Government of **Western Australia**
Department of **Commerce**
Office of the Director General

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The Chairman
Economics and Industry Standing Committee
Legislative Assembly
Parliament House
PERTH WA 6000

Dear Chair

INQUIRY INTO TECHNOLOGICAL AND SERVICE INNOVATION IN WESTERN AUSTRALIA

The Department of Commerce appreciates the opportunity to provide a submission to the Economics and Industry Standing Committee on this important topic. Please find attached the Department's submission for the Committee's consideration.

Yours sincerely

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DEPARTMENT OF COMMERCE'S SUBMISSION TO THE INQUIRY INTO TECHNOLOGICAL AND SERVICE INNOVATION IN WESTERN AUSTRALIA

Background

The Department of Commerce (Commerce) welcomes the opportunity to provide a submission to the inquiry. As an agency that provides industry development services it is essential to consider future factors that will underpin productivity and competitiveness, while being aware of challenges facing the State economy. Where impediments exist that make it difficult for local businesses to transition to a new economic paradigm or to grow at their potential, Government may have a role in providing assistance.

As an industry development agency Commerce has daily exposure to innovation that underpins traditional industries, services and emerging sectors of the economy. This practical knowledge and insight will assist the inquiry.

Key Concepts

To discuss technological and service innovation it is necessary to first consider key concepts underlying innovation and advanced manufacturing.

Innovation can be described as improvements in technology, products, services or business operations that lead to a distinct competitive advantage or productivity gain. While there can be social innovation this submission is focussed on commercially orientated innovation, encompassing basic science through applied research to substantial improvements in technology-based processes, services and products.

Advanced Manufacturing is an emerging terminology and there are many views as to what it means. The idea that it only covers new industries using specialised materials is far from reality as it can encompass a wide range of traditional manufacturing sectors. What defines advanced manufacturing are the features of the manufacturing process that may include design as part of the manufacturing process, extensive individual customisation, highly automated processes, integration of the latest technologies and materials and quality production involving high value-add.

An example of this would be Perth based bicycle maker Flying Machine. The company custom designs bikes and has key titanium components printed by CSIRO on a 3D printer. Delivery times for the parts have been cut from 10 weeks for imported components to 10 days and each bike can be custom made. Over time this will open up the market for a far wider range of customised bikes and parts.

Fremantle Steel Fabrication was highlighted as a model supplier by customer Woodside, a traditional steel fabricator using 5D production technology (3D

design, together with a materials input dimension and labour dimension) to outperform larger Asian suppliers.

Echo Yachts in Henderson is using 3D printing technology to enhance their ability to customise super yachts and to do so more efficiently, effectively and cheaper than by traditional methods.

Matrix Composites & Engineering used the latest technologies to drive its international competitiveness in the oil and gas sector with 80% of its production exported.

As seen by the above Western Australian examples advanced manufacturing mitigates Australia's competitive disadvantage given its comparatively high labour costs.

Engagement is a Barrier for many Western Australian businesses. The state business structure is characterised by large end users (major project proponents, government, utilities and defence), large universities with an academic and global focus and the major employing sector being small and medium sized enterprises (SMEs). There is a wide divide between the diverse range of SMEs suppliers seeking to grow their businesses base in Western Australia (WA) and the scale and complexity of end-users and major research organisations. There is a difference in focus, available resources, specialisation of employment and professional tasks, capacity to invest and knowledge base. These differences can result in a mismatch of the ability to communicate, engage, negotiate and create opportunities.

This capacity for SMEs to engage with both the suppliers and end-users of products, services, to adopt new technological solutions is a major barrier for SMEs growth, expansion and diversification. A further barrier for SMEs can be a lack of awareness of available assistance programs.

In Western Australia's small and isolated market competitive tension will impact the level of SME-to-SME collaboration. There needs to be a culture encouraging SMEs to collaborate with each other and a mindset that the businesses must innovate or they will fail. There needs to be a desire to capitalise on technological developments. To do this SMEs need greater access to business ready science, technology, engineering and math (STEM) skills.

Economic Background and State Priorities

As can be seen in Chart 1 below, the Western Australian economy has grown substantially over the past 20 years. Key sectors of the economy include, mining, oil and gas; construction, manufacturing, logistics and professional services.

