



# Australia's Aerospace Industry Capability

Research and Economic Modelling of the  
Aircraft Manufacturing and Repair Services  
Industry in Australia

12 June 2019

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# Aircraft Manufacturing & Repair Services



## ECONOMIC CONTRIBUTION

In 2016-17, the Aircraft Manufacturing and Repair Services industry contributed

*\$2 billion*

in Gross Value Added to the Australian economy.



Through linkages to the Australian economy and flow-on effects, the industry contributes an additional

*\$0.9 billion*

in related value-add annually.



There are **937 registered businesses** in this industry – 96% of these are non-employing or employ less than 20 workers.

*13,396* workers were employed by the industry nationally in 2016-17.

An additional **4,889 workers** were employed in jobs that support the industry.

The Aircraft Manufacturing and Repair Services industry made a

*sales revenue of \$4.8 billion*

in 2017-18.



The users of industry output include **Commercial Airlines, Australian Defence Force, private government and businesses and Export markets.**



In 2016-17, the industry delivered

*\$2 billion*

in merchandise exports.

Consultation with industry stakeholders and surveyed businesses have highlighted **key opportunities and challenges** for the Aircraft Manufacturing and Repair Services industry in Australia.

## OPPORTUNITIES



Australia ranks in the *top 10 amongst OECD* countries for its quality of research.

Gains have been identified in **building industry-academia partnerships** and tapping into universities and institutions like CSIRO for commercializing research work through development of innovative industry tools.

### *Niche segments*

within the aerospace industry like Unmanned Aerial Systems and



advanced manufacturing present good opportunities to expand industry offerings and alleviate the negative impact of some contracting in transitional sectors.



Australia's **Maintenance, Repair and Overhaul sector is ready for expansion,**

given a strong skills base and presence of MRO operations of large multinationals. Building regional capacity to service the Regular Public Transport (RPT) and provide maintenance training stands to greatly benefit the domestic industry.

## CHALLENGES



**Access to a skilled labour force remains a key challenge for the industry.**

A decline in the number of new trainees and an aging workforce is limiting the number of skilled workers available to the industry.



Many businesses also find the **regulatory environment and lack of mutual recognition of certifications** challenging, with some industry participants indicating that this negatively impacts on the industry's global outreach.



**Case Studies** throughout this report bring to life the breadth of examples of the **Australian Aircraft Manufacturing and Repair Services industry's** skills, innovation and expertise; and highlights some real challenges and opportunities faced by businesses in the sector.

**Inherent Limitations**

*This report has been prepared as outlined in the scope section. The services provided in connection with this engagement comprise an advisory engagement, which is not subject to assurance or other standards issued by the Australian Auditing and Assurance Standards Board and, consequently no opinions or conclusions intended to convey assurance have been expressed.*

*No warranty of completeness, accuracy or reliability is given in relation to the statements and representations made by, and the information and documentation provided by stakeholders consulted as part of the process.*

*KPMG have indicated within this report the sources of the information provided. We have not sought to independently verify those sources unless otherwise noted within the report.*

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*The findings in this report have been formed on the above basis.*

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# Table of Contents

Executive Summary .....	i
<b>1 Introduction .....</b>	<b>1</b>
1.1 Scope .....	1
1.2 Report structure.....	2
<b>2 The Aircraft Manufacturing Industry in Australia .....</b>	<b>6</b>
2.1 Australia's capabilities in the Aircraft Manufacturing industry.....	6
2.2 Company innovation and investment in research and development.....	14
2.3 International markets and supply chains .....	18
2.4 Growth opportunities and barriers .....	20
<b>3 Economic Profile of the Aircraft Manufacturing Industry.....</b>	<b>27</b>
3.1 Business locations .....	27
3.2 Direct employment .....	31
3.3 Value added .....	35
3.4 Expenditure.....	36
3.5 Sales .....	37
3.6 Exports .....	40
<b>4 Economic contribution and linkages of the Aircraft Manufacturing Industry.....</b>	<b>47</b>
4.1 Scenario design.....	47
4.2 Results .....	48
<b>5 Conclusion .....</b>	<b>54</b>
<b>Appendix: KPMG–CGE Model Description.....</b>	<b>57</b>

# Executive Summary

The Australian Aircraft Manufacturing and Repair Services industry is an important part of the Australian economy and holds a key position in the Asia Pacific aviation market. The industry is underpinned by the technical capabilities of businesses encompassing expertise in engineering, design, aircraft parts manufacturing, maintenance, research and development and training.

This report provides an overview of Australia's capability in the Aircraft Manufacturing and Repair Services industry and examines the industry's economic contribution, both financial and non-financial to the Australian economy. Our analysis of the industry is based on the latest available ABS Input-Output tables (2015-16), ABS Manufacturing data (2016-17) and KPMG economic modelling. KPMG also consulted with industry stakeholders and conducted an industry survey of relevant businesses to collect their views on key aspects of the Aircraft Manufacturing and Repair Services industry and to identify the industry's non-monetary contributions.

The unique capabilities and global position of the industry are highlighted through the Case Studies presented in this report, which examine various different sized and types of aerospace businesses within the industry.

Australia's Aircraft Manufacturing and Repair Services industry encompasses manufacturing of commercial and military aircraft and parts; design and systems engineering; Maintenance, Repair and Overhaul (MRO) services for airlines and manufacturers; training; and research & development (R&D). While the sector does include the space subsector, the focus of this study was confined to that of non-space activity.

The industry's main capabilities include:

- manufacture of avionics, aircraft structures and airframes- including advanced composites, aviation parts;
- helicopter manufacturing;
- ground support equipment (GSE);
- aircraft maintenance, repair and overhaul, sustainment;
- aeronautical design; and
- unmanned aerial systems.



The direct economic contribution of the Australian Aircraft Manufacturing and Repair Services industry is measured through employment within the industry and value-added by the industry. Value-added refers to the outputs from the Australian Aircraft Manufacturing and Repair Services industry less inputs from other industry sectors. In the financial year 2016-17, the Aircraft Manufacturing and Repair Services industry directly added over \$2 billion to Australia's Gross Domestic Product. In the same year, nationally, the industry employed 13,396 workers across manufacturing and repair activities, with the key occupation that of aircraft maintenance engineers, with other engineering professionals and technicians also important occupations in this industry.

To assess the Australian Aircraft Manufacturing and Repair Service industry's linkages with other industries, economic modelling of the industry (in terms of an increase in its size) was simulated. The impacts represent the industry's current contribution, based on current industry relationships and input choices.

Through industry and supply-chain flow-on linkages that connect the Australian economy, it is estimated that the Aircraft Manufacturing and Repair Services industry supports an additional \$0.9 billion in related value-add annually. A further 4,889 workers were employed in jobs flowing from activities related to the Aircraft Manufacturing and Repair Services industry. This highlights the importance of the Aircraft Manufacturing and Repair Services industry's inherent linkages to other sectors in the Australian economy.

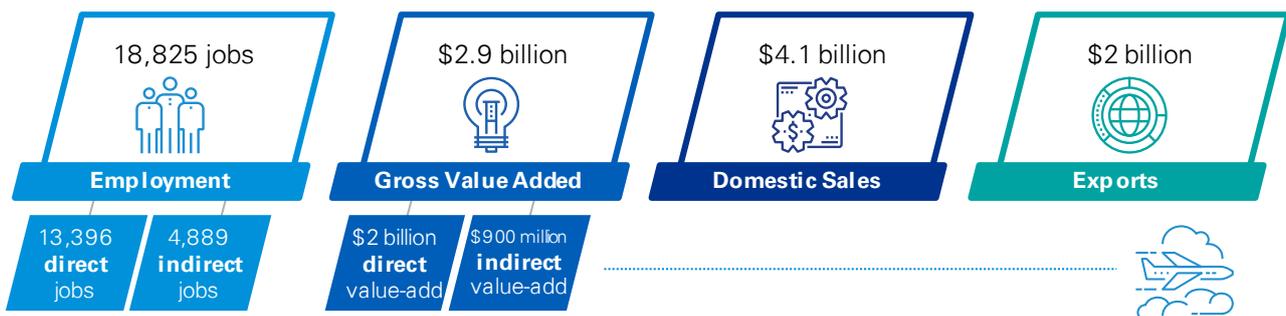
Thus, in total, it is estimated that the Australian Aircraft Manufacturing and Repair Services industry supported an annual contribution to Gross Domestic Product (GDP) of around \$2.9 billion (\$2.0 billion direct + \$0.9 billion indirect) and around 18,285 jobs in Australian industries (13,396 direct + 4,889 indirect) in 2016-17. This is equivalent to around 0.2 per cent of total Australian GDP and jobs in 2016-17.

A number of strengths and challenges within the Australian Aircraft Manufacturing and Repair Services industry were highlighted in the industry survey and consultations with stakeholders.

High standards of product safety and Australia's reputation in the industry globally were identified as two key strengths of the industry.

The commitment to providing quality products and services, despite some constraints, has helped build trust in Australian products and build a strong brand reputation for the industry in the global market. However, with the expected growth in Asia Pacific's air travel and Australia's growing foothold in some of the niche sectors like Unmanned Aerial Systems (UAS), industry representatives expressed concern over some impediments to these opportunities at present. The availability of skilled labour and the lack of mutual recognition of certifications from key trade partners, further weighed down by regulatory requirements, are considered to be the top challenges faced by industry players going forward.

While there is an ongoing degree of volatility in the global aerospace industry, industry representatives believe that building on these current strengths and, where possible, exploring new avenues (like developing regional maintenance hubs and translating relevant research work into practical tools) can help alleviate some of the challenges and build a more competitive Aircraft Manufacturing and Repair Services industry in Australia. Further, a common pool of resources and skill sets between defence and civil sectors can be leveraged to support both long-term high volume contracts in the former and a consistent stream of smaller engagements from the latter.

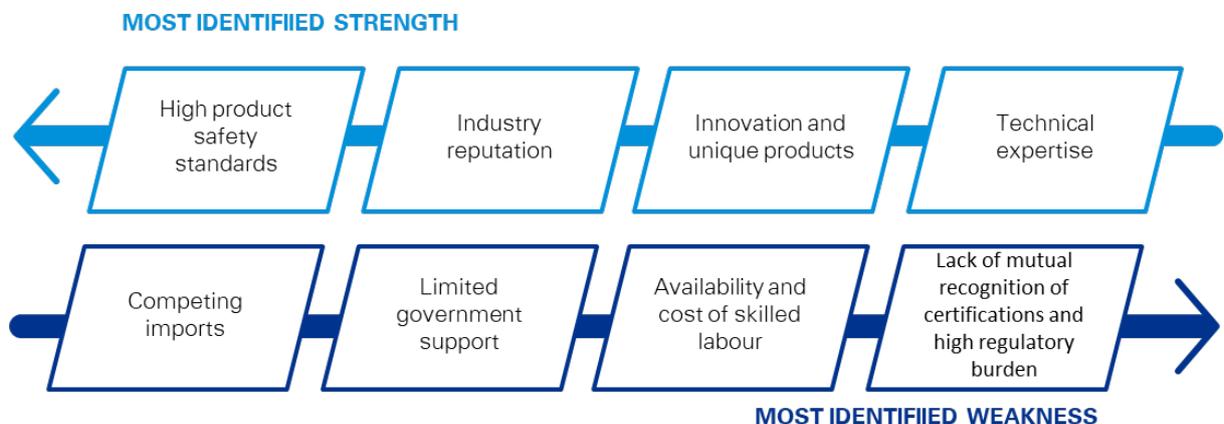


The Australian Aircraft Manufacturing and Repair Services industry is well placed globally, with around 600 companies participating in the aerospace manufacturing global supply chain. Australia has a number of key capabilities across the aerospace industry that separates it from its counterparts and provides a high level of trust in Australian products across the global market. In-depth analysis of the industry brought some key features to the forefront that go beyond the industry's fiscal contribution to the economy. The industry's broader non-financial economic contributions include:

- Research and Development (R&D)** - R&D activities play an important role in the domestic industry successfully reaching out to international businesses and remaining globally competitive. While Australia's absolute investment in R&D in air, spacecraft and related machinery is relatively low compared to other OECD countries, Australia is recognised through its position in the top 10 OECD countries for its quality of research.
 

Also partly attributed to the government's R&D Tax Incentive to businesses, Australia has become a popular destination for many R&D activities carried out by big international Original Equipment Manufacturers (OEMs). Prominent examples include Boeing's Research and Technology Australia branch – the company's biggest offshore research and development facility – and Lockheed Martin's STELaRLab – its first multidisciplinary R&D facility outside of the US.
- Innovation** - Australia's strong reputation in the Aircraft Manufacturing and Repair Services industry stems from its capability to develop innovative products. The industry is recognised for its problem solving capabilities and skills in modifying existing technologies/products to gain efficiencies like the CSIRO patented carbon fibre technology. Unique business strategies and an "attention to detail" approach adopted by many Australian firms also often presents learning opportunities for international businesses that work with these Australian firms.
- Industry collaboration** - Australia is highly regarded for its research capacity in organisations like the CSIRO and technology universities. Recognising the need to translate research work to industry applications, the industry is making efforts to collaborate with universities. These partnerships are also leading to many start-ups spinning out of universities to bring high-tech products to market, thus expanding the industry's capabilities.

In going forward, both the significant increase expected in the magnitude of air traffic (particularly in Asia-Pacific), and the in-flow of aerospace related defence contracts to support Australia and its allies, present opportunities for the domestic Aircraft Manufacturing and Repair Services industry. Up skilling and effective utilisation of Australia's SME capability can prepare the industry to leverage these upcoming opportunities.



# Introduction



01

# 1. Introduction

Australia's geographical distance from merchandising partners and a population spread out across a large internal landmass was an initial driver of the establishment of the aerospace sector in Australia. Since then, the Australian aerospace industry has developed to encompass a wide range of services and has built a reputation of capability and innovation. The Australian aerospace industry's primary sub-sectors include Defence, commercial aviation, aircraft parts, Maintenance, Repair and Overhaul (MRO) services, business jets, helicopters, aerial agriculture and Unmanned Aerial Vehicles (UAV).

The Aircraft Manufacturing and Repair Services industry forms an important part of the well-respected Australian aerospace industry, providing support to civil as well as defence aviation sectors both domestically and internationally. The Aircraft Manufacturing and Repair Services industry had estimated annual revenue of nearly \$4 billion in 2017-18, directly employing over 13,000 individuals across its sub-sectors. While Boeing Australia Holdings Pty Ltd, Airbus Group Australia Pacific Limited and BAE Systems Australia Holdings Limited account for 70 per cent of Australia's market share<sup>1</sup>, the operations of these major global aerospace players are largely supported by a wide range of home-grown small and medium enterprises (SMEs). These local firms specialise in maintenance and repair, manufacture and distribution of parts, engineering services, airframe and engine component manufacturing, airport systems, avionics, and a select few carry out commercial aircraft maintenance.

## 1.1. Scope

KPMG was engaged by the Department of Industry, Innovation and Science to provide a report on the Aerospace Industry in Australia, with a particular focus on the aircraft manufacturing industry, the maintenance, repair and overhaul (MRO) industry, and related supply chains.

To achieve this, KPMG's research and analysis has included desktop research, surveying companies, consultations with industry associations, case studies of innovative Australian companies and economic modelling of the Aircraft Manufacturing and Repair Services industry in Australia.

The scope of this report covers:

- Australia's industry capability in the aerospace industry, focusing on the Aircraft Manufacturing and Repair Services industry;
- Innovative activities, research and development and connections to international markets and supply chains;
- Identified growth opportunities and barriers/challenges for the aerospace industry;
- The contribution of the sector to the Australian economy; and
- Case Studies of Australian companies which are innovative and operating globally.

According to the Australian New Zealand Standard Industry Classification (ANZSIC),<sup>2</sup> *Aircraft Manufacturing and Repair Services* is classified as follows.

Division C – Manufacturing

Subdivision 23 Transport Equipment Manufacturing

- Group 239 Other Transport Equipment Manufacturing
  - Class 2394 Aircraft Manufacturing and Repair Services.

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<sup>1</sup> IBIS Aircraft Manufacturing and Repair Services Industry report, 2018

<sup>2</sup> Australian Bureau of Statistics (2013), Australian and New Zealand Industrial Classification (ANZSIC), 2006 (Revision 2) (catalogue number 1292.0).

All references in this report to the Aircraft Manufacturing and Repair Services industry refers to the activities as per the ABS ANZSIC Class 2394 definition, which is replicated below.

### Aircraft Manufacturing and Repair Services

This class consists of units mainly engaged in manufacturing or repairing aircraft, aircraft engines and frames, as well as specialist aircraft repair services not elsewhere classified.

Primary activities include:

- Aircraft engine building or repairing
- Aircraft manufacturing
- Airframe building and repair
- Avionics equipment repairing n.e.c.
- Glider manufacturing and repair (except hang glider)
- Guided missile manufacturing
- Helicopter manufacturing or repairing

The focus of this study was confined to that of non-space activity.

While Australia's commercial civil aviation segment, with Qantas and Virgin groups being major operators, sources its carriers and major equipment directly from the OEMs, approved suppliers in the global supply chain are a preferred choice for spares and components. Domestic businesses have a sizeable market share of Australia for products ranging from avionics to ground support equipment, but the best opportunities remain in supplying aircraft parts and components as well as MRO services for US-manufactured aircraft. Further, Australia's focus on acquiring various fixed wing, helicopter and Unmanned Aerial Systems (UAS), as part of Defence's Integrated Investment Program, demonstrates its willingness to expand capabilities and promote the rapidly growing helicopter and UAV sectors.

There are over 15,500 aircraft registered in Australia's civil aircraft register, with its fleet of 2,259 civil helicopters ranking fifth highest in the world. Australia has a large and growing helicopter market, suitable for remote oil, gas and mining projects as well as catering well to island tourist resorts, medical and rescue operations, and agricultural activities.

