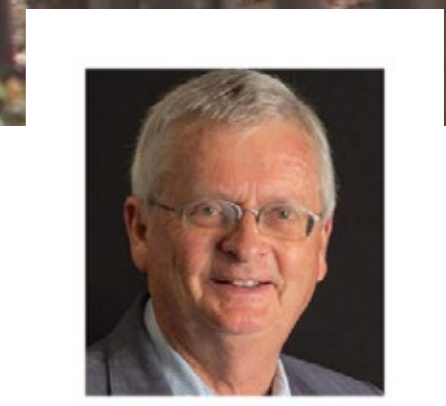


NSW Innovation and Productivity Council

Let's Collaborate: SMEs using research to drive innovation





Foreword from the Chair, NSW Innovation and Productivity Council

Significant global events can have a profound impact on economies, changing consumer behaviour and business practices, as we are witnessing with COVID-19. The impact on the NSW economy has been significant, yet these events can also drive innovation through research collaboration that helps businesses adapt and prosper.

It is imperative given the current economic circumstances that we actively encourage collaboration between researchers and businesses to seize these opportunities to innovate and come out stronger. Doubling our current rates of collaboration, could see a productivity increase worth up to \$150 million per year for New South Wales.

New South Wales has world-leading researchers and institutions in over 50 specialised growth areas such as robotics, smart sensing, materials science, data science, and artificial intelligence. However, as our NSW Innovation and Productivity Scorecard found, we perform less well in terms of university-industry collaboration.

University-industry collaboration is a well-researched area, yet less well understood is the relationship between research organisations and the small-to-medium sized enterprises (SMEs) that comprise 99 per cent of all businesses in New South Wales.

To better understand the factors involved in successful collaboration, the NSW Innovation and Productivity Council (IPC) undertook this research to help learn, improve and remain competitive.

Good collaboration requires commitment, knowledge and connections, funding to scale and grow, simple interfaces, and bridging cultural differences. The IPC has developed seven mutually supporting recommendations that build on successful existing programs to capitalise on New South Wales' research strengths. They are also designed to incentivise academics, increase awareness for SMEs and address cultural barriers. I am particularly pleased by the support of universities represented on the IPC to establish a Research Collaboration Pact.

The Pact provides a public commitment to actively embed collaboration within their practices, address cultural differences, and improve commercial outcomes.

Looking ahead, leveraging New South Wales' research capabilities to innovate through better SME collaboration will become more critical as we exit a period of economic stagnation. I am pleased to provide this report to the NSW Government on how we can improve our research collaboration to drive innovation and economic growth.

Mr Neville Stevens AO
Chair, NSW Innovation and Productivity Council



Foreword from Project Champion, Professor Attila Brungs

It gives me great pleasure to commend to you this important report from the NSW Innovation and Productivity Council on how the NSW economy—and the broader society it supports—can benefit from greater collaboration between SMEs and research organisations.

SMEs are a critical part of the NSW economy, and will only become more central to it in future. The great wave of technological innovation sweeping the world and disrupting the traditional workforce is requiring businesses and organisations to respond and acquire new innovations and skills. This will perhaps disproportionately impact SMEs more than in any other part of the economy.

The COVID-19 pandemic is proving to be an accelerator of this wave of disruptive change, meaning the time we have to plan for and prepare the ground for the change to come is rapidly disappearing.

Yet how we as a State ready for that disruption, and actively foster and encourage innovation, new skill development and new growth in SMEs, will ultimately shape how well we can capitalise on the opportunities that present themselves, for our individual and collective prosperity.

Moreover, Australia's unusually high proportion of SMEs compared to other developed nations, is both a great opportunity, but also a risk if we do not take action now.

Our research organisations are world-class, but getting the wonderful innovation that already exists out and into the hands of SMEs has always been our greatest challenge.

Sometimes SMEs may not know how research could benefit their business. And sometimes it can be difficult to know where to start, whom to contact or how to navigate the hurdles of a large bureaucracy.

Acknowledging these challenges, universities continue to improve the ways in which they engage with SMEs. Providing single entry points, establishing multiple engagement pathways, building communities of interest, simplifying intellectual property policies and standardising commercial agreements are all commonplace.

While these initiatives are a great start, there is more to be done to overcome barriers, bridge cultural differences and improve project outcomes. Further, many of the already extensive programs undertaken by universities are relatively unknown in the business community, particularly the SME community.

The recommendations in this report, as its title suggests, are focused on building connections between the two sectors. There is no easy solution to the challenges we face, but the path of innovation transfer from research organisation to SME, begins with a shared commitment to, and accountability for, working together for the mutual benefit of all parties.

That is why the first recommendation of this report is to establish a NSW Research Collaboration Pact which will highlight research organisations' ongoing commitment to collaboration practices. This will hopefully raise the profile of existing partnership mechanisms, the dedication to increase collaboration and encourage businesses and SMEs to also commit to reaching out and collaborating with universities.

Finally, I would like to congratulate the members of the IPC on this report, and for their important role in providing leading-edge research to advise the NSW Government on innovation-led economic development and productivity.

Professor Attila Brungs

NSW Innovation and Productivity Council Member and Project Champion

Vice-Chancellor and President, University of Technology Sydney



About the NSW Innovation and Productivity Council

The NSW Innovation and Productivity Council (IPC) was established by the *Innovation and Productivity Council Act 1996*. It advises the NSW Government on priorities for innovation-led economic development and productivity.

IPC members are leaders from industry, education and research sectors. Members are appointed for three-year terms, bringing a rich and diverse range of experience and expertise to the work of the IPC. The current Council was appointed in 2020 and is chaired by Neville Stevens AO, a former Secretary of the Australian Department of Industry and the Australian Department of Communications, Information Technology and the Arts.

The NSW Chief Scientist & Engineer, Professor Hugh Durrant-Whyte and the NSW Chief Economist, Stephen Walters are special advisors to the Council.

IPC publications are independent reports and do not constitute NSW Government policy. This is consistent with the role of the Council and its object under the *Innovation and Productivity Council Act 1996* (NSW).

Contact

The Council welcomes feedback and inquiries regarding publications, website and media. To contact the Council secretariat:

Phone: +61 2 9372 7472

Email: ipc.secretariat@treasury.nsw.gov.au

Physical mail:

NSW Innovation and Productivity Council Secretariat
GPO Box 5469
Sydney NSW 2001
Australia

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Acknowledgement of Country

NSW Treasury acknowledges that Aboriginal and Torres Strait Islander peoples are the First Peoples and Traditional Custodians of Australia, and recognises their continued custodianship of Country—land, seas and skies. We acknowledge the diversity of First Nations cultures, histories and peoples, recognise their enduring connection to our State, and we pay our deepest respects to Elders past, present and emerging.

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Executive Summary

01

Small-to-medium enterprises are the backbone of the NSW economy, comprising some 99 per cent of all businesses.

At the same time, we have a highly educated workforce and some of the finest research institutions and researchers in the world.

SMEs that collaborate with researchers often see increases in productivity, sales and business growth, supporting their competitiveness in a global economy.



2 out of 3
NSW employees work for SMEs

To date, collaboration between business and research institutions has mainly involved larger enterprises. Many SMEs understand the importance of research and development in driving the innovation economy and what it can do for their long-term productivity and prosperity.

However, partnerships between SMEs and research organisations are still very limited in number and have not yet yielded the types of business outcomes they are undoubtedly capable of. SMEs may not know how to initiate or draw on research expertise or may consider it cost-prohibitive.

Additionally, COVID-19 may have slowed the progress of a number of joint business/research initiatives, but the opportunities for lasting and lucrative collaborations remain vast.

New South Wales has world-leading business acumen and research capability and further collaboration will be essential in driving the information economy of the 21st century.

The NSW Innovation and Productivity Council (IPC) conducted in-depth research and stakeholder consultation to look at the barriers and benefits for SMEs and tertiary institutions forging meaningful partnerships.

This report focuses on the opportunities and challenges for SMEs collaborating with research organisations in New South Wales. The report identifies recommendations to encourage greater SME-research collaboration.

Doubling our current rates of collaboration between SMEs and researchers could see a productivity increase worth up to \$150 million per year for New South Wales.

The benefits of collaboration

Research and development (R&D) is essential to speed up innovation, improve existing businesses, create new products and markets, and enhance daily life.

New business innovation is responsible for over 50 per cent of economic growth in OECD countries.



Delivers a strong return on investment

For every \$1 invested in collaborative university research in Australia, there is a strong direct return on investment to companies of \$4.50, according to Universities Australia. This does not, of course, mean that research is a one-way bet, and the distribution of returns is likely to be broad.

Collaboration with a university can also increase a company's reputation for innovation, attractiveness as an employer, and the level of positive attitude that consumers have about the company.

Increases business growth and productivity

Research-business collaboration can more than triple the likelihood of a business achieving annual productivity growth. Collaborating businesses are also 70 per cent more likely to develop new-to-world products.

Increases business competitiveness

Investment in any type of innovation, including technology by a business is a strong predictor of higher revenue, productivity and job growth. Innovation-active businesses are consistently more likely to increase employment, productivity and sales, compared to businesses that do not innovate. For businesses that collaborate on innovation, these benefits are even more pronounced.

Collaborating with research organisations can help businesses gain a competitive advantage through expertise and resources not available to their business, leveraging their intellectual capital, access to cutting-edge technology and equipment, and sharing the investment risk.

Triple

likelihood of productivity growth with research collaborations



Photo courtesy of UNSW

The benefits of innovation are compounded when collaboration occurs. Research into 7,000 Australian SMEs over a five year period found that companies that introduced innovations increased their annual productivity by 2.7 per cent the following year over their non-innovating competitors, with businesses that introduced the innovations as part of a collaboration increasing their productivity by 4.4 per cent.

Similarly a Danish study of over 6,000 formal collaborations between the University of Copenhagen and businesses found companies achieved a productivity increase of up to 16 per cent relative to a control group six years after the collaboration.

Current context

We have lots of SMEs, but not many that collaborate with researchers

Currently, most research collaboration involves big business, despite SMEs comprising the vast majority of all businesses in New South Wales and two out of three employees in the State working for an SME. Thirty per cent of SMEs are based in regional New South Wales.

Nationally, only an estimated 6 per cent of innovation-active large businesses collaborate in joint R&D projects with research organisations. This however represents double the 3 per cent of innovation-active SMEs that collaborate.

By comparison, collaboration rates for the UK, Germany and Finland are between 27 to 69 per cent for large businesses and 14 to 24 per cent for SMEs.

Australia has world-leading researchers and institutions, but translating research into commercial outcomes is weak

New South Wales is home to some of the world's top-ranked research universities. The State is a world-leader in specialised growth areas such as robotics, smart sensing, materials science, data science, artificial intelligence, water supply, and engineering.

Yet Australia has low collaboration rates, reflected in our poor performance in international rankings. Australia ranks 31st out of 129 countries in innovation outputs in the Global Innovation Index 2018, and 88th for knowledge diffusion. This often means that great research and technology is underutilised or leaves the country and is commercialised overseas and sold back to Australia as a higher-value product.

Collaborating SMEs tend to be in research-intensive industries

SMEs that collaborate with research organisations tend to reside in research-intensive industries such as medtech, biotechnology, advanced manufacturing or technology with higher levels of patenting activity. Nationally, R&D collaboration is highest in the mining sector, followed by professional, scientific and technical services, utilities and manufacturing.

Different sectors interact with research organisations in diverse ways due to their differing processes and business models. For example, manufacturers may require access to physical infrastructure to enable prototyping, whereas a service business may focus more on process innovation.