Chart 1

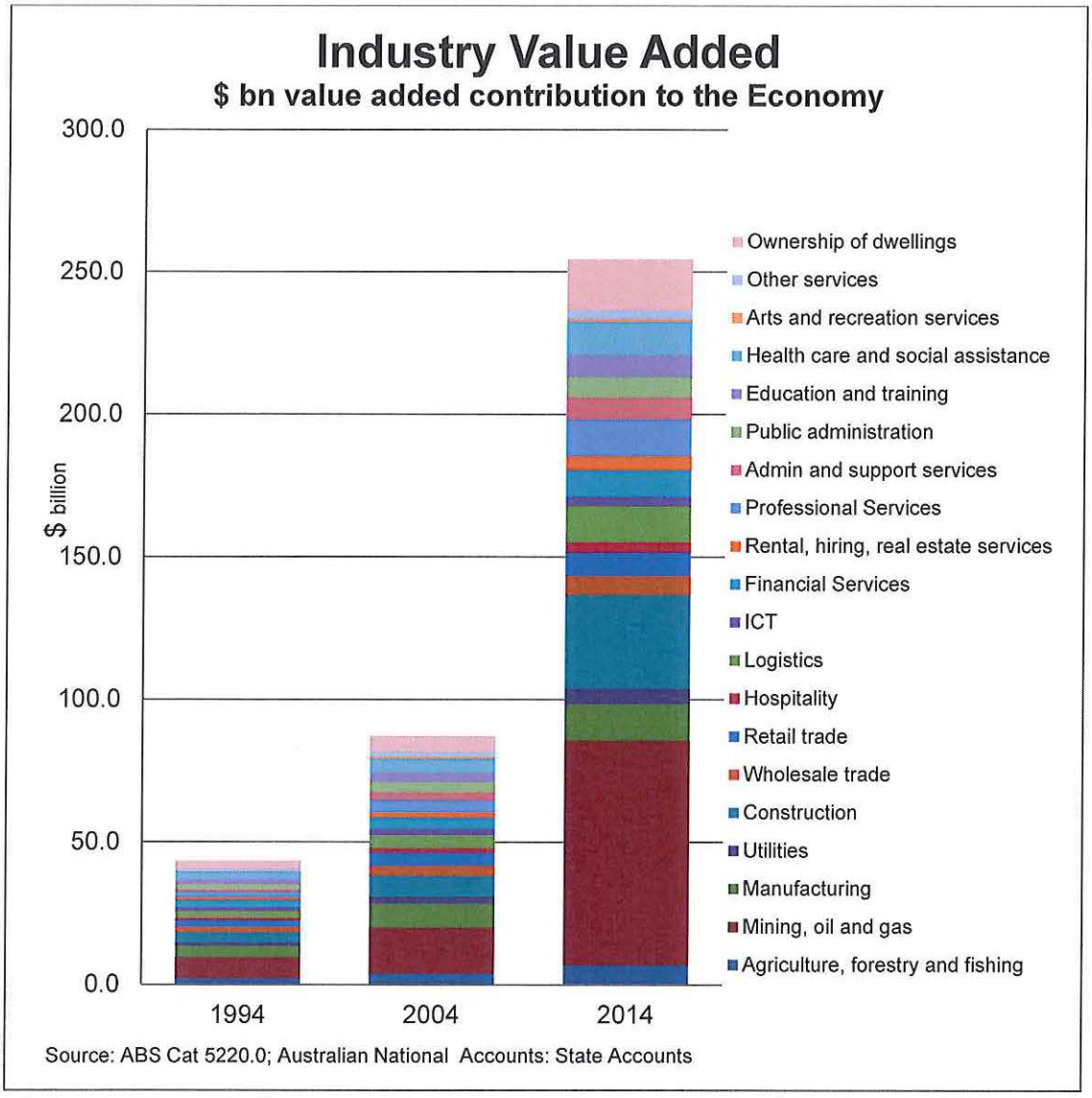


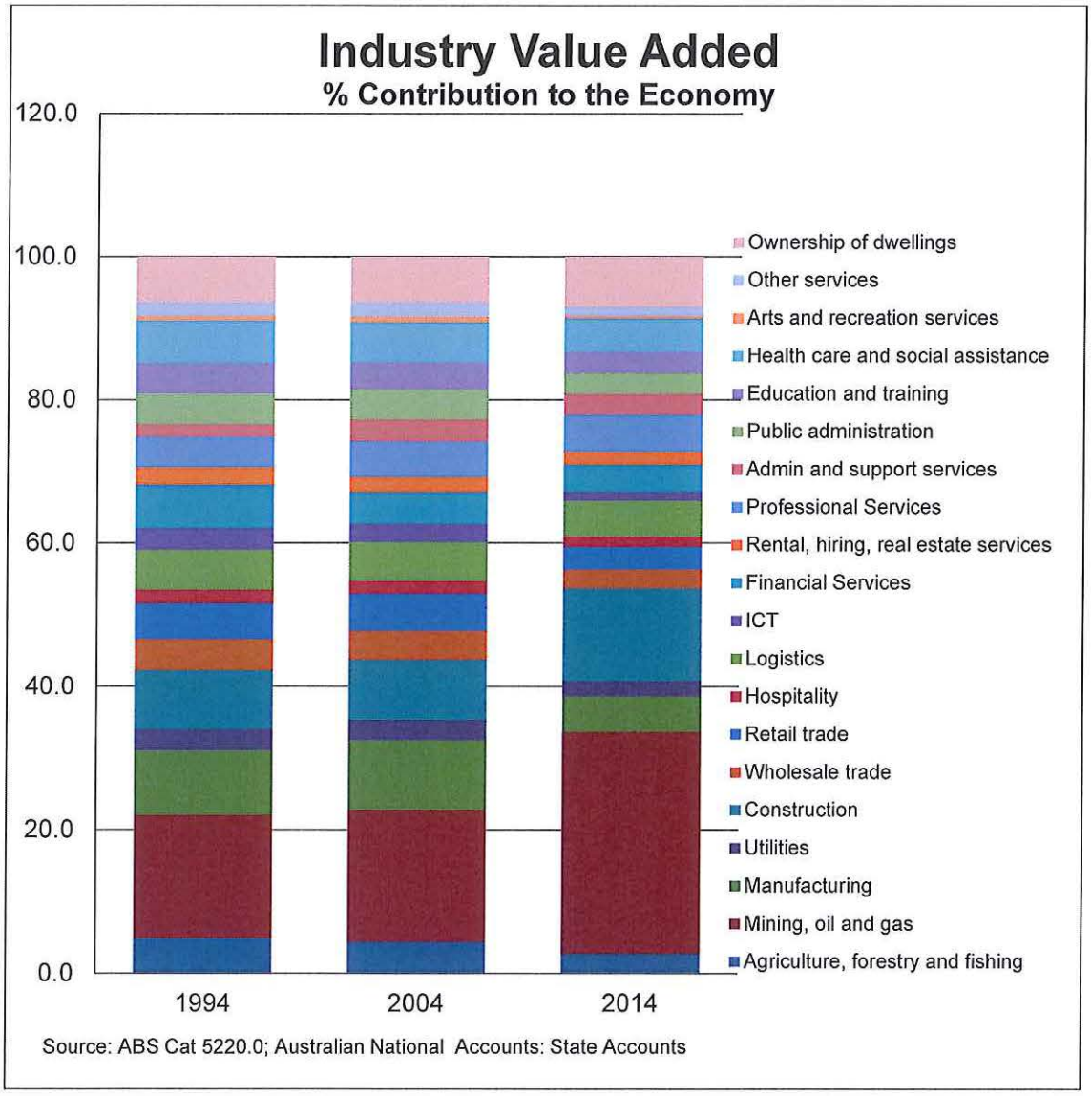
Chart 1 shows the growth in industry value added over this time, partly expanding through inflation, but also through factors such as quantity of production, sales volumes and higher intrinsic value contributions.