## 1.2. Report structure

The remainder of this report is structured as follows:

- Section 2 summarises the features of Australia's Aircraft Manufacturing and Repair Services industry in terms of capability, innovation, international trade and competition. This section also identifies opportunities for growth in the sector and barriers to future development.
- Section 3 contains a detailed economic analysis to present an economic profile of the Aircraft Manufacturing and Repair Services industry in Australia.
- Section 4 estimates the overall contribution of the Australian Aircraft Manufacturing and Repair Services industry to the Australian economy.
- The appendix contains an overview of the KPMG–CGE model, used to estimate the overall contribution of the industry to the Australian economy.
- Finally, case studies have been included at the end of each section to give a deeper understanding and some real life examples of the capabilities, capacities, challenges and opportunities faced by businesses in the Aircraft Manufacturing and Repair Services industry.



## Seeing Machines

An embodiment of the technological expertise held by Australia's start-ups, Seeing Machine's Driver Monitoring Systems is stirring up interest in the global aerospace sector, well suited to partially offset a shortfall in pilot numbers and manoeuvring in plausibly busier air paths.

Seeing Machines is part of the start-up culture that is gaining momentum in Australia. It was founded in 2000 by four PhD students at the Australian National University and has grown to employ 200 people in over a decade. The technology start-up, with its headquarters in Canberra and a presence in the United States, the UK and Japan, draws on the interaction between humans and machines to save lives. Their core business involves using computer vision and machine learning technology to track eye and face movement and interpret these movements to detect fatigue, distractions, and enhance driver safety. After engaging in research applications in controlled environments for nearly a decade, Seeing Machines saw its first commercial opportunity in the mining sector during the resources boom, to monitor driver attention and fatigue. The application of this technology in driver monitoring systems set Seeing Machines on its path to success, which has diversified away from the mining industry into the road, rail, automotive and now aviation sectors.

### Taking off in the aviation industry

Seeing Machines is in the post research & development and pre-commercialisation stage in the aviation market. The FOVIO Driver Monitoring System (DMS) is a unique offering that has not yet been tested in the aviation sector. As such, venturing into this sector has meant creating a new market for its product, rather than entering an existing one. Seeing Machines notes that growth of the aviation industry coupled with a shortage of pilots globally has provided additional momentum for conversations with airlines and has already led to initial commercial engagements in areas of pilot training and crew resource management.

While aviation does not account for a significant share of the business at the moment, Seeing Machines sees a multi-million dollar market in the future. In 2017, there were an estimated 25,000 commercial aircraft in operation, with this number expected to double in the next 20 years. Heading towards a future of higher automation and significantly lesser airspace, Seeing Machines' technology has the potential to be a key component in supporting the sector's safety standards.

In collaboration with aviation carriers, three product lines have been developed to manage constraints in the current aviation systems.

The Pilot/Crew Training System is a sophisticated tool that provides aviation training providers with an objective assessment of trainees based on tracking their eye movement, which can be used to select, train and assess pilot candidates.

The Pilot Support System technology is designed to assess a pilot's exhaustion and alertness levels in real-time during a live flight. This can then be used as a measure to evaluate work schedules and pairing designs in order to mitigate risks due to pilot fatigue.

Seeing Machines' Operator Alertness System is developed to assist air navigation service providers and controllers with managing the foreseeable exponential increase in safety concerns by providing live data on alertness levels of pilots and using it to inform effective resourcing and scheduling decisions.<sup>3</sup>

In light of an increasing global focus on safety, Seeing Machines views its eye tracking system as a mainstream commercial product for the aviation industry, rather than a niche product.

### Regional presence – Global outreach

Spun out of a university in Canberra, Seeing Machines strategic decision to continue with its base here has helped them retain an Australian identity and allows for easier communication with regional customers. While access to domestic talent may have been challenging, having the flexibility of tapping into the international workforce market on a needs basis has been useful.

Seeing Machines core engineering and development of hardware is mainly done in Canberra. While availability of skilled personnel for design and engineering has not been a hurdle, Seeing Machines has found that being based in Canberra can impact business development. To mitigate some of these challenges, Seeing Machines has expanded its footprint into the United States. However, this has also had its share of challenges, as the United States already has an established pool of local talent and solutions to meet demand. This, however, has not stopped Seeing Machines from counting firms such as Caterpillar, General Motors, Emirates, Bosch, Progress Rail, Coach USA and Transport for London among its major clients.<sup>4</sup>

### Manoeuvring the market

As a start-up exploring various commercial avenues, Seeing Machines indicates the pivotal role of research and development grants in supporting cash flows, until investments could be realized. Receiving such grants in both Australia and US not only provided incentives to

innovate, but also helped in boosting its visibility and exposure in these markets.

The market for global commercial air freight operators potentially stands to gain from DMS technology, where pilot fatigue is exacerbated by the demanding predominantly night time flight schedule, relative to passenger aircraft operations. Seeing Machines' technology also has good prospects in the defence export market as it is classified as a controlled, rather than restricted product from a defence perspective. Seeing Machines successfully landed its first commercial deal with the Royal Australian Air Force this year, and is set to continue exploring potential civil and defence applications. Opportunities have been identified in the space of ab-initio pilot training, wherein student pilots can be trained and assessed under different scenarios using gaze tracking technology, before they are type-rated and certified. Additionally, mature and innovative Full Flight Simulator OEMs such as L3, as well as several premium airlines, have announced formal partnerships and engagements with Seeing Machines, further validating the value proposition of evidence-based training on operational efficiencies and effectiveness. A senior training captain at a major Australian airline noted that the impact of gaze-tracking on evidence-based training was a key differentiator and factor in "creating skilled thinking pilots," such that "eye-trackers should be fitted to every sim and every aircraft in the fleet."

Operating in over 13 international markets across Europe, Americas, the Middle-East and Asia Pacific, exports account for a large proportion of Seeing Machines' sales in the aviation industry. Notwithstanding the industry's cyclical nature (in terms of pilot demand and supply as well as the manufacture of business/commercial aircraft), recognition of the DMS technology as being critical to safety has helped Seeing Machines navigate this volatile market.

Envisaging a future with (nearly) complete automation across various transportation sectors is increasing the demand by carriers for the company's Driver Monitoring Systems, with the dual purpose of monitoring the comfort and condition of passengers, as well as improving safety (averting emergencies). Increased human-machine interactions in education and medicine is also seeing this eye tracking technology pave its way into new sectors.

<sup>3</sup> <https://www.seeingmachines.com/industry-applications/aviation/>

<sup>4</sup> <https://www.seeingmachines.com/about/>

# The Aircraft Manufacturing Industry in Australia



02

## 2. The Aircraft Manufacturing Industry in Australia

Australia's Aircraft Manufacturing and Repair Services industry comprises manufacturing of commercial and military aircraft and parts; design and systems engineering; MRO services for airlines and manufacturers; R&D and training.

Our industry consultations with aerospace industry representatives indicate the distinctive nature of operations yet synergistic interactions between the defence and civil sectors of the aerospace industry. There are standard compliance requirements for products and services (like AS9100, which includes the quality management system certification ISO9001 and other requirements specific to the aerospace industry), as well as for workers across all parts of the industry. This means that the standards do not necessarily influence a company's decision to work in one or the other part of the industry. Although it was mentioned that defence related work is not covered by some of the regulatory standards that are applied to the civil sector, it can have its own challenges (in particular, some businesses indicate that the Defence procurement process can be complex).

The defence and civil sides of the industry are largely separate in terms of company structures, technologies and capital requirements. In particular, defence work tends to be highly specialized. Some of the prime contractors ("primes") like BAE, Boeing and Airbus do operate in both spaces, indicating operations that can be complementary between civil and defence. It is also fair to expect transfer of R&D between the two sectors. Further, activities relating to manufacturing or repair are seen as somewhat complementary between the two sectors. While the significant defence budget has provided much of the work in this space, in recent times there has been some shift to the civil side of the industry.

This section provides an overview of Australia's current capabilities in the Aircraft Manufacturing and Repair Services industry in terms of business size, skills and market segmentation. This is followed by an overview of innovative initiatives currently employed by the industry. Focus then shifts to international trade and the competition present in international markets and the final subsection identifies opportunities for growth as well as barriers to the development of the domestic industry.

### 2.1. Australia's capabilities in the Aircraft Manufacturing industry

The Australian Aircraft Manufacturing and Repair Services industry includes a broad range of businesses and specialists involved in manufacturing aircraft and aircraft parts as well as maintaining and repairing commercial and military aerospace equipment. The industry prides itself in having unique capabilities across various aerospace segments as well as solid engineering and design skills.

#### **Business size**

In Australia, in 2017-18, there were 937 registered businesses operating in the Aircraft Manufacturing and Repair Services industry.<sup>5</sup>

Figure 1 shows the size of these Australian aircraft manufacturing and repair service businesses in terms of number of employees and turnover at the end of 2017-18. It can be seen that over half the

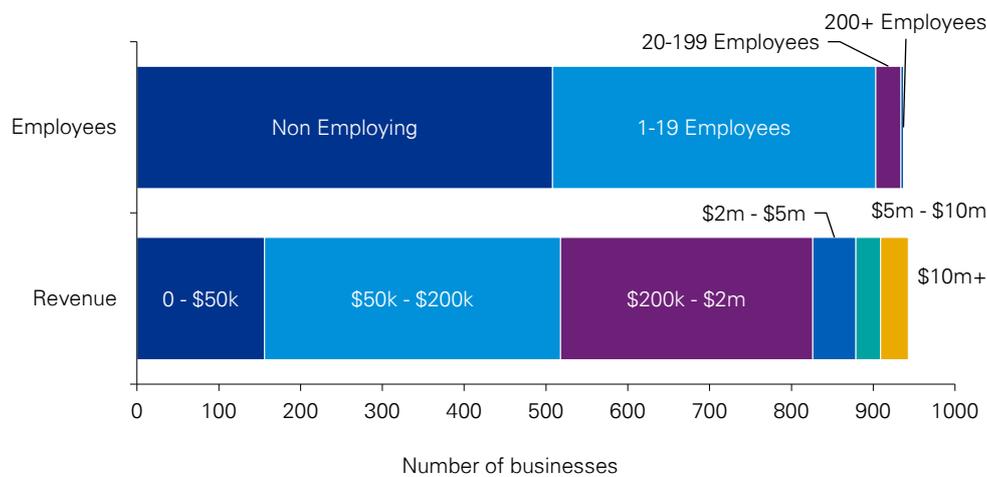
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<sup>5</sup> Australian Bureau of Statistics (2019), Counts of Australian Businesses, including Entries and Exits, June 2014 to June 2018 (catalogue number 8165.0)

businesses in the Aircraft Manufacturing and Repair Service industry are non-employing, operating as sole proprietors or in partnerships. There are another 380 businesses in the market that operate at a small-scale, employing up to 20 employees. At the larger end of the market, the data identified only three businesses that employ more than 200 workers.

(It should be noted that this data can be subject to reporting errors, and likely underrepresents the number of large-sized businesses in this industry. Under this survey, a business involved in multiple commercial activities will be classified under a particular industry according to its main activity. Moreover, as one would expect, increased diversification in services provided by the bigger firms means there may be differences in categorisation of the same business across different years, which could result in significant variations from year to year).

Figure 1: Number of businesses in the industry according to employee strength and revenues (2017-18)



Source: ABS 8165.0

On the revenue side, over 70 per cent of all businesses registered an annual income between \$50,000 and \$2 million at the end of financial year 2016-17. The remaining 30 per cent of the operators were placed relatively evenly at the far ends of the spectrum, registering an annual revenue of either less than \$50,000 or greater than \$2 million.

In general, while the Aircraft Manufacturing and Repair Services industry is largely made up of small and medium-sized enterprises (SMEs), industry revenues are concentrated at the top end with few big players. The underlying characteristics of this high-tech industry including high costs, low volumes limits the number of businesses who can enter and survive the industry. However, market share growth of the big players means an increasing amount of work is outsourced to the smaller players, resulting in the subcontractors specialising, while the big players focus on top-end product integration.

### Business capability – products and services

Australia's Aircraft Manufacturing and Repair Services industry supplies a range of products and services to multiple entities in the economy. The products supplied include airframes, aircraft parts and components, and advanced composite materials. Industry stakeholders credit research and innovative business practices to have enabled businesses enter niche markets and secure a share of the global market in new areas within aerospace. This includes development of Australia's capability in the engine space, light-weight materials, and use of 3D printing of aircraft components. Companies with an international footprint, like Quickstep and Cablex, also demonstrate Australia's appeal and competitiveness in the aerospace sector.

Australia's maintenance, repair and overhaul (MRO) sector comprises of original equipment manufacturers (OEMs), independent service providers, and commercial airlines with in-house MRO capabilities. Services offered include line and heavy maintenance, repair, overhaul and modification of aircraft, aircraft engines and components, airframes, aircraft systems, avionics and instruments.

The diversity of work within the industry is seen as a favourable trait. The industry has a larger share of defence work than ever before, owing in part to the large Australian Defence budget and government initiatives towards becoming a top ten defence exporter. As an example, federal government's Defence Export Strategy (released in 2018) has earmarked \$20 million in additional annual funding from 2018-19 to support defence exports. In general, diversification across both the defence and civil space, and across manufacturing and MRO, has meant that work across the industry tends to be less "lumpy" and that there are more opportunities.

Civil aircraft manufacturing and repair is also seen as a large opportunity for Australia, as this sector is a significant and growing part of the world aerospace market. The Australian Government's Industry Growth Centre Initiative identifies Advanced Manufacturing as one of the six priority sectors in Australia. Each sector is supported by government funding through industry led Growth Centres to drive innovation and competitiveness. The Advanced Manufacturing Growth Centre (AMGC) was established in 2015 to engage with manufacturers, research institutions and export hubs to translate its research on Australian Manufacturing potential into opportunities for the industry. AMGC counts roughly 400 companies in its member base, the majority of which are in NSW, which has the largest manufacturing activity across all states.

The current global automation trend (the Fourth Industrial Revolution, or Industry 4.0) – driven by technological developments in machine learning, the Internet of Things (IoT), additive manufacturing and robotics – is set to digitally disrupt and revolutionise the aerospace industry, altering efficiency parameters. As our global counterparts embrace this technological wave, it is imperative for Australia to rapidly adapt in order to secure a competitive future. Some noteworthy initiatives in Australia include AMGC's Industry 4.0 audit (to develop an audit tool in partnership with Robert Bosch Australia), which will identify the gaps in business processes of a few SMEs and recommend practical technological transitions spanning Industry 4.0 themes. In addition, BAE Systems Australia and the AMGC are working together to test supply chain digitisation in the Joint Strike Fighter program, to improve risk management and optimise production in response to issues identified in real time. The recent establishment of an Industry 4.0 Testlab at the University of South Australia is set to make smart technologies promised by Industry 4.0 accessible to high-tech SMEs and start-ups.

Developments in each driver of Industry 4.0 is reshaping and transforming industries, supporting the clear opinion of industry representatives on the need to focus on smarter manufacturing and keeping up with advancements in technology. While headed in the right direction, Australia has a long way to go before it can harness the benefits of Industry 4.0.

One of the Industry 4.0 drivers, **additive manufacturing** (which involves addition of materials, layer by layer, to make the end product), is slated to alter the design, manufacture and repair of aircrafts in the future. Its potential to reduce lead times, produce lightweight components at lower costs and improve spare parts supply chains calls for widespread adoption across commercial and military aerospace sectors. In Australia, the work done by organisations such as Monash University's Centre for Additive Manufacture, RMIT's Centre for Additive Manufacturing and the Additive Manufacturing Hub in Victoria has exposed the domestic industry to applications in the manufacture of specialised components and parts on demand, tailored to specific requirements and in small batches. A recent example is RUAG Australia's two year collaboration with researchers from the Innovative Manufacturing Cooperative Research Centre (IMCRC) and RMIT University to investigate the potential use of 'laser metal deposition' technology to significantly reduce build and repair costs for military aircraft parts.

Another Industry 4.0 driver, **developments in machine learning**, is propelling the aerospace industry towards a future of automation, as machines are being designed to make decisions and perform complex tasks with minimal input from human controllers. Lockheed Martin Australia's three year partnership with the University of Adelaide's Australian Institute for Machine Learning (AIML)

will bring together researchers to develop machine learning capabilities in areas like automated information processing and decision support. AIML is also engaging with and financially supporting South Australian SMEs in adoption of machine learning and artificial intelligence based processes to improve productivity. Despite some exceptions, such as Australian start-up Seeing Machines (refer to the case study), Australian businesses in general have maintained low investments in artificial intelligence based automation, necessitating the need for an accelerated uptake to realize the associated benefits.

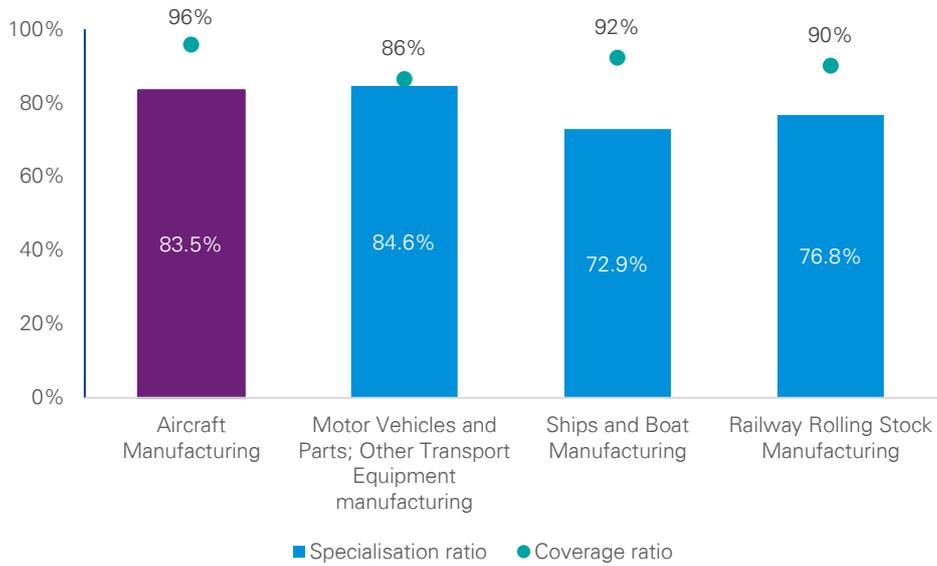
**Internet of Things (IoT)**, referring to the seamless coordination of large volumes of data from people, products and machines, is touted to transform the aerospace industry by bringing efficiencies across manufacturing, maintenance and operations. A particular application lies in predictive maintenance, which can improve the responsiveness of aerospace businesses by flagging equipment issues before maintenance is scheduled or required. Boeing Australia's recently developed data analytics system is set to provide predictive maintenance insights, to be first incorporated in BDA serviced CH-47F Chinook fleet. Australia's budding UAV sector can also reap potential benefits from greater integration of IoT. For example, Telstra is currently exploring the potential use of its long-range IoT networks to monitor vehicles like UAVs in Australia's low-altitude airspace, enable navigation through airspaces with high traffic volumes, or react to emergencies such as airspace closures in near-real-time.