Collaboration is only relevant for some SMEs

There is a huge variety of SMEs in the economy—from tradespeople, accounting firms and shops and hotels, to high-tech start-ups, farms, consultancies, medical practices, and IT businesses. While many SMEs don't have an imperative for R&D, many do.

Around 45 per cent of SMEs nationally state they are actively innovating. However, with only 3 per cent of innovation-active SMEs collaborating on research, this effectively means that the other 42 per cent of innovation-active SMEs are not collaborating.



Why is there a lack of collaboration?

The challenge is to address barriers to collaboration for SMEs with an imperative to innovate. Barriers include:

- **Differing objectives, priorities, and cultures**—there are challenges forging mutually beneficial collaborations given the objectives of research organisations and an SME may not align.
- **Technical and institutional challenges**—issues to overcome include management of intellectual property, knowledge transfer, and accommodating the SME imperative for nimbleness and flexibility against institutional bureaucracy.
- **Limited connections and networks**—SMEs and universities operate in very different environments.
- **External factors**—external factors can influence decision making and prioritisation, such as the types of performance criteria faced by researchers.
- **Economics and transaction costs**—most SMEs face significant financial and resource constraints.

What does good collaboration require?

- **Commitment and bridging cultural differences**—mutually beneficial collaboration requires commitment from both parties and trusted relationships which are usually driven by effective leaders.
- **Clarity and incentive alignment**—Clear roles and responsibilities that develop a mutual understanding, establish a shared purpose and manage expectations are needed. Issues such as risk allocation and intellectual property need to be quickly addressed with minimal bureaucracy.
- **Capability and capacity**—Collaboration is more likely to succeed if SMEs can identify and evaluate experts, assess the costs and benefits of collaboration and develop problem-solving skills across their workforce.

Recommendations

Government at all levels can play a vital role in bringing these sectors together and this report offers ideas that can encourage greater collaboration between SMEs and researchers. While research organisations, particularly universities, play an important leadership role in actively driving collaboration with businesses.

The IPC recommends seven mutually supporting actions to increase SME collaboration and capitalise on New South Wales' research strengths. These actions seek to incentivise academics, increase awareness for SMEs and bridge cultural differences. They are:



1. Develop a NSW Research Collaboration Pact—to publicly demonstrate the importance of collaboration and knowledge exchange between research organisations and businesses, particularly SMEs, to improve strategy and collaboration across university and government and translate research into economic and social outcomes.

It should outline the principles to embed collaboration within research organisation practices and include three key areas: incentives for researchers to embed collaboration; bridging cultural differences; and improving project delivery and commercial outcomes.

2. Grow researchers' commercialisation and business engagement capacity—to build their knowledge of key translation gaps around different stages of commercialisation, how to identify commercial opportunities, how to undertake patenting, how to pursue market validation and scaling solutions, and best practices for engagement.

Building this knowledge will encourage and equip researchers to seek out opportunities to commercialise their research, rather than trying to change the nature of academic studies for universities.



3. Develop tools to address organisational differences—to better manage SME and academic expectations and set the collaboration up for success. Tools could include templates, guides and checklists, and information on intellectual property and contract requirements to ensure SMEs are well informed prior to establishing a partnership with a research organisation.

4. Develop a digital platform to facilitate connections—to establish a new 'one-stop-shop' digital platform to help broker connections between SMEs and NSW research organisations. This will significantly improve accessibility and awareness of networks, services, events and potential collaborators.



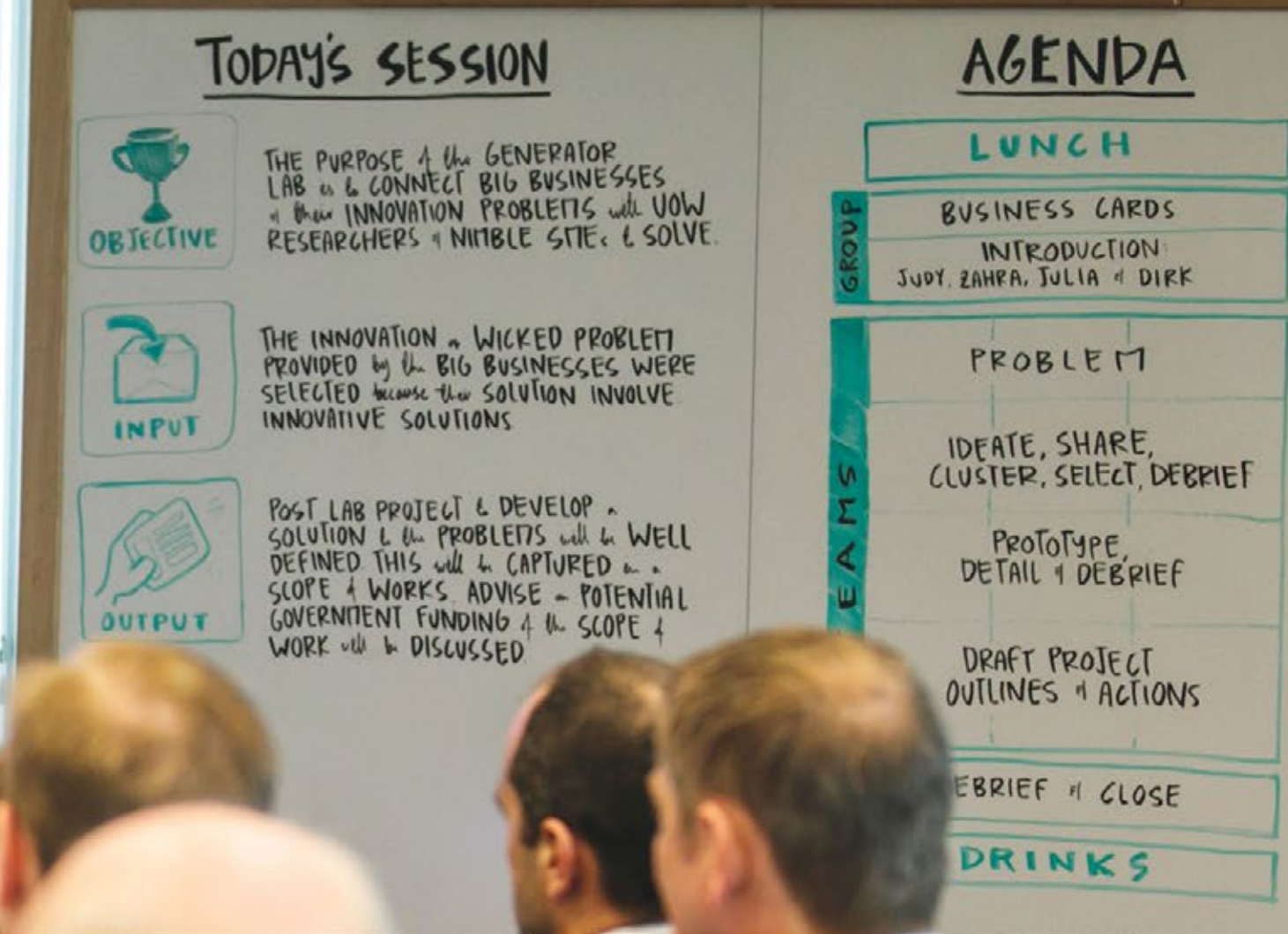
5. Provide financial incentives for NSW SMEs to boost collaboration—to lower upfront costs for SMEs and bring people together. Financial incentives could be provided through existing NSW Government programs using tiered funding models that reflect the varying business needs and technical complexity of projects. To address barriers to collaboration in regional areas and help boost employment opportunities, specific incentives could be offered, such as regional student internships.

6. Build SME awareness of research partnership benefits—by training NSW Business Connect Advisors in business-research collaboration to help SMEs better understand how they can collaborate with research organisations. This would enable advisors to provide information to SMEs on issues such as intellectual property, contract requirements, the 'proof of concept' life cycle, and how businesses can develop, sell and scale to position themselves into new and emerging areas. It could also involve helping SMEs to identify and connect with research organisations with the capabilities they need.

7. Establish a NSW Innovation Challenge Fund—to help support local businesses and researchers translate their ideas to market, and/or scale these ideas up. Innovation challenges can be mission-based rather than product-based, tackling societal, environmental or industrial challenges. Alternatively, they can also be used to focus efforts on government priorities or be defined by an external stakeholder which requires innovation.

Theme	Recommendation
 Incentives for researchers	1 Research Collaboration Pact
	2 Grow researchers' commercialisation and business engagement capacity
 Bridging cultural differences	3 Tools to address organisational differences
	4 Digital platform to facilitate connections
 Improving awareness and incentives for SMEs	5 Financial incentives for SMEs to boost collaboration
	6 SME awareness of research partnership benefits
	7 NSW Innovation Challenge Fund

The benefits of collaboration



02

Research and development (R&D) is essential to speed up innovation, improve existing businesses, create new products and markets, and enhance daily life.¹

New business innovation is responsible for over 50 per cent of economic growth in OECD countries.² Innovation is also critical to a region's productivity, economic growth and living standards, and strategies to boost innovation are essential for long-term sustainable growth.³



Innovation also provides other indirect benefits that can improve outcomes for society. Examples include new types of renewable energy solutions and water technology that improve a region's water security and quality.

But first and foremost, collaboration will only occur if it provides direct benefits to the businesses and research organisations that partner. SMEs need to see a clear business reason as to why they would partner with another organisation.

Successful partnerships between businesses and research organisations produce new ideas, products and ways of doing things—this drives improvement in productivity and lifts economic growth. However, quantifying these benefits can sometimes be complicated by the fact that:

- there are many types of collaboration, from joint publications to licensing new technology
- the impacts of innovation are difficult to capture and quantify

- the impacts are often felt over a long period of time, and
- the benefits spill over to many parts of society and countries.

Yet the difficulty in capturing the benefits does not mean that benefits do not exist. A fitting example of how the benefits of collaboration can be significant but difficult to capture is in the creation of a successful COVID-19 vaccination. Several industry-universities partnerships are currently developing candidate vaccinations, including collaborative partnership between Australian universities and industry.

If one of these collaborations produce a successful vaccination, it will generate vast positive economic and social spill overs globally that will be difficult to quantify.

This chapter explores the potential benefits of collaboration from a variety of studies that were able to capture the benefits, the different ways partners might engage, and how this may vary for different sectors.

Collaboration increases business competitiveness

The globalised economy offers greater potential benefits from successful innovation, especially for SMEs that are operating wholly in the domestic market and facing increased competition.¹

R&D is one pathway to build new markets and increase competitive advantage. Each stage of the commercialisation journey can be undertaken in a variety of ways and through a myriad of collaboration partners across the innovation ecosystem.

But because the commercialisation of R&D can be a long and complex process, many startups may find that a multi-faceted support service, such as that provided by an incubator or accelerator, will help them navigate the challenges of accessing finance, getting the right regulatory and IP advice, access to mentors and peers, and to the technical facilities that they need.⁴

While this process may be particularly valuable for commercialisation of deep tech R&D, not all SMEs will need the assistance of such an environment. Many businesses may have a discrete R&D need or project that would benefit from collaboration with a partner—whether it be working with another business, a consultant or a researcher—that can offer specialist skills or services.

There are also a range of innovation activities that do not stem from original research or involve R&D activities in the traditional sense.

Investment is now moving from physical assets such as manufacturing equipment, to more intangible assets such as productivity-enhancing technologies, new business models, branding and marketing, and new staff capabilities.⁵ For example, SMEs in the services sector may be focused on new or improved software or operating systems that can provide better data and insights on their business.

Investment in any type of innovation by a business, including technology, rather than purely measuring expenditure on R&D, is a strong predictor of higher revenue, productivity and job growth than businesses that do not invest.⁶

In addition to investment in innovation, the more diverse the sources of information and ideas, the stronger the innovation performance of a business.⁷

Market sources are considered more important for all OECD countries, and are more likely to be used as sources of ideas or information than institutional sources.

