology and Cognitive Sciences | 4 | 4 | 5 |

In reviewing its own performance, the University considers the outcomes of the ERA scheme, which can have a strong impact, particularly in terms of informing staff recruitment and the strategic allocation of Higher Degree by Research scholarships. Although it is important to note that the decision to prioritise specific areas will always be related to a number of changing factors including:

- social demand and need
- funding body priorities
- individual academic interest
- the need for critical mass
- competition from other institutions
- emerging opportunities.

The Federal Government has also undertaken an 'Engagement and Impact' assessment designed to examine how universities translate their research into economic, environmental, social and other benefits. The results of the first assessment were released in March 2019. Unlike ERA, there was a greater focus on qualitative statements over quantitative indicators. The scheme has attracted some criticism and demonstrates the challenges of using qualitative measures for research impact.

However, the E&I assessment did highlight some very successful areas at the University of Adelaide. The assessment criteria comprised three categories - engagement, impact and approach to impact – with outcomes based on a single case study.

The University of Adelaide saw 14 fields of research rated as 'High' (the top rating) for Engagement (e.g. Biological Sciences and Engineering) and 13 for Impact (e.g. Information and Computing Sciences, and Medical and Health Sciences). In addition, it achieved a 'High' rating for all three criteria of assessment in four areas: Mathematical Sciences (the only university in Australia with this result); Agricultural and Veterinary Studies; Engineering; and Law & Legal Studies.

**Table 3: Engagement and Impact Assessment 2018 – University of Adelaide – 'High' rankings in all three assessment criteria**

| Field of Research / Unit of Assessment | Title/ Topic |
|---|---|
| 01 Mathematical Sciences | Capex: making Telstra's mobile network a world leader |
| 07 Agricultural and Veterinary Sciences | Cereal gain: driving Australian producers' competitive advantage |
| 09 Engineering | Pipe dream: in-use pipe assessment technology saving time and money |
| 18 Law and Legal Studies | Using law reform to drive social change in the lives of LGBTIQ South Australians |

From the wider perspective of all relevant stakeholders in the R&D ecosystem, including society at large, different measures may have more relevance. In addition to capturing common measures such as patents, publications, number of new products/services or processes introduced, and number of staff receiving R&D training, collaborative measures provide another important way to understand inputs and results, e.g. employees dedicated to external R&D relationships (input), collaborative R&D projects, R&D partnerships etc.

For example, measures that have been used in the entrepreneurship space include technology newness, e.g. the extent to which a business employs technology or knowledge that was not available 1 year (or 5 years) ago, as well as IP applications / grants. A measure of the economic impact in this context is the future revenue (or employment) growth of the business. For start-ups and small business, the effect is quite direct. Spill-over effects may also be measured for broader economic impact.

***How aligned are SA's research strengths with existing and future opportunities for growth in the SA economy?***

There is no doubt that, as a nation and a region, we face complex social, technological and environmental challenges. Addressing these challenges requires high-quality research: first to facilitate deep understanding, and second, to create ways to apply that knowledge. Universities, working in a mutually beneficial partnership with government, business and the community, are well placed to contribute to this essential process.

From the perspective of the University of Adelaide, defence, cybersecurity, space science, agri-tech, health equity, biomedicine, advanced manufacturing, etc., are all areas which we are well-placed to contribute value, through the provision of a skilled workforce and significant research development. Encompassing these with a focus on sustainability would resonate with the current community climate, and would be a useful point of differentiation between South Australia and other states. Judicious investment in at least some of these areas, leveraging existing strength and with appropriate scale and focus, will help to underpin considerable growth for the State. This is about sustaining broad capability to enable a future we cannot yet see, and to enable a timely and informed response to unforeseen events that might arise within that future.

As a real-world example of how quickly resources within a university can be mobilised to address a real challenge, the Inquiry panel is requested to review the University's COVID-19 website: https://www.adelaide.edu.au/research/connect/covid-19-research. Much of this research was not being undertaken in 2019, or else was being directed at different problems. While focused on response rather than growth *per se*, the ability to respond to shock is an important moderator of productivity loss and enabler of economic recovery.

As part of our strategic approach to build scale and focus in research, over the next 5 years the University plans to lead strategic development, in particular, on three main sectors of significant potential mid-term growth. We will *inter alia*:

- amplify our digital and defence capabilities in the STEM precinct (leveraging the opportunities of Lot 14 and including Information Capability);
- raise economic value through the Waite Campus (including the emerging Agri-tech area); and
- build our biomedical impact (e.g. cellular reprogramming, cancer immunotherapy) around SA's leading medical school.

Considerable detail on these sectors is contained elsewhere in this submission (section 5.5 on industry structure, 5.7 on Science Parks and Precincts, and section 5.11 on collaboration). However, the following provides a summary of these initiatives.

***Information Capability***

To date the strong connections between Defence and universities have been in the more traditional areas of defence research. However, we need to develop capabilities to respond to new threats (e.g. cyber warfare), bringing together diverse technologies such as Artificial Intelligence and Machine Learning with the human-oriented disciplines of social sciences, psychology, law and creative arts. Enabling collaboration through the co-location of defence personnel, industry and universities will be critical to building both secure and resilient information systems and new capabilities for Australia.

Adelaide is the logical home for a nationally-leading Institute due to the combined capabilities already present in South Australia. These include Defence's operational EW capabilities, the largest DST site of around 1000 scientists, a strong Defence industry presence and the University of Adelaide, which has a track record of strong, long-standing, defence collaboration. An entire ecosystem of digital and high-tech industry capability is being constructed on Lot Fourteen, which is home to the Australian Space Agency, the Australian Cyber Collaboration Centre, and the University's Australian Institute for Machine Learning. Lot Fourteen will nurture highly skilled talent in key industries like artificial intelligence and machine learning, cyber security, robotics, creative technologies, defence and space research. This new Institute is a collaboration model fit for the 21st Century – an Australian 'Bletchley Park"' of Information Capability.

Government investment will be needed to provide for the secure zones to be predominantly occupied by DST and Defence personnel, who are pivotal to "Five Eyes' co-operation. It is expected that industry will be an integral element of this partnership, and secure collaboration zones are envisaged within the Institute and precinct more broadly, including within the Innovation Hub.

***AgTech and the Waite***

South Australia should strategically choose to capitalise on its advantage of the growing demand for safe, healthy food and the opportunities for transforming the agriculture and food industries through advanced technologies. Many of these technologies will have commonality with defence, enabling platforms such as autonomy and data science to be leveraged more broadly for economic return. The future competitiveness of agriculture will be as reliant on improvements in automation and digital agriculture as it is on genetic improvements and water use. All stakeholders need to be cognisant of opportunities for carbon neutrality or carbon capture in agriculture, and the innovations needed to drive this. Furthermore, manufacturing, value-adding and understanding consumer behaviour will become increasingly important components that drive growth.

The establishment of AgTech industry-university co-operation precincts would allow the fast-track adoption of technologies and ensure South Australian agriculture remains globally competitive. Bringing partners together would support the research, development and technology innovation and commercialisation required to develop a new AgTech industry, and build a culture and capacity in the agriculture sector for continuous innovation that is strongly market-driven. Finally, these AgTech precincts would also support the training and extension required to lift the capacity of our horticultural, livestock, viticultural cropping, wine and food industries, and would provide incentives for industry participation. South Australia is a natural home to the next innovations in AgTech, given its investment into high technology capability development for Defence.

Realising this vision will require strong backing and co-investment from partners including governments and industry. With a project value of approximately $120 million, this investment will place the Waite at the forefront of agricultural and wine innovation, future proofing the thriving agricultural and wine sectors that underpin the future success of our regional communities and state and national economies.

***Biomedical impact***

There are clear areas of synergy between biological sciences, chemistry and chemical engineering (e.g. with pharmaceutical and bioprocessing researchers who specialise in the conception, design and scale-up of manufacturing processes for the conversion of chemical and biological materials into pharmaceuticals and medical interventions). Further interdisciplinary opportunities could centre on links between health and research in environment, water quality, animal health and nutrition as key aspects of human health. This in turn could inform policy on food and nutrition, zoonotic transition of diseases, and global issues associated with drought and famine. Many of the real innovations globally are occurring at the intersection of health and technology, and we need clear incentives and business models to resource the interface between these areas.

For further detail, your attention is drawn to the separate submission to the SAPC Health and Medical Research Inquiry lodged by the University.

One other area of significant mid-term opportunity is that of **Space (science and industry),** particularly in light of the fact that the Australian Space Agency has its headquarters in Adelaide. Not only should we focus on the more obvious realm of space technology such as the development of

'CubeSats', but there are many other interdisciplinary opportunities, e.g. micro-flow spacelabs for on-orbit formulation and pharmaceutical manufacturing, technology to make in-situ resource utilisation in space viable, and creation of closed-loop agricultural systems for food production off planet. The offshoots of research in this area can be a reinvention of whole other sectors based on advanced technology.

While the University moves ahead with these major strategic initiatives, we will continue to work on incubating our other strengths to provide for interdisciplinary and new options.

In its Strategic Plan, the University has sought to align many of our research strengths explicitly with those of the State, the nation, and indeed the globe via a set of 'Grand Challenges', namely:

- Sustainable Energy
- Good Health and Wellbeing
- Environmental Sustainability
- Food Security
- Indigenous and Societal Wellbeing

These fit well with the South Australian Government's Growth State Plan. The University is strongly involved in almost all of the priority sectors of the Plan, with considerable research strength in Health and Medical Research, Agricultural Sciences, Energy and Mining, and Technology. Some recent actions in two of the other priority areas, Defence and the Space industry, include the establishment of a Research Centre for Sustainable Planetary and Space Resources; and signing of the Defence Science Partnership Deed 2.0 with Defence Science Technology for long-term strategic engagement, utilising complementary skills bases, improving mutual access to world-class research infrastructure, and increasing access to research programs.

As well as addressing State priorities, the University's major research funding agencies (the ARC, NHMRC, MRFF, GRDC, etc.) expect us to address areas they identify as being of strategic importance. While we must retain the capacity and freedom for basic research as a fundamental characteristic of the research endeavour, we clearly need to be sensitive and responsive to the demands and expectations of those who fund and use our research.

The University's current research priorities (in no particular order) include:

- Cybersecurity, Machine Learning and Information Capability
- Optical Physics and Photonics
- Energy and Water Resources
- Earth Sciences, including Critical Minerals
- Civil Engineering
- Particle Physics
- Quantum Materials and Nanotechnology
- Law – National Security and Space, Defence and Reform
- International Security
- Viticulture and Oenology
- Agriculture, including Drylands and Decision Agriculture
- Agri-tech, Agribusiness, and Food Security
- Ecology and environment, including earth surveillance and restoration
- Creative arts including music, media and creative writing
- Humanities, Philosophy, Ethics and History
- Indigenous languages
- Housing/housing economics
- Applied Economics
- Social and Public Policy
- Aging and Palliative Care
- Complex comorbidity
- Epigenetics, stem cells and cellular reprogramming
- Precision oncology and cancer immunotherapy
- Immunology, infection, inflammation and immunity.

For innovative research, one of the keys to success is the promotion of interdisciplinarity to leverage the knowledge and expertise in one area to create something new in another discipline.