Australia's start-up segment has also been pro-active in integrating IoT technology and space sector systems. For example, Fleet Space Technologies, an IoT nanosatellite technology start-up, was launched in 2015 before Australia's commercial space sector was established. Fleet's uses nanosatellites to connect the world's IoT devices to an industrial internet which can be used for tracking, monitoring or safety purposes at a low cost, across industries like agriculture, mining, oil and gas and maritime. Fleet's first commercial satellite launch in 2018, also a first for Australia received an overwhelming response for its cost-efficient and low-power industrial IoT solution to connecting devices, and secured funding to launch ten additional satellites by 2020. Another example, Myriota (a spin-out from the University of South Australia), also operates in the area of nanosatellite-enabled global connectivity for the IoT, and is expected to grow to a size of 50 employees by 2020. Myriota recently secured Boeing HorizonX Ventures' first outside of US funding to develop micro transmitters that could directly connect to satellites in orbit to enable secure information sharing.

Overall, Australia's Aircraft Manufacturing and Repair Services industry ranks high in technical expertise as well as provision of high value, specialised goods and services. In particular, as shown in Figure 2, the 'specialisation ratio' indicates that 83 per cent of this industry's output is made up of aircraft manufacturing products and repair services. In comparison to other transport industries, the Aircraft Manufacturing and Repair Services industry has a similar specialisation index to Motor Vehicle and Other Transport Equipment Manufacturing, but is relatively more specialised than the Ship and Boat Manufacturing and the Railway Rolling Stock Manufacturing sectors.

Being a specialised industry with high demand for technical expertise, Australian businesses in the Aircraft Manufacturing and Repair Services industry also have a high 'coverage ratio'. That is, 96 per cent of aircraft, parts and maintenance services are provided by the Aircraft Manufacturing and Repair Services industry itself (as defined by their primary output), as shown in Figure 2.

Figure 2: Specialisation and diversification of selected manufacturing sectors (2015-16)

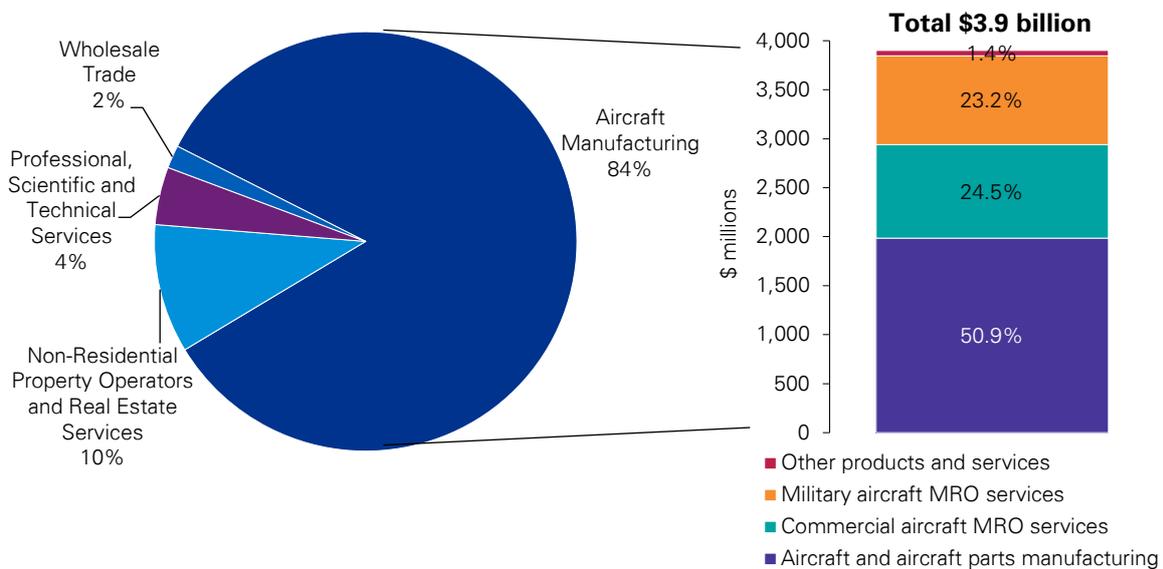


Source: ABS 5209.0.55.001, Table 19

Note: The specialisation ratio indicates how much of an industry's output is made up of that industry's product type. The coverage ratio indicates how much production is produced by primary manufacturers.

In 2017-18, Aircraft Manufacturing and Repair Services industry produced \$3.9 billion worth of aircraft manufacturing product, which comprised of nearly 84 per cent of the total industry output. A more detailed breakdown of goods and services within the aircraft manufacturing product can be seen on the bar graph in Figure 3.

Figure 3: Goods and services produced by the Aircraft Manufacturing and Repair Services industry (2017-18)



Source: ABS 5209.0.55.001 Table 1; IBISWorld; KPMG Analysis

While aircraft manufacturing output accounts for the largest share, the industry also provides non-residential real estate services; professional, scientific and technical services; and wholesale trade services. These goods and services are described as follows:

- Non-residential property operators and real estate services include units engaged in renting or leasing of airport real estate, airfields, hangar space etc.
- Professional, Scientific and Technical services include services provided by aerospace engineering and operations technicians. This may include testing as well as maintenance and repair of equipment, components and assemblies. Design consulting as well as research and development services are also included.
- Wholesale trade services include wholesaling of basic material, machinery and equipment for manufacturing processes as well as wholesaling of aircraft parts and components.

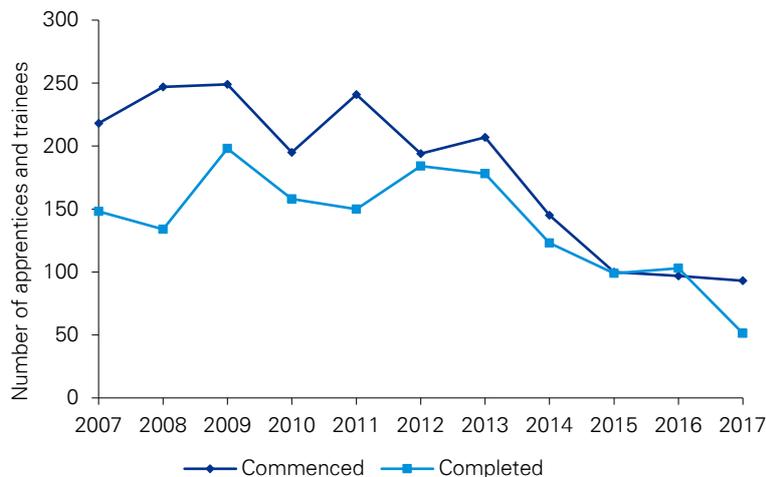
### Skills and training

Australia has high quality engineering and design skills within the aerospace sector. Business owners and senior staff are seen to have significant knowledge of the aviation platforms and a passion for the industry. However, industry representatives have indicated that retaining aviation specialists is proving to be a challenge, as the talent within the industry is not utilized to its full potential and they are often recruited by the prime contractors<sup>6</sup> supporting high-tech defence work. There is also a significant international outflow of workforce with technical expertise and skills within the aviation industry, to the detriment of the Australian sector. Regard for Australian skills and somewhat simpler regulatory systems overseas are encouraging designers, innovators and other skillsets to shift bases.

It was also noted that domestic qualifications and training do not completely align with the industry's requirements – especially overseas – further increasing the difficulty in accessing skilled resources. Thus, it is important to look at ways to expand and better maintain a pool of skilled workers across the Aircraft Manufacturing and Repair Services industry, to be able to sustain and meet the increasing needs of the aviation industry.

Figure 4 shows the number of apprentices and trainees in the Aircraft Manufacturing and Repair Services industry commencing or completing training between 2007 and 2017. There has been a declining trend in both the number of enrolments as well as completions by aerospace-related apprentices and trainees in the past decade, thus substantiating the concern expressed by industry stakeholders around increasing difficulties in finding skilled workers.

Figure 4: Apprentice and trainee enrolments and completions



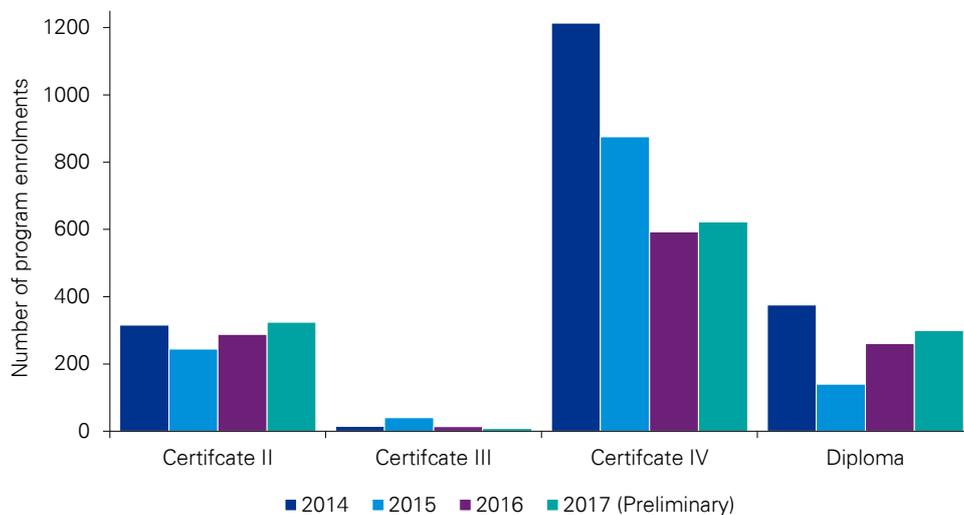
Source: NCVET Vocstats

<sup>6</sup> Prime contractor refers to large multinationals in the aerospace industry that manage contracts and integrate the work of many different businesses.

The MEA Aeroskills Training package provides qualifications at various levels in Avionics, Mechanical and Maintenance and other aeroskills. These qualifications are designed to meet civil and military aviation requirements when performing various maintenance activities, and are applicable to airline employees as well as operators of powered aircraft and helicopters. Figure 5 indicates the total number of enrolments in the MEA Aeroskills program for various qualifications in 2014-2017.

The highest share of enrolments in all years between 2014 and 2017 was for a Certificate IV qualification, which is an entry level requirement for the industry. However, the number of enrolments for this qualification has halved over the past few years. In comparison, while the number of enrolments in Certificate II and Diploma qualifications are a much smaller share, the 2017 enrolments in these two courses combined are at a similar level to their 2014 levels. Interestingly, in 2017, enrolments in the Certificate IV fell to the same level as the combined enrolments for the Certificate II and Diploma.

Figure 5: Total enrolments in the MEA Aeroskills program by qualification level



Source: NCVET VOCSTATS

Note: 2017 values are preliminary published data.

Both industry stakeholders and survey respondents have commented on challenges around the availability of skilled workers in sufficient numbers. With technological advancements taking place, there are also concerns that a lot of the 'blue-collar artisan skills' are being missed as people gravitate towards university courses. TAFE courses are considered very favourable for much of the workforce in this industry as they generally include both theoretical qualifications and practical training, making students more "work-ready" for Apprenticeship Programs, such as those run by various airlines. Also, industry representatives have expressed the need to harmonise training and adopt international training standards to ensure recognition of domestic qualifications for overseas work.

A review of Australia's global competitiveness in the AMGC's Sector Competitiveness Plan highlights the need to promote STEM subjects and attract more workers into manufacturing. In particular, this Plan indicates that Australia's high labour costs make it difficult to compete globally, particularly for low-skill jobs. Although Australia holds a wage cost advantage for high-skilled workers, it is undermined by low labour productivities in manufacturing. This is attributed to the industry's large share of small scale businesses, resulting in relatively inefficient production processes due to costs spread over smaller volumes of output. A shortage of skilled and technology sound personnel at the manager level also feeds into lower uptake of automation and Industry 4.0 processes.

There is increased recognition of the need to attract and retain engineering talent, with some progress made as demonstrated in the newly set-up Australian Space Agency that is designed to attract bright students with technical skills into the industry. The Defence Industry Skilling and STEM Strategy is also a step towards training the future workforce in the required fields. While such

government strategies define the broader industry focus, collaborative work done by startups has set the ball rolling in the right direction. JAR Aerospace, a technological startup, believes in the need for a young, enthusiastic workforce to drive the industry forward. It has partnered with UNSW's ARC Training Centre for AMAC on R&D and has also initiated an educational branch, JAR Education, separate to its commercial operations. This branch works with school students in a hands-on learning environment, to develop their understanding of drone science and stir their interest in STEM branches.

In spite of some degree of labour migration between the defence and civil sectors, they are mutually supporting sectors in terms of meeting skill requirements. It was noted during consultations that, in fact, the civil and defence sides of the market keep each other's skills base refreshed. For instance, there is reduced defence training in skills like metal work, electronics and the like, while this is now a civil focus. Having a common workforce thus enables one sector to leverage the skill set of another.

While a VET certification does equip individuals with the necessary qualifications and skills to enter the Aircraft Manufacturing and Repair Services industry, obtaining a university qualification also retains its appeal and importance. In 2016-17, of the total workers employed by the Aircraft Manufacturing and Repair Services industry, approximately 1,100 (or only 15 per cent) had a VET qualification (majorly Certificate IV), while the remaining 85 per cent were university graduates.<sup>7</sup> Individuals with higher education in engineering are considered to be well-qualified and highly employable, and thus are sought after not just by the Aircraft Manufacturing and Repair Services industry, but also by other industries.

Figure 6 lists the top six qualifications in the Aircraft Manufacturing and Repair Services industry (indicated in the blue boxes, as measured by the share of all those employed in this industry). It then identifies the major other industry competitors for these skills.

Figure 6: Top five industry competitors for top aerospace qualifications (2016)

<b>Aerospace Engineering and Technology</b>	<b>Air and Space Transport (19%)</b>	<b>Defence (6%)</b>	<b>Transport Equipment Manufacturing (5%)</b>	<b>Transport Support Services (2%)</b>	<b>Other Transport (1%)</b>
<b>Engineering and Related Technologies, nfd</b>	<b>Oil and Gas Extraction (14%)</b>	<b>Repair and Maintenance (11%)</b>	<b>Transport Equipment Manufacturing (10%)</b>	<b>Machinery and Equipment Manufacturing (10%)</b>	<b>Petroleum and Coal Product Manufacturing (10%)</b>
<b>Business and Management</b>	<b>Administrative and Support Services, nfd (16%)</b>	<b>Administrative Services (14%)</b>	<b>Insurance and Superannuation Funds (13%)</b>	<b>Finance (13%)</b>	<b>Public Administration (13%)</b>
<b>Mechanical and Industrial Engineering and Technology</b>	<b>Primary Metal and Metal Product Manufacturing (25%)</b>	<b>Fabricated Metal Product Manufacturing (21%)</b>	<b>Mining, nfd (16%)</b>	<b>Coal Mining (15%)</b>	<b>Petroleum and Coal Product Manufacturing (14%)</b>
<b>Electrical and Electronic Engineering and Technology</b>	<b>Electricity Supply (30%)</b>	<b>Telecommunications Services (17%)</b>	<b>Construction Services (13%)</b>	<b>Electricity, Gas, Water and Waste Services, nfd (11%)</b>	<b>Machinery and Equipment Manufacturing (11%)</b>
<b>Automotive Engineering and Technology</b>	<b>Repair and Maintenance (27%)</b>	<b>Motor Vehicle and Motor Vehicle Parts Retailing (15%)</b>	<b>Motor Vehicle and Motor Vehicle Parts Wholesaling (14%)</b>	<b>Transport Equipment Manufacturing (6%)</b>	<b>Road Transport (5%)</b>

Source: ABS 2016 Census

In 2016, workers with a qualification in Aerospace Engineering and Technology formed 37 per cent of the Aircraft Manufacturing and Repair Services industry's workforce. At the same time, the biggest competing industry for these qualifications was the Air and Space Transport industry, accounting for 19 per cent of all workers with these qualifications in 2016.

<sup>7</sup> NCVER VOCSTATS; ABS Census

Other engineering graduates, such as those specialising in Mechanical and Industrial Engineering are highly sought after by the Metal Product Manufacturing and Mining industries. Specialists in Electrical and Electronics Engineering are often employed by the Electricity services industry, while Business and Management skills support the Administrative and Finance industries as well.

## 2.2. Company innovation and investment in research and development

The Aircraft Manufacturing and Repair Services industry is a technologically intensive industry. The production processes and inputs in this industry meet stringent safety requirements and require the scales to balance between cost, efficiency and reliability. This warrants the perpetual need for innovation in order to remain technologically ahead and globally competitive. Industry stakeholders made note of Australia's strength in its high safety standards and a commitment to providing superior and innovative products despite limited resources (trained staff and equipment).

It is believed that the key drive to innovate should be to meet market demands and leverage new opportunities in niche markets, which can eventually be commercialized. For instance, GippsAero initially found a niche market for 8-seater aircraft and, as customers requested improvements to the aircraft, has continued to redevelop its product – such as introducing a turbocharged version – to meet these needs.