Chart 2 below shows the percentages of value added by industry sector to the economy. This chart shows the relative contribution of each industry sector as the WA economic structure has changed over time.

The Information and Communications Technology (ICT) contribution to the economy appears to be getting smaller in Chart 2, however, it does not highlight how ICT is being integrated as an enabling technology and is now considered to be a natural component of other sectors such as the resources industry.

Chart 2 highlights that education and training as a portion of the economy is reducing, this is occurring at a time when STEM skills are increasingly in demand and essential for people seeking employment.

Chart 2



The structure of the State's economy, the State's natural assets and the focus of government services are the foundation to the State's science priorities and outlined in the WA Governments Science Strategy. The five areas of focus are:

- Mining and Energy
- Medicine and Health
- Biodiversity and Marine Science
- Agriculture and Food
- Radio Astronomy

The focus of research and development expenditure is also reflected in Table 1 below. The top areas of research by WA business as reported by the Australian Bureau of Statistics (ABS) in 2011-12[1] are:

Table 1

Industry Sector	$ Value
• Metal Ore Mining	$1,244 million
• Oil & Gas Extraction	$ 694 million
• Manufacturing	$ 384 million
• Professional, Scientific & Technical Services	$ 294 million
• Exploration & Other Mining Support	$ 241 million
• Non-metallic Mineral Mining and Quarrying	$ 228 million
• Construction Industry	$ 207 million

This level of investment underlines how important business rates innovation. By way of comparison the commonwealth invested $701 million[2][3] in research and development within Western Australia for the same period. This makes the Commonwealth the second largest investor in innovation in the State.

Innovation Drivers

The drivers can broadly be considered as supply push, operational imperative, or market driven.

Supply push is where a researcher or an innovative project undertakes "blue sky research" or speculative innovation. Someone has an idea they think will potentially have a major impact.

Operational innovation is driven by a business for its own outcomes, usually where it has identified process inefficiencies, cost imposts or higher than acceptable risk. Operationally driven innovation primarily focuses on productivity and cost.

Market driven innovation is where a need in the market has been identified and a solution is developed. Equally it may be a specific response from a client request or it may be a response to general market trends. Market driven innovation focuses on products and services.

Market driven innovation can be essential to the survival of a business. In the face of global competition encroaching further into the Australian market, competitive local suppliers that have developed innovative and value for money solutions will be able to adapt to sell into international markets and supply chains, broadening their customer base, improving the profitability of the business and making the business less susceptible to collapse through the loss of a major client.

[1] Research and Experimental Development, Businesses, Australian Bureau of Statistics; Cat No 8104.0, 2014
[2] Research and Experimental Development, Higher Education Organisations, Australian Bureau of Statistics; Cat No 8110.0, 2014
[3] Research and Experimental Development, Government and Private Not-for-Profit Organisations, Australian Bureau of Statistics; Cat No 8109.0, 2014

Technologically based businesses also find it easier to diversify their markets across sectors. A company producing truck positioning technology for mining sector remote operations will be able to more readily diversify that product to supply the larger logistics sector.

An opportunity for WA resides in Asia which is driving huge demand for a diverse range of goods and services. At the same time, new markets are being created and many services once only delivered locally are now regularly imported, as trade barriers fall and technology improves. New models of logistics are supporting this trend.

Supporting the above perspective is the ABS research[4] into innovative businesses in Australia. According to ABS the key drivers of innovation in business were.

- Profit motives (72.0 %)
- Increased responsiveness to customer needs (51.2 %)
- Increase or protect market share (43.4 %)
- Establish new markets (35.3 %)
- Improve quality of goods (37.7%)
- Increase efficiency of supplying goods or service (34.4 %)
- Ensure price competitiveness (29.9 %)
- Improve IT Capability or better use IT (22.5 %)
- Improve safety or work conditions (21.8 %)

For SMEs it is fundamental that an understanding of the market and customer needs and expectations drives innovation and diversification.