For example, an essential area to develop is that of energy research and development which needs to include consideration of the geologic, engineering, economic, environmental and societal aspects of energy production and storage. This will encompass the resources needed to support mining, petroleum extraction, hydro-carbon, the further development of renewable energy and batteries - including rare earths and lithium. In addition, the availability of subsurface storage, energy transport systems (power networks, pipelines, refining, LNG etc.), and application (industrial energy, future vehicles, smart homes and cities, efficiencies and conservation) are all equally important considerations to energy research when broadly defined across the value chain.

Integrating science and engineering with economics and social issues is critical if the outcome is going to be seen as relevant by the broader Australian community and create intended impact. Therefore, the energy transition will become a matter of an integrated, holistic approach considering geology and energy resources already in use, advanced computing, electrical engineering, advanced chemical engineering (for materials and fuels processing), chemical and material innovations, and business modelling and assessment.

Successful research translation requires a sound understanding of the goals and expected outcomes, the funding and investment strategies, requirements and returns, as well as clear accountability for delivery. Critically, the first stage of translation, i.e. getting funding to move from Technology Readiness Level 3 to 6, is an area where Australian researchers have experienced considerable difficulty, especially when compared to the USA, EU, Chinese and UK funding environments. Translation initiatives need to be backed by seed funding opportunities and underlying core infrastructure, services and facilities. This will encourage the establishment of translation eco-systems that engage both research providers and translation partners.

Another related example is the significant opportunity for South Australia to further develop its water capabilities over the coming 5 years to position the State more strongly as a globally recognised leader in water innovation, research and education, targeting global water threats, particularly across the Asia Pacific and at home. While research in SA is exceptionally strong and internationally competitive, particularly in the dryland context, efforts are often dependent on a single-researcher, with individual groups operating below critical mass, creating significant risk.

A renewed focus on water research and development would be a critical foundation for the further growth of the State's water sector and there is a strong existing institutional base on which to build. This could be facilitated by a new partnership model for water innovation between current research institutions, national and international research providers, local industry and government, delivering a coordinated research and development agenda directly targeting emerging water issues at the local and global levels. For example, opportunities for expanded agricultural productivity will draw heavily on innovation in the water space, given that the State's existing resources are already heavily allocated.

***What regulatory barriers impede the translation of SA research into new products and services? How material are they compared to best practice?***

Refer to section 5.10 for a response to this question.

**Information request 5.2 – Drivers of research and development output**

The Commission seeks further information on the following issues:

- How can South Australian businesses', universities', and research institutes' R&D funding be increased and how can this funding be better targeted?
- What role has the South Australian Government played in assisting public and private researchers to access Australian Government funding?
- What are the key factors which influence SA's total R&D funding?
- Why does such a small percentage of private non-profit expenditure on R&D occur in SA and what barriers, if any, are there to private non-profit R&D in SA?

***How can South Australian businesses', universities', and research institutes' R&D funding be increased and how can this funding be better targeted?***

The University's research produces demonstrable benefits for the State, and it is one of the major contributors to State GDP. It contributes to the growth and development of key industries including agriculture, food and wine, defence, advanced manufacturing and health. It also informs and enriches policy-making and public debate in areas including economics, law and social well-being. The existence of world-leading research in areas such as defence has helped to attract major projects and investment into the State. Less directly, the research intensity of the University contributes strongly to its global reputation as a top 1% university, which in turn attracts large of numbers of international students, contributing to a major export industry for the State (noting the current challenges facing all universities at this time). A strong, vital and growing research-intensive university makes a major contribution to the State's strategic goals.

The State Government can support the continuing growth in quality and volume of the University's research through co-investment and coordination of strategic research developments. As mentioned earlier, the large mid-term initiatives on which the University will be focussing, and which have significant potential to assist the State, are in digital and defence capabilities (including Information Capability and Space Science); the Waite Campus (including the Agri-tech); and biomedical research.

The effectiveness of this approach can be seen in the dramatic improvement in the quality and scale of research at the University of Queensland (UQ) which has been greatly assisted by substantial co-investment by the Queensland Government. This investment has elevated UQ from being a backwater institution to one of the top 5 in Australia.

As described elsewhere, co-investment may include joint funding of infrastructure, an area in which the SA Government has been actively supporting universities. However, there is scope to increase the effectiveness of this investment through improved levels of co-operation and communication with departments and agencies, better coordination of planning priorities and sustainment of critical research infrastructure.

The State Government can also invest in bringing top research talent to South Australia (e.g. assisting with the considerable cost of set-up grants), partnering with the University to up-scale research programs that will support the establishment or growth of critical industries in the State. Flexible co-investment, whether in staff, equipment, scholarships, buildings or relationship-building, clearly aligned to the strategic goals of the State, can assist the University at critical times to take advantage of opportunities to establish world-leading research programs supported by industry. Good examples of successful joint initiatives and co-operation between the University and State Government for the benefit of South Australia include the PIRSA/SARDI Strategic Research Alliance, the Defence partnership, the establishment of SAHMRI, and the development of Lot 14.

South Australia's ability to gain R&D funding nationally may be limited by its population size and lack of critical mass, along with the relative paucity of major industries that provide R&D funding. In this context, the State Government can assist in promotion of the research strengths of its universities and in building industry connections nationally and internationally, especially in relation to State and Federal Government international development priorities. This not only helps to attract external interest and co-investment in research, but also promotes the reputation of the State and its institutions as a world-leading provider of education, knowledge and innovation.

Universities also need to consider the extent to which a traditional academic culture fits with significant drivers of research and development activity. For example, the emphasis in some areas has been on fundamental research funded by competitive grants, although noting that this provides the long-term foundation for most applied R&D, along with cultural and community benefits, e.g. in areas like music or history. For those areas where fundamental research can be further developed, a significant expansion and deepening of the communication between industry and researchers would be beneficial, so that university researchers can better understand the specific areas where South Australian industry requires assistance, and industry members can deepen their understanding of the specific skills, expertise and assistance that researchers are able to provide.

In comparison to some other Australian states, South Australia has a limited pool of local philanthropic, non-profit individuals and organisations and this presumably impacts private non-profit expenditure on R&D. To encourage additional philanthropy, the State Government could consider selectively co-contributing to university projects funded by philanthropic sources that are aimed at creating value in the State.

***What role has the South Australian Government played in assisting public and private researchers to access Australian Government funding?***

The University of Adelaide has considerable research strength and expertise in a myriad of disciplinary and interdisciplinary areas, and is well placed to play an important role in achieving the research imperatives associated with the State's strategic priorities. For example, reducing the incidence of childhood illness; improving nutrition; providing breakthroughs in plant biotechnology; developing sustainable energy solutions; creating new mining technologies; and providing expertise in advanced manufacturing materials such as lasers, nonlinear optics and nano-biotechnology.

Of course, this needs to be a mutually-beneficial relationship, so support for the promotion of research excellence in priority areas is particularly important. As mentioned earlier, for South Australia drought and water security are a particularly confronting environmental challenge, and potentially very economically costly. This is an obvious example of the need to focus our resources and efforts to achieve internationally-competitive levels of research performance. Resources are scarce and competition is intense, and those resources should support quality, excellence and impact.

Funding from the State Government plays a small, but important, role in supporting the University's research endeavour, either via a number of regular programs, ad hoc support or collaborative research projects with members of Government agencies with which the University has close connections, e.g. Department of Environment and Water, Department of Health (including the public hospitals), Primary Industries and Regions South Australia, the SA Museum, etc.

Examples of regular State Government funding programs include the Premier's Research and Industry Fund (from which the University has received approximately $12M for three projects), and the Research, Commercialisation and Startup Fund (RCSF). In the latter case, three companies associated with the University (GPN Vaccines, Carina Biotech and FUSETEC) were awarded over $2M in April 2020. The RCSF also supports strategic research initiatives and a CRC Assistance Program funds, encouraging government agency involvement in bids. However, while appreciated, relative to the amount of funding obtained from the Federal Government, the support from the RCSF is modest.

As described in more detail under Section 5.6 on Infrastructure, due to the considerable cost of building and operating large-scale infrastructure, the University will often collaborate with other institutions and external organisations to partner in infrastructure bids, including with the State Government, leveraging relative strengths to compete successfully. In this regard, the SA Chief Scientist and the Department for Innovation and Skills have worked with universities in bids to various Federal Government programs, for example the National Collaborative Research Infrastructure Scheme (NCRIS).

It is important to note that continuing Federal Government support to address the increasing indirect costs of research is critical if South Australia seeks to host a vibrant research system which is internationally competitive and economically viable. However, Federal Government research and development funding schemes should provide the full costs of undertaking research, rather than be 'grants in aid'. Research Block Grant funding remains insufficient to cover the full indirect costs of research funded by schemes on the Australian Competitive Research Grants Register. For every $1.00 of Category 1 research won, it is estimated that we need to spend approximately an additional $1.55 on the indirect costs of completing the research. This is compounded by the fact that the external funding of the direct costs of research often falls short of the full cost, leaving universities with a funding gap. Furthermore, in the majority of cases we are also paying the salary of the researchers and/or are co-contributing cash to projects or fellowships as part of the eligibility requirements of various national research funding schemes. The larger national research funding agencies are under considerable pressure to maintain their application success rates in the face of limited growth in their funding base and rapid growth in research application numbers. The result is often to fund research

grant applications only partially. While the scope of the research can usually be reduced, the most problematic outcome is where there are salary shortfalls. The State Government can assist here in schemes that provide for co-contribution to attract academic talent and create infrastructure leverage, e.g. NCRIS.

The State Government also directly funds research when it aligns with its priorities. (Refer to the example of the Australian Institute for Machine Learning in section 5.11 on collaboration). However, it is significantly less than in other states. There are some good examples of long-term government investment in R&D interstate, including the Institute for Molecular Bioscience at the University of Queensland and the Institute for Marine and Antarctic Studies at the University of Tasmania (which incorporates state government fisheries and aquaculture research), which then leverages significant additional funding. Current SA Government R&D funding is welcome, but it needs to extend beyond project funding to include long-term (5+ years) strategic investment. Reaching a point where it is possible to generate significant R&D outcomes is not a short-term proposition, and this is why universities play such a significant foundational role in the research ecosystem, and one on which state governments should seek to capitalise. For example, the current developments at Lot 14 are based on work in the fundamental sciences of physics, computer science and engineering, etc., which go back decades.

**Information request 5.3 - Educational attainment**
The Commission seeks information on:

- whether the existing mix of labour force skills has a material impact on the State's ability to undertake research in the State;
- how employers might assertively attract and retain high quality R&D talent; and
- whether the expected supply of students and graduates can support higher output in R&D.

***Whether the expected supply of students and graduates can support higher output in R&D.***

The capacity to undertake productive research in the State, whether in industry, the public sector or in research institutions, is critically dependent upon the supply of a workforce that has been trained to undertake research. In organisations in which there is a strong culture of research, educational programs usually include a mixture of Honours, Masters and Doctoral-level graduates.

National surveys show that in Australia more than 50% of PhD graduates find employment outside of academia. Many commercial and government organisations recognise that PhD graduates bring highly-developed critical thinking, analytical, discovery and communications skills that can be transformative for their organisations. However, many employers shun graduates qualified to these higher levels, mistakenly believing that their deep specialist knowledge is a limitation and not recognising that in most cases the true value that they bring to an employer is the discipline-independent high-level generic capabilities.