The presence of three key aerospace R&D institutions in Victoria speak to Australia's excellence in innovation. The Defence Science and Technology Group's Aerospace Division in Melbourne provides essential support and technical advice on the Australian Defence Force's (ADF) aircraft platforms. In addition, the Defence Materials Technology Centre undertakes aerospace R&D to address industry challenges and support commercialisation of technology, while the Defence Science Institute facilitates defence aerospace research. The domestic defence industry's innovation potential has received considerable support, with total funding of over a billion dollars reserved by the Defence Innovation Hub and Next Generation Technologies Hub over the decade to 2025-26. These investment initiatives aid innovation in future technologies, exemplified by the recent win of over \$1.2 million in contracts by three Australian businesses, developing lightweight armour solutions and combining features of a helicopter and fixed wing aircraft to build efficiency. As part of the government's Industry Growth Centre Initiative, AMGC is delivering the Advanced Manufacturing Early Stages Research Fund (AMESRF) to provide up to \$1 million per year from 2017-18 to 2020-21 for small-scale and pilot research projects with a feasible potential to boost Australia's capability in advanced manufacturing processes.

Innovation can be measured by the amount of R&D taking place in a country. Industry consultations indicate that this activity is not observed much industry-wide in the Aircraft Manufacturing and Repair Service industry. The incentives to engage in R&D are largely driven by the existing technology base of a business and profits. Aircraft Manufacturing and Repair Services lie at the high technology end of the spectrum. This keeps companies self-motivated to engage in R&D in order to improve process efficiencies and innovate to create points of differentiation over competitors. For example, Quickstep, Marand, and Boeing Aerostructures have all recognised the importance of improved technology to remain at the forefront of the market.

Further, due to the high costs of engaging in R&D and the generally long payback times, it mostly remains in the ambit of larger companies that have the resources to allocate to new innovations. Many small businesses develop new technologies to meet ever changing activities in their business, but they are not generally capitalized sufficiently to procure new technology products that could improve their business capability. It is believed that tax incentives and access to funding and R&D support for the industry can incentivise more players and stimulate the sector.

The government provides an R&D tax incentive to businesses to encourage a higher spend on research and innovation. Reforms to the scheme, following its review, are aimed at providing a reasonable cash flow support to small firms with an annual turnover of less than \$20 million.

Moreover, government initiatives such as the Defence Innovation Network, which facilitates partnerships between the NSW Defence industry and universities, is an opportunity for businesses to accelerate R&D activities and deliver innovative technologies. Another significant initiative is the Australian Research Council (ARC) Training Centre for Automated Manufacture of Advanced Composites (AMAC) at the University of New South Wales, which aims to forge industrial partnerships that unlock Australia's capability and build international competitiveness in advanced manufacturing.

It is recognised that the Australian Aircraft Manufacturing and Repair Services industry is not a traditional manufacturer, like some of the big players in the market, but instead has a solid problem solving capability. This includes adopting existing technology in the market, modifying it to enhance its use and "making it our own". This ability has helped the Australian Aircraft Manufacturing and Repair Services industry endure in spite of intense competition, thus making survival another one of its key strengths.

Overall, the 'air and spacecraft and related machinery sector' in Australia allocates considerable funds towards R&D, estimated at AUS\$35.6 million (or US\$23.6 million) in 2011 according to the OECD's Analytical Business Enterprise Research and Development (ANBERD) database.

The two figures on the following page show the annual R&D expenditure in the 'air and spacecraft and related machinery sector' by different countries over 15 years. It can be seen that the level of R&D spending in this sector in Australia rose between 2004 and 2006 and has declined significantly since then to just over US\$20 million in 2011. In contrast, other countries (such as Canada, Japan, Spain, Poland and Belgium) have been steadily increasing their R&D expenditure in the aerospace sector over the past decade, with Canada (as an example) investing in excess of US\$120 million in recent years.

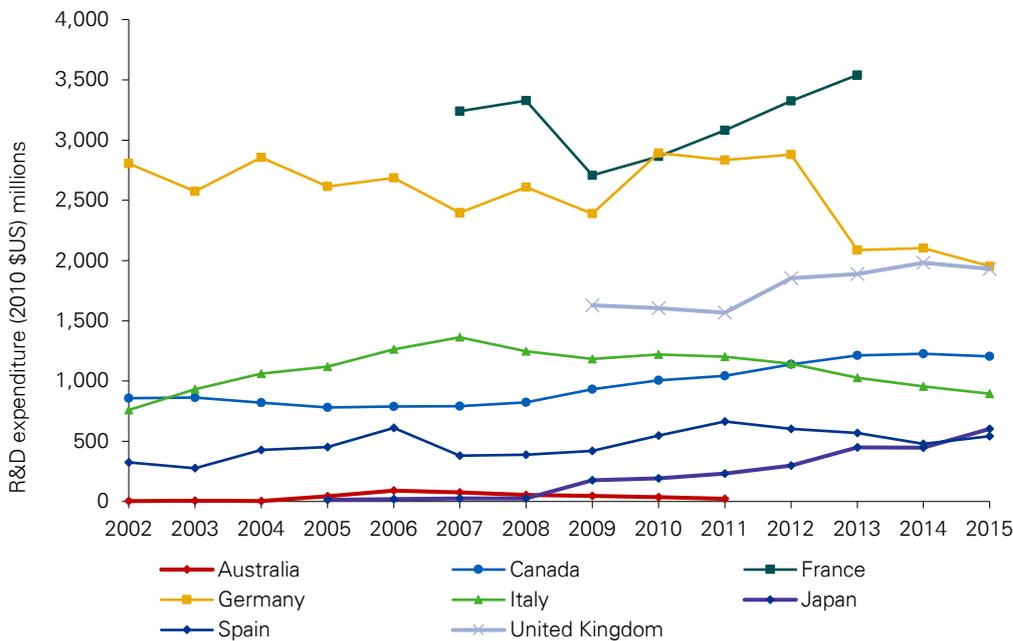
Of the big R&D investors in this space, the US is by far the largest and has maintained aerospace R&D investment at around US\$25 billion since 2011. France continues to grow its aerospace R&D spending (reaching \$3.5 billion in 2013) and while there has been a lot of variation in R&D investment by Germany and a decline in recent years, its levels of R&D investment in aerospace still remains significantly ahead of the other countries matching the United Kingdom's spend of around \$1.9 billion in 2015.

Another measure of R&D, the 'R&D intensity index', provides an indication of the amount invested in research and development relative to the gross value added by the Aircraft Manufacturing and Repair Services industry. Under this index, this industry is classified as a high R&D intensity industry based on average investments across OECD countries.<sup>8</sup>

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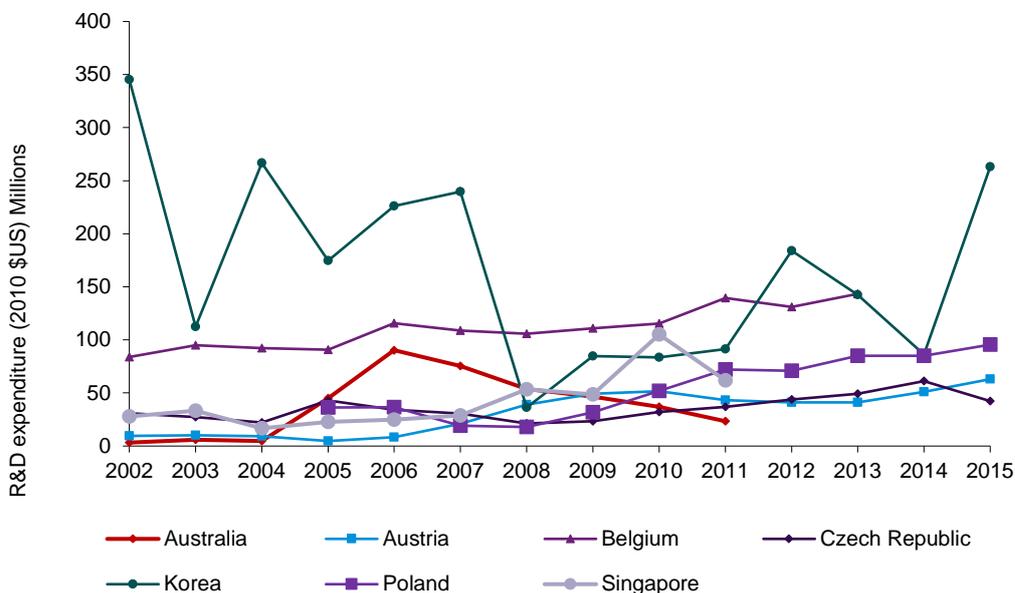
<sup>8</sup> Galindo-Rueda, F. and F. Verger (2016), "OECD Taxonomy of Economic Activities Based on R&D Intensity", OECD Science, Technology and Industry Working Papers, 2016/04, OECD Publishing, Paris

Figure 7: Annual R&D expenditure in air & spacecraft and related machinery sector by country (Australia plus the top 7 excluding the US)



Source: OECD ANBERD database, Galindo-Rueda, F. and F. Verger (2016) <sup>9</sup>

Figure 8: Annual R&D expenditure in air & spacecraft and related machinery sector by country (Australia plus the remaining 6)



Source: OECD ANBERD database, Galindo-Rueda, F. and F. Verger (2016) <sup>10</sup>

<sup>9</sup> Galindo-Rueda, F. and F. Verger (2016), "OECD Taxonomy of Economic Activities Based on R&D Intensity", OECD Science, Technology and Industry Working Papers, No. 2016/04, OECD Publishing, Paris.

<http://dx.doi.org/10.1787/5jlv73sqqp8r-en>

<sup>10</sup> Ibid

Notwithstanding moderate investments at an individual business level, Australia's Aircraft Manufacturing and Repair Services industry is regarded for innovative products and practices. A likely driver for this is Australia's increasing industry collaborations with research organisations and universities that fosters product development through translation of academic excellence into industry and commercial opportunities. These industry-academia partnerships and encouragement for entrepreneurial activities through university startup support programs have also seen Australia's startup economy gain momentum in the past decade, opening new doors for the industry in niche untapped sectors such as UAVs, agritech and the space sector. Example include the following.

- JAR Aerospace, a tech start-up operating out of two facilities in Sydney, has made a successful launch into the UAVs space in less than two years since its inception in 2017 and aspires to enter Australia's promising space industry in the next five years. The business develops UASs for commercial applications, with a clear focus on the defence sector. In 2018, the company secured a Defence Innovation Hub contract from the Australian Army to develop a vertical take-off and landing (VTOL) fixed-wing UAS.
- Demonstrating the importance of university support for entrepreneurial initiatives to flourish, Flurosat was born out of a pilot program at the University of Sydney. This program is designed so that university students can work on real-world problems. In the case of Flurosat, the program helped facilitate a cross-disciplinary application of aerospace technology to improve food security. Specifically, Furosat is an ag-tech start-up that uses satellite imaging to monitor crop health and thus inform resource management by farmers. Having won a number of government grants, Flurosat most recently secured a \$3 million Cooperative Research Centres Project (CRC-P) grant, which will help the business make data insights more accessible for agricultural use.

A further area for innovation in Australia is the space sector. Amid a burgeoning global space sector, the launch of the Australian Space Agency in 2018 has provided the much-needed entry into space for Australia, with the apex body intended to provide financial and legislative support as well as promote Australian space capabilities on a global platform. With Australia's demonstrated and varied aerospace capabilities, it stands to reason that this know how can be built on to not only expand the domestic space industry, but also access new global supply chain opportunities. The broad spectrum of capabilities required along the space supply chain presents opportunities for Australia's large proportion of SMEs in the aerospace sector. Companies involved in manufacturing aerospace vehicle components or other products as well as those employing manufacturers, precision engineering enterprises, transportation companies, fuel and chemical suppliers, resources companies, construction firms, telecommunication specialists and associated service providers all possess existing skills and expertise that are adaptable and transferrable to an emerging space sector. In addition, manufacturing skills and technological expertise in advanced manufacturing, 3D printing, high-tech materials, earth observation, remote asset management and robotics are easily applicable in developing space-ready technology.

The space industry is synonymous with specialist and advanced technology as well as high product standards delivered under a tight regulatory framework, thus making the aerospace industry well placed to cater to this emerging sector. The aerospace experience with meeting strict aviation regulations and its expertise in air and space law and air traffic management could be beneficial in navigating space-related regulatory frameworks and fulfil a foreseeable need for space traffic management.

The presence of a highly skilled workforce and a strong research base in both civil and military aerospace sectors could help spearhead Australia's growing space sector, while potentially limiting the migration of Australia's engineering talent to more advanced and established space sectors in US, UK and Canada. Australia is believed to have a strong hold in communications technology and space services like situational awareness, ground stations which could help cover the gap with other countries.

A number of big aerospace players like Boeing, Airbus and Northrop Grumman are involved in the global space segment. Growth in the Australian space sector could incentivise them to expand their

current Australia operations. Moreover, Australia's developing space sector is attracting up-and-coming start-ups to explore its commercial aspects. For example, Queensland spacetechnology start-up, Gilmour Space Technologies, is a launch provider that supplies hybrid rockets for the small satellite industry. This start-up's innovative and low-cost manufacturing capability has enabled it to secure AU\$19 million of funding to launch its first commercial rocket into space by 2020. It is the first Australian start-up to sign a Space Act agreement with NASA on collaboration projects. Whilst doing commercially well, the business flags potential challenges for the space sector in Australia in terms of high launch permit costs and limited launch opportunities.

Overall, early stage businesses have received immense support from government and university seed funding, thus enabling them to sustain and thrive in the capital-intensive aerospace and space sectors with high-quality infrastructure requirements. However, in general, industry stakeholders believe that the importance of reaching out to innovation and research when facing a business problem does not yet appear in-grained in the local industry. Industry sees opportunity in further developing an innovative culture across the whole industry and believes this can help develop more competitive and sustainable businesses. Strategic procurement from military/government is also seen as an opportunity for the industry, with knowledge transfers from these projects assisting the industry on a path to success.

## 2.3. International markets and supply chains

As the current wave of globalisation rides high, integrating into global supply chains of the big aircraft manufacturers and delivering value services to global customers is essential for the Aircraft Manufacturing and Repair Services industry to sustain itself.

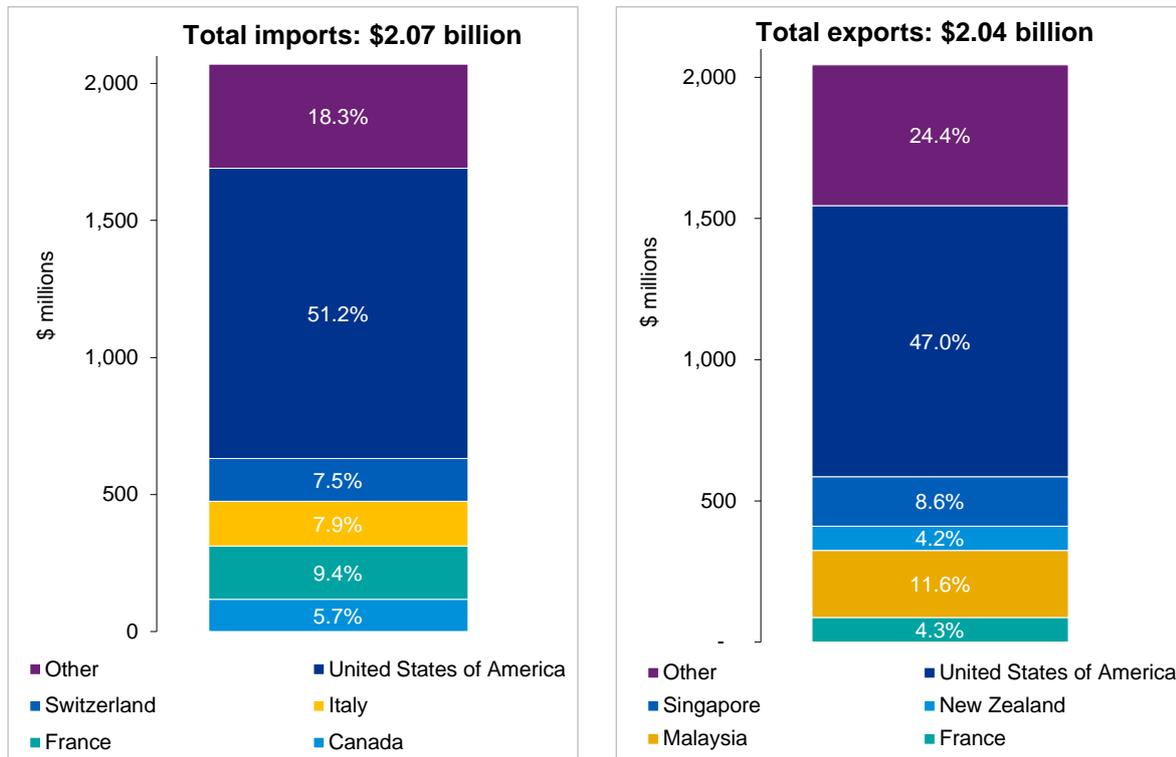
Australian companies are not generally 'one stop shops' and the physical distance from the market place presents additional hurdles for Australian businesses. For example, being part of an international supply chain brings complications associated with communication (different time zones) and distance to market. Although geographical barriers cannot be removed, efforts in building trust with prime contractors and establishing a reputation of proven performance has been key to overcoming some of these challenges. For instance, companies such as Marand and Quickstep are both successfully integrated into prime contractor global supply chains.

Additionally, the global manufacturing sector's digital transformation has seen AMGC actively involved in promoting the creation of Australia's brand equity. It believes that building global competitiveness warrants a shift away from traditional manufacturing towards innovation and ramping up pre and post-production services including design, engineering, sales, logistics, and packaging.

Industry representatives and survey respondents indicate that Australia is not a low-cost manufacturer relative to the rest of the world, attributed in part to high labour costs. This makes it more efficient for businesses to import some of their inputs (upstream) into the Aircraft Manufacturing and Repair Services industry than for these components to be produced domestically.

Figure 9 indicates the top five countries from which Australia imported aircraft, spacecraft and aircraft parts in 2017-18. It can be seen that half of Australia's imports are from USA, being the biggest aerospace industry in the world. A large share of the imports included parts of aeroplanes or helicopters excluding propellers, rotors and under-carriages. Aeroplanes and other aircraft (unladen weight between 2,000kg and 15,000 kg) as well as air combat simulators were also a significant share of imports. A moderate share of imports also come from France and Italy, supplying \$194 million and \$163 million worth of aircraft products to Australia respectively, in 2017-18. Imports from these two countries included helicopters of an unladen weight less than 2,000kg as well as parts of aeroplanes and helicopters.