Access to STEM skills is a critical capacity constraint that can dampen the drive to innovate in SMEs.

Collaboration between government, universities and business

Various reviews, reports, and global indexes highlight the fact that Australia (and WA) is good at research, performing well given the size of the nation. However, it appears that much of the research is not translated to practical application, with one issue being the relationship and collaboration between government, universities and business.

One aspect of the relationship is the research culture and view of the role of research needing to be independent without perception of influence. However, increasingly government policy initiatives are requiring greater industry involvement in research. There is ongoing public debate regarding the need for closer collaboration and for more benefits to flow to local businesses. This is resulting in increased and better quality collaboration, but there is still a long way to go.

The global innovation index over a number of years consistently ranks university/industry collaboration in Australia as 12th to 14th in the world. However, when it comes to overall innovation linkages, knowledge absorption and knowledge diffusion the global ranking declines, suggesting the researcher – industry linkage may not be as deep as it should be.

[4] Innovation in Australian Business; Australian Bureau of Statistics; Cat No. 8158.0; 2014

Table 2

Year	University / industry Collaboration	Innovation Linkages	Knowledge Absorption	Knowledge Diffusion
2011	12	23	50	70
2012	13	36	61	83
2013	12	36	43	63
2014	14	48	42	78

Source: Global Innovation Index

Australian industry and university researchers are aware of the issue and in recent years have worked to improve this situation.

The State can create the environment to maximise the investment levels by industry and the Commonwealth, and facilitate the capture by local companies of outcomes that flow from this investment. Assisting SMEs engagement is central to this.

The State Government is well placed to undertake these roles through facilitation and acting as a catalyst. Assisting local SMEs to engage both with researchers, major project proponents and key markets is best undertaken at a State level. Further, the State can assist SMEs by creating a legal, finance and collaborative environment that will enable them access to innovations to support development of new products and services.

The State Government has endorsed the Western Australian Intellectual Property Policy 2015 which sends a policy signal to agencies that Government Intellectual Policy should flow to industry. Engagement mechanisms and a positive management culture are required to maximise the potential opportunities for SMEs.

The benefits of good linkages can be seen overseas. For example in the United States of America the Federal Government has mandated the linkage between government researchers and industry. The Bayh Dole Act 1980, Stevenson-Wydler Technology Innovation Act 1980 and the Federal Technology Act 1986 require United States Government agencies to make research outcomes available to American industry.

In 2010 alone, the US Energy Department's 17 laboratories and five facilities executed more than 13,500 technology transfer transactions.

Business engagement with government and universities is also critical to ensure the need for STEM skills is articulated and sufficient numbers educated in the appropriate fields. Increasing the number of STEM skilled employees in the business sector will also help with networks into universities

Research can lead to the development of new products, services and jobs

The need for businesses to access technology and continuously innovate applies to established industries. The resources sector that is considered a primary industry has invested heavily in research and development (R&D) and developed remote operations technologies to improve productivity and remain competitive. Long term access to the resource sector's global supply chains requires access to and use of the latest technologies. The breadth of the mining sector supply chain sees mining companies and their suppliers developing technologies in areas such as construction, processing equipment, transport equipment, sensors, communications, information technology, and energy. Without a technological edge it will be very difficult to be price competitive, to win contracts against competitors. Lost contracts equates to lost jobs.

The mining sector has a high exposure to energy usage with rock breakage being the most energy intensive process on a mine consuming approximately 40% of mine-site energy and accounting for 4% of electricity used world-wide. Traditional energy sources are becoming more expensive and exposed to policy decisions regarding pollution and climate impacts. Traditional energy also involves transport either via fuel trucks, gas pipeline or electricity transmission lines exposing remote mines to interruption of power supply. At the same time new disruptive energy and energy storage technologies are evolving that will potentially change the cost structure, operational models and level of processing possible at mine sites. Renewable energy is a critical technology for the long-term competitiveness of the mining sector. Most mining companies are closely monitoring renewable energy technologies.

The oil and gas sector, for example, is developing Floating Liquefied Natural Gas (FLNG) technology. Therefore traditional suppliers of onshore construction services and equipment will need to adapt and innovate to remain relevant to the supply chain and for the delivery of operations and maintenance for FLNG.

Attached are a number of articles that demonstrate how research and innovation have led to the development of new products or services. These include the Becher Process that led to the wide development of the WA mineral sands industry.

A further example is provided below.

- Investment in the Cooperative Research Centre for Spatial Information (CRCSI) assisted a team of dedicated scientists from Curtin University to develop technology which is now being used to improve the efficiency of mining and mineral processing operations. The *WA* Government's investment of $316,400 to establish the Centre attracted $4 million of external funds and demonstrates how public-private-academic partnerships can lead to productive outcomes.

  CRCSI support was instrumental in the start-up of WA company Scanalyse. Scanalyse has invested up to $3.5 million, including $1.75 million awarded through the Federal Government's Climate Ready Program, to help mineral extraction companies maximise safety, energy efficiency and revenue. Scanalyse developed a tool called MillMapper which measures the rate of wear and shape of the liners in mineral processing mills. MillMapper optimises

the performance of grinding mills, which generally work at low efficiency levels but consume about 60 per cent of the energy used in mineral processing. Energy use in rock crushing and grinding has been estimated to consume 3 per cent of the world's electricity. The tool uses three-dimensional laser scanning remotely, eliminating the costly, inaccurate and dangerous work of measuring liner wear by hand. The commercialisation potential of this product is demonstrated by Scanalyse's growth abroad and top clients, such as Alcoa and BHP Billiton. The benefits of increasing safety, efficiency, and productivity to a core *WA* industry make the Government's investment in CRSCI and its emerging technologies a strategic investment.