The perception that employment opportunities are limited, and the 'penalty' of receiving a low pay rate for three or four years during their studies, are major disincentives to a student contemplating undertaking a research degree, and we see a slow declining rate of enrolment of domestic students in research degrees. Ultimately this will limit the capacity of research in the State to grow, and of industry in this State to keep up with the pace of global innovation.

To help make research degrees more attractive, initiatives encouraging Higher Degree by Research (HDR) and other postgraduate student involvement across business and government sectors would be extremely valuable. Furthermore, a clear narrative and explanation is needed to ensure businesses understand the value they can gain from engaging with or hiring postgraduates, and the value of their own staff undertaking such degrees. Highly successful examples can be found in Europe, e.g. in France, Germany and Denmark. Not only do such initiatives ensure employers are able to attract and retain high-quality R&D training, they also establish a system that enables familiarity between sectors and eases broader R&D collaboration opportunities. The innovative culture prevalent in European industry recognises the critical role of research-qualified employees in building and sustaining a competitive knowledge-based economy. For that reason, research trainees

and research-qualified staff are much more commonly part of the makeup of normal business in European industries than is the case in Australia.

Recent years have seen the rise of educational programs and professional programs that include coursework, are less 'traditional' in structure, and can be tailored to external needs through modular offerings, particularly at the research and coursework Masters level. This may be appealing to industry, e.g. for upskilling their workforce.

At the doctoral level, the University of Adelaide is modifying its HDR programs to address external expectations better, and offers a number of industry engagement programs and placements to supplement traditional research training, including:

- The Industry Engaged PhD
- The Industry PhD (which includes a 6-month placement)
- The Adelaide-CSIRO iPhD program
- Australian Postgraduate Research (APR) Intern program.

However, these have been of limited scale and it has been a resource-intensive process to encourage enrolments and build the confidence of local industry in the value of these programs. We are able to find placements for only 2-3% of commencing PhD students each year. As well as the University continuing to consider the needs of industry, a strong informational and promotional campaign, possibly augmented by subsidies, is needed to convince industry more broadly of the value of engaging with research trainees and employing research graduates.

While we do not see a general shortage of supply of graduates with research qualifications in many of the University's major disciplines, this is less so in areas most aligned to the State growth agenda. In the longer-term, we foresee a shortage of research graduates for the broader industry sector as the defence, cybersecurity and space industries in particular start to draw in larger numbers of highly-qualified graduates, making it harder for smaller SMEs and developing innovation industries to find graduates. A similar issue may be seen in other disrupted sectors (e.g. agriculture by technology). A partnership between these key industries, the universities and government to recruit new students into research could help to head off this looming problem. This includes the need for adaptation by some more fundamental disciplines to these external changes and their consequences, e.g. human factors, environmental impacts, etc. State-based planning of future workforce requirements with respect to its growth agenda, particularly in research-dependent sectors, would help universities to focus their HDR investments to best effect.

**Information request 5.4 - Academic Workforce**
The Commission seeks information on:

- How important is it to retain young researchers in SA and what incentives could be developed to do so?
- Are there any barriers to the recruitment of additional world class academic talent?
- To what extent does the existing mix of skills and fields match SA's industries?
- What are the barriers to a better match, and how can they be removed?
- Are there any barriers to the recruitment of additional world class academic talent?
- What factors are influencing the relatively low level of PhD students enrolled relative to the academic workforce?

***How important is it to retain young researchers in SA and what incentives could be developed to do so?***

It is essential to support and attract researchers at the early and mid-career levels in order to build strong teams around research leaders. High-performing young researchers will work where they are best supported to achieve their goals, and are often drawn away by large start-up packages offered by institutions, states and countries with greater financial capacity. Therefore, it is important to ensure that they are embedded in an enabling ecosystem, characterised by research excellence at scale, research funding and infrastructure, well-regarded mentors and other support mechanisms. Given the current uncertainty in the higher education system and the strong reliance on individual grants and related short- or medium-term contracts, an increased level of job security would be an important

incentive to attract and keep young researchers in SA. Providing a significant start-up package to get them going would be the biggest enabler.

While young researchers trained in South Australia can certainly benefit from the opportunity to undertake research and develop elsewhere, they need strong incentives to return. Funding schemes and postdoctoral initiatives are critical to academic success, providing support and opportunities for researchers to collaborate and to develop the research capacity required to attract future funding. One of the ways in which the University is able to support academic workforce development is through the hosting of Postdoctoral Fellows and Research Fellows. In some cases, these positions will be fully funded by outside agencies (e.g. the ARC or NHMRC), and sometimes they will receive some matching funding from the University, as is the case with of ARC Future Fellowships. The State Government could consider replicating this type of scheme at the local level. The Veski Fellowships offered in Victoria provide a useful example. One way might be to introduce a series of bridging scholarships for early career researchers. This would help to alleviate the problems associated with the long lead-in time associated with participating in annual research grant processes.

An increase in the number of research and development jobs in South Australia, plus expanded career opportunities through robust and growing STEMM-based industry sectors would also help to keep many more talented people in our State. These sectors include defence, space, mining, energy, cyber and renewables, plus other sectors which are currently experiencing rapid digital transformation and the associated increased need for employees with knowledge in specific areas such as data science, machine learning and artificial intelligence.

In this regard, industry engagement will provide increasing opportunities to attract young researchers with desired skills, and innovative initiatives are needed to promote this arrangement. For example, a research accelerator network could be developed for select individuals (thus making it highly prestigious), which could offer seed funding, industry mentoring and connections to relevant industry networks, as well as exclusive development opportunities for members. Postdoctoral level industry internships would also be a useful attractor for those not looking for a research career in a university.

***Are there any barriers to the recruitment of additional world class academic talent?***

One of the main keys to delivering successful and innovative research outcomes is centred on having great research teams, led by inspiring researchers, working in areas of significant value and stimulation. Building a high-performing and diverse research workforce is of critical importance for sustaining a high-performing R&D ecosystem.

As the SAPC Inquiry Issues paper (p.35) rightly points out:

> *The international flow of academic talent is an important factor in the transmission of knowledge and skills in a globalised economy and in establishing local centres of excellence… The recruitment of new, world-class academic talent, and how that talent is developed, retained and rewarded is an important element in the R&D landscape for South Australia.*

There is no doubt that, due to the highly competitive nature of world-class research, South Australia is often at a disadvantage in retaining and attracting new and innovative researchers due to a lack of critical mass, a lack of capacity to invest collaboratively in people and infrastructure (new buildings notwithstanding), and a lack of niche research areas having demonstrated leadership. In this regard, it is important to build up selected Centres of Excellence in South Australia as part of a strategic scale and focus approach.

In 2019, as a component of its new Strategic Plan, the University of Adelaide implemented a new scheme called ‘Investing in Top Talent’, a pro-active recruitment strategy to attract a cohort of new, high-performing research leaders to South Australia with the aim of generating new or transformational capability, and building up of critical mass in new interdisciplinary areas. Examples of key appointees include:

- *Machine Learning - Professor Simon Lucey*
  Professor Lucey will be moving from Carnegie-Mellon University in October 2020 to expand on the University's strong expertise in this area, particularly with the predicted explosion in investment for agricultural, medical and defence robots.

- *Critical Minerals – Associate Professor Carl Spandler*
  This appointment will be leading and developing research in technologically critical minerals exploration, particularly those elements that are crucial to the transition to a renewable energy future. Associate Professor Spandler moved to Adelaide in May 2020 from James Cook University.

- *Plant Synthetic Biology – Associate Professor Jenny Mortimer*
  This position has been created to provide leadership to the field of synthetic biology, which applies the principles of engineering, such as standardised parts and design, to biology. Dr Mortimer will commence at the University in January 2021, moving from the Lawrence Berkeley National Laboratory in California.

- *Imaging and Neurodegeneration – Professor Mark Jenkinson*
  The development of methodologies for the analysis of structural MRI data has revolutionised the capacity to investigate the changes associated with neurodegeneration. New approaches to cognitive ability will add significantly to the areas of Frailty and Ageing and machine learning. Professor Jenkinson is jointly employed by the University of Adelaide and Oxford University, and the SA half of his position is jointly funded by the University and the South Australian Health and Medical Research Institute.

While this scheme will help boost the University's research performance over time, due to the nature of the associated costs (highly-talented researchers need to be supported by research teams, research infrastructure, set-up funds, etc.), any single university is limited in its capacity to attract such people. Joint appointments are a useful mechanism in this regard, and support from non-university sectors needs to be expanded.

***What factors are influencing the relatively low level of PhD students enrolled relative to the academic workforce?***

It is important to remember that the area of research training is an essential part of a knowledge economy and an important element in any research workforce strategy. We need highly-qualified research graduates with skills in critical thinking to drive innovation in developing new industries, and we need to be able to attract students from across the globe to our research programs. In this regard, governments, business and universities need to work together in promoting the advantages and opportunities available in South Australia.

In some applied research areas (e.g. geology/resources or computer science) when jobs are booming the relatively low stipend of a PhD may in fact be a disincentive to undertaking a higher degree and proceeding down an academic pathway.

Given the critical importance of PhD students for enhancing R&D and for developing the skilled labour driving future advances, initiatives to increase the cohort of quality postgraduates are important for the State's future. To support growth in this area, efforts could be made to increase business investment and philanthropy supporting Higher Degree by Research (HDR) stipends, for example by means of a State Government initiative offering incentives for businesses to jointly fund HDR students on selected collaborative projects, e.g. in line with Danish industrial PhD program.

**Information request 5.5 – Industry Structure**

The Commission seeks information on:

- Whether and how to encourage small and medium sized businesses to participate more in R&D.
- Whether and how to encourage interstate and international firms to invest more in SA.
- What government regulations or processes are blocking South Australian businesses from pursuing research and development opportunities?
- How can the government remove barriers for businesses to access public and private equipment and infrastructure, to enable increased research and development?
- Given that governments are key purchasers of goods and services, what reforms could be made to support business research and development growth within the SA economy?
- Are there other ways to support local businesses to invest efficiently in research and development as part of their growth strategy?
- Which industries could contribute more to rapid growth of the SA economy? Does the State have the necessary R&D base to contribute to the growth of these industries in SA?

As a University we have a strong commitment to delivering research outcomes to the community. To do this we must maintain a balance between support for both pure and applied research. This includes working with industry and business for mutually beneficial outcomes. It always needs to be remembered that a research engagement with industry that does not incorporate a "discovery engine" is not likely to be sustainable in the long term.

***Whether and how to encourage small and medium sized businesses to participate more in R&D.***

There should be a targeted approach to those SMEs interested in future growth and innovating, as compared to lifestyle businesses. The former would benefit from programs supporting them to develop their capacity to innovate and develop their readiness to engage with research organisations such as universities, as noted in the 'Business Research Collaboration Create Project' from the Department of Industry, Innovation, and Science[1]. In this context, a global best practice example is the Warwick Manufacturing Group (University of Warwick) SME Program[2], dedicated to the support of SMEs in the manufacturing sector. More extensive communication and celebration of SME R&D and R&D collaboration would be an important step to develop further an innovation and innovation collaboration culture in the State.