This is reflected in Australia, where businesses are more likely to network with external sources such as customers and suppliers (68 per cent of businesses, ranking Australia 4th out of 24 OECD countries), rather than with external institutions such as universities (only 6 per cent of Australian businesses, ranking Australia 19th out of 26 OECD countries).⁸

This does not mean that research organisations do not have an important role to play in advancing business innovation and commercialising R&D. What this does mean however, is that Australian businesses are yet to fully recognise the potential value that research organisations can provide, as described further in this section.

¹ Defined as having 200 or less employees. See Australian Bureau of Statistics 2002, 1321.0 - Small Business in Australia 2001, <https://www.abs.gov.au/ausstats/abs@.nsf/mf/1321.0>.



“Universities have time to investigate problems and conduct really in-depth research that companies just don't have the time to do, and they're trusted.”

SME based in Sydney

Collaborating with research organisations can help businesses gain a competitive advantage

1.

Access human capital



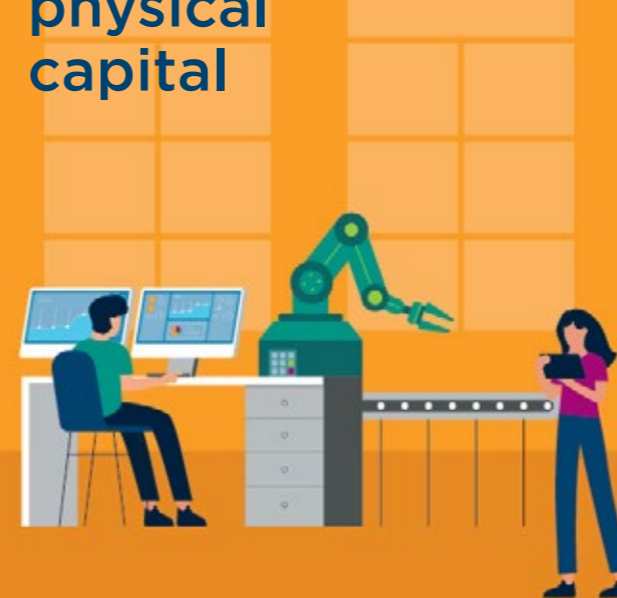
2.

Leverage intellectual capital



3.

Share physical capital



4.

Spread investment risk



Collaboration can give businesses access to expertise and resources not available in their business to help define problems and develop ideas. Research organisations can also provide training and help people to build new skills to develop an adaptive workforce.

Collaboration with researchers can develop new business knowledge and apply advanced problem-solving skills. It can also provide access to next generation technology to provide sophisticated data and analysis that can improve business systems and performance.

Collaboration with researchers can provide access to cutting-edge technology and equipment, which is too costly to operate in-house to prototype, product test and validate.

Collaborating with partners may be able to reduce the SME's level of investment and risk, by temporarily accessing the required services, skills, equipment and technology, rather than taking on their outright or permanent cost.

Case study: The Ripper Group International

The Ripper Group International is a global leader in using AI-enabled, drone-deployed solutions. The company was established in 2015 through a partnership with Westpac to develop search and rescue services in Australia using drones to address the significant challenges in patrolling Australia's extensive 36,000 km coastline and providing time-critical search and rescue. Little Ripper drones are currently operating at 11 NSW beaches, nine with surveillance and two with rescue capability.

The Ripper Group established a research partnership with the **UTS Centre for Artificial Intelligence (CAI)** because of their strong research background in AI-based coastal management

applications. This includes an AI-system that detects a variety of marine threats, such as sharks with high accuracy, in real-time. The solution provides lifeguard performance using human-robot technology, to detect threats, raise alarms and provide time critical first response to save lives. The technology has won multiple national and international awards.

Most recently, the Ripper Alliance was formed in the wake of Australia's devastating bushfires of 2019-20 to use drone technology to bring cost-effective, innovative and hi-tech solutions to disaster and recovery. The Alliance brings academics, researchers and scientists together with experts in search and rescue, drone operations and data analytics to bushfire recovery assistance that helps develop effective front-line initiatives and reduces risk to life.

There is a strong return on investment

Formal collaborations between Australian businesses and universities generate \$10.6 billion a year in revenue directly for the businesses that partner with universities.⁹

For every \$1 invested in collaborative university research in Australia, there is a strong direct return on investment to companies of \$4.50, according to Universities Australia.¹⁰ This does not, of course, mean that research is a one-way bet, and the distribution of returns is likely to be broad.¹¹

In addition, a company's reputation for innovation, attractiveness as an employer, and the level of positive attitude that consumers had about the company have been shown to be positively impacted just by the awareness that a company has partnered with a university.¹²

“
If I can see that there's
a benefit for me and I can
fit it in with my other primary
duties, then I will definitely
like to take advantage of it.”

SME based in regional NSW

⁹ Mazzucato reports that the evidence that R&D leads to business growth is weak: other things have to be in place as well (Mazzucato, M., *The Entrepreneurial State*, Magdalen House, London, 2011).

Increased business growth and productivity

Innovation-active businesses are consistently more likely to increase employment, productivity and sales, compared to businesses that do not innovate. For businesses that collaborate on innovation, these benefits are even more pronounced compared to those businesses that do not collaborate.¹³ Innovation-active businesses collaborating with any Australian organisation report a ten per cent increase in sales and productivity and a 6.7 per cent increase in employment.¹⁴



Triple

likelihood of productivity growth with research collaborations



The Australian Chief Economist reports that research-business collaboration can more than triple the likelihood of a business achieving annual productivity growth.¹⁵

A study by the Reserve Bank of Australia also found that the benefits of innovation are compounded when collaboration occurs. The performance of 7,000 Australian SMEs was examined over a five-year period. Companies that introduced innovations had an annual productivity increase of 2.7 per cent over their non-innovating competitors the following year. However, the firms that did so as part of a collaboration raised their productivity by 4.4 per cent a year.¹⁶

Similarly, collaborating businesses are 242 per cent more likely to increase productivity and 70 per cent more likely to develop new-to-world products.¹⁷

A Danish study examined 6,000 formal collaborations between the University of Copenhagen and private businesses from 1998 to 2009.¹⁸ The types of collaboration included in the study were:

- Companies' purchase of R&D from universities,
- R&D projects co-financed entirely by business and the university,
- R&D projects co-funded by public programs, and
- Joint scientific publications and patenting.

Analysis showed that the productivity of businesses that had engaged in at least one of these collaborative practices grew twice as fast over subsequent years than the productivity of businesses in a control group. In fact, six years after collaborating, businesses received a productivity premium of nearly 16 per cent on average relative to the control group. The study demonstrates the significant payoffs businesses receive when they collaborate with universities.¹⁹

Studies observe that there is often a time lag between business-research collaboration and productivity improvements, suggesting that the full effect of productivity occurs 4 years after the research collaboration.²⁰

Benefits to the economy

The NSW Economic Blueprint helps chart a course for future prosperity, however the current COVID-19 pandemic is adding to economic challenges.²¹

Taking better advantage of our many research and business strengths will help drive our economy to produce higher-value products and services.

Collaboration benefits not only the partners involved, it also supports economic growth and employment.

Around 16,000 Australian businesses have formal partnerships with a university. This equates to an average 410 industry partnerships at each of the country's 39 universities.²² This does not include the significant number of informal relationships between universities and industry.



16,000
Australian businesses have **partnerships** with a university

These formal collaborations are estimated to contribute \$19.4 billion a year to Australia's income and have created an extra 30,000 full-time Australian jobs, in addition to the 120,000 jobs directly supported by the university sector.²³

A 50 per cent increase in the number of these formal collaborations would see the value of these collaborations be worth close to \$30 billion a year. This significant increase would be needed to lift Australia's rate of business-university collaboration to that of innovation leaders such as Israel and the United States.²⁴

Collaboration enables research commercialisation

Collaborative research is an increasingly recognised way to transfer knowledge and commercialise research. Australia's difficulty in commercialising publicly funded research may in part be due to the low level of collaboration.²⁵

For universities and research organisations, collaboration greatly assists the commercialisation of their intellectual capital. Good collaboration showcases the impact of its research, builds its reputation and provides academics and students with vital industry and commercialisation experience.

Universities and research organisations also benefit financially through industry-funded projects or royalties from patents or IP licensing and from providing a way to keep their highly skilled researchers local.

It also connects higher education and researchers with industry and entrepreneurs to apply new technology and use integrated learning experiences. These interactions help provide opportunities to solve industry and global challenges, and to apply research for positive economic, environmental and social impacts.

Collaboration differs across sectors

Different sectors may interact with research organisations in different ways due to their differing processes and business models. For example, manufacturers may require access to physical infrastructure to enable prototyping, where a service business may focus more on process innovation.

For some service and primary industry sectors, where output is more homogenous, research and collaboration efforts can benefit the whole sector, not just one business. Service sector research collaborations generally produce digital products which are not constrained by geography.²⁶

Primary industry research collaboration, on the other hand, is usually specific to agricultural commodities and generally managed by a Rural Research and Development Corporation (RDC) on behalf of its members.

Manufacturing typically requires specialist research expertise, aspects of which can be commercially sensitive and can limit broader collaboration. While the greater demand for customisation means collaboration often requires physical infrastructure for prototyping to produce a physical product.



Types of business-research collaboration

Collaboration consists of formal and informal arrangements between higher education institutions, research organisations and businesses. Partnerships can range in complexity, and not all collaborations require R&D—a business might approach a research organisation to help identify ways to streamline their processes or develop software to increase productivity.

In essence, collaborations provide exchange of knowledge and technology that may foster innovation and improve business performance. Examples include contract research, internships, PhD sponsorships, collaborative grants and projects, training, independent testing and validation, industry prototyping and licensing arrangements that provide access to university created IP (Table 1).

Collaborations also vary greatly in their levels of investment and risk. Some collaborations require low levels of engagement, such as R&D contracts or the placement of a researcher in a business. At the other end of the spectrum, a collaboration might involve a consortium with several partners working on R&D in cutting-edge technologies with a high level of investment and complexity.

While the gamut of partnerships varies incredibly, businesses recognise the value that these collaborations provide. A 2017 study found 99 per cent of Australian businesses that collaborated with a university planned to maintain or increase their cooperation with universities.²⁷



99%






of Australian businesses planned to **maintain or increase** their cooperation with universities.