Figure 9: Top five import and export countries for Aircraft Manufacturing and Repair Services, 2017-18



Source: ABS 5368.0 & UN merchandise trade data on DFAT STARS database  
 Note: 2017-18 values are preliminary published data.

Turning to downstream (sales), Figure 9 indicates that the United States was Australia's largest export partner as well, accounting for 47 per cent of the total exports in 2017-18. Industry stakeholders noted Australia's capability in manufacturing parts, components, engines and supplying these to the big aircraft manufacturers based overseas for assembly. This concurs with the ABS international merchandise export data,<sup>11</sup> which shows that parts of aircraft or helicopters (excluding propellers, rotors or the like) account for 86 per cent of Australia's total exports from this industry in 2017-18 to other countries. After the U.S., Malaysia, Singapore and France were Australia's major export destinations, together accounting for a quarter of the imports share. New Zealand is also a purchaser of helicopters and aeroplanes (unladen weight between 2,000kg and 15,000kg) from Australia, with total exports to this country worth \$86 million in 2017-18.

Conversations with stakeholders in the Aircraft Manufacturing and Repair Services industry have highlighted the strong competition faced by small suppliers at the Tier1 & Tier2 level for a place in international supply chains of the Primes. Australia's cost disadvantage puts further pressure when competing with Asian markets, like China and Singapore, which are major competitors to local businesses for high-volume and cheaper products. While the large big OEM's like Boeing, Airbus, and Lockheed Martin are the dominant players in aircraft manufacturing, the growth of some Australian home-grown manufacturers has earned accolades for the Australian aerospace industry. These include:

- GippsAero – Based at LaTrobe, this Australian commercial aircraft manufacturer builds single-utility aircraft. Its piston-powered GA8 as well as turbine-powered GA10 aircraft have been a success in the export market among private and commercial users alike. Airvan 10 is the first of its type single engine turboprop-type certified aircraft manufactured in Australia.

<sup>11</sup> ABS 5438.0, International merchandise exports (2011-12 to 2015-16)

- Jabiru – renowned for manufacture of light sport aircraft as well as aircraft engines, propellers. It has a strong international presence with customers including recreational flyers and flight training facilities.
- Airborne – specialise in the manufacture of ultralight aircraft, hang gliders and sport planes. Its CASA approved micro lights are exported to various countries for use in general aviation as well as the commercial sector.

## 2.4. Growth opportunities and barriers

The Australian Aircraft Manufacturing and Repair industry has unique capabilities, yet lacks a strong global foothold, with some key perceived challenges raised by industry representatives and survey respondents alike. Nevertheless, with a competitive Australian dollar at the moment and widespread recognition of the domestic potential to enter untapped markets like space sector and UAVs, business and industry representatives generally see opportunities and a positive outlook for the industry.

### Industry challenges

The Australian regulatory framework was identified as one of the biggest challenges to businesses operating in the aerospace industry. Industry stakeholders qualified their comments around regulatory burdens by recognizing that this challenge is multifold and exists from both the business and regulation perspective.

- The regulatory system established in 1998 is currently undergoing updates to better align with international frameworks. The need for change has been recognized, and the regulatory body is working to introduce appropriate changes while continuing to be mindful of ensuring aviation safety and economic balance for the industry. As this has meant a more drawn out process for change, this has added the challenge of keeping people engaged in the process.
- While there has been increased efforts to harmonize legislations with best practices around the world, it is still not seen as a level playing field. International certifications like the FAA in US and EASA in Europe are recognised in Australia, but Australian certifications are not given the same recognition globally (aircraft, parts, and components). In the MRO space, businesses have indicated that some primes have put in “drive downs”, requiring SMEs to be compliant with international quality and security requirements. This presents a large challenge for the industry. Without harmonisation, businesses see it as a significant challenge to conduct operations globally. For example, businesses indicated that obtaining the required accreditations to be a part of the global supply chain can be a 10-year journey, during which domestic players in aircraft manufacturing stand the risk of missing out on opportunities.
- A key recommendation from most consultations was for more work to be done with other international aviation authorities to achieve mutual recognition and uniformity in standards.

Businesses feel that there is only modest government support for the traditional sector and that red tape from local government can impact on operators’ ability to expand into new premises, if required. Aircraft manufacturing developments, like *Aerotropolis* in Western Sydney, tend to rely heavily on big Primes to develop and maintain capability within Australia. An industry participant indicated that they would like to see greater government support in attracting higher volumes of work on-shore and enhancing visibility for businesses in the domestic and global market, like the support observed in the U.S., New Zealand and Europe

Our survey respondents also expressed concern over regulatory changes being extremely expensive and time consuming. The sector that appears sensitive to this is Australia’s General Aviation (GA) sector, which covers all flying activity in Australian-registered aircraft except commercial air transport. In particular, a ‘one size fits all’ regulatory approach has caused concern in this sector, as some of the changes applied to all aircraft are not believed to be appropriate for smaller GA aircraft.

The GA sector is also facing increasing maintenance costs associated with an ageing VH-registered aircraft fleet, with an average age of 32.3 years,<sup>12</sup> which is making it harder for businesses to sustain themselves. As the GA sector of the industry is contracting, industry representatives warn of the flow-on effects of not addressing this issue. It is believed that government has a role to play in terms of working with Primes to forge long-term partnerships and develop a genuine strategic approach to attract new technologies and investment to support local businesses.

Additionally, the Aircraft Manufacturing and Repair Services industry is grappling with a shortage of technical talent, expected to worsen in the future. Stakeholders indicate that it is getting increasingly difficult to attract and retain young apprentices in the (already limited) training and apprenticeship programs. It is also believed that current education and training for the new workforce could be better aligned to industry needs. A shortfall of skilled engineers and mechanics is a challenge for businesses.

Human capital is a valuable resource for an industry as specialized and technologically intensive as the aerospace industry, thus a double whammy of an ageing workforce and potential shortage of skilled personnel in Australia is raising alarms. Australia's larger defence budget and an expected doubling of air traffic in the Asia-Pacific region over the next decade is anticipated to generate higher demand for carriers as well as maintenance services, thus building the pressure to deliver. Concerted efforts in providing new and adequate facilities for skills training and STEM programs is imperative to sustain the industry in the long run. Also, there is a need to harmonise training and adopt international training standards to ensure recognition of domestic qualifications for overseas work.

## Future prospects

Whilst the aerospace industry is battling against some immediate challenges, our industry consultations highlight that saturation of some of the traditional sectors, like GA, has been a significant factor in the start of a generational process of change in terms of exploring new opportunities.

Ranked amongst the best in the world, Australian universities and organisations like CSIRO present significant opportunities for translation of research output into useful industry tools. Owing to Australia's niche capabilities, industry representatives see potential in diversifying away from traditional manufacturing into non-conventional sectors within the industry, like the UAV segment and robotics. The Defence Industry Policy Statement and National Innovation and Science Agenda (NISA) reflect steps taken to embrace collaboration and innovation in the industry. The AMGC promotes a collaborative model for Australia's manufacturing sector, taking steps in bridging the gap between manufacturers and universities and facilitating dialogue.

Opportunities outlined in the 2016 Defence White Paper are reaching fruition through the recently announced AIR 7003 program, a collaboration between General Atomics-Aeronautical Systems Inc. (GA-ASI) and their Team Reaper Australia (TRA) to supply Australia's future medium-altitude long-endurance (MALE) armed UAS. This joint venture has not only enhanced the ADF's intelligence and surveillance capabilities – one of the priority areas identified in the 2016 Defence White Paper – but also opened doors for the defence industry to provide logistics, operational and maintenance support for long-term sustainment of airframes, weapons systems, communications infrastructure and ground stations.

With growth in Australia's startup culture, there are increasing employment opportunities for the youth who are able to reach out to their university networks. However, aerospace representatives expressed the need to develop more business-industry and industry-academia partnerships between universities, research organisations, private sector and government to be able to export our problem-solving capabilities in the global market.

Australia is not a low cost provider of services, attributed in part to the high costs of labour in Australia. This means that the Australian MRO businesses tend to be localised, rather than exporters.

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<sup>12</sup> Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2017, General Aviation Study

As modern aircraft have lower maintenance requirements, payback times on investment for domestic MRO companies is much longer. At present, a significant proportion of Australia's airline and aerospace maintenance work is outsourced on grounds of cost-saving. However, going forward, as the manufacturing and maintenance processes become more automated, the challenge associated with higher labour costs is expected to diminish. Competitive gains have been identified in building and capitalising Australia's aircraft maintenance and training capabilities across general aviation, commercial airlines and the ADF.

Largescale MRO operations in Australia including Boeing Australia Component Repairs (BACR), provision of MRO services to Tigerair by BAE Systems, as well as valuable maintenance skills within Australia's SME segment, makes a good case for bringing back some of the maintenance work to Australia and meeting its domestic needs. There is competition for work at the regional level, including capability in Williamstown to support the Defence JFS program for other countries. Specialised independent third-party MRO organisations like the Hawker Pacific MRO facility at Cairns International Airport demonstrates Australia's capabilities to service single-aisle domestic carriers and small planes used for regional Regular Public Transport (RPT) in Australia. Industry also indicates that consideration should be given to expanding these maintenance hubs to service the wide body segment, as wide bodies continue to find increased presence on domestic routes. State governments have actively promoted regional MRO activity through establishment of maintenance clusters, for example the joint defence/civil facility at Townsville and a diverse aviation maintenance base at Cairns, providing aviation and avionics services to domestic, international and GA sectors. There is also the Australasian Aviation Group – Cairns (AAG-C), which encompasses an industry cluster of aircraft maintenance facilities, a training centre and specialist support services. In addition, the prospect of making Australia a regional service training hub for heavy maintenance and aircraft on the ground (AOG) services presents a possibility of further economic gains in the maturing helicopter, regional jet and business jet markets. Given countries like China are incipient in the broader GA sector, Australia could secure a first-mover advantage if it fitted out export services for ground maintenance and GA maintenance training. Recognising gaps in Australia's current MRO offerings and a spare capacity, Heston Aviation recently acquired Aircraft Maintenance Services Australia (AMSA) to develop an independent one-stop MRO company in Australia, expanding its services beyond line maintenance to include component and engine solutions as well as heavy maintenance to a certain extent. It is believed to be well-positioned to support mid-sized to small and regional airlines.

Boeing Aerostructures Australia's Fishermans Bend factory in Victoria. Attribution is Woodrow Wilson.



## CASE STUDY

### Boeing

Establishing its largest offshore presence in Australia and being invested in matching export opportunities to domestic capabilities, Boeing has played a pivotal role in bringing competent Australian SMEs to the global forefront.

As the world's largest aerospace enterprise, Boeing is an unprecedented brand in the global aerospace industry. With a heritage spanning more than 90 years in Australia, this region is home to the business's largest operation outside of the US. More than 3,000 workers employed across 27 locations in Australia support the company's broadest portfolio of products and services, including advanced composite components manufacturing, design and development of defence systems, research and development, platform support and training.

In 2007, Boeing's Office of Australian Industry Capability (OAIC) was opened in Washington, reflecting the company's continued support for the Australian aerospace industry. The OAIC was established to increase the scope for Australian enterprises to bid for business opportunities within Boeing's commercial and defence programs as well as supply chains of other tier one and tier two manufacturers.

#### Pushing Australia's global capabilities

In response to Australia's move away from providing industry offsets, the former Defence Materiel Organisation (now Capability Acquisition & Sustainment Group) introduced

the Global Supply Chain (GSC) program. This program has been designed to bring Australian businesses into international supply chains and to help build the domestic industry's global profile. This government funded program helps introduce export opportunities to Australian small- and medium-sized enterprises (SMEs) that have a capability, product or service that could potentially meet commercial needs of prime defence contractors ("Primes"). Of the seven global defence multinationals that are currently contracted in to the GSC program, Boeing was the first one to sign up in 2009, with the OAIC playing a pivotal role of identifying competent Australian SMEs for the program.

The OAIC's initial focus was on assessing technological capabilities in Australia by having Boeing personnel tour various Australian company sites and by facilitating visits by Australian businesses to the US to introduce these companies to Boeing and its sub-contractors. It also hosted capability conferences for Australian SMEs to demonstrate their technological expertise and skills in advanced composite manufacturing, metal sheeting, and modelling and simulation, and brought top executives to visit the production facilities of select Australian companies.

Training and development activities have been crucial elements in uplifting the global competitiveness of Australian SMEs. In particular, the OAIC provides marketing assistance to domestic suppliers by identifying export opportunities. It then helps Australian

SMEs market themselves globally to the primes by refining their skills in presentations, proposal writing and effective communication. It also provides essential aerospace-focussed training and mentoring in areas such as Lean manufacturing, modelling simulation tooling, quality assurance and high speed machining skills. Additional training opportunities include Program Management courses that Boeing offers through the Boeing Leadership Centre complex located in the US, which is designed to help improve compliance with international quality standards.

The OAIC and Boeing's Australian subsidiaries work hand in hand to identify opportunities with Australian SMEs and engage high-performing suppliers across both its Australian and global supply chains. Boeing's local profile and engagement with industry enhances the opportunities available to Australian businesses within the Boeing ecosystem.

In addition, Boeing has made significant investments in setting up a local state-of-the-art surface treatment processing facility. This facility allows for aerospace components to be chemically treated, tested and painted as part of the manufacturing process requirements. This means that Australian exporting companies no longer need to ship parts overseas (to California, for example) for processing, return the processed parts to Australia and then ship the end product. These local facilities not only provide significant savings in shipping costs, but also provide local supplies that meet Boeing standards.

#### **Boeing's engagement with Australian SMEs**

Boeing counts on its extensive supplier network to remain true to its reputation of delivering value products and services to its global customers. In support of Boeing's aerospace products and services, suppliers are required to obtain an AS9100 certification before they can be contracted to manufacture parts or products. The investment required to obtain this international standard means that only those manufacturing organisations that meet the high standards required for aerospace applications find their way into Boeing's supply chain. Nevertheless, Boeing encourages technologically proficient companies without certification to seek aerospace work opportunities with large domestic companies

that have their own certification (and thus the restrictions may not apply as subcontractors).

Boeing Defence Australia (BDA) provides sustainment services, training and capability upgrades to all Boeing military aerospace products in Australian service including the Wedgetail E-7, C-17 Globemasters, F/A-18F Super Hornets and CH-47 Chinooks. It is also the prime contractor for the design and delivery of the Helicopter Aircrew Training System (HATS), and is an Original Equipment Manufacturer for complex defence ground-based systems such as Vigilare, Currawong Battlespace Communication System and the Defence High Frequency Communication System. BDA engages an extensive network of SMEs in all related specialist fields and advises relevant SMEs on compliance with Defence security and regulatory requirements. Boeing credits Australian SMEs with being well placed to win long-term contracts. Such work engagements have proven beneficial for Boeing in terms of lowering its overall costs and lead times, and agility in working through fast design-build cycles.

Boeing Australia (including Boeing Aerostructures Australia, BDA, Boeing Research & Technology – Australia, Insitu, Aviall, and Jeppesen) has a significant local presence, which provides more direct visibility of the Australian supply chain's performance, and allows stronger collaboration in addressing supplier challenges in real time or taking advantage of opportunities as they arise. The knowledge of having readily available expert advice also provides Australian SMEs with the confidence to take calculated risks and to work with Boeing on international contracts. As an added advantage, the time difference between Australia and the US allows work to be done round the clock at both ends.

In an effort to remain cost competitive, Australian businesses exporting their goods and services internationally have made efforts in honing their innovation, automation and streamline operations to reduce their logistical costs, resulting in some truly innovative and world-class local businesses. Their agility and their can-do, have-a-go attitude means the often really tough challenges can be overcome by engaging Australian SMEs. However, when it comes to aerospace applications, the limited number of businesses with AS9100 certification represents a constraint.

As part of Australia's innovative aerospace industry, SMEs are adept at reinventing existing technologies and processes to offer unique manufacturing capabilities. While these home-grown work strategies of domestic SMEs present high quality product/solutions to Boeing, the experience of this working environment also provides learning opportunities for Boeing.

### **Tapping into Australia's unparalleled research competence**

Australia's skilled workforce, including graduates from Australian universities such as Royal Melbourne Institute of Technology, Queensland University of Technology and University of Sydney, are well qualified and highly employable for aerospace industry jobs in areas including design, cybersecurity, and composites and machining. Boeing's continued engagement with Australian universities indicates a recognition and support for further development of domestic aerospace and Defence capabilities.

Following major investments in manufacturing upgrades at its facility in Melbourne, Boeing set up an Australian branch of Boeing Research & Technology (BR&T-A) in 2008. BR&T-A has provided a focal point for collaboration with local research organisations including universities, private sector providers, the CSIRO and the Defence Science and Technology Organisation. Access to Australia's advanced technological practices and innovations has significantly boosted Boeing's R&D capabilities. At the same time, Boeing's advanced development teams in the US are readily available to assess Australian capabilities in new avenues and assist with technological developments, for example, in areas of AI and robotics.

BDA partnered with the government in South Australia in 2017 to extend its growing defence presence into the state. The state's investment in cutting-edge technology aligns with BDA's innovation culture, and a number of key Boeing SME partners have been headquartered there for many years. In addition, South Australia has had a healthy defence industry for a long time, with a highly skilled, defence-ready workforce. Thus, a local footprint allows BDA to be close to a wealth of talent and provide opportunities to better collaborate with their industry support network of SMEs and other defence primes.

Recognising Australia's strong presence in the global UAV sector, Boeing also collaborated with the Queensland government in 2018 to set up its largest international autonomous systems development project. It recently completed successful testing of its Command and Control System on synchronised UAV flights at a Queensland airfield, issuing more than AU\$2 million in contracts with 14 local businesses.

### **Future opportunities for Australian SMEs**

In terms of commercial manufacturing, Boeing Aerostructures Australia is one of Australia's most significant designers and manufacturers of advanced composite aerostructure components and it continues to drive Boeing's success in the SME space.