***Whether and how to encourage interstate and international firms to invest more in SA.***

The important point here is to create an ecosystem which encourages SME business engagement in South Australia, particularly in the absence of a significant number of Head Offices. This includes a strong tertiary sector, feeding into good relationships with the business community to provide the right skills for the workforce, encouraging skilled immigration, government grants for early stage funding, and strong facilities for networking. These things will take time, and although some of the infrastructure already exists, it must be supported over a period of time to allow it to develop, including financial and policy support, and actively resisting expectations of a 'quick fix' or immediate results.

Refer to the example of Dassault Systèmes under Section 5.11 as an example of the benefits of attracting international firms.

***Are there other ways to support local businesses to invest efficiently in research and development as part of their growth strategy?***

Encouragements for businesses to invest in R&D include tax incentives, for both large and small businesses. These should be reviewed and adjusted, if necessary, in order to ensure that the incentives for R&D investment in South Australia are, at the very least, favourably competitive when

[1] https://www.industry.gov.au/sites/default/files/2019-02/business-research-collaboration-project-create-phase-summary-report.pdf

[2] https://www.ub-cooperation.eu/pdf/cases/N_Case_Study_WMG.pdf

compared to the those provided by other states. This should include supporting or encouraging businesses to build their readiness to collaborate with R&D partners including universities.

In addition, the responsiveness of some State regulatory agencies (e.g. Consumer and Business Services, SafeWork SA and the EPA) can be an issue. Slow responses to potential opportunities contribute to a slow-down of engagement and growth. It would be useful to review these agencies to identify efficiencies and resources needed to improve responsiveness.

***Which industries could contribute more to rapid growth of the SA economy? Does the State have the necessary R&D base to contribute to the growth of these industries in SA?***

The University engages with industry and government across a wide range of areas. To provide focus, the University has established a set of Industry Engagement Priorities (IEPs) to act as a portal for industry, connecting compelling external opportunities with outstanding internal capability, and addressing major societal and technological challenges. Complementing and leveraging the University's fundamental research excellence, the IEPs are designed to deepen our relationships with industry in selected areas and in doing so to broaden the skills of our staff and students. The five IEPs, supported by an identified director and an Industry Advisory Board, are:

- Agrifood and Wine
- Creativity and Culture
- Defence, Cyber and Space
- Energy, Mining and Resources
- Health and Biotech.

The IEPs closely reflect the State Government's Growth State Agenda, enabling the University and Government to work together to identify and implement the productivity improvements needed for South Australia's growth. They are not mutually exclusive and work together when multi-disciplinary approaches are required e.g. in areas such as AgTech, food and health. As mentioned in Section 5.1, investment in at least some of these areas, leveraging existing strength, could see considerable growth.

To provide an illustration of the potential for growth, the following section focuses on AgTech as a major exemplar.

South Australia needs to take advantage of the growing demand for safe, healthy food and the opportunities for transforming the agriculture and food industries through advanced technologies. The future competitiveness of agriculture will be as reliant on improvements in automation and digital agriculture as it is on genetic improvements and water use. All stakeholders need to be cognisant of opportunities for carbon neutrality or carbon capture in agriculture, and the innovations needed to drive this. Furthermore, manufacturing, value-adding and understanding consumer behaviour will become increasingly important components that drive growth.

While the agricultural sector is (and has been for a very long period) essential to the SA economy, it can be grown even further using 'smart' technology and associated industries. This is particularly relevant in developing the subsequent value-adding (food) industries that use our existing crops, where there are potentially greater gains to be made than by simply increasing production. Basically, we need to be using these new technologies to help produce a premium product that has greater value.

For many regional areas, agriculture underpins the local economy, providing employment on farms and in related industries/sectors. Therefore, reduced crop and livestock production (e.g. due to droughts, floods, saline soils, heat waves, frosts) can have a profound effect on regional jobs. A National Mission for Future Crop and Community Resilience would necessarily have spill-over benefits to rural communities. It is essential that those communities be central to such a Mission, namely to drive adoption and uptake of new technologies and to ensure that the social changes and adaptations occur smoothly and effectively. This proposed Mission needs to be structured to drive the convergence of diverse technologies (synthetic biology, big data, satellite imagery, etc.), together with socio-economic, and more explicitly social capabilities in order to drive adoption and ensure that resilience in communities is achieved.

Moreover, to maximise benefits to regional economies, AgTech innovation precincts need to be developed to help ensure the adoption of technology such as machine learning, artificial intelligence and development of new crop types. Importantly, the advent of 'smart crops' will provide opportunities for regionally-based agricultural scientists and consultants working with farmers to optimise crop selection to suit upcoming seasons, develop new management practices, and ensure productivity is maximized across heterogeneous landscapes. In this context, the University of Adelaide employs an interdisciplinary approach to agricultural research. Currently a new wave of engineering, data science and mathematical capabilities are being deployed into this area in order to capitalise upon the translational skill sets that have been successfully applied across the defence, minerals, energy, remote sensing, and water sectors.

In order to fully capitalise on potential productivity gains, digital and engineering solutions need to be married to the latest innovations in crop and animal sciences. In particular, the deployment of genomic selection in breeding, gene editing and the judicious use of GM. Coupling these developments with advances in agronomy and AgTech will be necessary for Australia to meet the required 2-3% p.a. productivity gain.

**Information request 5.6 – Infrastructure**

The Commission asks stakeholders, based on their views and experience:

- What R&D research infrastructure does the state possess? Is it nationally and/or globally competitive?
- Whether infrastructure investments in research and development infrastructure have been effective to date?
- What other roles can the state government undertake in infrastructure provision, for example coordination of joint ventures?
- What barriers exist to the efficient provision and use of R&D infrastructure in South Australia?

***What R&D research infrastructure does the State possess? Is it nationally and/or globally competitive?***

As noted in the Inquiry Issues paper (section 5.2.5), research infrastructure is spread across sectors, varies in size, operation, complexity and funding arrangements. However,

> *"the most significant infrastructure assets in South Australia are contained within the higher education institutions and state-based operations of national research organisations funded and operated by the Australian Government…".*

Unfortunately, it is difficult to know the exact breadth of the State's infrastructure. While we are aware of the infrastructure within the University of Adelaide, and the shared infrastructure with which we are a partner (usually large-scale), an inclusive inventory is unknown. It would be useful to have a central register of infrastructure that is easily visible to individuals and organisations across South Australia who are interested in accessing it on an appropriate basis.

The University of Adelaide has a wide range of cutting-edge research facilities and services available across our campuses for researchers, students, government and industry. These include facilities for advanced Microscopy, Ancient DNA, Data Analytics, Health Technology Assessment, 3-D Printing, Omic technologies, a Plant Accelerator, photonics and optical technologies for advanced materials and manufacturing, etc.

Our infrastructure inventory also includes several state-of-the-arts buildings such as:

- the Adelaide Health and Medical Sciences (AHMS) building, completed in 2017 at a cost of $246 million (of which $60M was provided by the Federal Government). AHMS brings together more than 1700 students and 600 health researchers in a vibrant and innovative environment of learning and discovery; and
- The Braggs Building, funded by the Federal and State Governments, DST, Defence SA and the University to house a specialist suite of transdisciplinary laboratories with facilities for

optical fibre fabrication, laser and device development, luminescence dating, environmental genomics, etc.

However, it must be acknowledged that the University of Adelaide's built infrastructure contains a significant number of older buildings that are less suitable for the new ways of learning, and do not always provide suitably adaptable research laboratory spaces to house research equipment to satisfy current research needs. There is a need for significant development of existing and or new infrastructure, including new ways of learning following the impact of COVID-19.

The University is undertaking a significant survey of its Science, Technology, Engineering, Mathematics and Medicine (STEMM) supporting buildings to determine an efficient way forward. It is acknowledged that development does need to occur in order to remain competitive against other Go8 universities (many which are or have undergone significant development and STEMM supporting building programs) to be able to attract the best staff and students, and support technologically-advanced instrumentation required to enable internationally-competitive research.

The State possesses some excellent examples of nationally-competitive infrastructure largely funded through the National Collaborative Research Infrastructure Scheme (NCRIS). For example, major items in which the University of Adelaide is currently in the acquisition phase include the following 2019 NCRIS-funded projects, which will enhance established NCRIS facilities:

Microscopy Australia - Adelaide Microscopy:

- Cryo Transmission Electron Microscopy, TEM
- Ultra-high-resolution scanning Electron Microscopy

Australian National Fabrication Facility - Optofab Adelaide:

- Optical fibres and speciality glass synthesis
- Mid-IR Glass fabrication

Terrestrial Ecosystem Research Network:

- Storage infrastructure as part of establishment of a sophisticated ecosystem surveillance

Australian Plant Phenomics Facility - The Plant Accelerator:

- Machine learning and big data analytics facility
- X-ray CT based plant phenotyping facility
- Hyperspectral imaging with drones/UAV facility.

The University also contributes financially and in-kind to NCRIS facilities managed by other institutions, including the Large Animal Imaging Research Facility, Clinical Data Linkage, AUSCOPE, Bioplatforms Australia and the Integrated Marine Observing System.

Global competitiveness is probably best exemplified by major infrastructure precincts or clusters (refer to section 5.7 for more detail), with one example being Adelaide Bio Med City. This contains the University's Health and Medical Sciences building, the University of SA Cancer Research Institute, the Royal Adelaide Hospital and the South Australian Health and Medical Research Institute (SAHMRI), although this development has yet to reach its full potential. The commitment to the building of SAHMRI 2 and the facility that it will house enabling Proton therapy will be a further step in developing this potentially world-leading precinct.

Looking forward, the current infrastructure build programs on Lot 14 will aid in significant development of a number of R&D facilities and the placement of key industry partners. With intent and investment, this also could become a national and globally significant R&D area by attracting high-profile researchers and global companies. For example, the University of Adelaide is looking to develop R&D facilities alongside its Australian Institute of Machine Learning which would support the activities of the Australian Space Agency, the Defence sector and other entities. It is already contributing financial and other resources to the Australian Cyber Collaboration Centre, A3C.

For the university sector, the definition of globally-competitive infrastructure is not reliant solely on the physical built infrastructure, but is contingent on the whole ecosystem that drives the research and development framework. If there is no uniqueness or follow-up support to allow researchers and/or

developers of new technology to be successful in that new environment, then this infrastructure will struggle to be globally or nationally competitive. These large-scale R&D spaces often take 5-10 years to reach the benchmarks in order to be considered a truly globally competitive, and need to be nurtured through that 10-year phase.

Increasingly, including with NCRIS, skilled technical support in the form of staff supporting physical infrastructure, is recognised as an important infrastructure asset in its own right. In this sense, South Australia has not benefited from NCRIS funding to the same extent as east coast Go8 universities. For example, eResearch is centred strongly at the Universities of Monash, Melbourne and Queensland, with significant staff levels providing disproportionate service to Lead Agent institutions. This leads to the obvious question as to whether governance of the NCRIS projects is optimised from the perspective of the smaller states and universities. Indeed, the recent investment by BioPlatforms Australia into South Australia to enable the South Australian Genomics Centre was an order of magnitude below that actually required, but regarded as acceptable in a State which has been historically under-served by NCRIS funding.