“

Industry collaborate with universities to get access to a skillset that they may not need long term in their business. ”

NSW Innovation Connections government facilitator

TABLE 1: TYPES OF COLLABORATION BETWEEN BUSINESS AND RESEARCH ORGANISATIONS

 <p>Internships</p>	<p>Internships enable businesses to attract new talent to work on graduate-level tasks and undertake collaborative activities.</p>
 <p>Contract research</p>	<p>Designed to solve specific industry problems, long-term global challenges or to find emerging opportunities. A fee-for-service activity is often delivered over one to three years to align with PhD requirements. It often includes access to government grants and R&D tax incentives to help de-risk the investment.</p> <p>For example, the University of Technology Sydney's IPD-R program breaks down an SME problem into a series of low-level (student centred, immediate outcomes) and high-level (complex, longer term, underpinned by academic rigour) projects for collaboration.</p> <p>The Interface program in Scotland is an international example that successfully promotes business/academic collaboration by translating what a company needs into manageable projects for universities and research institutions. This covers knowledge exchange, business and product development, process or service improvement, and analysis and testing by matching businesses to research bodies and providing funding through innovation vouchers.</p>
 <p>PhD sponsored research collaboration</p>	<p>Designed to solve medium-term business challenges, it enables SMEs to conduct high-risk research in a low-risk environment and usually involves a business sponsoring a research project.</p> <p>An example is the University of Sydney's PhD scholarship programs that include work in technology start-ups, Cicada Innovations and the NSW Industry and Community Engagement Seed Fund. These allow researchers to partner with industry on projects ranging from 3D printing of the human heart and developing new drugs for osteoarthritis to creating affordable energy solutions for low-income households.</p>
 <p>Research secondments</p>	<p>Involves academic secondment within a business to work on a specific project. This enables academics to work with industry to gain commercial experience, which assists in knowledge transfer and building long-term research partnerships.</p> <p>The Australian Government's Innovation Connections program is an example of successfully placing researchers with SMEs. One part of this initiative is a free session to research an SME that identifies its strategic priorities then pairs it with the most relevant research institution through a matched \$50,000 grant.</p>
 <p>Training</p>	<p>Involves technical training by university researchers tailored to an SME's specifications or can be of a more general nature. Training may support the skill updates or provide insights into more cutting-edge technology.</p> <p>The Lancaster University/Entrepreneurs in Residence Program in the UK is globally recognised for creating a local innovation ecosystem of continuous knowledge transfer between universities, next-generation business leaders and the established business community. Similarly, universities in Israel and the USA have developed a range of programs to teach university staff how to make their research ideas a reality through commercialisation training courses, mentoring, and recognition.</p>

 <p>Research organisation created IP</p>	<p>Business-research collaboration is common when commercialising research innovations for a global market (e.g. Cochlear), yet it often takes significant R&D and commercialisation management experience to convert a scientifically validated proof of concept into a commercial product or service.</p> <p>Many research translations fail between Technology Readiness Levels (TRL) 4–7, which is known as the valley of death because they need significant investment to commercialise and scale production.ⁱⁱⁱ</p>
 <p>Proof of concept validation/ use of facilities</p>	<p>Businesses also collaborate with research organisations to develop proofs of concepts or to use specialised equipment to test new products, services and methods. This can lead to higher levels of venture capital investment as the products have been accepted following a globally recognised research validation process. For example, the Biologics Innovation Facility at UTS that was established through a partnership with GE Healthcare with funding from NSW Government to deliver a series of clean rooms and containment laboratories for single use, small batch production and testing for the biotech and pharmaceutical sector.</p>



Research collaboration between Baraja and CSIRO Lindfield Collaboration Hub

Deep-tech business Baraja has designed and built a light detection and ranging (LiDAR) technology—the eyes for driverless vehicles—at CSIRO's Lindfield Collaboration Hub, crediting some of its success to the world-class facilities and expertise they had access to.

The **Lindfield Collaboration Hub** provides collaborative workspaces, access to high-tech equipment, manufacturing workshops, and researchers for start-ups and SMEs to develop unique, high-tech products and devices. Baraja is now valued at \$145 million, has grown from two to 120 employees, and is expanding into China and the USA.



ⁱⁱⁱ https://en.wikipedia.org/wiki/Technology_readiness_level

Current context



03.

New South Wales has a significant SME sector

The vast majority of individual businesses in New South Wales are SMEs²⁸, with around two out of three employees in New South Wales working for an SME.

The sector is diverse and dynamic, ranging from sole traders and microbusinesses, through to startups and medium-sized businesses that are scaling up.

The Australian Bureau of Statistics defines an SME as a business that employs up to 200 full-time equivalent staff.²⁹

Small- and medium-sized businesses include tradespeople, accounting firms, high-tech start-ups, shops, medical practices, farms, small hotels, and IT companies—to name just a few.



2 out of 3
NSW employees work for SMEs

30%
of SMEs are based in regional NSW



New South Wales has world-leading researchers and institutions

New South Wales is well placed to harness our world-leading research institutions to solve complex problems and contribute to the wellbeing of future generations.

Several of the world's top-ranked research universities are in New South Wales.³⁰

Almost 90 per cent of Australian research is rated at or above world standard.³¹ For example, the State is a world-leader in over 50 specialised growth areas within robotics, smart sensing, materials science, data science, artificial intelligence, water supply, and engineering. Additionally, many researchers are globally recognised as being among the top ten in their respective fields.

Australia's research strengths are reflected in its high ranking in the WIPO's Global Innovation Index for inputs.³² The inputs take into account all innovation enablers such as institutions, human capital and research, infrastructure, market sophistication and business, based on a highly educated workforce and world-leading research organisations.

90%
Australian research rated at or above world standard



Translating research into commercial outcomes is weak

Australia under performs when turning research capabilities into commercial outcomes, ranking 31st out of 129 countries in innovation outputs in the Global Innovation Index 2018. Australia is ranked 88th for knowledge diffusion. This often means that great research and technology is underutilised or leaves the country and is commercialised overseas and sold back to Australia as a higher-value product.³³

Harvard University's international rankings of economic complexity confirm Australia's lack of research conversion. Australia has fallen from 57th in 1995 to 93rd in 2017 out of 133 countries.³⁴ This is lower than expected given its income level, placing it behind many developing countries. High rankings in this index tend to predict future economic growth.³⁵ Australia also ranked only 76th on the WIPO's Global Innovation Index in 2018.^{iv}

The Australian Research Council's (ARC) Engagement and Impact (EI) assessment, conducted for the first time in 2018, provides some more positive information.

The EI assessment aims to provide clarity on how investments in university research translate into tangible benefits. Overall, 85 per cent of the fields of research assessed were rated at medium or high for engagement, 88 per cent were rated as high or medium for impact, and 76 per cent for approach to impact.^v

Australia and New South Wales can achieve greater economic benefits from businesses harnessing research to solve industry problems.

For example, Australia is a top OECD producer of high-value Artificial Intelligence (AI) research³⁶ (estimated to be a US\$15.7 trillion economy by 2030³⁷), with most of the critical research talent located in New South Wales. Despite this, Australia does not yet have a mature AI industry.³⁸

^{iv} World Intellectual Property Organization, Cornell University, INSEAD, Global Innovation Index. This is based on the "innovation efficiency ratio", the ratio of the output and input indices, which was not included in the 2019 report because it is statistically unreliable.

^v This is based on a subjective panel assessment. Research engagement is the interaction between researchers and research end-users outside of academia, for the mutually beneficial transfer of knowledge, technologies, methods or resources. Research impact is the contribution that research makes to the economy, society, environment or culture, beyond the contribution to academic research. Approach to impact relates to the mechanisms and strategies the institution had in place to support translating the associated research into the impact described in the study.

Our rates of collaboration are low compared to other countries

Across a range of collaboration metrics, Australia typically sits in the bottom half of the OECD.³⁹

Australia is ranked 34th for multi-stakeholder collaboration in the World Economic Forum's Global Competitiveness Report 2019, despite having an overall ranking of 16th.⁴⁰

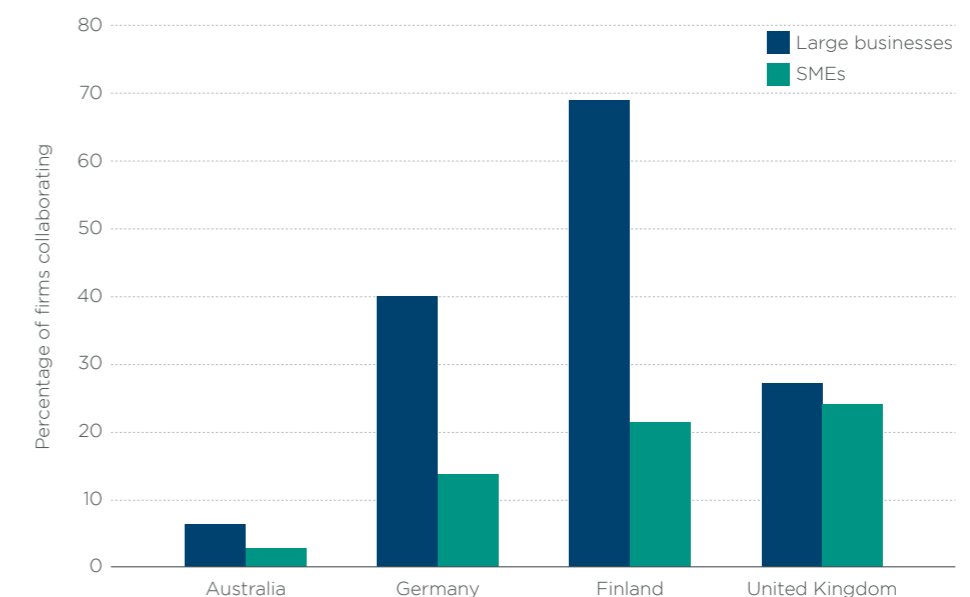
Australia needs a fourfold increase in industry research collaboration with SMEs and a fivefold increase with larger firms to meet the average collaboration rates for OECD countries.⁴¹ While to achieve collaboration rates of the top five OECD countries, Australia needs at least an eightfold increase in business-research collaboration rates.⁴²

In 2012-14 (latest internationally comparable data), Australia ranked last of 29 OECD countries for the proportion of SMEs collaborating with universities or other non-commercial research organisations. Only an estimated 3 per cent of innovation-active SMEs collaborate on joint R&D projects with research organisations. Large firms performed only slightly better, with an estimated 6 per cent collaborating on joint R&D with researchers, ranking Australia 27th out of 29 OECD countries.^{43, 44}

By comparison, collaboration rates for the UK, Germany and Finland are between 27 to 69 per cent for large businesses and 14 to 24 per cent for SMEs (Figure 1).⁴⁵

Universities are committing more to collaboration and are starting to include commitments to collaboration in their strategic plans, which is influencing Australian Government funding decisions.^{vi}

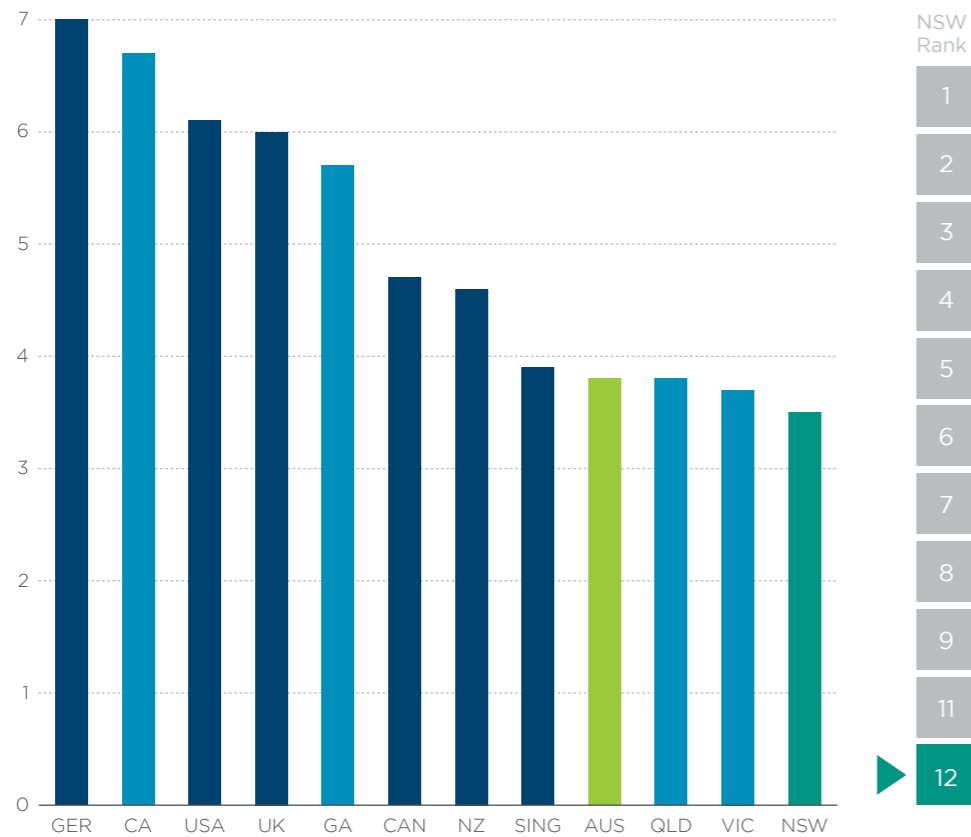
FIGURE 1: BUSINESSES COLLABORATING ON INNOVATION WITH HIGHER EDUCATION OR RESEARCH INSTITUTIONS, BY SIZE, 2012-14



Source: OECD, "Businesses collaborating on innovation with higher education or research institutions, by size, 2012-14: As a percentage of product and/or process-innovating businesses in each size category", in *Research excellence and collaboration*, OECD Publishing, Paris, 2017.