As air traffic in the Asia-Pacific region is estimated to triple by 2030, it is believed that commercial and defence aerospace businesses in Australia are well-placed to help support the demand for equipment and support to meet this surge in demand. Boeing supports the growth of Australian SMEs beyond the 'SME size', allowing the industry to continue to develop as these "former SMEs", in turn, start to support the local industry by building their own domestic supply chains.

# Economic Profile of the Aircraft Manufacturing Industry



03

# 3. Economic Profile of the Aircraft Manufacturing Industry

The Australian Aircraft Manufacturing and Repair Services industry contributes to the Australian economy as both a major provider of goods and services to other industries, and as a consumer of goods and services from supplier industries.

The economic contribution of a sector is generally measured by its employment levels and its industry share in terms of the revenue from sale of final goods and services as well as the sector's value added (output less inputs from other industries outside the sector). Over the period 2014-15 to 2016-17, the Aircraft Manufacturing and Repair Service industry's value added grew by roughly 23 per cent.<sup>13</sup>

This section provides a general overview of the entire Aircraft Manufacturing and Repair Services industry, first in terms of capacity (the number of businesses operating across states and territories in Australia) and then in terms of contribution (employment and operational activity by the sector). This aims to provide an understanding of the direct contribution of the Aircraft Manufacturing and Repair Services industry to the Australian economy that is based on the latest available ABS data – in particular, the manufacturing industry statistics (2016–17), the national input-output tables (2015–16), the Labour Force Survey 2018, the 2016 ABS census – and other public data sources.

While this section discusses the impact of the sector both upstream (suppliers) and downstream (customers), it is in Section 4 where we estimate the flow-on impacts of the sector across Australia.

## 3.1. Business locations

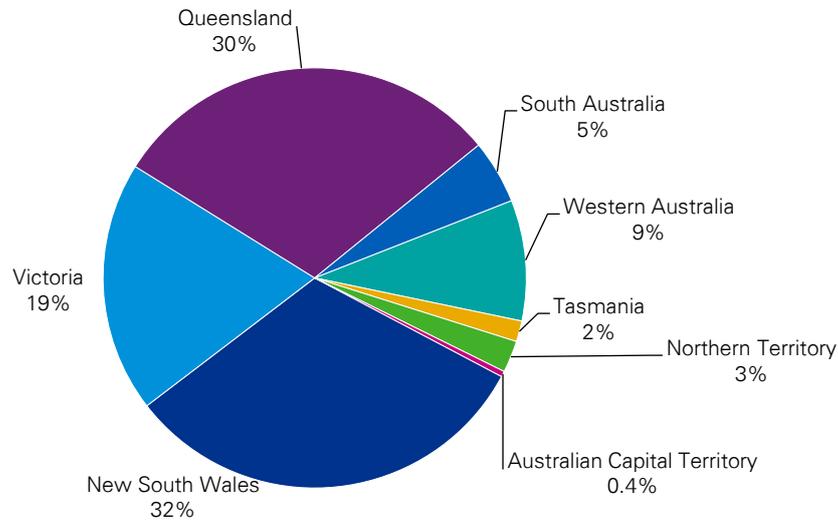
While there are aircraft manufacturing and repair services businesses in every state and territory in Australia, the majority of these industry enterprises are located in the three largest states of New South Wales (32%), Queensland (30%), and Victoria (19%). Queensland's large share of aviation businesses can be attributed to the vastness of the state and a significant population of remote workers, driving demand for air transportation and consequently, maintenance and repair work.<sup>14</sup> All the other states and territories account for the remaining 20 per cent of the aerospace business presence in Australia.

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<sup>13</sup> ABS Australian Industry, catalogue number 8155

<sup>14</sup> IBIS Aircraft Manufacturing and Repair Services Industry report, 2018

Figure 10: State distribution of Aircraft Manufacturing and Repair Services businesses (business count, 2017-18)



Source: ABS 8165.0

Victoria leads the way for Australia's defence sector, with aerospace design and advanced manufacturing capabilities. Australia is providing the MRO and upgrade services, as well as manufacturing critical components, for the F-35 Joint Strike Fighter (JSF) fleet. This has brought the state's capabilities to the forefront, as showcased at the 2019 Avalon Airshow. In the past decade, Victorian defence suppliers have secured the majority of the F-35 JSF contracts, accounting for 65 per cent of the total project value to Australia.<sup>15</sup>

Being home to one-third of the continent's aerospace companies and four international airports, spanning across metropolitan and regional locations, Queensland is becoming increasingly prominent in Asia-Pacific's aviation sector. As a testament to this, Brisbane is set to host MRO Australasia 2020 event, a significant opportunity for businesses in the aviation maintenance industry. In addition, the presence of Hawker Pacific, an aircraft maintenance specialist and the only Bombardier-accredited facility in the southern hemisphere, and its recent expansion of hangar capacity in Cairns, has further augmented Queensland's heavy maintenance capabilities and bolstered regional services.

In 2017-18, the 937 businesses in operation mainly comprised of either non-employing or small-sized businesses (1-19 employees). Figure 11 shows that there is a relatively similar share of non-employing and small businesses within most states and territories. In addition, there are 33 medium-sized businesses (20-199 employees), predominately based out of NSW and Queensland, and only 3 large businesses, which are situated in NSW. Some of the big businesses that operate in Australia include international players like Airbus Australia Pacific, Boeing Australia, Raytheon Australia, with significant operations across the big states and headquarters in Queensland. BAE Systems Australia is headquartered in South Australia, while Lockheed Martin recently moved its head operations to the ACT.

<sup>15</sup> Victoria State government website

Figure 11: State distribution of Aircraft Manufacturing and Repair Services businesses (employee strength, 2017-18)



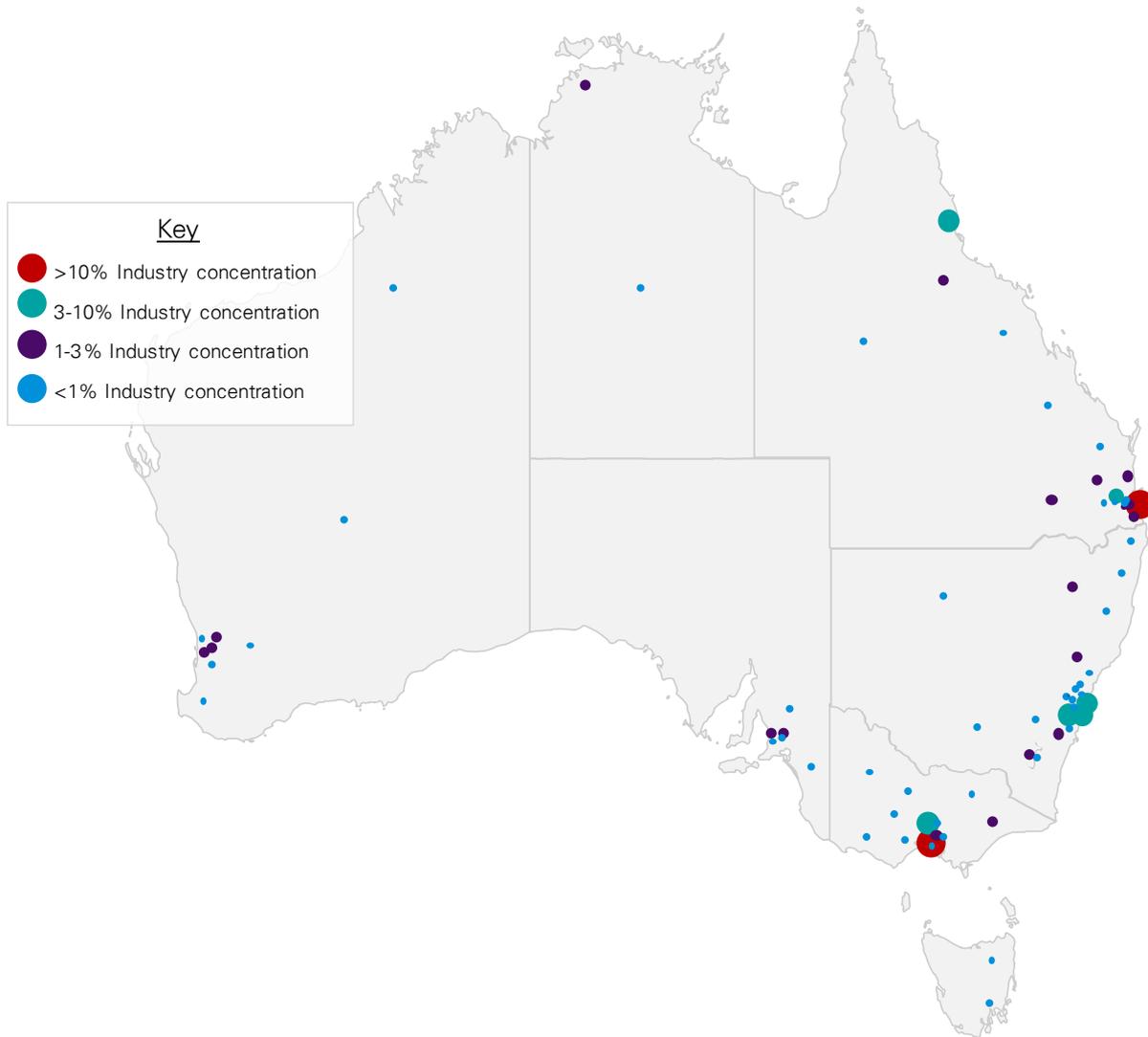
Source: ABS 8165.0

The regional distribution of Aircraft Manufacturing and Repair Services businesses can be seen in Figure 12, based on location of employment in the industry. While the industry has business presence in every state and territory, the majority of the activities are concentrated on the eastern coast of Australia. Inner Melbourne and North Brisbane are hubs of Aircraft Manufacturing and Repair Services activity, together accounting for a quarter of the industry concentration. A vast majority of the big multinationals and SMEs operate out of these two locations. Greater Sydney, North West Melbourne, Cairns and Ipswich contribute another quarter of the industry's employment in Australia.

Looking at the location of the remainder of industry activity:

- Elsewhere in Queensland – other parts of Brisbane, Gold Coast, Sunshine Coast, and Townsville have a moderate amount of business activity.
- Beyond the Greater Sydney region – a moderate amount of industry activity is located in Hunter Valley excluding Newcastle, Southern Highlands and Shoalhaven and there's a small industry presence in the Riverina, Murray and Illawarra regions of NSW.
- A moderate amount of activity is located in Adelaide, the Latrobe-Gippsland region of Victoria, Perth and ACT, with businesses few and far between in other regions of Western Australia and Tasmania.

Figure 12: Regional distribution of Aircraft Manufacturing and Repair Services activity (by employment, 2016)



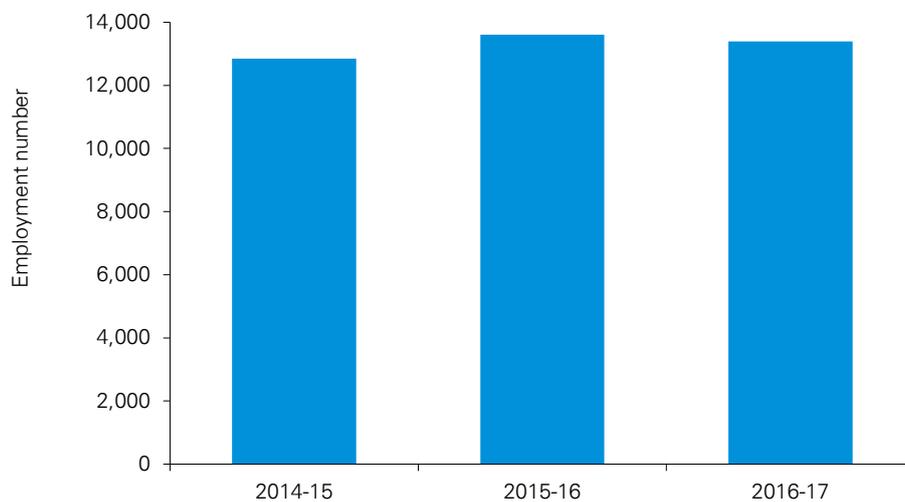
Source: ABS 2016 Census

Notes: Industry concentration is based on share of regional employment. Regions are mapped at the Greater Capital City boundary and Statistical Area level 4.

## 3.2. Direct employment

The latest data on total employment in the Manufacturing industry across Australia indicates that an estimated 13,396 people were employed directly in the Aircraft Manufacturing and Repair Services industry at the end of financial year 2016-17.<sup>16</sup> As indicated in Figure 13, there was a modest increase in employment levels between 2014-15 and 2015-16, with employment dropping back slightly over the following year. Conversations with industry stakeholders indicate that while the wave of start-up organisations is seeing young talent from universities getting involved in the aerospace sector, the overall employment numbers are being hit by relatively reduced labour supply in the Australian Aircraft Manufacturing and Repair Services industry. A global shortfall in licensed pilots and engineers, modest uptake of STEM branches in higher education, as well as relatively low penetration rates of advanced Industry 4.0 processes in this industry appear to be resulting in an overall declining pool of human skilled resources for this industry, when compared with other domestic technology-based industries and the overseas aviation market.

Figure 13: Total employment in Aircraft Manufacturing and Repair Services industry (2016-17)

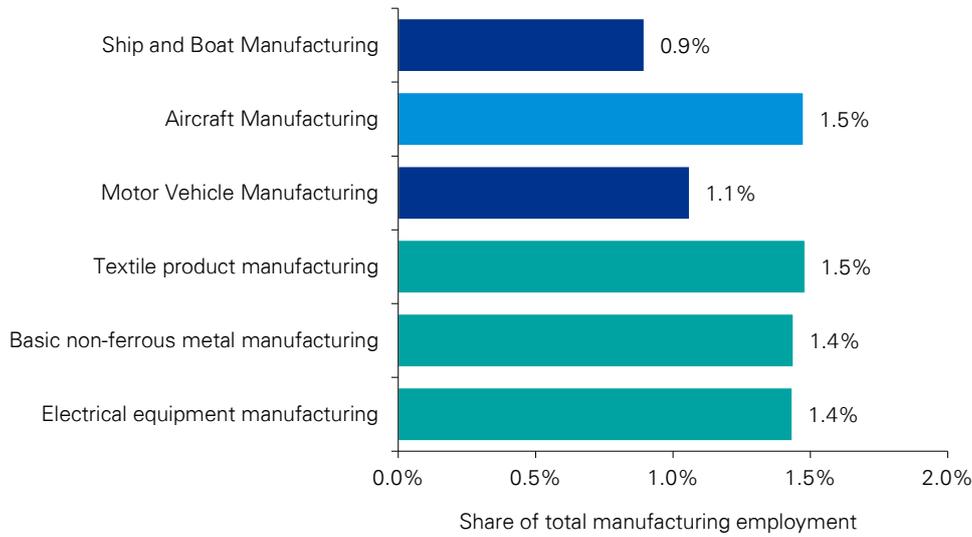


Source: ABS 8155.0

In 2016-17, the Aircraft Manufacturing and Repair Services industry accounted for nearly 1.5 per cent of the total employment within the manufacturing sector in Australia, as shown in Figure 14 below. This was similar to the contribution from other manufacturing industries such as textile products, basic non-ferrous metals, and electrical equipment, and higher than the employment share of other transport equipment manufacturing sectors, including ship and boat building and motor vehicle manufacturing.

<sup>16</sup> Sourced from the latest ABS Australian Industry data (catalogue no. 8155).

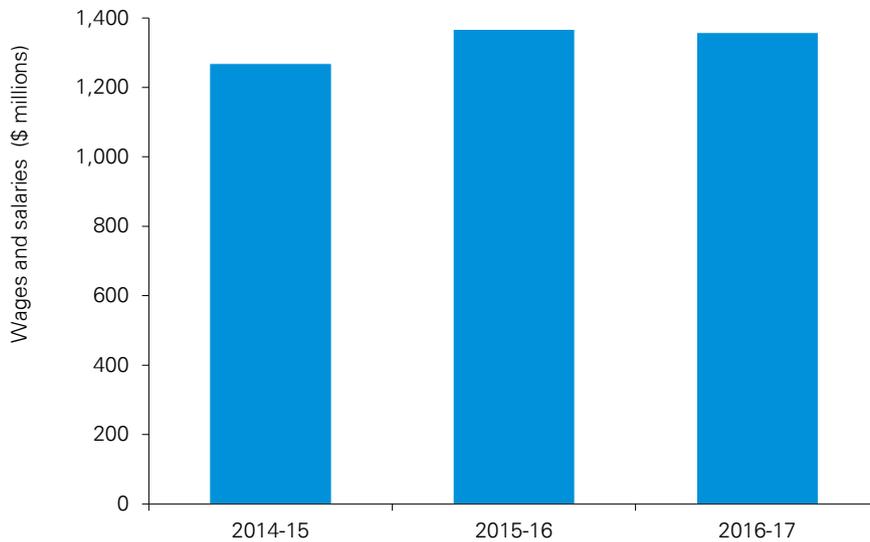
Figure 14: Share of total employment in the manufacturing sector (2016-17)



Source: ABS 8155.0 and Labour Force Survey

Figure 15 shows that the total wages and salaries paid in the Aircraft Manufacturing and Repair Services industry in Australia were estimated to be just under \$1.4 billion at the end of financial year 2016-17. Total wages in this industry increased modestly from 2014-15 to 2015-16, before falling slightly in 2016-17. This is similar to the trend observed in employment levels within this sector.

Figure 15: Total wages and salaries paid in Aircraft Manufacturing and Repair Services (\$million, 2016-17)



Source: ABS 8155.0

Industry stakeholders spoke highly of the engineering talent in Australia and regarded the pool of graduates as being highly employable. However, it was noted that the aerospace sector is facing a significant shortage of skilled personnel, due to an aging workforce and migration of some of the experienced staff towards more rewarding and less demanding professions.

Figure 16 summarises the key occupations employed by the Aircraft Manufacturing and Repair Services industry. Aircraft maintenance engineers is the single largest occupational group in this

industry, accounting for 43 per cent of the total industry employment in 2016. These workers are responsible for maintaining high safety standards of Australia's private and commercial aircraft fleet. Other engineering professionals formed nearly 3.4 per cent of the pool of employed workers in the industry, while all other engineers, technicians, project administrators, clerks etc. made up less than 2 per cent each of the employment pool. At the broad occupational level, technicians and trades workers (specifically automotive and engineering trade's workers) form half the jobs in the Aircraft Manufacturing and Repair Services industry.