***Whether infrastructure investments in research and development infrastructure have been effective to date?***

This is a very difficult question to answer in general, given the timeframes to demonstrate clearly-linked research outcomes. As mentioned, research infrastructure can vary from buildings and laboratories (e.g. the Adelaide Health and Medical Sciences building) to a specific piece of equipment (e.g. a High-Resolution Micro-CT system for bio-imaging capability) or skilled technician. It can also include non-physical infrastructure of various forms such as subscriptions for researcher access to external infrastructure (e.g. international telescopes, Lucas Heights nuclear facilities, the Australian Synchrotron) and online databases, cloud computing and other resources. While the investment in large-scale buildings creates an easily identifiable physical presence, many smaller investments might lead to high-impact journal articles, which are essential parts of the research endeavour but less visible to the wider community. In the latter (and more common) instance, the correlation between a piece of research infrastructure and specific outcomes is much harder to identify, at least as far as any detailed, high-level perspective is required.

That said, the supporting “skilled human” infrastructure from NCRIS, which as noted above is disproportionally absent in South Australia, enables both large-scale and distributed investigator-led research within proximity of its physical location.

The following provide just two examples of the impact arising from the funding of NCRIS-funded facilities.

The Australian National Fabrication Facility (ANFF) links eight university-based nodes to provide researchers and industry with access to state-of-the-art fabrication facilities. The Optofab Node of the ANFF at the University of Adelaide is committed to the micro-and nano-fabrication of optical components and optical materials. Optofab has built up a strong base of users who access a diverse range of services including the supply of custom glasses and optical fibres used for fundamental and applied research projects in defence; environmental monitoring; medical technology; mineral exploration and processing; and agriculture, food and wine. This facility is unique in Australia and has enabled engagement with global industry players including Trajan Scientific, Mitsubishi Heavy Industries and international research agencies (Asian Office of Aerospace Research and Development, US Army and Navy Research Labs), and puts Australia at the forefront of glass and fibre research. In addition, Optofab Adelaide has assisted over 15 South Australian companies in developing new products or services. These innovative companies have achieved economic growth estimated in the order of $5-10M to date through product sales, investment, inward investment and jobs created and safeguarded with significant future upside as these products/services achieve greater market penetration.

The Terrestrial Ecosystem Research Network (TERN) invests in collecting excellent environmental monitoring information, data and samples to enable research, innovation and reporting on the state and trajectory of key environmental variables across South Australia. This enables researchers and land managers to conduct biodiversity and land management, and inform on the most appropriate ways to sustainably manage our natural resources into the future. The freely available data, samples

and products facilitate novel and innovative research and management investigations in a multi-disciplinary way that has not been widely available previously, resulting in increased understanding of how our plants and animals interact with soils, ands insights into the cause and effect of environmental change. The information is collected in a way that enables comparisons of change through time and was created in consultation with State Government agencies to ensure that the program met their research and management requirements. This information provides direct input into improved policy development, along with guidelines and best practice information that can be provided to land managers to improve decision making. It also assists the Government in making strategic plans for appropriate land use, conservation and sustainable development, considering best available environmental change predictions.

These national facilities also train highly skilled and specialised technical and support staff, providing a source of expertise that would not otherwise exist in South Australia.

***What other roles can the State government undertake in infrastructure provision, for example coordination of joint ventures?***

Significant State Government support is essential for the continuing growth in the quality and volume of the University's research through co-investment and coordination of strategic research developments. This is particularly important in the main future-facing sectors for mid-term growth listed in section 5.1, i.e.:

- digital and defence capabilities in the STEM precinct (leveraging the opportunities of Lot 14 and including Information Capability);
- the Waite Campus (including the emerging AgTech area); and
- biomedical research.

Due to the considerable cost of building and operating large-scale infrastructure, the University will often collaborate with other institutions and external organisations to partner in infrastructure bids, including with the State Government, leveraging relative strengths to compete successfully. In this regard, the SA Chief Scientist and the Department for Innovation and Skills have worked with universities in bids to various Federal Government programs. The information above on the 2019 NCRIS funding round is an excellent example in which State Government support was instrumental in the universities' successes.

In a very competitive climate, joint ventures are a must in building significant momentum to ensure their efficient use and to demonstrate the strategic need, locally and nationally, to help provide the drivers for leveraging further funding from industry or government sources. Joint ventures are increasingly required right down to the operational levels, as seen in the NCRIS program. Without significant, on-going State Government support many of these projects would founder. This enhanced support will become even more critical with the compression of University co-investment capacity in the face of COVID-19 impacts.

While acknowledging the co-investment support which has been provided by the SA Government, there is scope to increase its effectiveness through improved levels of co-operation and communication, better coordination of planning priorities and sustainment of critical research infrastructure.

The State Government also directly funds research when it aligns with its priorities. As an example, it contributed $7.1M towards the establishment of the University's Australian Institute for Machine Learning in 2017, a key research institution in machine learning globally, ranked number one in the world for three key areas of artificial intelligence and machine learning. This funding included $1.5M for defence capability research.

With infrastructure provision, it is also essential to have a long-term strategy. An example of future planning, building on the previous co-investment strategy across NCRIS, universities and state governments, is that of Microscopy Australia. They are currently preparing a 10-year research infrastructure roadmap for 2020-2030 to support research related to defence, minerals, energy, manufacturing, communication, medical treatment and diagnostics, environmental management and agriculture. Some of the proposed new infrastructure (as examples of future need) include:

- Combined atom probe/transmission electron microscope to image the exact position of atoms in 3D for reconstruction and analysis, with applications into the development of new materials such as structures for quantum computing and communications, solar cells and more.
- Next generation ion beam platform for shaping and analysing samples in 3D, which can be used for advanced engineering, biomedical, materials and geoscience research.
- Combined Cryo- and Aberration Corrected TEM for determining the structure of large biological molecules and molecular assemblies, leading to new solutions to intelligent drug design, and in materials science for new alloy development.
- Enhanced bioinformatics capability, in particular for the Waite Campus, noting that the new South Australian Genomics Centre is focused at SAHRMI with only one FTE dedicated to the Waite precinct.

***What barriers exist to the efficient provision and use of R&D infrastructure in South Australia?***

It is necessary to acknowledge the synergies between infrastructure acquired for one area of research and research excellence in other, indirectly related fields. These novel connections can yield excellent opportunities for research, e.g. engineering/materials fabrication/characterisation facilities and biological research, astronomy and photonics research. We need to encourage such behaviour and ensure against the creation of silos.

A review of critical SA-based infrastructure (and gaps) would be highly beneficial in prioritising future investment and inform future strategic development and recruitment initiatives across the State.

Shared access agreements have also been problematic in the past when individual institutions own specialised equipment and seek to restrict external access to maintain a competitive advantage. Similarly, some institutions have set the charges for external access at very high levels. These are all impediments to productivity. This is an area where the State Government could make a difference, by ensuring critical base infrastructure is housed in open access, well-managed facilities that are set up for cost recovery and provide a wide range of value-add services.

There are numerous positive examples of infrastructure collaboration within the State, and this is an area which should be expanded. In this respect, it is important to create incentives to share infrastructure across institutions. The quality and breadth of baseline infrastructure in South Australia which is readily accessible and cost-effective is critical to building productivity and attracting new talent to the State. Many topflight researchers are attracted to the eastern seaboard institutions precisely because it is easier to undertake their research there, and they get better outcomes from access to cutting-edge technologies. Consolidation, done in a strategic manner with support and input from the State's research institutions, would facilitate collaborative research that is affordable while maintaining and replacing equipment to retain access to up-to-date technologies.

The extent of research collaboration will also depend on the type of infrastructure and the type of use to which it is put. The important thing is to focus on access for researchers and the production of high-quality research outcomes and translation. This needs to incorporate robust consultation and outreach processes, to help ensure that as many researchers as possible are given opportunities to contribute to the development of new facilities and priorities. Furthermore, the provision of operational support for the running of such facilities going forward is often insufficient or absent, and this leads to obvious problems with long-term sustainability. It is also a barrier to the provision and use of some infrastructure. This is especially true of equipment purchased through programs such as the ARC Linkage Infrastructure, Equipment and Facilities scheme where it is often the case that such equipment is distributed throughout institutions and not part of broader facilities. In addition, the funding and expertise to maximise postgraduate and researcher training is a critical issue to be addressed.

A very recent example of shared enabling facilities (an area of considerable potential) is the new South Australian Genomics Centre (SAGC), a consortium involving SAHMRI, the SA universities and other partners, and due to open on 1 July 2020. The consolidation of bioinformatics support in SAGC is a strong, mutually-beneficial initiative with considerable value to the University and the State more widely. It was created in response to the growing scale of research utilising bioinformatics, with the aim of creating new engagement opportunities between researchers and facilitating further integration between genomics user groups and bioinformatics experts. SAGC is also a further move towards

aligning infrastructure in precincts that facilitate broader engagement and development and, while requiring a fuller complement of staff to serve fully all relevant disciplines, it is a useful model to enhance accessibility and support of such infrastructure.

Of critical importance are effective and accessible collaboration tools, data storage and access and IT infrastructure to the delivery of these strategies. The University is planning further investment in built infrastructure as well as equipment (high-performance computing, analytical instruments, imaging and microscopy, etc.), resources (library materials, shared databases, etc.) and shared services.

There are also some fundamental types of infrastructure and facilities that underpin all research in South Australia, including biobanks, animal houses, big data storage, secure storage and curation in data centres. These are all examples of basic research support services that individual institutions struggle to fund effectively. They provide opportunities for State-level facilities that remove the element of competition and could be run far more efficiently as larger-scale, shared, user-pays facilities based on similar principles to the NCRIS facilities. This is particularly important in a smaller state like South Australia.

South Australia also lacks higher-cost research capabilities that are routinely available interstate, such as modern Nuclear Magnetic Resonance (NMR) spectroscopy - an analytical chemistry technique used in quality control and research for determining the content and purity of a sample as well as its molecular structure. Similarly, nanoscale secondary ion mass spectrometry (NanoSIMS) is an analytic technique used to gather nanoscale resolution measurements of the elemental and isotopic composition of a material with potential applications across engineering, minerals and health. At a cost of over $6M plus operating costs, SA has not yet been able to fund this capability (whereas Western Australia has). Due to the value of a NanoSIMS to all the key SA economic sectors (agriculture, mining, advanced manufacturing, defence and medical), the University was considering building a consortium. The partner organisations could then share the cost and spread it over multiple years as required. However, one critical need is an organisation, potentially the SA Government, that has the capacity to act as the “banker” and pay the provider company Cameca (a world-leading supplier of microanalytical and metrology instrumentation) the full price in the one year as required, and then be reimbursed via the various partner inputs over a multi-year period by agreement. This is a model that would work for other larger items of infrastructure. The lack of access to high-end infrastructure of this kind impacts the national competitiveness of South Australian research and also impacts the potential flow-on benefits for local industries. These are just two examples of where State investment could have a step-change impact on R&D in SA.

A final example, and one of significance for the South Australian Wine industry, is the need for a new research and training winery on the Waite campus. The existing winery has been of tremendous significance in training a generation of South Australian winemakers, but the cost of replacing the outdated facility to support an emerging high-tech wine industry is a major investment challenge for a single institution.

**Information request 5.7 - Science Parks and Innovation Districts**
The success or otherwise of efforts to establish clusters of research and development infrastructure in common locations will be a matter that the Commission will consider. The Commission seeks feedback and advice regarding:

- whether the clusters are best practice, including in terms of location, development, operation and use of taxpayer funds, and how they could be improved; and
- examples of best Australian and international practice.