^{vi} For example, UTS's 3-year strategic plan includes: people management processes recognising and rewarding external collaboration; implementing a network of partnership managers to assist in significant external collaborations; and better understanding any barriers impeding external connections.

FIGURE 2: UNIVERSITY-INDUSTRY COLLABORATION SCORE BY CWTS LEIDEN RANKING 2018



Source: NSW Innovation and Productivity Council, Innovation and Productivity Scorecard 2019, New South Wales Government, Sydney, 2019.

Using the university-collaboration score by the Netherland's Leiden University, New South Wales compares poorly with the other comparable jurisdictions covered in the 2019 NSW Innovation and Productivity Scorecard.⁴⁶

The Scorecard provides a snapshot of the State's innovation and productivity performance in comparison to other selected states and international economies.

This graph compares New South Wales with that of Germany, the US State of California, the USA, UK, the US State of Georgia, Canada, New Zealand, Singapore, Australia, and the Australian states of Queensland and Victoria.

All jurisdictions outperform NSW for university and industry collaboration, although NSW's performance is comparable to other Australian benchmarks. This metric is measured by the Netherland's Leiden University by looking at the number and proportion of a university's publications that have been co-authored with private sector for profit enterprises.

Collaborating SMEs tend to be in research-intensive industries

SMEs looking to collaborate with research organisations tend to reside in research-intensive industries such as biotechnology, advanced manufacturing or technology with higher levels of patenting activity.⁴⁷ Nationally, R&D collaboration is highest in the mining sector, followed by professional, scientific and technical services, utilities and manufacturing.⁴⁸

The percentage of businesses engaged in collaboration decreases by size, with medium-sized businesses having higher rates than small businesses.⁴⁹ SMEs in medtech collaborate more frequently than other sectors.⁵⁰

The sector is supported by the NSW Medical Devices Fund.

Collaboration on innovation is associated with higher productivity growth.⁵¹

Effective collaboration involving SMEs often occurs in an emerging business area, where universities have research expertise that can solve challenges and create new-to-world solutions.



Why is there a lack of collaboration?

04.

The IPC conducted in-depth interviews with a sample of NSW SMEs (including those that have partnered with universities and those that have not), expert facilitators, university research managers and research staff to identify factors hindering collaboration across regional and metro New South Wales.

In addition, the report was informed by foundational research by UTS and insights from The Strategy Group's in-depth interviews with stakeholders.

This work identified a range of challenges to collaboration and confirms that SMEs and research organisations have very different priorities, ways of working and timeframes.^{52,53,54,55}

Five key pain points were identified and are described in this section and summarised on the SME-research R&D collaboration map (Appendix 1).

Collaboration is only relevant for some SMEs

There is a huge variety of SMEs. They include tradespeople, accounting firms, shops, high-tech start-ups, farms, consultancies, medical practices, hotels, and IT businesses. While SMEs comprise 99 per cent of all businesses in New South Wales,^{vii} their share of employment is about 67 per cent. About 45 per cent of SMEs nationally stated they are actively innovating. SMEs who are less likely to seek out collaborative research partnerships tend to have fewer collaborative networks, may be isolated regionally, or have limited international exposure.

Given these characteristics, only a small proportion of SMEs are likely to benefit from R&D collaboration. This includes those trying to grow their business and those operating in a dynamic market characterised by technology change or other competitive forces. The challenge, therefore, is to identify the barriers to greater collaboration among these SMEs and consider the scope for cost-effective policy interventions to help lower these barriers.

^{vii} The data in this section are from Australian Bureau of Statistics 2019, 8165.0 Counts of Australian Businesses, including Entries and Exits, Jun 2014 to Jun 2018, Australian Bureau of Statistics 2018, Innovation in Australian Business data, Reference period 2016-17 <https://www.abs.gov.au/statistics/industry/technology-and-innovation/innovation-australian-business/latest-release#data-download> and NSW Innovation and Productivity Council, Business Size Report, June 2019.



Barriers for innovating SMEs

Barriers for innovating SMEs can be grouped into five categories (with some overlap):

- 1. Differing objectives, priorities, and cultures**—there are challenges forging mutually beneficial collaborations given the objectives of research organisations and an SME may not align.
- 2. Technical and institutional challenges**—issues to overcome include management of intellectual property, knowledge transfer, and accommodating the SME imperative for nimbleness and flexibility against institutional bureaucracy.
- 3. Limited connections and networks**—SMEs and universities operate in very different environments.
- 4. External factors**—external factors can influence decision making and prioritisation, such as the types of performance criteria faced by researchers.
- 5. Economics and transaction costs**—most SMEs face significant financial and resource constraints.



You have to have a very clear brief and a complete understanding from both parties.



Manufacturing SME, metropolitan based

Barrier 1

Differing objectives, priorities, and cultures

Research organisations primarily focus on creating new knowledge using advanced problem-solving skills. The time horizon for research can often be long and success is delivered and measured through the publication of research papers in high-quality journals. These affect global university rankings^{viii} that in turn attract top scholars and international students.

The dominant cultural norm for university academics in Australia historically has been to ‘publish or perish’.⁵⁶ Many research organisations are also in the education business, as teachers and as developers of human capital including research skills.

In the short term, SMEs have to make enough money to stay in business and are generally focused on meeting business deadlines that typically operate over a much faster timeline than the ones used by research organisations.

Smaller SMEs tend to be particularly resource and time-poor and the time required to apply for grants, to train students and to align thinking and goals are all relevant factors, particularly when there is no guarantee of the outcomes delivered.⁵⁷

Many researchers have a limited understanding of the challenges SMEs face in staying commercially viable, as they lack business experience or entrepreneurial skills. In addition researchers may believe that the challenges SMEs face are not complex enough to produce new research that contributes to their individual researcher rankings, making SME collaborations less valuable to researcher academic careers and reputations.

There is anecdotal evidence that academics are already overworked,^{ix} limiting their capacity to collaborate, and while this is changing, there is an overall perception that research organisations do not see commercialisation of their research as a key to success.

SMEs may desire a fairly immediate business benefit such as more sales or productivity to justify investing in research. They may perceive researchers as lacking commercial drive or the skills required to deliver project milestones on time. SMEs may also feel the consequences of failure more than the research organisation.

Many SMEs do not consider research collaboration because they believe the academic focus is on early stage research, which may not be relevant to the SMEs-needs.⁵⁸

Appointing graduates and interns is a growing trend, but time-poor SMEs remain sceptical about the value of such initiatives.⁵⁹ They may also be unsure about how to engage a research organisation, how they can use it to solve their problems,⁶⁰ and question their academic mindset or commercial drive. For these reasons, SMEs do not necessarily see the value of partnering with researchers.

Barrier 2

Technical and institutional challenges

Universities may be protective of their IP, which may be a barrier to contracting.⁶¹ On the other hand, an SME may be concerned about the commercial value of IP as opposed to a university’s desire to publish research.⁶² Achieving satisfactory risk allocation between such different partners may be challenging, especially if the objectives are not in perfect alignment.



Whoever you’re cooperating with, talk to them upfront and define, in writing, the IP rights and any of the money that flows from exercising those rights.

High-tech SME based in Sydney

University administrative processes can be bureaucratic and complex.⁶³ In addition, the incentives to work with industry partners can differ between a university administrator and an individual researcher, particularly when commercialisation is involved. There will be numerous issues for each party to negotiate, including who pays for initial IP protection, legal and financial advice, and then later on, agreements for sharing of revenue generated including royalties from IP licensing and equity in spin-off companies.

There may be implications for a researcher’s employment at the university, or tax implications. Universities need to demonstrate a commitment to commercialisation in policies and practice, by providing researchers with sufficient incentives and adequate finance and human resources support in order to encourage commercialisation.⁶⁴

^{viii} For example, the QS World University Rankings include a 40% weight on academic reputation, and a 20% weight on citations per faculty. The Times Higher Education World University Rankings place a 24% weight on academic reputation and research productivity, and 30% on citations.

^{ix} See for example <https://www.insidehighered.com/advice/2014/12/01/essay-why-academics-feel-overworked>, and <https://newmatilda.com/2014/08/28/ecrs-guide-escaping-sessional-trap/>

From an SME's perspective, there is no single access point, customer service is limited, and SMEs noted that the quality of follow-through varies.⁶⁵ Additionally, IPC research found the complex language used in research contracts can be a barrier for SMEs, as can the structure of grants, which may focus more on research outcomes than commercial success.

SMEs may also have difficulty in navigating a variety of platforms and processes, while jargon such as 'innovation ecosystem', 'accelerator', and 'incubator' acting as a deterrent as they don't resonate with their business needs. Innovation means different things to different people and, as such, can cause misunderstanding. For example, mature businesses can find the terms used when discussing innovation confusing and more relevant for the start-up sector.

Barrier 3 Limited connections and networks

From the SME's perspective, the user experience is complicated, consisting of a maze of people, various platforms, information and processes, and it's challenging to know whom to talk to about engaging a research organisation, let alone how to identify the right person to work with.

The IPC's research shows a strong correlation between an SME's external networks and levels of collaboration. Many businesses have limited exposure to research organisations and are not aware of the potential business value of R&D.

At the same time, researchers may not have any connections to SMEs, some of whom may feel intimidated when engaging with researchers. For many SMEs, a lack of awareness of the opportunities available is a significant barrier to collaboration, as is finding partners with the right skills and mindsets.

Where there has been a successful collaborative arrangement, it has often been through personal relationships between the SME and the research team. Collaboration is commonly fuelled by 'who you know' or 'who you may just bump into' within your personal or professional network.

Many collaborations start with being part of the 'right' network, and SMEs who are 'connected' have easier access to programs, skills and pathways than those without networks. Similarly, researchers tend to use their professional networks with businesses to engage in collaboration.

While some SMEs have good local and international networks with government, researchers and supply chains, some don't feel that their network enables effective research collaboration. This is amplified in regional areas where SMEs have limited opportunities to engage with research organisations or find the right research partner.^{66,67}

SMEs that don't have strong personal networks can use a facilitator through the Federal Government's Innovation Connections program or the NSW Government's Boosting Business Innovation program. These facilitators play a critical role in match-making SMEs with the right researcher and sustaining these relationships.

“

You don't really know who to talk to.
So that takes quite a long time. ”

Software startup based in Sydney

“

It would be good to be aware of and across upcoming research or potential ideas for research ... Universities could pitch to a bunch of CEOs. ”

Property development SME based in Sydney

Barriers are greater for regional SMEs

IPC research found that the above-mentioned barriers such as limited awareness, connections, and resource constraints are amplified the further an SME is located from a metropolitan or regional hub. Regional SMEs do not have the same access to the range and variety of support through networks, university partners, skilled resources and business collaborators as those in metro areas.