Figure 16: Main occupations within the Aircraft Manufacturing and Repair Services industry

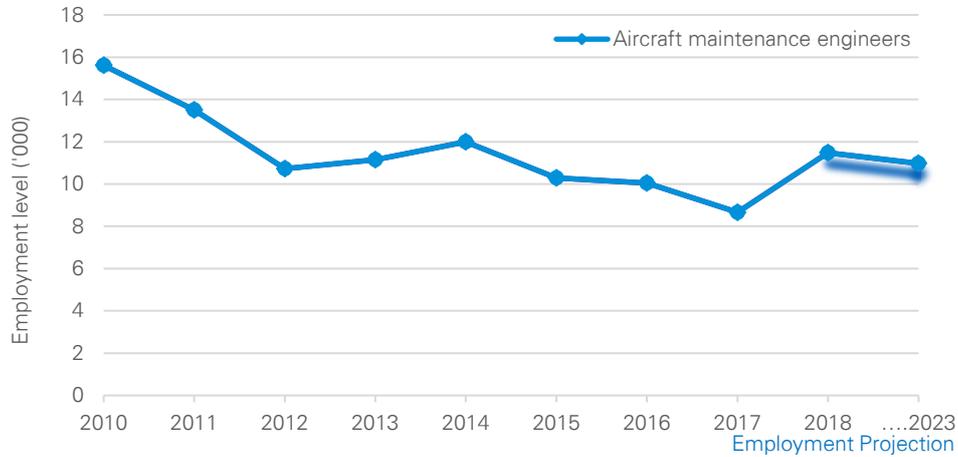
Occupation	Aircraft Manufacturing and Repair Services
Aircraft Maintenance Engineers	43.2%
Other Engineering Professionals	3.4%
Other Building and Engineering Technicians	2.0%
Industrial, Mechanical and Production Engineers	2.0%
Contract, Program and Project Administrators	1.8%
Storepersons	1.7%
Other Specialist Managers	1.7%
Purchasing and Supply Logistics Clerks	1.7%
Product Assemblers	1.6%
Metal Fitters and Machinists	1.6%
Engineering Managers	1.4%
General Clerks	1.3%
Other Mobile Plant Operators	1.2%
Vehicle Painters	1.2%
Metal Engineering Process Workers	1.2%
Software and Applications Programmers	1.2%
Office Managers	1.2%
Production Managers	1.1%
Engineering Professionals, nfd	1.1%
Accounting Clerks	1.0%
Other occupations	26.8%
<b>Total</b>	<b>100%</b>

Source: ABS 2016 Census

While an indispensable part of the Aircraft Manufacturing and Repair Services industry's workforce, nearly 60 per cent of the total share of the skilled (albeit declining) pool of aircraft maintenance engineers are picked up by the Air and Space Transport and Defence industries. These include workers servicing a wide array of defence contracts as well as the aircraft charter, air freight and air passenger transport sectors. As shown in Figure 17, the number of workers employed as Aircraft Maintenance Engineers has seen some variation across the years between 2010 and 2018, with an overall downward trend. In 2017, the employment level for this occupation reached its lowest level in a decade (at about 8,600 employees) before recovering in 2018 to 11,475 aircraft maintenance engineers. CASA's records for this period indicate approximately 8,700 licensed aircraft maintenance engineers in Australia, which may include some retired licence holders as the licence is perpetual. The remaining number likely represents those workers who are either less than 21 years of age or completing the minimum stipulated years of work experience and examinations before they are

eligible to obtain a license. Over the next five years to 2023, a slight decrease in employment is projected for this occupation.<sup>17</sup>

Figure 17: Employment trend for Aircraft Maintenance Engineers



Source: ABS 6291.0.55.003 and Labour Market Information Portal

While everyday activities like line maintenance work well in Australia, labour intensive periodic services like heavy engineering pose large feasibility constraints, owing to Australia's low labour cost competitiveness. This has made outsourcing of airline heavy maintenance operations to Asia a regular feature, causing significant job losses and a subsequent contraction in Australia's aircraft maintenance labour market. Tigerair Australia outsourced the heavy maintenance for its Airbus A320 fleet in 2016. Operational restructuring by Qantas post 2010 saw the closing down of two heavy maintenance bases in Victoria with the Brisbane facility's expansion now to be the airline's only heavy maintenance operation in Australia, handling work on its A330 and 737 fleet. In addition to contracting out heavy checks on its smaller fleets of the 747s and the Airbus A380s, maintenance work on QantasLink's Boeing 717s has also been outsourced to Singapore from July 2019, after a four year stint at a maintenance base in Canberra proved unsustainable.

<sup>17</sup> Labour Market Information Portal- Employment Projections

### 3.3. Value added

The direct economic contribution of the Aircraft Manufacturing and Repair Services industry in Australia is sometimes measured in terms of the value of final goods and services (or gross outputs) produced by the sector. However, industry value added is a more appropriate measure of a sector's direct contribution to a country's Gross Domestic Product (GDP).

Value added captures the return to an industry's labour and capital and other fixed factors. It is calculated as the gross outputs of the industry less goods and services purchased from other industries including imports, and is therefore the industry's direct contribution to GDP (except for indirect tax payments). By excluding goods and services inputs from other industries and imports, 'value added' avoids double counting as it does not include the value added from other industries.

Economic activity in the Aircraft Manufacturing and Repair Services industry directly adds value to Australia's economy and is higher than the contribution of many of the other transport (non-motor) manufacturing sectors such as ships and boat manufacturing and railway rolling stock manufacturing.<sup>18</sup>

As shown in Figure 18, the sector directly contributed over \$2 billion in gross value added to Australia's GDP in 2016-17, with almost \$1.4 billion in wage payments to employees and \$672 million in gross operating surplus (a return on capital). Australia's GDP was almost \$1,765 billion in 2016-17. Thus, the Aircraft Manufacturing and Repair Services industry contributed approximately 0.12 per cent of GDP to the Australian economy in that year.

Figure 18: Aircraft Manufacturing and Repair Services industry's gross value added (2016-17)

	2016-17 (\$ million)
Gross output	4,673
Purchased goods and services	2,574
<b>Gross Value Added</b>	<b>2,099</b>
Expenditure	1,427
• Wages	1,358
• Taxes less subsidies on products	12
• Other taxes less subsidies on production	57
Gross Operating Surplus	672

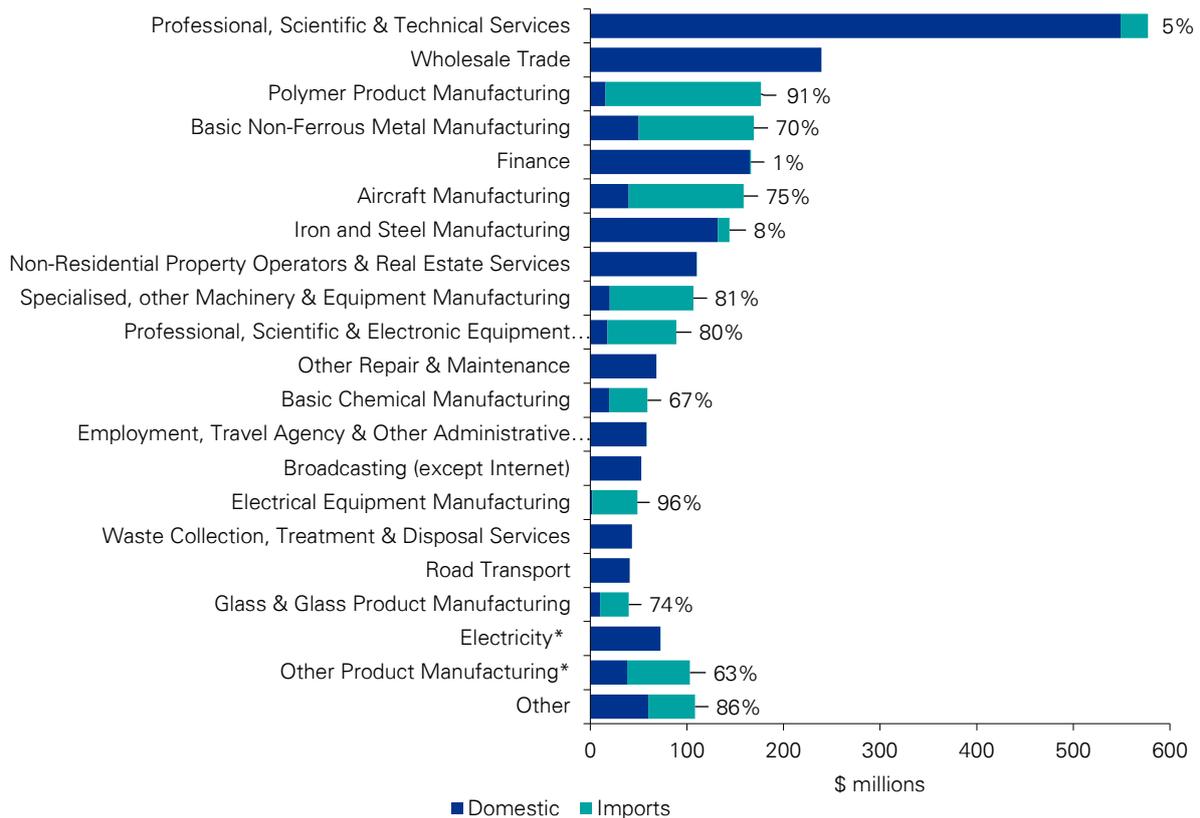
Source: Estimates based on ABS 8155.0 and ABS 5209.0.55.001

<sup>18</sup> ABS Input-Output table 2015-16

### 3.4. Expenditure

In addition to adding value to the domestic economy and contributing to the income of Australians, the Aircraft Manufacturing and Repair Services industry also contributes to the economy through its purchase of goods and services from other industries. In 2015-16, the industry spent over \$2.6 billion on inputs from other industries, which includes both domestic production as well as imports.

Figure 19: Aircraft manufacturing and repair services industry's direct expenditure on goods and services (2015-16)



Source: ABS 5209.0.55.001

Notes: \* Electricity includes generation as well as transmission, distribution, on selling and market operation  
 \* Other Product Manufacturing includes Natural rubber product, Other fabricated metal product, Textile product and Other wood product manufacturing

Figure 19 shows the industries from which inputs are purchased by the Aircraft Manufacturing and Repair Services industry and the import share of those inputs. The largest input into the industry is from the Professional, Scientific and Technical Services sector, accounting for around 22 per cent of the total expenditure on intermediate (non-capital) inputs. Other main inputs into the Aircraft Manufacturing and Repair Services industry were purchased from Wholesale trade, Polymer Product and non-ferrous Metal Manufacturing, Finance and Other Aircraft Manufacturing businesses. Nearly 40 per cent of the inputs from these industries were imported, with Polymer Product, Non-ferrous Metal and Aircraft Manufacturing making up the majority of the imports.

KPMG conducted an industry survey of businesses in the Aircraft Manufacturing and Repair Services industry. The survey responses indicate a similar mix of total operating expenditure across imported products and services of different industries. In particular, aircraft parts accounted for a large share of imports out of the total business expenditure, and other imports included metal products (non-ferrous and iron and steel) and a small proportion of professional, scientific, technical and financial services.

These results align with the ABS 2015-16 input output data, thus indicating no major changes in the industry structure and business expenditures.

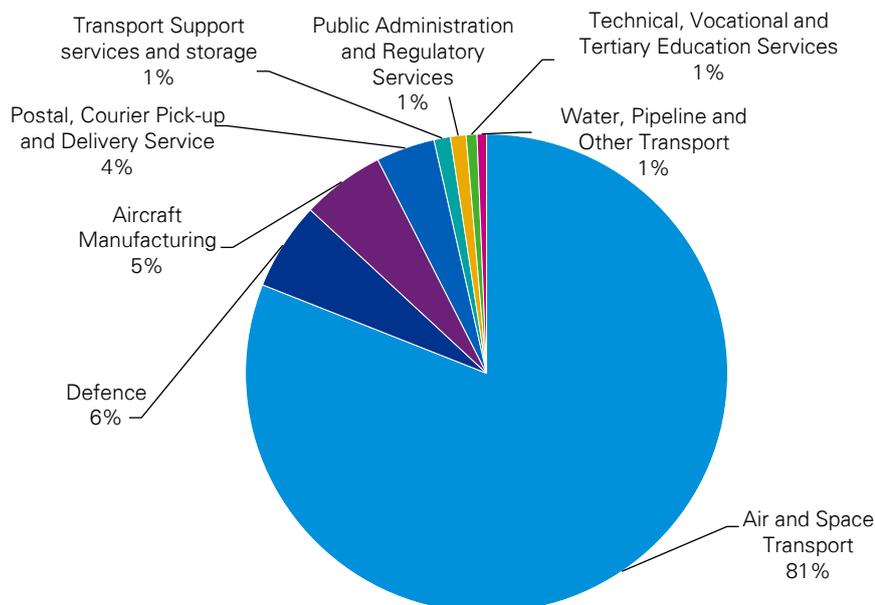
### 3.5. Sales

Australia's Aircraft Manufacturing and Repair Services industry involves a variety of activities. It includes production of light metal (titanium and aluminium) and composite aero structure components. It also includes manufacture of helicopters and light aircraft for recreational, agricultural and training purposes. On the maintenance and repair side, Australian businesses have capabilities in line maintenance and a sizeable portion of heavy maintenance for international and domestic airline carriers as well as maintenance of engines, components and small planes.

The output produced by the Aircraft Manufacturing and Repair Services industry is used by other industries as intermediate inputs into their business activities and as a final product by private, commercial and government sectors. In 2015-16, the Aircraft Manufacturing and Repair Services industry supplied an estimated total of nearly \$4,073 million worth of domestically produced goods and services to industries as well as final product users. Imports to the industry included an additional \$4,610 million worth of aircraft products and services.

First, we look at the industries to which Aircraft Manufacturing and Repair Services are sold for their intermediate use. The latest ABS input-output table shows that of the total products and services supplied (including imports), \$2.86 billion worth of parts and maintenance services were used as intermediate inputs by other industries in 2015-16. In particular, the maintenance, repair and servicing of aircraft accounted for 90 per cent of the intermediate usage by industries, while the remaining small proportion comprised the use of aircraft or part manufactures.<sup>19</sup> It can be seen from Figure 20 that Air and Space Transport industry was the single largest user of these products and services (81 per cent), followed by Defence (6 per cent) and the Aircraft Manufacturing and Repair Services (5 per cent) sector itself.

Figure 20: Industry Users of Aircraft Manufacturing and Repair Services output (percentage share, 2015-16)



Source: ABS 5209.0.55.001 and KPMG analysis

<sup>19</sup> ABS catalogue number 5215.0.55.001

In addition to its use as an intermediate input into other industries, the Australian Aircraft Manufacturing and Repair Services are used as final products by different entities in the economy across private users and both the civil and defence sectors. Industry consultations with stakeholders indicate different views across the industry around the ease and benefits of working in civil and defence parts of the industry.

- Some businesses believe that, for smaller businesses, **civil aviation** tends to provide better consistency in providing work packages even though the margins of profit may be less than defence related work. This is largely because they believe that obtaining contracts with Defence is a difficult and bureaucratic process, and they have found it easier to take on increasing amounts of work from companies overseas.
- Others believe that businesses, particularly small manufacturing and repair service providers, could continue to benefit from greater support and opportunities from **Defence**, as this market provides consistent high volumes of work as well as exposure to ongoing technology and equipment developments. It was also noted that although Defence policy encourages supply chain participation<sup>20</sup>, it often relies on a certain number of individual companies for different parts and subassemblies, owing to a niche nature of work. It was suggested that it could be highly beneficial if Defence took a strategic approach to developing aerospace clusters in Australia, both physical as well as digital, to mitigate supply disruption risks.
- Our industry consultations indicate that companies are happy to move across the two sectors, if given the opportunity and also do more work domestically if the regulatory/accreditation system was simplified.

In 2017-18, the Aircraft Manufacturing and Repair Services industry made sales revenue of \$4.8 billion. The industry's users can be categorised into the following four broad categories listed below and then individually described in more detail.

Figure 21: Categories of Users of Aircraft Manufacturing and Repair Services (2017-18)Users	2017-18 sales	Aircraft Manufacturing and Repair Services industry
Commercial Airlines	\$1,180 million	<b>\$4.8 billion</b>
Australian Defence Force	\$1,117 million	
Other (includes private and other government/business)	\$58 million	
Export Markets	\$2,461 million	

Source: IBIS World. KPMG analysis

## Commercial Airlines

It is estimated that commercial airlines accounted for \$1,180 million worth of the Australian Aircraft Manufacturing and Repair Services industry's sales revenue in 2017-18. This segment is dominated by maintenance, repair and overhaul services contracted by major airlines and aircraft manufacturers. This category also includes a (albeit much smaller) component of sales in aircraft parts.

### Australian Defence Force

The ADF is the government's largest purchaser of aircraft, contributing roughly \$1,117 million in revenues to the Aircraft Manufacturing and Repair Services industry in 2017-18. The ADF maintains a fleet of aircraft for through-life support and logistics support analysis.

<sup>20</sup> For instance, the Australian Industry Capability (AIC) Program requires primes wishing to bid for Defence projects over \$20 million to identify local suppliers to meet the needs of Defence contracts.

In 2017-18, Defence's budget for major acquisition projects in the air domain was an estimated \$3.4 billion.<sup>21</sup> A third of this budget was earmarked for Defence's New Air Combat Capability, which includes the acquisition of 72 F-35A aircraft for operational and training purposes, based out of RAAF Williamstown in Newcastle, New South Wales.<sup>22</sup>

#### Other Users (private, other government and business)

In 2017-18, the Australian Aircraft Manufacturing and Repairs industry made around \$58 million in sales to other users. This segment includes private and recreational aircraft use by households or businesses, such as corporate jets, light sport aircraft, powered parachutes, and UAVs (or drones). It also includes aircraft used for business purposes such as tour operations, crop spraying, and business jet hire. This market has a very small and declining market share due to limited domestic demand and strong growth of the export market (for example, see Jabiru case study).