***Whether the clusters are best practice, including in terms of location, development, operation and use of taxpayer funds, and how they could be improved.***

While a few independent clusters or districts have formed in South Australia, their value to the State could be elevated by enhancing the collaboration and knowledge exchange across these districts. It is generally accepted that place-based innovation systems require three primary forms of assets: physical assets such as buildings, open spaces and other infrastructure; economic assets such as organisations and institutions that engage in and facilitate innovation; and networking assets to

facilitate a culture of idea sharing and collaboration[3]. Taking this understanding beyond the individual district level, it is the joint learning and the collaborative approach to advancing R&D and prosperity through collaboration between the districts that can help elevate overall success of the State in the global innovation arena.

One of the difficulties in any large-scale collaborative venture can be maintaining balance in operational cost-effectiveness versus ease of access to required infrastructure and services. For example, the University of Adelaide is a major partner in the South Australian Health and Biomedical Precinct, which includes the Royal Adelaide Hospital, the South Australian Health and Medical Research Institute (SAHMRI), the University's Adelaide Health and Medical Sciences Building, and forthcoming University of South Australia's Health Innovation Building. This includes being a foundation partner in SAHMRI. While there have been strong efforts to promote the (North Terrace-focussed) this precinct, it must be said that it has yet to deliver as an interconnected and collaborative initiative. There are overlapping jurisdictions, unnecessary duplication of existing capabilities, misaligned partner aims and strategies, siloed cultures, and a lack of overall awareness of the purpose of each component.

However, the general strategy of co-location offers a range of benefits for universities and their partners and as well as an important mechanism for enabling engagement, by brokering access to external services offered by those partners. Our current approach is to build an immersion model of industry engagement rather than a traditional Science Park. In this way we are building formal strategic partnerships with organisations including PIRSA and Defence Science Technology, creating an ecosystem to link university, major research organisations and business with growing co-location of these parties on our campuses.

As one small example, in 2015 the University established a new industrial research and development and manufacturing hub as part of an agreement with Australian company Trajan Scientific and Medical, supported by Health Industries SA and the Department of State Development. Trajan's focus is on developing and commercialising technologies that enable analytical systems to be more selective, sensitive and specific for biological, environmental or food-related measurements, especially those that can lead to portability, miniaturisation and affordability.

One of South Australia's most significant clusters or precincts is the Waite Research Precinct (or Waite Campus, http://www.thewaite.org/), the largest university agricultural research and teaching precinct in the Southern Hemisphere. With appropriate strategic investment, a reinvigorated Waite can provide a national focal point to assist regional communities to adapt and thrive in an era of major transformational change as a consequence of climate change, increased water scarcity, rapid technology development and advances in automation, and demographic shifts to urban centres.

Established in 1924, 'The Waite' is a co-located partnership of 15 complementary organisations and centres engaged in world-class research and development in plant, agricultural, food, wine and natural resources science. It houses more than 1,100 of Australia's best researchers and technical people in a wide range of plant and agriculture-related disciplines. These disciplines include microbiology, genetics, phenomics, entomology, molecular biology, plant physiology, soil, water, climate, biosecurity and adoption specialists, precision agriculture and remote sensing, weed management and others. The Waite conducts more than 70% of the nation's wine research, is the origin of the majority of the dominant cereal varieties over decades, and has successfully transitioned several of its breeding programs to commercialisation – notably through the highly successful plant breeding company, Australian Grain Technologies.

The co-location of complementary non-University research organisations such as CSIRO, the Australian Wine Research Institute (AWRI), and the South Australian Research and Development Institute (SARDI) is a real strength of the Waite precinct. Often housed within the same buildings, scientists and researchers from separate organisations work side by side. This enables cooperation, sharing of resources and synergies that would otherwise be difficult to achieve. The partnership also facilitates co-supervision and industry placements for postgraduate students, joint applications demonstrating critical mass for funding of step change agricultural research programs and recruitment

[3] Katz and Wagner 2014; https://c24215cec6c97b637db6-9c0895f07c3474f6636f95b6bf3db172.ssl.cf1.rackcdn.com/content/metro-innovation-districts/~/media/programs/metro/images/innovation/innovationdistricts1.pdf

of promising graduates to work in breeding programs. However, more could be done to ensure seamless cross-institutional collaboration with greater consistency in policies and ways of working across the co-located partners e.g. with respect to IP policies, employment frameworks, regulatory requirements etc. Such differences can be significant impediments to e.g. the establishment of joint appointments.

Combined with the expertise available at the University's Roseworthy Farm, incorporating the partnership between PIRSA and Elders at the Struan Research Centre site in the heart of the State's productive livestock region, and the facilities of SARDI at Turretfield, there is an outstanding opportunity to create a new precinct at the level of international best practice.

The establishment of AgTech industry precincts would allow the fast-track adoption of technologies and ensure South Australian agriculture remains globally competitive. Bringing partners together would support the research, development and technology innovation and commercialisation required to develop a new AgTech industry, and would build a culture and capacity in our agriculture sector for continuous innovation that is strongly market-driven. Finally, such precincts would also support the training and extension required to lift the capacity of our horticultural, livestock, viticultural cropping, wine and food industries, and would provide incentives for industry participation.

Realising this vision will require strong backing and co-investment from partners including governments and industry. With a project value of approximately $120 million, this investment will place the Waite at the forefront of agricultural and wine innovation, future proofing the thriving agricultural and wine sectors that underpin the future success of our regional communities and state and national economies.

***Examples of best Australian and international practice.***

The Triple Helix Model of Innovation refers to a set of interactions between academia, industry and government, to foster economic and social development. The Philips Research Eindhoven Lab is an excellent international example of this approach, combining "research activities with 'first of a kind' product development based on our advanced engineering competencies." It is located on the High Tech Campus Eindhoven, Netherlands, which has over 8000 researchers, developers, and entrepreneurs working together.

Within the agricultural space, best international practice is exemplified by Wageningen University and Research, with global strengths in agriculture, horticulture and food all in the one place, and benefiting from the combined efforts of the various fields of natural and social sciences.

**Information request 5.8 - Demography**
The Commission seeks information on the areas of opportunity that may be created by SA's age profile including examples. What R&D activity would support exploiting those opportunities?

Taking into account the ageing population within the State, a strong focus on interdisciplinary research and technological advances for better health outcomes would be logical. However, it is also important to consider the fact that many younger people tend to move interstate in pursuit of employment opportunities in the higher productivity sectors (e.g. business, media, technology) where this State's employment projections are almost completely flat. Therefore, it is important that the Inquiry consider ways in which investment in high productivity sectors can be created to help stem or reverse the demographic and migration trends that have tended to undermine productivity in the past.

**Information request 5.9 - Access to Data**
The Commission seeks further information on the following issues:

- Is the current regulatory environment at the national level conductive to data generation and sharing?
- Is the current regulatory environment at the State level, including the operation of the *Public Sector (Data Sharing) Act 2016*, conductive to data generation and sharing?
- Is there overlap between national and state legislation?
- What are the barriers to accessing and using public sector data for R&D in South Australia and how material are these barriers?
- How could these barriers be addressed? Are there any barriers related to sharing of data among non-government research providers created by government policy? And where is it done better?

***What are the barriers to accessing and using public sector data for R&D in South Australia and how material are these barriers?***

As mentioned under section 5.6 (Infrastructure), of critical importance are effective and accessible collaboration tools, data storage and access and IT infrastructure to the delivery of these strategies.

Access to large pools of high-quality data is a crucial prerequisite to success in many areas of research, especially in those areas with widespread applications to industry, including data science, machine learning and artificial intelligence. Due to data quality, confidentiality and data localisation issues, often such data pools may be difficult for researchers to access. However, high-quality data can sometimes be effectively sourced through industry collaboration in research and development. Increased access to such data pools is an additional, potential future benefit which may arise in the medium term from deepened engagement and strengthened collaboration with industry.

Although there is an ever-increasing need for open access data (and in fact a requirement of such by government-funded research agencies such as the ARC and NHMRC), there are some regulatory impediments to a fully open access system where data can be easily shared. Several national organisations collate metadata or datasets (e.g. the Australian National Data Service) and there are also State-based repositories. However, while these can be open access, different government agencies tend to support different systems.

Barriers to data sharing include having data organised in different ways, different data repositories, data licencing and copyright issues, and costs associated with placing data in repositories and keeping it updated. To address these barriers, decisions around a single repository are required, the funds to support such a repository need to be available and researchers need to ensure that costs for depositing data are included in R&D applications. There is also a need to ensure that data captured as part of development proposals (e.g. environmental impact data) are made publicly available.

In addition, Intellectual Property, particularly the issues around novelty and creation of patents, can create a barrier to the sharing of data for R&D. Here is it important to ensure the rights of the community and the individual are fair and balanced.

As suggested in the University's submission to the SAPC Inquiry into Health and Medical Research in SA, an underutilised area which could well provide a competitive advantage relates to the scope for extensive data linkage activities across South Australia, particularly with the implementation of a universal electronic health record in the State, which could facilitate highly significant research focused on health outcomes, and encourage university collaboration with the private healthcare sector in health research. The University of Adelaide has considerable capability in this area and could lead a South Australian program, in partnership with SA government departments and agencies, community stakeholders, as well as researchers from other SA institutions.

This could build on the data linkage agency SA NT DataLink, established in 2009 as a collaboration between the South Australia and Northern Territory partners to inform many areas of policy and service development. It could also leverage the significant potential of the University's Australian Institute for Machine Learning.

**Information request 5.10 - Business Investment**
The Commission seeks stakeholder views and evidence on:

- How do businesses determine the balance between adopting or innovating technology and processes as a driver of innovative products and processes?
- Are there ways that the South Australian Government can efficiently support business endeavours in R&D?

***Are there ways that the South Australian Government can efficiently support business endeavours in R&D?***

The rate or speed in which research is commercialised is determined by three main drivers:

- Need: there is a change or disruption (regulatory, competition, etc.) that requires a quick response. We have seen adaptability in our manufacturing sector with the recent COVID-19 outbreak and, previously, with the loss to the automotive manufacturing industry (e.g. SMR Automotive Australia moving into medical devices).
- Adaptability: a desire and willingness to change. Again, SMR is a good example, although most manufacturing and agricultural sectors have been slower to adapt.
- Fit-for-Purpose: this is about quick wins with high Technology Readiness Level opportunities. These are rarer within the university sector unless there are projects already well progressed. Staff turnover and short-term grants can hinder this. The University's Australian Institute for Machine Learning may be a good example of having a repository of prior code which can be adapted for purpose.

The general focus of university research tends to be on projects that have a duration of 2-3 years plus, which impacts on rate of research commercialisation. To accelerate this rate, it is necessary to get closer to the end commercialiser at an early stage of the R&D process. Examples of how this may be facilitated include:

- Developing infrastructure to create the necessary foundation
- Creating talent pools in high-demand areas
- Utilising think tanks
- Ensuring detailed project management
- Facilitating joint industry engagement
- Expanding Industry PhDs.

The commercialisation of new technologies can be a long and complicated process. It is well documented that the timeframe to go from 'bench to market', that is from the initial breakthrough in a research laboratory to a new product or service delivered in market, can take several years. There are also many costs associated in developing and launching products.

If we take this from the 'bench' starting point, funding to support this is typically led by national competitive grants schemes such as those provided by the Australian Research Council, as well as larger coordinated efforts of Research Development Corporations. This work will often yield interesting research outcomes that could have translation utility.