While regional SMEs do not view communicating digitally as a barrier, they find other regional or metro collaborators are often hesitant to conduct 'online only' interactions.

“

Lack of people, lack of knowledge, and isolation. ”

High-tech SME based in regional NSW

Barrier 4 Complex and time-consuming grants and funding

The university sector has a heavy reliance on public funding, and government priorities have a significant influence on research organisations' priorities.

Grants are important for creating research collaborations, which otherwise may not be financially feasible for an SME, as research organisations have to cost research at its true value. However, administrative processes often preclude SMEs from participating in grants or research contracts because of the time and effort it takes. SMEs typically do not have the in-house expertise to perform this duty.

While funding programs and performance measures do increasingly place value on collaboration (see examples of Australian Government funding criteria below), the IPC's research found that both SMEs and researchers can find the reporting expectations for grants overly time-consuming and restrictive due to tight timelines for submitting reports.



Additionally, audit requirements can be overly burdensome. For example, audits of the Federal Government's Research and Development Tax Incentive is retrospective and, in many cases, commences several years after the activity was undertaken.



Grants can just be too complex and restrictive to use them.



High-Tech SME based in regional NSW

Grants or incentives can sometimes be administered by more than one department, adding further complexity to the process. For example, the Australian Government Department of Industry, Innovation and Science (AusIndustry) and the Australian Taxation Office (ATO) are both responsible for delivery of the Australian Government's Research and Development Tax Incentive. Accessing information about programs can also be difficult, as there is a plethora of information that can appear daunting.

A facilitator who can advise and guide the SME can help, ensuring they feel more in control of the overall grant process.



Australian Government research programs and funding criteria

Externally determined incentives include public funding imperatives, captured in funding criteria for the **Australian Research Council (ARC)** and **National Health and Medical Research Council (NHMRC)**.

The ARC administers the **National Competitive Grants Program (NCGP)**. As well as supporting excellent research, the program assists research training and career development, international collaboration and priority research areas. The program is about more than supporting academic research measured in terms of quality journal articles.

The **ARC's Linkage** funding schemes are designed to facilitate collaboration. Specifically, they aim to encourage and extend cooperative approaches to research and improve the use of research outcomes by strengthening links within Australia's innovation system and with innovation systems internationally.

Linkage promotes national and international research partnerships between researchers and business, industry, community organisations and other publicly funded research agencies. Through these schemes, the ARC helps secure commercial benefits through the transfer of skills, knowledge and ideas.

The most comprehensive performance measures for eligible higher education research institutions are the ARC's **Excellence in Research Australia (ERA)** periodic evaluations, and the **Engagement and Impact (EI) assessments**. These incorporate information beyond the traditional research outputs including patents, external research reports, and commercialisation income. The EI is a companion to the ERA and these ratings are designed to create incentives that improve research quality, engagement and impact.

The ARC's KPIs (outlined in its Corporate Plan) include measures related to collaboration such as the proportion of co-funding from partner organisations, the satisfaction of partner organisations and the completion of the EI assessments.⁶⁸

The Commonwealth also provides **Cooperative Research Centre** projects grants for industry-led collaborations. Project partners must:

- include a research organisation;
- develop a product, service or process that will solve problems for industry and deliver real outcomes;
- benefit SMEs;
- and include education and training activities.

Barrier 5

Economics and transaction costs

Smaller businesses can find research collaboration challenging. They lack the resources of larger businesses and the research is an inherently risky activity, with no guarantee of success and highly uncertain returns.⁶⁹

Smaller businesses also lack the ability to absorb and diversify risk, though some forms of collaboration are less risky than others. There may be circumstances where an SME grouping can support collective collaboration to spread the risk.

The transaction costs of establishing a collaborative relationship can also be relatively high for an SME. However fee-for-service contracts can also be straightforward and low risk, where standard agreements can be used, the work to be undertaken can be clearly defined and the outcomes sought can be measured.



How much is the research going to cost us? Are we going to see a return on our investment? Need to understand how the cost and the time work.

Property development SME based in Sydney

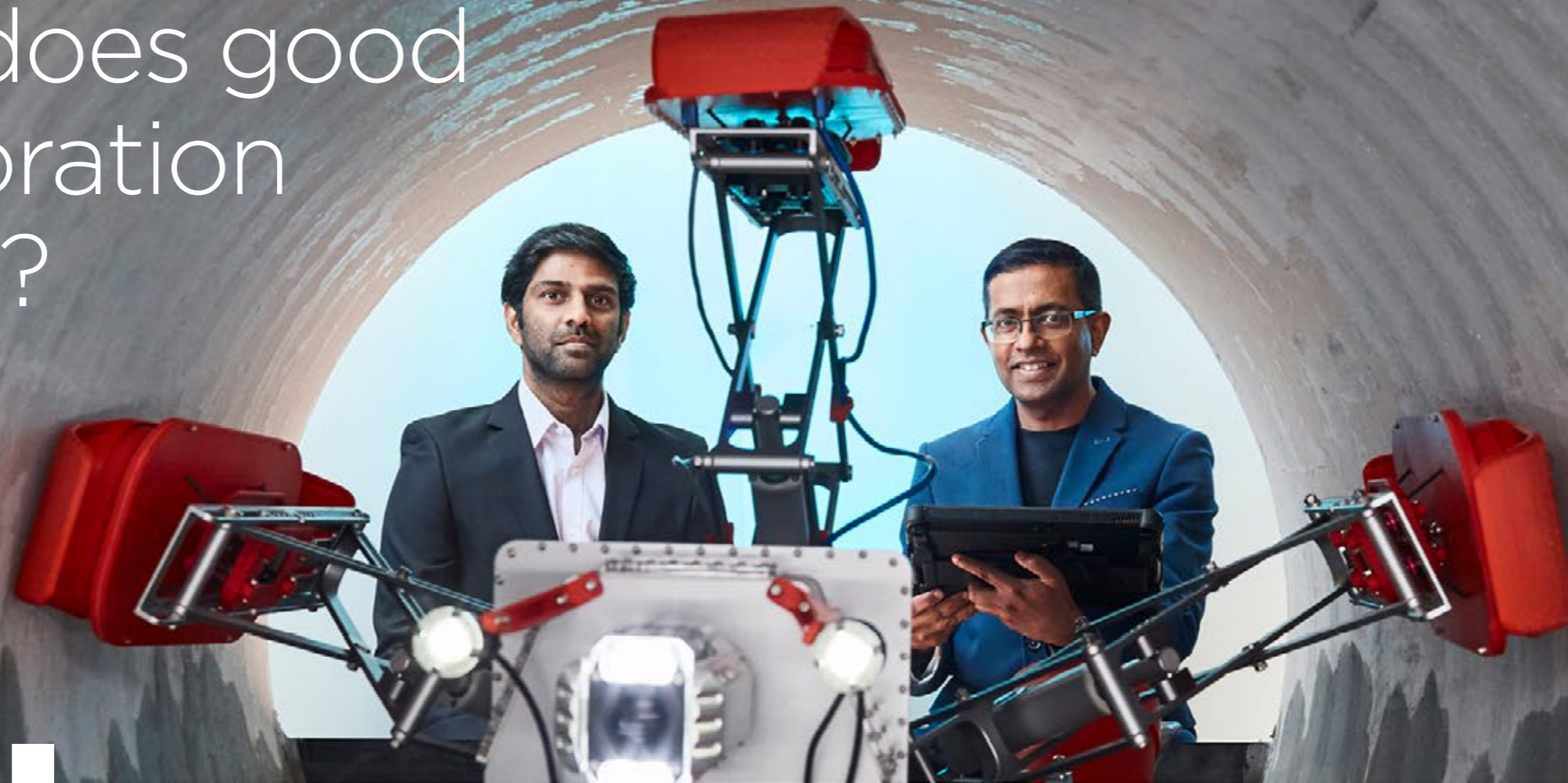


I can't afford \$3,000 on the off chance that a researcher/intern could make my business sky rocket but I just don't know. \$3,000 is nothing to them but a significant amount of money for me and could be a make or break situation.

SME based in Sydney

What does good collaboration require?

05.



The IPC's interviews with SMEs that have developed world-leading products and business outcomes from repeat university collaboration identified several requirements for successful collaboration.

Commitment and bridging cultural differences

For collaboration to be mutually beneficial it requires a commitment from both parties. Leadership can be important for this, along with trusted personal relationships.⁷⁰

Collaboration needs to be driven from the top down to be sustainable. To move beyond just talking, organisations need leaders who are catalysts for change. An effective leader can create and sustain a commitment to collaboration, providing clarity and a willingness to be held accountable.

Establishing good relationships increases the likelihood of success.⁷¹ Trust can enhance the flexibility of collaborators, which is desirable as long as the roles and responsibilities of each party are clear. A higher level of trust also leads to more resource sharing and increases the willingness of parties to participate in joint ventures where the risks may be high. Ultimately, trust comes down to communication and the quality of interpersonal relationships.

Research organisations and SMEs have different cultures, so a mutual understanding is necessary to establish a shared purpose. Many universities now have Business Development Managers, whose role may include helping SMEs to work effectively in an unfamiliar culture, navigate university processes, and translate specialised language, jargon and terminology as necessary.

Other jurisdictions have recognised this challenge. For example, the Catapults (UK) and Fraunhofer Gesellschaft Institutes (Germany) successfully bridge the gap between researchers and businesses by demonstrating the value of R&D, providing independent physical centres to connect researchers and industry, and bringing the key players together to help translate research into new products and services.



Any partnership has challenges—it’s how you work together as a team to solve. Being upfront and addressing issues before they become bigger problems.

High-tech SME based in Sydney



Clarity and incentive alignment

Specialised research and proof of testing facilities

The UNE SMART Region Incubator supports SmartShepherd design, an innovative technology solution enabling livestock breeders to collect pedigree information quickly and cost-effectively. Founder Dave Rubie won the Most Innovative International Farm Tech Start-up Pre-Series A at the World Agritech Conference, San Francisco and was named in the top 200 Westpac Most Outstanding Australian Businesses Take on Tomorrow. The **SMART Region Incubator and UNE SMART Farms** provide a place to road-test technology, enabling entrepreneurs to work with producers and researchers to find solutions for a global marketplace.



Successful collaborations involve good upfront engagement that establishes a shared purpose and manages expectations.⁷² This includes clear timelines, milestones, budgets, and deliverables. Industry stakeholders are more likely to experience better outcomes when expectations are established early. Having a strategic mindset that understands longer-term relationships can also be beneficial.

Research organisations need to align their practices and skill sets to their collaborator’s expectations while both parties need to recognise each other’s drivers and priorities. Tailored resources for SMEs at different stages of business growth or development can help align expectations. MaRS Innovation District in Canada, for example, provides a variety of services based on business needs, including advisory support and connections to talent, access to investors, and connections to partners.

The successful execution of research or other collaboration outcomes are always uncertain, so clarity around risk allocation is highly desirable. This requires some upfront effort to identify the main sources of risk. A good principle is for risks to be allocated to the party best able to manage them, if possible.

Clear university policies regarding Intellectual Property (IP) are invaluable, despite it not playing a big role in a lot of research collaboration. University Technology/Knowledge Transfer Officers (TTOs/KTOs) should be facilitators of information without adding another layer of bureaucracy, while a possible source of tension in a research collaboration involving IP is an SME wanting commercial confidentiality and a researcher wanting to publish.