> *"Scanalyse is growing rapidly and aggressively expanding its services internationally. The creation of new jobs in Western Australia to enable this expansion provides a lasting benefit from the WA Government's initial investment" (Chief Executive Officer, Peter Clark).*

Since preparing this case study Scanalyse was bought by Outotec, at the time of the sale Scanalyse had grown to 36 employees. Outotec maintains operations in WA.

Entrepreneurship and a flourishing start-up community promote job creation and productivity growth. These types of businesses benefit the broader economy by testing new ideas, developing new products and implementing new business models. Creating the conditions which encourage risk taking, entrepreneurship, investment and work is important to foster innovation in WA.

There are also legislative barriers that stop new product development. The lack of a legislative framework to allow discovery of new biologically based pharmaceuticals and chemicals based on native flora and fauna is stopping Western Australia's well developed medical research sector from discovering new products.

As seen previously business is a major investor in innovation, and companies will naturally seek to maximise returns, however the low commercialisation rates flowing from Commonwealth research funding is a point of, as yet, untapped opportunities waiting to be unlocked.

The challenges associated with financing and commercialising new technologies, products and services

The WA industry and research sector structure creates a challenge where there is a mis-match in the size, resourcing and sophistication of different groups within the economy. SMEs encounter obstacles engaging with the large end-users, financial sector and research organisations. SMEs make up the vast number of businesses in WA and are also a major source of jobs. SMEs play an essential role in a diversified economy. Yet with limited capacity at management level and lacking resources of the end-user market, engagement is a critical impediment.

The size, scale and density of Australian markets, especially the WA market, is reflected in the overall level of innovation. Venture Capitalists and other commercialisation investors seek scale and choice. The small size of WA's commercialisation sector means that there is a lack of scale in the innovation pipeline and consistency of access to new ideas. Venture funding organisations

do not see sufficient opportunities to invest in dedicated commercialisation funding vehicles in WA. If the amount of venture capital available in WA increased ten-fold it may be difficult to find quality investment opportunities.

One way to address this is to make it easier for researchers and innovators to promote a greater range of their innovations through one or two central hubs. This would not exclude using other means to identify funding options, rather seeks to create sufficient quantity and quality of ideas to attract more interest from financiers.

Distance from major financial hubs also means that the range of financial skills and depth of venture capital capability do not readily exist in WA. While there are some very good examples of capable investors and venture capital operators (for example, Yuuwa and previously Stoneridge Ventures), there is not the necessary depth of capability that exists in some other jurisdictions.

Further, the size of the investment opportunity is sub-optimal for many superannuation funds. The size of a venture capital investment is far smaller than the normal superannuation portfolio and of a higher risk profile, thus making the investment decision unattractive for investment managers.

In a number of countries philanthropy based venture investments through groups like business angels is common. While business angels have been around for many decades, a WA business angel investor organisation did not establish until 2010, and is only now growing in momentum.

Crowd sourcing is the latest internet based method of raising funds and while this does present a unique opportunity for small start-up companies in WA the lack of regulation and the increasing level of fraud can be problematic. Legislation is struggling to keep pace with these types of global operating models.

One of the largest costs for a business progressing commercialisation is the cost of expert highly skilled staff. One option for a start-up company is to offer a share of the future wealth of the company in return for lower current salary. This is achieved through employee share ownership. Moves to refine the application of employee share ownership laws to create the environment to support start-up companies would be welcomed by technology developers.

Another issue is that researchers and innovators often do not consider the end users, market opportunities and investment requirements from the beginning. Research often needs to be packaged a certain way, and potential investors alerted early to enable the technology to be licensed and commercialised. Major research initiative could benefit by having access to business development managers to support and complement researchers.

Models of development by which technological and service innovation could be encouraged in Western Australia

As noted the research sector is dominated by business and Commonwealth funding. The largest single Commonwealth investment in R&D is through the R&D tax incentive. WA can encourage greater technology and service innovation through models and concepts used in other Australian jurisdictions, or overseas in countries such as Israel, Norway, the United State, Canada or Brazil.

A common theme is that all the countries mentioned above create an environment for investment in technology and its utilisation. The Government leverages its strengths to catalyse and facilitate research, technological developments, and innovation within these jurisdictions. The State Government can also encourage environments that will improve natural SMEs engagement. Some of the initiatives that could be adopted include:

- Enact legislation supporting Venture Capital Limited Partnerships that encourage and support venture capital funds to operate in WA and be eligible for specialised tax treatment (Drafting of this legislation is nearing completion).

- Development of an innovation manufacturing hub(s), virtual and physical, which are manufacturing and research precincts that may have specialised support services but can also be a model for trialling the latest infrastructure and services needed by industry.

- Where a product using State funds is commercialised and returns generated, seek some form of payment or repayment to make the cycle of support more sustainable.

- Use of standards to drive innovation adoption. One example was the modernisation of standards related to light bulbs and light bulb energy efficiency.