The challenge is funding the next step beyond this point which is to demonstrate proof of concept or a functioning prototype. From a technology development perspective, achieving this de-risks the new discovery enormously, but this is also the point at which many new discoveries will fail where they can't be scaled up in manufacture and/or they fail to demonstrate functionality as expected. This is often referred to as one of the 'valleys of death' in commercialisation. Funding for this work is extremely limited in Australia it does not look to make new discoveries and it is also not taking a new product to market. Venture investors are reluctant to fund this work because of the failure rate, and as such there is a failure of the market to support it.

Many years ago, the SA Government supported Bio Innovation SA as a dedicated granting body for health and medical research commercialisation. In more recent years, this group was re-branded to TechInSA and the remit extended beyond biotech to include engineering, software and agriculture-related project opportunities. The funding that this organisation administered was specifically targeted at this first 'Valley of Death' with the aim of supporting new technologies from South Australia to be

investor ready, i.e. developed to the point where Venture Capital funds would now be able to invest in new start-up companies to take these technologies to market.

While grant support from the State Government is available through the Research Commercialisation Start-up Fund, unfortunately it is a relatively small resource that is promoted to support technology opportunities from across all sectors, further diluting the scale of funds available.

Universities also have proof-of-concept funds committed and budgets to fund Intellectual Property protection. In the highly competitive higher education sector, these funds are extremely difficult to defend and are themselves limited in scale and expected to support technologies developed from all research areas of the university.

Overall, what is lacking is funding at scale to support research breakthroughs to advance further down the development path. Access to such funding would see more, new, locally-developed research breakthroughs reach the point of further investment by companies and/or investors to commercialise these outcomes and deliver new products to market.

**Information request 5.11 - Collaboration**

The Commission seeks stakeholder views and evidence on:

- best practice examples of collaboration between higher education institutions and businesses;
- the advantages and costs of collaboration among research institutions at local, national and international levels;
- examples of best practice collaborations between higher education institutions;
- incentives that encourage collaboration; and
- regulatory barriers to collaboration that the South Australian Government can address.

Within the University, collaborations are determined by a combination of individual contacts and strategic institutional initiatives. Often the former (via conferences, publications, joint projects, contract research, etc.) lead to more formal collaborations between research groups in each institution. However, the University also makes strategic decisions to target specific institutions, industries or countries with the aim of encouraging research collaboration. Crucially, fundamental basic research that generates the ideas and intellectual property for applied research and commercialisation must continue to be supported and valued.

In considering challenges to collaboration with non-academic partners, it is important to acknowledge the different roles of industry and the research sector in our innovation system. Research organisations have a broad range of responsibilities with public good outcomes, such as improved healthcare and environmental management, which are at least as important as the commercial outcomes from research. In this respect, universities collaborate not just with government, industry and other research institutions, but also with charities, community groups, not-for-profit organisations, etc. For example, in June 2020 Masonic Charities made a $650,000 commitment to support a research partnership between the University of Adelaide and the University of South Australia to develop an interactive, online wellbeing tool to help people with practical, evidence-based strategies to manage stress, adapt to change and strengthen their mental health and wellbeing.

***Best practice examples of collaboration between higher education institutions and business, and between higher education institutions***

Within the university system, there are numerous public programs which support and/or require collaborative partnerships, e.g.

- Australian Research Council (ARC) Linkage Projects
- ARC Industrial Transformation Research Program (research hubs and training centres)
- Medical Research Future Fund programs
- Cooperative Research Centres (CRC) program
- National Health and Medical Research Council (NHMRC) Centres of Research Excellence.

These are complemented by contract and consultancy research designed for work with individual businesses and organisations. The University of Adelaide currently partners with over 400 businesses and research organisations on research and consulting projects helping them address new opportunities, solve unique problems, generate jobs and economic value, and grow productively.

The University has also established an innovation hub, ThincLab Adelaide, to facilitate a collaborative and entrepreneurial community, attract diverse members and mentors with diverse knowledge and experience, facilitate creativity and collaboration, stimulate an entrepreneurial culture, and link to other innovation precincts both internal and external. With over 100 registered occupants, ThincLab Adelaide also includes a TechLab with 3D printers, vision equipment, etc., and is part of a distributed network model (ThincNet). Internationally, two ThincLab Nodes have been established, one in the Singapore Biopolis Innovation Precinct, and one in the French town of Chalons-en-Champagne. Importantly, ThincLab is highly visible to and engaged with students, promoting entrepreneurship within the young people who will create the State's future.

There are many examples of best practice collaboration with both industry and other academic institutions. For example:

- The $11M Research Consortium Program for Agricultural Product Development at the University of Adelaide's Waite campus, launched in October 2019, aims to turn the high volumes of waste from South Australia's primary production into high-value products for new markets such as pharmaceuticals, cosmetics or packaging. The Consortium has been supported with a $4M grant from the SA Research Consortia Program, and its partners are: the University of Adelaide, the University of South Australia, CSIRO, KTH Royal Institute of Technology (Sweden), Filsell's Orchards Pty Ltd, Raw Nation Wholefoods Pty Ltd, AE Cranwell & Sons, Ashton Valley Fresh, JVJ Co Pty Ltd, Vanquish Technologies, SA Mushrooms, Coopers Brewery Ltd, Potatoes South Australia Inc, CarbOzide Pty Ltd, Agilent Technologies Australia Pty Ltd, Plant & Food Research, Ingredion Inc (USA), Carlsberg Group A/S (Denmark).

- The Teletraffic Research Centre (TRC) at the University of Adelaide has a long and successful tradition of working with industry on long term R&D collaborations. For example, the TRC has collaborated with Telstra on every technology refresh in its networks over the last 30 years, and Telstra uses the group's TelAri Analytics network dimensioning technology to optimise capital expenditure on capacity upgrades.

- The University of Adelaide has partnered with medical technology company Sienna Cancer Diagnostics and Griffith University's Institute for Glycomics in an exclusive worldwide licensing agreement to develop a unique cancer probe with the potential to detect a sugar molecule only present in cancer cells. The technology grew from research started more than a decade ago by University of Adelaide researchers Professor Adrienne Paton and Professor James Paton. This is an outstanding example of transformational benefits to human health emanating from basic research in the university environment.

- The three South Australian universities, the French National Scientific Research Agency (CNRS) and Naval Group are working together to form an international research lab (IRL) on human-autonomy teaming and working with artificial intelligence. Expected to open in September 2020, it will be the first CNRS-supported IRL in Australia and the fifth associated with an industrial partner in the world. The IRL will offer an enduring link to the CNRS, which is one of the premier scientific agencies in Europe, and directly supports the State Government's Strategic Framework, establishing a skills pipeline through internships and industry-linked PhDs. Its research applications will cover defence, space and other hi- tech industries such as oil and gas, manufacturing and mining.

- The University of Adelaide has close collaborative relations with Shanghai Jiao Tong University (SJTU), which includes a Joint Laboratory for Plant Sciences and Breeding led by Professor Dabing Zhang, who has held a joint appointment with the University and SJTU since 2015, and a joint laboratory on renewable energy supported by both the Australian and Chinese governments.

In some cases, the University also encourages collaboration with industry by providing an on-campus presence, and the following provide two best practice models:

- Dassault Systèmes is a US$22B global company with a leading role in a range of sectors that are key to Australia's economic activity and future (mining and offshore, defence, advanced technologies and advanced manufacturing, biotechnologies and data mining). In 2017, they established a partnership with the three SA universities and SA Government to provide access to their 'Virtual Shipyard', as a key training vehicle for future defence workforce needs in SA. The University of Adelaide has a formal strategic partnership with the company, with a strong focus on academic and research collaboration. This saw the company relocate their Australian headquarters to the University's North Terrace campus. Some of the advantages of this include diversification of the defence profile of the University beyond DST and the Defence primes; building a University profile with Dassault Systèmes' clients and partners nationally and globally, and benefiting from their formidable communication capabilities and global and national networks; and providing the opportunity for students to gain international industry and education exposure, *in situ* on campus. All first and second year undergraduate students have now taken foundational engineering courses, including practical applications in a state-of-the-art digital engineering platform. This provides them with the ability to conceptualise and capture innovation in a digital environment, and collaborate productively across boundaries between countries, cultures, and disciplines well beyond engineering.

- Silanna Semiconductor is a hi-tech, research-intensive company with an embedded presence on the University's North Terrace campus. Silanna designs and manufactures advanced semiconductor devices for many sectors with a specialisation in high power-density devices. Its $23M University of Adelaide facility undertakes research in emerging Gallium Oxide technology which promises some of the highest power densities achievable in semiconductors today. Silanna and the University share a vision to see an advanced semiconductor manufacturing capability established in South Australia. Silanna brings know-how and experience and a financial investment in a new Quantum Material PhD program; and the University is making relevant academic appointments, e.g. using its 'Top Talent' scheme to invest in a Chair in Quantum Materials - a new field at the boundary of condensed matter physics, quantum physics, material sciences, chemical engineering and optoelectronics. Our two organisations are working together to build a pipeline of talented researchers necessary to realise this ambitious vision to create jobs and a new industry in South Australia.

It is also important to mention the long history of collaboration between the University and State Government departments and agencies, including joint appointments. These relationships take a long time to build up and are incredibly valuable for local collaborative networks. One example is the South Australian Regional Facility for Molecular Ecology and Evolution (SARFMEE) housed at the University's North Terrace campus adjacent to the South Australian Museum. It provides a central resource for SA researchers using molecular genetic techniques in evolutionary and ecological studies. The Evolutionary Biology Unit, led by a University of Adelaide titleholder and involving researchers from across the State, is the core partner in SARFMEE. The University of Adelaide, Flinders University, the University of South Australia and the SA Department of Water, Environment and Natural Resources are all partners in the operation of the Facility.

The University of Adelaide also has close connections to the SA Local Health Network, particularly Central Adelaide Local Health Network and the Women's and Children's Health Network (WCHN), and is developing a closer relationship with the Northern Adelaide Local Health Network, for example in the area of indigenous health equity. One notable example is the strong connection between the WCHN and the University's Robinson Research Institute (RRI), one of the flagships of our research strength. The RRI is a collective of internationally-renowned researchers in human reproduction, pregnancy and child health at the University of Adelaide.

The University is also a foundation partner in the South Australian Health and Medical Research Institute (SAHMRI), the State's only MRI, and continues to be its major stakeholder. SAHMRI's members are the SA Government, the University of Adelaide, the Flinders University of SA and the University of South Australia.

The following section provides an expanded example of successful collaboration across academia, government and industry sectors working together to address the global challenge of food security.

The University of Adelaide has a distinguished 135-year history of research and education in agriculture, food and wine. We operate both Waite and Roseworthy agricultural campuses and the Roseworthy working farm; both campuses run a co-location model with industry and government partners, and are innovation hubs that link the training, research, development and translation essential for sector transformation.

The University has a strong history of partnering with other institutions to ensure its food-related investigations meet real world needs and deliver a smooth, lab-to-plate transition of benefits. In addition to working closely with key food industry groups and government, the University invests considerable time and resources in focused research partnerships with more than 30 major companies and not-for-profit organisations. These range from international giants such as Pfizer, Nestle and Unilever, to national leaders including Woolworths, Elders, Coles Teys-Cargill, San Remo and Westpac, and local icons like Haighs, Coopers Brewery and Thomas Foods.