Capability and capacity

The Sydney Business Chamber identified absorptive capacity—the ability to recognise and apply external knowledge—as a key enabler for successful collaboration, and that this attribute was frequently missing in NSW research-business collaborations.⁷³ SMEs with absorptive capacity are more likely to benefit from collaboration, are better equipped to identify and evaluate experts, assess the costs and benefits of collaboration, and are less restricted by geography.⁷⁴

The Chamber also found that SMEs can have a larger proportion of workers involved in the implementation of business innovation on the ‘shop floor’ than large companies, making workforce development initiatives particularly important.

SMEs that develop problem-solving skills across their workforce are more likely to succeed in developing new products or processes. The longer the term of the research, the more considerable the preparation, monitoring time, and resources required, which often come with a very high opportunity cost to the SME.

A collaboration is more likely to succeed if it facilitates knowledge transfer and supports workforce development. Some forms of collaboration are considered ‘one way’ from the perspective of the university, because they do not receive any input to inform ongoing research. Another potential benefit to the university is feedback into curriculum development.

Physical proximity can also influence collaboration and the quality of the relationship is likely to be better if it involves greater face-to-face interaction.

Research collaboration: Flo Gardens

Northern Rivers business Flo Gardens has invented a self-cleaning and self-sustainable domestic aquaponics system that grows seafood and plants together, using 90 per cent less water than soil gardens through the Enterprise Lab, a start-up hub and co-working space located at Southern Cross University in Lismore. Founders Adam Grabowski and Zerina Millard designed the backyard ecosystem to make food sustainability more accessible for domestic households.

The **Enterprise Lab** is expanding the capacity and capabilities of the Northern Rivers region’s entrepreneurial ecosystem. Since its launch, the Lab has nurtured entrepreneurs by developing entrepreneurial mindsets, capabilities and connections for new and existing businesses.



Recommendations

06.

Doubling our rates of collaboration between SMEs and researchers could see a productivity increase worth up to \$150 million per year for New South Wales.^x

New business innovation is responsible for over 50 per cent of economic growth in OECD countries.

To maintain our prosperity, we need to be able to innovate and develop new, globally competitive products and services. New South Wales has all the right innovation inputs, but our ability to collaborate with research organisations is inhibiting our capacity to successfully translate significant transformative economic and social innovation outcomes.

In New South Wales, collaboration is mainly between large businesses and research institutions. While, many SMEs understand that research and development can help their long-term productivity and prosperity, partnerships between SMEs and research organisations are still very limited and have not yet yielded the types of business outcomes they are undoubtedly capable of. Our low collaboration rates in comparison to countries like the UK, Germany and Finland reflect this.

This lack of collaboration stems from limited knowledge and connections on how to initiate and draw on research expertise or engage with SMEs, differing cultures and timeframes, technical and institutional barriers, external pressures such as 'publish or perish' for researchers and market conditions for SMEs, and financial and resource constraints.

SMEs need to see a commercial proposition, while for universities or publicly funded research organisations, there is a strong incentive to produce outputs that support or improve their reputation. To increase our rates of collaboration requires a combination of awareness, behavioural change, and incentives.

To increase SME-research collaboration, the NSW Innovation and Productivity Council (IPC) recommends seven mutually supporting actions that build on existing programs to capitalise on New South Wales' research strengths. These actions seek to incentivise academics, increase awareness for SMEs and bridge cultural differences (see Figure 3).

Implementation of recommendations will require commitment from both government and industry players. While there is a strong role for both the NSW Government and Australian Government, ultimately it is NSW universities and publicly funded research organisations that must take the lead. There is much that can be done at an organisational level, but even more that can be done as a collective, through bodies such as the NSW Vice Chancellor's Committee.

^x Based on Mark et al., 2014, who estimate a potential uplift in productivity of up to 16 per cent, and Characteristics of Australian Business (ABS 8167.0).

Public funding of research is a response to a market failure. Research generates knowledge, which has public good characteristics relating to excludability and rivalry. There are positive externalities associated with research—that is, it produces benefits for third parties. These characteristics imply that left to the market, there will be insufficient research undertaken.

Another rationale for government intervention comes from the premise that the normal risk/return tradeoff does not apply for innovation because of the extreme uncertainty about outcomes.^{xi} That is, there is a lack of quantifiable knowledge, and the probability of research success is highly uncertain or unknown.

Where practical, the IPC recommends building on existing NSW programs that have delivered successful SME-research collaboration. Programs are significantly more effective when there is a strong commitment from government and funding longevity. The Boosting Business Innovation Program (BBIP) including TechVouchers, and Business Connect program are examples of such programs. These programs all sit under the NSW Government's new Global NSW Strategy, which has a focus on how researchers can work

with SMEs to develop new products and services, how to export and tap into global markets and supply chains, and developing local expertise in future industries, among other areas.

The NSW Medical Devices Fund and Physical Science Fund also appear to provide good funding models, both for the allocation process and governance. As is standard government practice, programs are regularly reviewed to ensure they are effective, adopting any evaluation findings that improve the program's implementation and optimal operation.

Finally, we recognise that the Australian Government controls many of the relevant policy levers, given its dominant funding role, and encourage its active support in transforming research into economic and social outcomes.

This includes valuing collaboration through actively measuring both the quantity and quality of interactions between researchers and businesses, particularly SMEs. While the ARC's Engagement and Impact (EI) assessment provides some information, it does not provide a comprehensive measure of the total collaboration effort, nor does it identify collaboration with SMEs.⁷⁵



Recommendation 1

Develop a *NSW Research Collaboration Pact*

Research organisations are critically important in driving greater business-research collaboration in New South Wales. The IPC recommends developing a *Research Collaboration Pact* to publicly demonstrate the importance of collaboration and knowledge exchange between research organisations and businesses, particularly SMEs, to translate research into economic and social outcomes.

The Pact also supports the CSIRO's SME Collaboration Nation that is designed to provide a coordinated, whole-of-ecosystem approach to increase SME-research collaboration by lowering the barriers to engagement. It aims to double the number of Australian SMEs engaging with publicly-funded R&D by 2025.

The IPC recommends the NSW Vice Chancellors Committee develop and deliver the Pact in consultation with all NSW research organisations. To ensure transparency, the IPC recommends that the Pact partners report annually to the NSW Vice Chancellors Committee and the NSW Office of the Chief Scientist and Engineer on implementation progress.

The Pact should include performance measures at regular intervals that can benchmark performance, identify areas for improvement, and encourage a healthy competitive environment for creating and commercialising research. This, in turn, will help embed collaboration in research organisation practices.

The Pact should outline the principles to embed collaboration within research organisation practices and include three key areas: incentives for researchers to embed collaboration; bridging cultural differences; and improving project delivery and commercial outcomes.

While the Pact is voluntary, it will provide a strong public statement of intention and commitment from signatories that they intend to work together to overcome the barriers to SME-research collaboration and research commercialisation.

Based on international experience and other jurisdictions, the IPC recommends the Pact partners consider the following activities to embed collaboration within their research organisation practices.

The purpose of the Pact is for NSW universities and research organisations to publicly demonstrate the importance of collaboration, research translation and knowledge exchange to support New South Wales' prosperity with a commitment to report on and improve all types of collaboration between SMEs and the research sector.

As a first step, the Pact should include all NSW universities, with the aim to expand it to cover publicly funded research organisations such as CSIRO and ANSTO.




The Pact supports work underway in the NSW Government's Waratah Research Network, improving strategy and collaboration across universities and government.

FIGURE 3: SUMMARY OF RECOMMENDATIONS

Theme	Recommendation
 Incentives for researchers	1 Research Collaboration Pact
	2 Grow researchers' commercialisation and business engagement capacity
 Bridging cultural differences	3 Tools to address organisational differences
	4 Digital platform to facilitate connections
 Improving awareness and incentives for SMEs	5 Financial incentives for SMEs to boost collaboration
	6 SME awareness of research partnership benefits
	7 NSW Innovation Challenge Fund

^{xi} Where risk is too uncertain to be quantifiable, this is known as Knightian uncertainty. See https://en.wikipedia.org/wiki/Knightian_uncertainty.

TABLE 2: KEY AREAS AND SUGGESTED ACTIVITIES

Key areas to embed collaboration into organisation practices	Suggested activities
 Incentives for Researchers	<ul style="list-style-type: none"> • Performance assessment processes for researchers to recognise industry collaboration. • Specialised academic positions for industry engagement. • A commitment to minimise the administrative burden of contracting between researchers and SMEs. • Advocate to the Australian Research Council (ARC) to establish a new category for co-authored industry publications that will recognise collaborative R&D outcomes more explicitly within the ARC's Engagement and Impact Assessment (ERA) framework.
 Bridging Cultural Differences	<ul style="list-style-type: none"> • Build capacity and awareness of research staff on best practice SME and industry engagement (including key commercialisation processes)—see recommendation 2 below. This could include identifying SME and research champions who are already engaged or have benefited from collaborative research to share their experiences to improve awareness and help bridge the cultural differences. • A commitment by research organisations to offer a range of contracting options. • University open days^{xii} for industry and researchers to meet and explore technical challenges. This provides a forum for SMEs to connect with researchers and for academics to connect with prospective business partners.
 Improving Project Delivery and Commercial Outcomes	<ul style="list-style-type: none"> • Universities to establish processes and programs for University Relationship Managers or equivalent to work with less experienced academic research teams or SMEs to bridge the cultural gap (including communication), particularly in the project's development phase. This could include identifying experienced SME and researcher collaborators willing to provide advice and 'mentor' the less experienced research team or SME.



Recommendation 2
Grow researchers' commercialisation and business engagement capacity

Build researchers' business skills and knowledge of the commercialisation process to encourage and equip them to seek out commercialisation of research, where there are clear opportunities to do so.

Increased education on the following issues will better enable researchers to identify commercialisation opportunities:

- key translation gaps around different stages of commercialisation
- how to identify commercial opportunities
- how to undertake patenting
- how to pursue market validation and scaling solutions
- best practices for engagement.

While this recommendation aims to encourage researchers to be proactive in identifying commercialisation opportunities, the IPC does not suggest that it is possible, or appropriate, to do so for all academic research or studies.

The NSW Government's Boosting Business Innovation Program (BBIP) partners include all 11 NSW universities and the CSIRO which deliver a range of new innovation spaces and support for SMEs developing new products and services. These partners have the right knowledge and expertise to deliver the tools and training needed to build researcher's commercialisation and business skills. The IPC recommends the BBIP deliver this recommendation with support from the NSW Vice Chancellors Committee.



Recommendation 3
Develop tools to address organisational differences

The IPC recommends developing tools such as templates, guides and checklists to better manage SME and researcher expectations and set the collaboration up for success.

Improving accessible information for SMEs on issues such as Intellectual Property and contract requirements will help SMEs to be well-informed prior to establishing a partnership with a research organisation. These materials complement one of the key areas of the NSW Research Collaboration Pact to improve project delivery and commercial outcomes by research organisations.

Information could also include case studies of SME champions who have collaborated with researchers to provide SMEs with examples and insights on how others have benefited from a partnership.

The IPC recommends the Boosting Business Innovation Program (BBIP) develop the tools, with the support of the BBIP partners, Research Collaboration Pact partners, and NSW Small Business Commissioner for their dissemination.

^{xii} Some universities are already doing this or similar. For example, the UNSW Knowledge Exchange program engages with government, industry, and the community to enable the translation of UNSW research into real-world outcomes. See <https://www.knowledgeexchange.unsw.edu.au/about-us>.



Recommendation 4

Develop a digital platform to facilitate connections

The IPC recommends establishing a new digital platform to help broker connections between NSW SMEs and research organisations to significantly improve accessibility and awareness of network, services, events and potential collaborators.



It would be useful if there was a website where all the research and opportunities for collaboration was listed because we don't know.

Property development SME based in Sydney

The new platform could build on Data61's Expert Connect^{xiii} platform to deliver a curated NSW match-making service that can be delivered by and integrated into the NSW Government's Boosting Business Innovation Program website.