- Unlock areas of strength through efficient and supportive legislation in areas such as biodiscovery and aquaculture.

- Actively support and promote emerging precincts being developed by industry or universities that encourage exchange of ideas between tenants; including technical collaboration between SMEs and research organisations.

- State investment in research, to be conditional on structures and programs to translate and transfer outcomes to local industry and require SMEs engagement.

- Provision of specific Business Development support for research organisations of specific scale that is modelled to support SMEs engagement.

- Utilisation of a common use infrastructure model when providing research equipment grants. This would maximise usage and accessibility without requiring substantial additional funds, and also allow greater company access on an as-needs basis.

- Ensure STEM students have business skills that will enable linkages between the innovation community and SMEs.

Technology driven future scenarios that could impact WA

While this Committee is seeking to encourage technology and innovation, there is often resistance to change across the community. With the advent of disruptive technologies maintaining the status quo is not an option.

The Australian economic landscape will change significantly in the next twenty years. The following list highlights existing, sometimes embryonic technology and the areas where WA industry could be impacted. The list is not comprehensive but is designed to ensure consideration of disruptive technologies.

- Drones
    - Supply vessel replacement
    - High risk maintenance or inspection
    - Pipeline and power line monitoring
    - Quantity surveying
    - Mineral surveying and detection
    - Crop monitoring
    - Logistical opportunities for high value perishable products
    - Policing, law and order
    - Search and rescue
    - Emergency supplies or medicine delivery
- Autonomous operations
    - Remote mine operations
    - Unmanned FLNG
    - Unmanned oil and gas platforms
    - Driverless trains
    - Driverless taxis and cars
    - Driverless busses
    - Remote plant operations (onsite processing of minerals with 3D printing for minor repairs to reduce transport costs – staff remain at population hub)
- Remote analysis
    - Digital medical diagnosis from remote locations
    - Home based medical monitoring and diagnosis
    - Equipment maintenance monitoring
    - Agricultural soil, moisture and pest monitoring
    - Automated traffic analysis and management

- Renewable energy & battery technology

    - Distributed energy systems
    - Reduced demand for transmission infrastructure
    - Off grid housing developments
    - New energy supply and pricing models
    - Electric vehicles displace replace fossil fuel vehicle – impact on fuel supply chains
    - New desalination models based on renewable energy developments – cheap, small distributed desalination
    - New models for mineral processing

- Digital tools

    - Ubiquitous machine to machine connectivity
    - Deployment of wide area sensor networks
    - Smart vests and goggles – maintenance support items linked to a central supervisor
    - On-site component printing (and associated reductions in physical inventory on hand)
    - Wearable computers – already have athletic monitoring devices, however this may be developed to include medical monitors, safety alerts, travel directions and entertainment centres. Such tools could be implemented in a work environment to shutdown machines if a person gets too close or to ensure vehicle pedestrian accidents are reduced.
    - New digital tools will change banking and banking security

- New materials

    - As part of the development of 3D printing technology new materials may be developed to allow on-site printing of major structures. This could have impact on some traditional construction materials.
    - Printed body parts allowing a whole new health sector to develop and its impacts on current health system structures.
    - Replacement materials stronger, lighter and cheaper than steel.

Government Role

It is important to consider the role of Government in technological and service innovation. Commerce believes that the rapid change in technology will require a collaborative whole-of-government approach.

Commerce's view is that Government is uniquely placed to intervene to mitigate critical risk factors highlighted in this submission and to encourage technology development and innovation that can underpin future competitive industries.

The regulatory environment can either support or hinder technology development. Commerce encourages a supportive legislative environment that will embrace local business adoption of technological and service innovation.

Government can work with key markets, industry and academia to regularly review and report on sector trends, opportunities and threats, noting where there are gaps in existing research and where resources may need to be focused. Examples of this include the Commonwealth approach to Industry Growth Centres and the State's pursuit of Regional Investment Blueprints.

Government can assist in identifying the research and innovation infrastructure needs of business and researchers, and highlight gaps. Government can facilitate common user clustering of research infrastructure to build industry and academia capability, with clusters also leading to increased linkages

Government needs to continuously update skills prioritisation that will guide training especially at the vocational and tertiary level, while at primary and secondary schools ensuring a broad STEM base. The skills priority should focus on the medium to long term given the lag between a student commencing and completing education and training.

Government can use its purchasing budget to encourage innovation rather than only purchasing items off the shelf. Commerce is responsible for the Buy Local Policy, Building Local Industry Policy and the WA Government Intellectual Property Policy and can work with key purchasing agencies to support local business innovation.

Government has a prime role to help local SMEs to engage with technology developers and major end-users. The State Government can identify critical issues and needs of major project proponents that may be difficult for a local business to ascertain.

Where Government directly contributes to research it should insist on SME engagement initiatives and support specific technology transfer activities that involve SMEs.

Key Recommendations

The State would benefit by:

- Works to ensure the appropriate STEM skills are available for a technology driven economy.
- Supporting innovation in key economic sectors such as mining, oil and gas, while also supporting innovation in new industries utilising under developed natural advantages such as biodiscovery, aquaculture and renewable energy.
- Focussing on attracting additional Commonwealth research funding to State priority areas and assisting local companies to turn the Commonwealth funded research into business opportunities.
- Facilitating SMEs engagement with key decision makers in major markets such as the resources sectors, defence, energy, construction and government.
- Ensuring emerging industry hubs have appropriate infrastructure to encourage technologically driven industries.
- Where State government directly provides research grants SME engagement should be a requirement.