Our academic staff work closely with partners along the food value chain to ensure their innovations are ready for commercialisation. For example:

- The ARC Industrial Transformation Research Hub for Wheat in a Hot and Dry Climate is a partnership between the Universities of Adelaide, South Australia and Sydney along with the Grains Research and Development Corporation and Australia's three largest wheat breeding companies to enhance productivity and secure high grain quality of wheat.
- We partner with Charles Sturt University, the CSIRO, the Australian Wine Research Institute and 10 other industry partners to investigate aspects of viticultural management and the winemaking process through the ARC Training Centre for Innovative Wine Production.
- We also partner with Meat and Livestock Australia, the University of New England and Murdoch University through the Rural R&D for Profit Advanced Livestock Measurement Technologies program.

In addition to the Waite Campus, the University's Roseworthy campus is renowned for excellence in dryland agriculture, natural resource management and wine education. It now houses South Australia's School of Animal and Veterinary Sciences including the Davies Livestock Research Centre which focuses on improving productivity, genetics, health, wellbeing and meat quality, whilst reducing the environmental footprint of meat production. The Australian Centre for Antimicrobial Resistance Ecology is also housed at Roseworthy, has 'One Health' (human and animal) as its mantra and works closely with the wool, meat, egg and milk industries. Synergistically, our North Terrace campus houses the Centre for Global Food and Resources which conducts multidisciplinary (policy, economics, business) research into achieving healthy, resilient and productive communities and landscapes that are food, water and resource secure; and the Food Values Research Group uses qualitative and quantitative social science approaches to understand how people make everyday food choices, and how their 'thinking frameworks' are shaped socially, culturally and historically.

Importantly, the University of Adelaide has had, and continues to have, a strong and very successful relationship with Australia's RDCs and is highly supportive of this partnership model. Over the past 10 years the University of Adelaide has ranked either 1st or 2nd nationally in terms of RDC income awarded to universities (Rural RDC Higher Education Research Data Collection, HERDC income data), and has engaged with 11 of the 15 current RDCs over the past five years, comprising:

- Grains Research and Development Corporation
- Meat and Livestock Australia
- Wine Australia
- Horticulture Innovation Australia Limited
- AgriFutures Australia
- Australian Pork Limited
- Australian Wool Innovation Limited
- Fisheries Research and Development Corporation
- Dairy Australia Limited

- Australian Egg Corporation Limited
- Cotton Research and Development Corporation.

That the Australian agrifood and wine industries face a number of unprecedented technological challenges in order to remain globally competitive is already well established, as is the industry demand for translational solutions. RDCs have recognised this need resulting in an increased focus on the application of technology to solve existing problems within the agrifood and wine supply chain. If Australia is to remain globally competitive, RDCs, with government, industry and research institutions, must work together even more effectively and keep working on systems approaches with transformational outcomes for Australian agriculture.

International partnerships should also be encouraged and nurtured through networks of researchers and industry leaders for:

- Impact – education, research and development that makes a discernible positive impact on the local agriculture, food and wine sectors;
- Leverage – better utilising and leveraging what is already in place, such as facilities, expertise, programs, technologies, research, or knowledge;
- Partnership – planning and delivering programs in partnership with industry and government to solve real life agricultural, food and wine challenges; and
- Coordination – facilitating connections between partners to ensure successful translation and commercialisation of solutions.

Building on this historical legacy, the University of Adelaide's vision is for South Australia to be a world-leader in agriculture and in the wine industry. Central to this vision is a major new infrastructure build at Waite which will lay the foundation for success. A new high-tech winery will teach the wine makers of the future and house the latest, world-leading research that will continue to underpin Australia's wine sector in the global market. The Waite will also bring together those central to driving the State's and nation's agriculture by co-locating industry, academia, government and international partners side-by-side within new buildings. This will become the home of the latest knowledge and technology, education and training, and research and development, creating a national asset to drive forward critical advances in these important sectors.

***The advantages and costs of collaboration among research institutions at local, national and international levels***

The advantages of collaboration include increased potential to utilise research infrastructure that is owned by different organisations in a more productive manner so there is no duplication. (Refer to section 5.6 for more detail).

In terms of the costs of collaboration, South Australia suffers in Australia's tyranny of distance stakes, both in terms of geographic distance from other research organisations, as well as having low 'economies of scale'. This tends to lead to SA organisations having to spend proportionately more time, money and effort in attempts to join with colleagues in larger institutions whether nationally or internationally.

The following section (initially mentioned in section 5.1) provides a detailed example of the advantages of collaboration (across all three components of the Triple Helix Model), and an essential area of strategic importance and opportunity to the State: **Information Capability**, integrating human, cyber and physical domains.

To date the strong connections between Defence and universities have been in the more traditional areas of defence research. However, we need to develop capabilities to respond to new threats (e.g. cyber warfare), bringing together diverse technologies such as Artificial Intelligence and Machine learning with the human-oriented disciplines of social sciences, psychology, law and creative arts. Enabling collaboration through the co-location of defence personnel, industry and universities will be critical to building both secure and resilient information systems and new capabilities for Australia.

Growing national information capability will require supercharging the connection between our best capability (in DST and Defence), our best future people (in universities) and translation (in industry), and South Australia is poised to lead development of Information Capability.

Adelaide is the logical home for this development due to the combined capabilities already present. An entire ecosystem of digital and high-tech industry capability is being constructed on Lot 14, which is home to the Australian Space Agency, the Australian Cyber Collaboration Centre, and the University's Australian Institute for Machine Learning (AIML). Lot 14 will nurture highly-skilled talent in key industries such as artificial intelligence and machine learning, cyber security, robotics, creative technologies, defence and space research. This new Institute is a collaboration model fit for the 21st century – an Australian 'Bletchley Park"' of Information Capability. (Bletchley Park in the UK was the principal centre of Allied code-breaking during WWII and developed the world's first programmable digital electronic computer - it was a unique model of co-operation between leading academics and defence).

A precursor to this development saw the SA Government contribute $7.1M towards the establishment of AIML in 2017, a key research institution in machine learning globally, ranked number one in the world for three key areas of artificial intelligence and machine learning. This funding included $1.5M for defence capability research. In February 2020, the SA Premier opened the AIML headquarters on Lot 14 noting that its cutting-edge research projects:

> *… will bolster South Australia's entrepreneurial activity across a range of industries from defence to tourism, providing us with new tools and capabilities to ensure that this State remains at the forefront of global innovation and enterprise*

As part of the wider collaboration model:

- In 2018, technology and innovation company Lockheed Martin Australia became the first Foundation Partner with AIML;
- In 2019, the University of Adelaide, along with Flinders University and the University of SA, signed a letter of intent with the peak French Government scientific research organisation, the National Centre For Scientific Research (CNRS), and French maritime technology, shipbuilding and energy company Naval Group, to develop an International Research Laboratory, one of only five industry-linked CNRS joint laboratories in the world; and
- in 2020 the University signed the Defence Science Technology (DST) Defence Science Partnership Deed 2.0 to engage in long-term strategic engagement.

***Incentives that encourage collaboration***

Incentives for academics need to align with their motivations for impact. Research indicates that academics are driven by a variety of largely intrinsic motives, such as generating a positive impact on society, having opportunities for stimulating new research ideas and exchanging knowledge, but also achieving peer recognition and promotion. Encouraging collaboration thus requires a comprehensive framework of incentives including promotion frameworks, recognition of excellence, and the recognition of collaboration activities as an essential workload activity. While some of these are specific to the institutional environment, academia is a global profession with a strong esteem component. Hence, opportunities exist for states and regions to incentivise through collaboration-focused appointments, roles demonstrating the importance of collaboration (e.g. a Director for R&D collaboration), collaboration training schemes and generally a strong narrative regarding collaboration.

As an example of a barrier to overcome, the Federal Government's Industry Growth Centres (IGC) are currently a key catalyser for industry-government-R&D ecosystems. However, none of the six IGCs are based (or have regional hubs) in South Australia. The longevity of the IGCs is not certain, but there seems merit in the SA Government working with Federal counterparts to better connect with such catalysing initiatives.

Some recent SA Government initiatives in trade and investment attraction are welcome, and there seems to be value in strategically expanding the "trade ambassador" concept to promote and incentivise R&D collaboration at scale nationally and internationally.

Incentives for businesses may connect to their tax, as noted earlier. Other incentives may specifically target key motives for businesses to engage with higher education institutions, such as accessing new technologies and knowledge, improving innovation capacity, along with an interest in positively impacting society and building the reputation of the business. Hence, they may be human resource-related incentives to allow for upskilling of staff or staff immersion in a university, or facilitated promotion of the businesses' R&D collaboration efforts, to name a few.

To enhance the impact of collaboration, a two-pronged approach is necessary: support existing collaborations to grow; and enhance the scale of collaborations between higher education institutions and businesses that do not yet collaborate but have a desire to innovate and grow long-term. Collaboration takes time to develop, requiring opportunities for learning and developing readiness as noted earlier. Increasing the permeability between the sectors is important when it comes to employment to enable careers spanning both university and business aspects.

Development of trust is also critical. In particular, businesses with little experience collaborating with universities rely on trust and mutual respect when first engaging, which helps to develop the knowledge and shared meaning required for successful collaboration with a multitude of universities/researchers over time[4]. The importance of schemes that introduce businesses to R&D related collaborations to enable such learning cannot be underestimated.

Global best practice examples exist of schemes calling for proposals to develop novel ideas of collaboration models, encouraging innovation in the framework, methods and processes and the implementation of such innovation in a region (e.g. Vinnova[5]). This enables a system-wide leap in facilitating such collaboration.

**Information request 5.12 - Policy**

The Commission seeks further information on the following issues:

- What other policy instruments should the state consider?
- What are the most important policy barriers for the South Australian Government to address?
- Are there any examples of policy levers and outcomes of policy in a national or global context that could be translated to SA?

From a legislative perspective, the State Government has provided some reforms that are critical to growing research in the State. A recent example is lifting of the GM moratorium, which provides greater opportunities to test and develop new crop varieties in South Australia suited to local conditions. This will help ensure the State and the University stay at the forefront of crop research with its associated economic benefits. The Strategic Research Alliance Agreement formally enacted between the University of Adelaide and the South Australian Research and Development Institute (via PIRSA) in early 2020 has significantly strengthened this objective.

Another important example is the proposed legislation requiring private providers to release de-identified patient details to public health experts, which will encourage collaboration with the private healthcare sector in health research.

One way to reduce perceived barriers would be to ensure fair and equitable sharing of benefits with associated clear Intellectual Property arrangements for potential commercial projects across organisations. For a significant proportion of 'public good' research, formal agreements at the institution-to-institution level that promote sharing of background IP might be considered. Either way, clear and more consistent IP policies are needed in the State, particularly as the number of joint appointments and affiliated appointments continue to rise. This creates a minefield of complex arrangements for researchers that are not consistent from project to project over time, let alone across institutions, and this could be an impediment to future growth.

-ends-

[4] Steinmo, M.; Rasmussen, E. (2018) "The interplay of cognitive and relational social capital dimensions in university-industry collaboration: Overcoming the experience barrier", Research Policy, 47 (10), 1964-1974

[5] https://www.ub-cooperation.eu/pdf/cases/N_Case_Study_Vinnova.pdf