The platform could link to the newly established Waratah Research Network website providing information on the research areas NSW Government is investing in for SMEs.



Recommendation 5

Provide financial incentives for SMEs to boost collaboration

SMEs need to make significant investments to engage in research collaboration. Financial incentives for SMEs can lower their upfront costs and encourage initial discussions. The IPC recommends using relevant NSW Government programs to help facilitate collaboration where it is beneficial to do so. For example, demonstrating research collaboration as part of a NSW Government program such as Minimum Viable Product (MVP).

Based on stakeholder feedback and international research, the IPC recommends using the existing TechVouchers as part of the broader Boosting Business Innovation Program (BBIP) to deliver a broader range of financial incentives and options than are currently available. Options for consideration are provided in more detail below.

The IPC notes that the BBIP is already providing additional funding to support research translation in the wake of the COVID-19 pandemic. This relates both to the commercialisation of COVID-19 related products, as well as for other products.

Tiered funding model for TechVouchers

The NSW Government currently provides TechVouchers under the BBIP that match funding up to \$15,000 for research and development. TechVouchers help businesses engage with research organisations earlier in their business' life cycle and support the Australian Government's Innovation Connections programme that targets businesses that are more established.^{xiv} To reflect varying business needs and technical complexities of projects, the IPC recommends a tiered funding model to provide a range of funding options.

For example, consideration of multiple and staged funding models where businesses progress to second or third rounds of research-collaboration, building on the successful completion and outcomes from the first TechVoucher. To recognise financial constraints by SMEs commercialising more complex research, separate requirements for second and third round applications, such as different ratios of government-to-applicant funding, and increased funding amounts could be considered.

Consistent with the Australian Government's approach, the IPC recommends considering additional TechVouchers up to a maximum of three within a five-year period to help fund complex research partnerships or collaborations across multiple research organisations.

TechVoucher: BuiltQuik

A TechVoucher grant helped **NSW small family business BuiltQuik** develop a housing frame system which provides safe and affordable housing construction kits that can be assembled in remote communities. A special database to support the BuiltQuik system was developed to identify suppliers, capabilities and materials in remote communities to help build the houses.



TechVoucher: Hone

TechVoucher recipient and **University of Newcastle Integrated Innovation Network Resident, Hone** developed a handheld light device which helps farmers test the chemical properties of soil, crops and grain samples, revolutionising what has been a slow and arduous process. The company was awarded an Accelerating Commercialisation grant from AusIndustry and is one of the five recipients of the \$5 million 2019 NSW Chief Scientist and Engineer's Physical Sciences Fund.



^{xiii} Expert Connect is a publicly searchable database of Australia's research expertise. Profiles for over 60,000 researchers spanning more than 200 research organisations are automatically created by drawing on data from ORCID, CSIRO, Web of Science, The Australian Research Council, The National Health and Medical Research Council, IP Australia and The Conversation.

^{xiv} Innovation Connections is part of the Entrepreneurs' Programme offered by the Australian Government. It provides eligible businesses access to expert advice, and financial support through grants and incentives. Eligible SMEs must have an annual turnover or operating expenditure between \$1.5m and \$100m (or a minimum turnover of \$750,000 in remote regions), have traded for at least three years and be financially solvent, and operate in one of the five growth sectors covered by the Australian Government's Growth Sectors (Advanced Manufacturing; Food and Agribusiness; Medical Technologies and Pharmaceuticals; Mining Equipment, Technology and Services; Oil, Gas, and Energy Resources; or provide enabling technologies and services (e.g. ICT) to a business working in one of the growth sectors).



TechVouchers for internships to boost regional engagement

Barriers to collaboration tend to be amplified in regional areas. This is reflected in the lower collaboration rates of SMEs based in regional New South Wales compared to metropolitan areas. To help address this, the IPC recommends the use of TechVouchers to provide financial incentives for regional student internships, such as a one-year Honours project or a third-year undergraduate project to work on a clearly defined project. This would allow regional SMEs to engage with universities on industry-focused research and offer students potential employment opportunities post-study in regional areas.

Support for an internship would be additional to the standard TechVoucher. BBIP could consider expanding the eligibility criteria to allow SMEs to use TechVouchers to employ a student on a specific research project and increase the funding available to cover the employment costs and research support from the university, similar to the Australian Government's Innovation Connections Graduate Placement grant. The Graduate Placement enables SMEs to employ a graduate or postgraduate into their business to undertake a research project for six to 12 months (up to a maximum of \$30,000). The proposed changes to the TechVoucher eligibility must complement the Australian Government's Graduate Placement initiative, not duplicate it.

Program design and implementation needs to consider risk management issues, including management and oversight of the arrangement by the research organisation to ensure the SME receives high quality research and advice, backed up by a service guarantee and/or quality assurance measures.

Recommendation 6 Build SME awareness of research partnership benefits

Many NSW SMEs lack awareness about how research partnerships can provide value to their business, including how research organisations can provide advice or support to improve their products and services.

Services may also include use of cutting-edge university facilities that SMEs may not otherwise have access to. For example, medical or scientific equipment and testing facilities that are too costly to acquire in-house for proof-of-concept or product validation and testing.

The IPC recommends utilising Business Connect, as part of Global NSW to help improve SME awareness of how researchers can help their business to innovate and grow. Business Connect is a dedicated and personalised NSW Government program that provides trusted advice to help start or grow a business through independent, accredited Business Connect advisors.

NSW Government can upskill Business Connect advisors, including through showcasing examples of successful collaboration, so they can provide SMEs with examples of how businesses have partnered with researchers to develop, sell and scale to position themselves into new and emerging areas.

Business Connect advisors can utilise the proposed digital platform (Recommendation 4) to help match business customers with the right research organisation, as well as inform SMEs of upcoming events and opportunities to connect with other SMEs or researchers, particularly SMEs experienced in research collaborations that are willing to support or mentor new SMEs.

The NSW Research Collaboration Pact, Boosting Business Innovation Program, and industry sector and lighthouse precinct strategies can also be utilised to promote the value of research partnerships.



Recommendation 7 Establish a NSW Innovation Challenge Fund

Mission-based research, where governments focus resources on solving important problems have led to outcomes that have, in some cases, transformed our lives. The invention of the internet, for example, was funded by the US Department of Defence. CSIRO's proposed 12 missions to solve big problems facing Australia,^{xv} are an example of directing research to tackle the most significant societal, environmental or industrial challenges of the time.

The IPC recommends a NSW Innovation Challenges Fund to help focus research on government priorities that will have the greatest societal benefits, such as delivering future growth industries and lighthouse precincts under Global NSW. To support development of supply-chain R&D relationships, the IPC recommends the Fund as a minimum require one research organisation and one innovative business.

The NSW Government's \$3 million Innovation Districts R&D Challenge to accelerate products to market that address the impact of COVID-19 is an example that the NSW Innovation Challenge Fund could be based on. Administered by NSW Treasury as part of the Boosting Business Innovation Program, it is designed to reflect the State's innovation diversity with a focus on building collaboration and connections.

TechVoucher: Archer Exploration

Sydney-based Archer Exploration, through a TechVoucher is making the world's first carbon-based quantum computing chip in partnership with the **University of Sydney's Nanoscience Hub**. Archer's development paves the way for widespread consumer use and ownership of quantum computing technology which will impact industries using high computing power such as financial services and cyber security.



^{xv} <https://www.nationaltribune.com.au/csiro-sets-sights-on-new-team-australia-missions-program/>

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The IPC commissioned the University of Technology Sydney (UTS) to undertake peer reviewed research to identify barriers to NSW university-SME collaboration and initiatives that have succeeded in other jurisdictions, and which could help address challenges in New South Wales. Special thanks are due to Associate Professor Renu Agarwal, Dr Katrina Skellern and Dr Paul Brown.

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An IPC subcommittee oversaw this project, with support from a NSW agencies advisory group.

IPC Subcommittee:

- **Mr Neville Stevens**,
AO, Chair of the IPC
- **Prof. Attila Brungs**,
Vice-Chancellor of UTS and IPC Member
- **Dr Rosalind Dubs**,
IPC Member
- **Professor Paul Wellings**,
Vice-Chancellor of University of Wollongong and IPC Member
- **Professor Hugh Durrant-Whyte**,
NSW Chief Scientist and Engineer and IPC Member
- **Professor Brian Boyle**,
Deputy Vice-Chancellor (Enterprise),
University of NSW
- **Katie Richmond**,
External Engagement Manager,
The University of Sydney
- **Helen Palmer**,
Associate Director, Business Innovation
and Ecosystems, NSW Treasury

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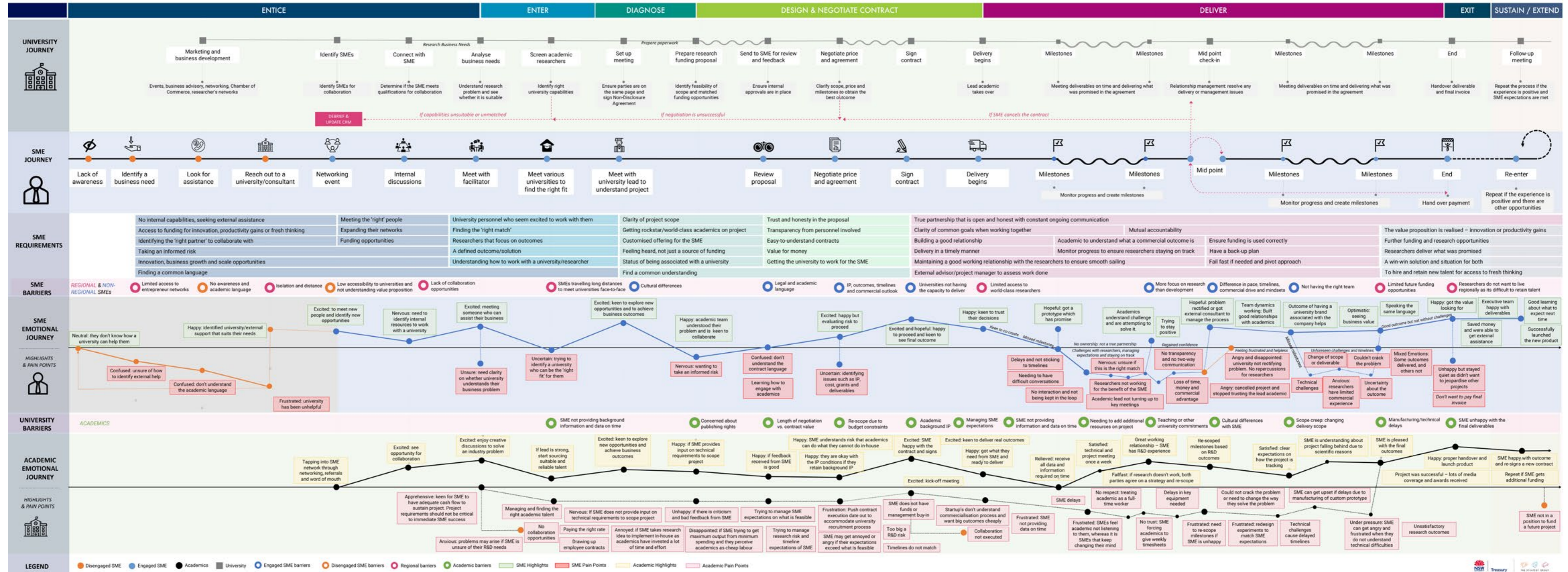
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Appendix 1—NSW R&D Collaboration Cycle

The below map shows an overview of the NSW R&D collaboration cycle across all NSW universities from engagement through to delivery.



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