Conclusion

Technology and innovation underpin WA's economic future and will assist the State and industries operating here remain competitive. There are global competitive challenges and the State Government has a critical role in creating a sense of urgency in the business mindset and the community more generally about:

1) The importance of continually adapting and innovating within business, and
2) Ensuring WA has the intellectual capacity to compete within these drivers.

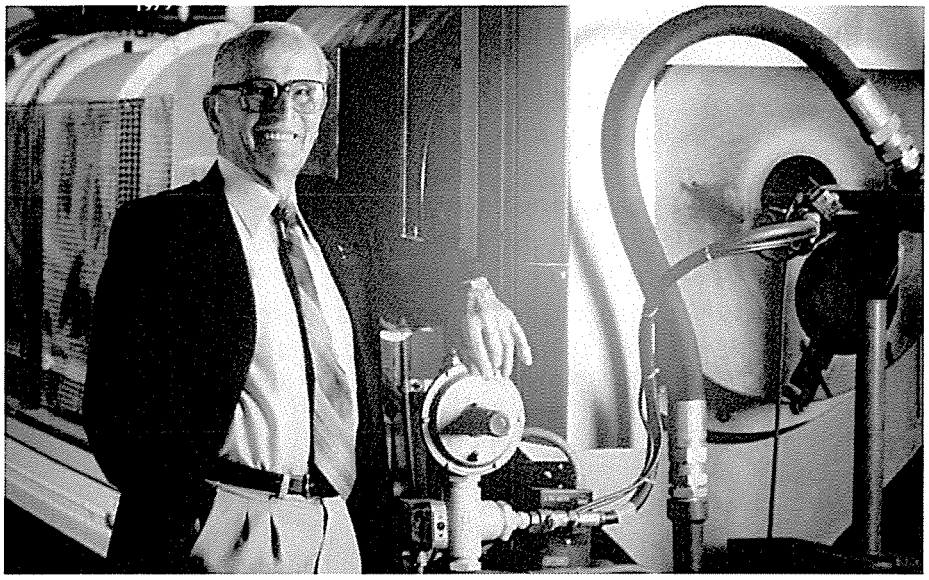
There is a need to encourage, catalyse and facilitate innovation where it can have a commensurate economic impact and supports local business competitiveness.

Ignoring the innovation trends and disruptive technologies emerging in this time of rapid change will severely impact the economy and the standard of life of all Western Australians.

A public sector innovator with a billion dollar idea

It's not often that one person comes up with an idea that completely revolutionises an entire industry and helps it earn billions of dollars.

But that's exactly what happened in the case of Bob Becher and Western Australia's mineral sands industry over the past five decades.



Mr Bob Becher with equipment to undertake the Becher Process which is a breakthrough in the mineral sands industry

His story is remarkable on many fronts. Due to family circumstances, Becher left school at 14 and was unable to go to university. During the Depression, he walked many miles each day doing odd jobs such as catching rabbits, building fences, and sewing wheat bags. Suffering from dyslexia, he later went on to study at night school and completed a diploma in chemistry.

He then went on to pursue his love of science working in the Western Australian Government's Mineral Processing Laboratory, which focused on undertaking research and development to assist industry.

In the early 1960s, he discovered a way of turning the cheap mineral ilmenite, found in mineral sands, into the much more valuable synthetic rutile. He was motivated by the wish to protect Western Australia's beaches from staining by rust, the then usual outcome of processing mineral sands *(see side story).*

He patented the discovery, which became known as the Becher Process, and later handed the patent to the Western Australian Government. The process was commercialised by the mineral sands company RGC – the forerunner to Iluka – in 1969.

"With the Becher Process, the mineral sands industry in Western Australia was able to develop a higher-grade product. Rather than digging ilmenite out and just exporting it, we were able to convert it to a high-value product," explains Dr Jim Avraamides, the former head of the Mineral Processing Laboratory.

"So you've increased the value of the product by a factor of five or 10 times.

"And that allowed Western Australia to become one of the world's major producers of synthetic rutile."

The development of the Becher Process meant that, by 1999, the mineral sands industry had become Western Australia's sixth biggest mining industry.

And by 2011, the total value of mineral sands sales from Western Australia was worth $602 million – largely due to the improved output and prices for synthetic rutile.

The Becher Process converts ilmenite – which is about 55 per cent titanium oxide – into synthetic rutile, which is more than 90 per cent titanium oxide.

"Titanium dioxide is widely used as a pigment in paint," explains Dr Avraamides. "It's what gives paint its opacity, and is also used in paper and plastics as a filler or whitener."

Dr Avraamides says the Becher Process is particularly suited to Western Australia's mineral sands and is used by major producers Iluka and Tiwest (now known as Tronox).

The Becher Process consists of roasting the low-grade ilmenite in a rotary kiln at temperatures of more than 1100 degrees Celsius to convert the iron oxide in the ilmenite to metallic iron, and then 'rusting' the kiln product in an aerated salt solution to remove most of the metallic iron.

"The Becher Process is a two-stage process: a reduction process followed by a rusting process, and it's the rusting process that is the Becher Process, and that's what Bob patented," says Dr Avraamides.

Dr Avraamides knew Becher and says he was a true innovator.

"He was ahead of his time," Dr Avraamides says.

"He always had an inquiring mind, he was always looking for something. Even on his honeymoon, he would be looking to see what the mineral prospects were in the bush where he and his wife would be having a picnic."

Tony Malkovic

Image supplied by Department of Mines and Petroleum.

Freo innovation helps freight fish further

In a group of corrugated iron sheds in Fremantle, researchers have been developing something which is set to save fish breeders hundreds of thousands of dollars in freight fees – and revolutionise the fish transport industry.

"We create IP out of necessity"

It's an innovative pump designed by staff at the Australian Centre for Applied Aquaculture Research (ACAAR), which is part of Challenger Institute of Technology.

"We create IP out of necessity," explains Greg Jenkins, the Director of ACAAR.

"We had a problem growing fish and moving them to Derby, nearly 3,000 kilometres away. We had to move 200,000 juvenile barramundi at a time."

He says that usually involved hiring a truck, using three drivers, and loading the tanks on the back of the truck, along with the equivalent of a 'life support' system for the tiny fish – blowers, oxygen bottles and the electricity to power them.

"We found very early that the limiting factor in transporting fish wasn't the ability to provide oxygen to the fish, but instead it was about removing the carbon dioxide they make," says Jenkins.

"So the IP that was developed is a small, simplified system that's placed inside a tank of fish that circulates the water through it and strips the carbon dioxide from the water."

The solution is more compact, more effective, and much cheaper.

"We could close the tank, get a fork lift and put them on a normal carrier going north, for a fraction of the cost," he says.

"We're talking about doing it for about 10 per cent of the cost that we're doing it now, and get the fish alive to Derby."

The ACAAR invention has wider uses.

More cheaply

"We also grow other fish and sell them overseas. Our most difficult transfer is yellowtail kingfish juveniles to a university in Holland," Jenkins says.

"Kingfish are difficult to move, because they have a high oxygen requirement and it's very expensive.

"So we see in the future, this same technology being used to send other, more fragile fish overseas more cheaply and safer."

There's considerable potential for the carbon dioxide pump.

"There are two main markets. The first is the market we initially developed it for, moving juvenile fish around," says Jenkins.

"This technology will enable large, centralised hatcheries to be located in convenient locations for hatcheries and then being able to ship their juveniles to farms anywhere in the world."

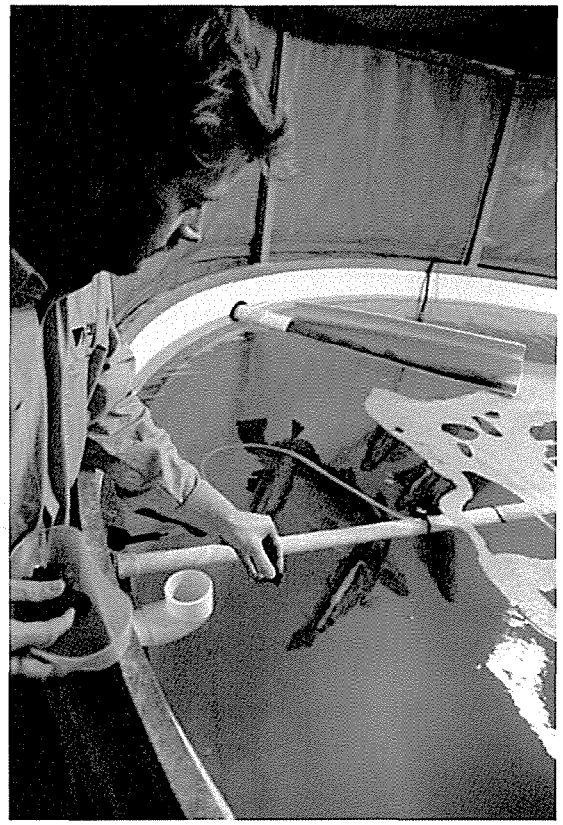
But ACAAR is also angling for a bite at a much larger market.

"The other market, which I suspect will be far bigger than that, will be moving large fish – that is, eating size fish – around in the seafood industry," he says.

"There's a lot of live fish trade in the world today. Most of that is done over relatively short distances because of the expense and difficulty in moving fish. And again, the biggest problem in moving fish big or small is removing carbon dioxide.

"So this is a technology that could expand those market and allow a lot more international trade and a lot more internal trade. For example, Japan and China and most of the Asian countries have a huge trade in transporting live fish to restaurants.

"So this could certainly tap into that."



Developing better ways of freighting fish further ... ACAAR's IP inventor Dr Gavin Partridge feeds some barramundi broodstock in Fremantle. (Image: Challenger Institute of Technology)

Expedient

In this case, ACAAR's approach to making the most of the IP is to team up with private enterprise.

"We developed the IP in conjunction with a private company," Jenkins says.

"We have an agreement where we own 75 per cent of the IP and they own 25 per cent.

"We believe it's a lot more expedient for a commercial company to develop the IP to the commercial phase than us.

"The IP is going to help us do our job – but our job is not to develop IP for commercial markets.

Developing and exploiting such IP is part of the key to ACAAR's future.

"We need to work in the commercial field, we need to generate funds – that's the business model we have – so anything that secures us money for the future is going to be good for us and also the industry we support," says Jenkins.