#### Export Markets

The export markets account for half the revenue share of the Aircraft Manufacturing and Repair Services industry. Australia has a number of smaller players with technical expertise in the production of aircraft parts, engines, components etc., which are contracted to ship parts and components to major commercial as well as military aircraft manufacturers based overseas.

In addition, military aircraft support features in the export market, with its future share expected to increase, owing in part to the industry's participation in export strategies like the F-35 Joint Strike Fighter (JSF) Programme. As part of the program, the industry has been able to secure more than \$1 billion of F-35 production contracts, engaging with over 50 Australian businesses at various stages of design and production.<sup>23</sup> Going forward, Australia's involvement in the JSF programme is expected to attract more than \$7 billion in F-35 production contracts out to 2038. Over one-third of these production contracts are expected to be fulfilled by the Australian Aircraft Manufacturing and Repair Services industry.<sup>24</sup>

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<sup>21</sup> Air Domain includes through-life support to Air Force fixed wing aircraft, Army and Navy rotary wing aircraft, Unmanned Aerial Systems, and a number of advanced flight simulators and ground support equipment fleets

<sup>22</sup> Defence Portfolio Budget statements 2017-18.

<sup>23</sup> Department of Defence- F 35 Australian Industry Participation, The Journey to \$1 billion

<sup>24</sup> Ibid

### 3.6. Exports

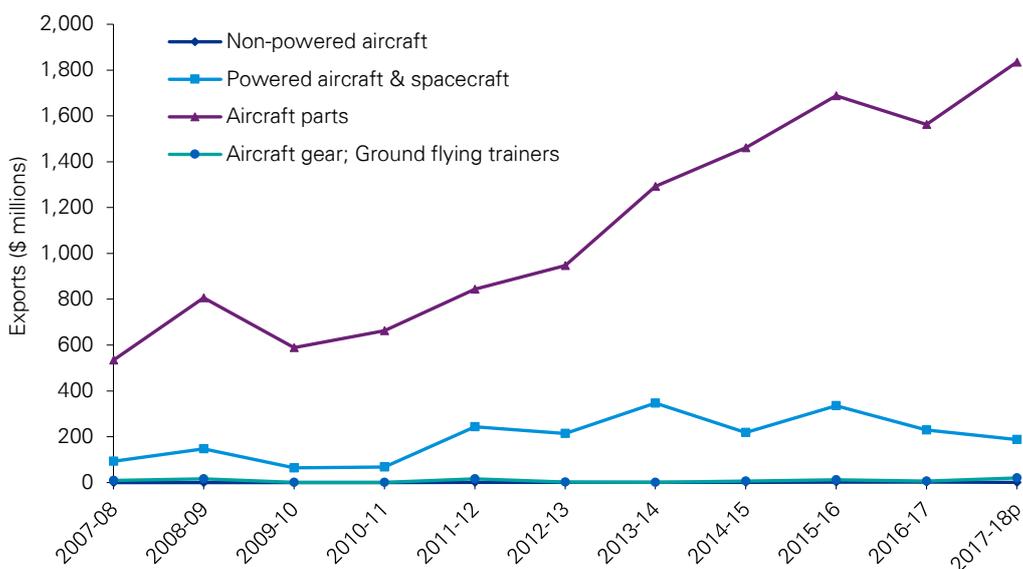
The Australian Aircraft Manufacturing and Repair Services industry has a strong brand reputation in the global market, enabling it to compete through value rather than costs. This has fuelled the export of quality products produced and services provided by domestic aviation businesses, attracting significant revenue and opportunities for the Australian economy. In 2017–18, merchandise exports by the industry contributed approximately \$2,043 million or approximately 14 per cent of Australia's total machinery and transport equipment exports.

The Australian Aircraft Manufacturing and Repair Services industry is a mix of majorly non-employing and small-sized enterprises, which specialize in maintenance and repair, engine manufacturing, aircraft components and parts manufacturing. Big OEM's, such as Boeing and Airbus, export Australian manufactured parts back to the US for assembly. This feature of the Australian aerospace market is reflected in Figure 22 below, which shows a three-fold increase in the export of aircraft parts (both powered and non-powered) over the past decade. Over the same period, export of powered aircraft and spacecraft has been extremely volatile, with a decline in numbers recorded in the last two financial years.

These findings are supported by our industry consultations, in which stakeholders made note of a dwindling general aviation sector in Australia and a cost disadvantage of manufacturing aircraft, due in part to Australia's high minimum wage rates. However, recognition of Australia's technological capabilities and innovation has seen steps being taken to strengthen the relationship between Australian industry and Defence, as well as to promote domestic capabilities in the export market. Industry strategies and programs like the Global Supply Chain program (discussed in the Boeing case study) and the Australian Industry Capability program encourages the involvement of businesses in supply chains to support Defence contracts.

This strategic approach is harder to achieve on the civil side, as the sector is more diffused and fragmented, without having one single entity to promote sector interests. The Small and Medium Enterprises (SME) Export Hubs initiative, announced in the 2018-19 budget, is designed to grant \$150,000 to \$1.5 million for up to four years from 2018-19 to 2020-21 to SMEs for setting up local and regional export hubs in priority Growth Centre sectors like Advanced Manufacturing. Through collaboration with Growth Centres, this program is slated to attract export opportunities to local firms, thus driving SME business growth and regional employment.

Figure 22: Aircraft Manufacturing and Repair Services industry's exports



Source: ABS 5368.0, International merchandise exports  
Note: 2017-18 values are preliminary published data.



## CASE STUDY

### Jabiru

Undying persistence and multi-skilled staff retention has seen this home-grown family business succeed in Australia's recreational aircraft market, in spite of regulatory challenges and lack of mutual recognition of Australian certifications globally. In the face of a saturated domestic market and transforming aviation industry, Jabiru has ventured into the UAV and engine manufacturing and maintenance sectors, while exploring opportunities with electric powered aircraft.

An Australia owned family business, Jabiru is a pioneer in the market for recreational aircraft manufacturing in Australia. Founded in 1988 in Bundaberg, Queensland, it is a leading manufacturer of kit and factory-built light sport aircraft and aircraft engines.

#### Regulatory headwinds

A well-established business now, Jabiru's journey in the aviation sector over three decades has been anything but easy, with regulatory changes identified as a particular challenge. The movement to manufacturer self-certification of Light Sport Aircraft appears to have opened doors to international competition from low labour cost countries, especially in Eastern Europe. This regulatory change means that overseas companies

selling into Australia have not had to attain CASA type certification like Australian firms had to, to enter the Australian market. Australian companies can now take advantage of self-certification too for future models of aircraft, but with the extra competition the portion of the pie is unlikely to be enough to fund further development into Light Sport Aircraft.

At the same time, there has been a domestic decline in demand for these aircraft by aviators, in part due to saturation of hangar space at airports. It is often difficult to get council permission for the construction of new hangars, due to the noise associated with an airport. Fortunately for Jabiru, Bundaberg council has been very supportive of their operations. There are also constraints regarding the restriction of public access to airports for security reasons. Jabiru raised that to obtain an Aviation Security Identification Card is an expensive process, and acts as a further deterrent to recreational flyers and new participants.

Regulation remains a key concern for manufacturers in the industry, such as Jabiru. The regulatory burden of operating in the aerospace industry is high, with concerns around safety and security being key drivers. However, some participants feel that the bodies charged with regulatory oversight can err on the side of risk-aversion and heavy-handedness, which can have the unintended

consequence of stifling innovation and slowing down the accreditation process, causing a potential loss of business opportunities. This approach runs in concert with the struggles resulting from a lack of recognition of Australian certification internationally, which is a source of considerable frustration in the industry and has led Jabiru to acquire certification under ASTM standards to access international markets. Smaller manufacturers like Jabiru are also subject to the same regulatory burden as large manufacturers, which increases the pressure on those smaller players in the market.

While the regulatory climate in Australia is seen as a challenge, there are many other features of the Australian market that are seen as beneficial to the industry. In particular, Australia's innovation gives it a competitive edge in the global market; there is regard for Australian product quality; and Australia has the envious combination of a skilled workforce and a favourable business climate. With these strengths, it is noted that a strong political will to strengthen bilateral agreements and bring in regulations that foster innovation is imperative to continue to support and further develop the domestic aerospace sector.

### Setting the business up for success

Jabiru founder Rodney Stiff's incredible tenacity and determination, driven by passion, has seen the business sustain itself in this industry.

Operating in a distinct market, Jabiru notes that manufacture and production methods associated with recreational aircraft have to be based around low volume production with low setup costs and flexibility for rapid change in demand and technology. Jabiru's industry success also rides on the long-time retention of its multi-skilled and flexible staff, all provided with hands-on training at its Bundaberg facility.

Sourcing quality inputs at the right price and on time from both Australian and overseas suppliers is a constant challenge. The domestic inputs market is small compared to other industries, such as automotive, and local suppliers get swamped very quickly.

There is also the economic challenge of finding funding for R&D to remain competitive and to continue to develop new markets.

While there are some R&D incentives available, the benefits of these are only accessible if a company has a tax liability. Further, for small businesses, the administrative burden associated with separately recording R&D hours may actually prohibit smaller businesses from accessing these incentives. Nevertheless, Jabiru's drive to innovate comes from its consumer demand for affordable, reliable and strong aircraft with low maintenance costs.

### Current demand and an electric future

The Australian market is only so big, and Jabiru has begun to saturate the domestic aircraft market. There are over 1,000 Jabiru aircraft operating within Australia. The business has seen sales decline over the last 10 years. However, Jabiru also has a strong international presence, with exports accounting for two thirds of engine sales and, overall, 64 per cent of the business. Jabiru has around 1,000 more aircraft around the globe, with definite room to expand further into the global market, although competition is very strong. Recently, the relatively low Australian dollar has helped bolster strong exports by allowing for competitive pricing against foreign competitors.

As maintenance for the existing Jabiru fleet is naturally increasing as it ages, there is a race towards electric powered aircraft and vertical take-off unmanned aircraft for many applications. Electric powered engines will greatly reduce the need for maintenance and hence running costs. High maintenance and fuel costs are also incentivising a pivot to battery technology. Battery powered aircraft are currently being utilised for flight training, with battery power well-suited to one hour sessions.

In the commercial sector, Jabiru's customers include flight training schools that cater to primarily recreational and a few career pilots. With the traditional aircraft sector taking a downturn, Jabiru's business in the domestic market is now primarily focussed on spare parts, maintenance and engine manufacture and supply. Recognising the need to diversify, Jabiru has also entered the UAVs market, and despite the difficulties of dealing with some of the larger organisations in this space, Jabiru sees an opportunity to expand further into this market.



## Thomas Global Systems

Thomas Global Systems delivers Australia's world-renowned advanced manufacturing capabilities, steered by practical innovation and a balanced business approach between defence and civil aerospace sectors. While well-integrated into global supply chains, Thomas Global Systems echoes industry wide sentiments of the need to establish recognition of Australian certifications by trading partners.

Thomas Global Systems is an industry leader in the design and production of electronic systems for aerospace and defence applications. The company's journey over six decades from being the largest manufacturer of cathode ray tubes for television sets, to an advanced manufacturer in the global civil and defence aviation sector is an Australian manufacturing success story.

### Surviving the initial turbulence

As a new entrant in the aviation industry, Thomas Global Systems believes it "stumbled through" the high quality systems and certification processes, before being able to adapt and refine its business processes. Unfortunately for Australia's aviation sector, it does not appear to be a level playing field with regards to certifications. While Australia accepts products certified under different standards, like the United States' Federal Aviation Administration (FAA) and Europe's European Aviation Safety Agency (EASA), Australia's Civil

Aviation Safety Authority (CASA) certified products do not appear to have the same worldwide acceptance. For many SME's, this has meant designing locally in Australia but undertaking most of the manufacturing overseas (like in the United States) so that they could access international certifications and, thus, an international market for their products. Having been around for a long time, Thomas Global Systems has witnessed the Australian aviation sector's transformation in terms of expanded capabilities and increased skill levels, but notes the pressing need for harmonisation of regulations worldwide, which ultimately comes down to trade treaties, rather than work by any single regulatory body like CASA. The high standards expected in aviation does help businesses to work in other industries, and Thomas Global Systems is looking to successfully establish itself in the global aerospace industry.

### Balanced Business Model with Innovative Solutions

Thomas Global Systems adopts a unique balanced business model to leverage opportunities and mitigate risks between the Commercial aerospace and Defence sectors. While Defence work tends to have long gestation periods with greater challenges in getting initial engagement, once contracted, Defence contracts tend to provide longer term sustainable work. Conversely, the commercial sector tends to be more dynamic with less barriers to entry, hence reasonably stable and providing a good base load of work.

The relationship between and across these two sectors has provided some beneficial outcomes as well as resource management challenges for the company. The two sectors have similar requirements with regards to certifications and skills sets, alongside a crossover of products. However, there can be capacity and finite engineering resource constraints as defence sales cycles tend to be much longer, while commercial aviation involves high volumes and quick engagements. Thomas Global Systems manages this work pipeline and the limited pool of resources by focussing on projects that meet the firm's existing capacity and are complementary to its technology and skills sets.

Working with critical and highly regulated items, Thomas Global Systems believes being compliant with safety standards defines its processes of delivering quality products and has helped develop its outstanding reputation in the market. Historical performance figures and an expertise to inform engineering decisions has helped strike a balance between cost, performance and reliability. While automation of manufacturing processes has reduced labour cost differentials, transacting in \$US makes exchange rate fluctuations a crucial factor in determining Australia's cost competitiveness in the export market base.

Thomas Global Systems has had an unwavering focus on practical innovation since its inception, corroborated by the recent launch of the Electronic and Embedded Systems Innovation Hub (EESI-Hub) in New South Wales. According to then Minister for Defence, Senator the Hon Marise Payne, "the Hub has been designed to optimise innovation, fully developing the technology concepts through to integration for applications in the commercial aerospace and defence markets."<sup>25</sup> Constantly evolving regulations in aviation to achieve higher safety standards are seen as extremely challenging by many, but Thomas Global Systems views this as an opportunity to innovate and improve existing products.

In addition, as cathode ray tubes slip into obsolescence, its use in over a third of the world's aircraft is becoming problematic for airline operators. Recognising the need for

operators to evaluate costs against performance figures, Thomas Global System's has focussed on providing simple solutions to operators to allow them to replace these parts, rather than having to upgrade the whole system.

### Regulatory Challenges

After successfully laying its foundation in the Australian market, Thomas Global Systems made the strategic decision to establish a presence in the United States. This was driven by a desire to capture some of the higher demand in the international commercial aviation marketplace and also by the ability to obtain US certifications due to a local presence. This setup has also enabled in consolidation of its work, with designing done in Australia and production done in close proximity to where there is demand. While Defence work is concentrated in Australia and the United States, the company has a global outreach in the commercial aviation sector, supplying its TFD-7000 Series flight displays to all Boeing 737, 757, 767 aircraft.

While US certification has provided Thomas Global Systems with easier access to the world market (including Australia), the company has expressed a willingness to participate more in the Australian market. Thomas Global System's experience with the local market – such as in sourcing quality materials and inputs locally – has been positive, with imports including only those items that are not manufactured in Australia (such as electronics, semi-conductors and LCD panels). The company indicated a desire to also certify products in Australia, if the issues surrounding mutual recognition with key international partners were to be resolved.

In general, while Australia provides significant tax incentives and R&D grants, the biggest challenge in commercial aviation lies with access to the world's largest market – the US. Australian companies have identified challenges, such as in the regulatory space, which makes it more difficult for Australian-certified products to enter.

### Global Connections

Thomas Global System's brand reputation and strong relationships with suppliers has earned it a place in the global supply chain network.

<sup>25</sup><https://www.minister.defence.gov.au/minister/marise-payne/media-releases/minister-defence-minister-opens-thomas-globals-new-innovation>

While this position provides access to demand for large volumes of products, there is a need to maintain global competitiveness, especially against technologically advanced competitors in countries like Germany.

Australia's geographic location makes the battle harder. Different time zones and the physical distance from bigger US and European markets puts Australian suppliers at a disadvantage. The inability to engage with Tier 1 suppliers personally is viewed as a risk by big Original Equipment Manufacturers (OEMs), compounded by the unacceptance of Australian certifications.

These challenges have not dampened Thomas Global System's spirits, having recently announced their partnership agreement with one of the largest aerospace and defence companies globally, Safran Electronics & Defence.<sup>26</sup> This strategic alliance will see Thomas Global Systems manufacture a range of Safran technologies in Australia, enhancing local capability as well as integration of supply chains to expand export opportunities. While the initial partnership centres on defence projects, there is scope to move into the commercial aviation space as well.

In the future, Thomas Global Systems wishes to see an industry shift, away from maintenance activities towards manufacturing work in commercial aviation. This is already taking shape as more companies are realising the need to be part of the global supply chain and engaging in manufacturing locally. As maintenance is becoming more centralised, there is additional pressure on Australian manufacturing capabilities to become part of the larger international companies supply chains. In the defence sector, Australia does not have capabilities to build, but as it acquires the F35s, there will be a need for domestic maintenance capability.



<sup>26</sup><http://www.australiandefence.com.au/news/thomas-global-to-manufacture-safran-technologies-locally>

# Economic contribution and linkages of the Aircraft Manufacturing Industry



# 4. Economic contribution and linkages of the Aircraft Manufacturing Industry

The previous section described the contribution of the Aircraft Manufacturing and Repair Services industry to the Australian economy. A pure analysis of employment, expenditure and sales data provides a good understanding of the direct contribution of an industry to the national economy, and provides some insights into how the industry supports other Australian businesses – by both providing quality products and services as inputs into other production processes, and/or by purchasing goods and services from Australian businesses.

The Aircraft Manufacturing and Repair Services industry contributes to the Australian economy through direct activity such as employment and value-added (outlined in Section 3). These direct activities also stimulate further activity in the economy as Aircraft Manufacturing and Repair Services related businesses source their inputs from other parts of the economy, and provide their goods and services as inputs to other businesses.

This means that the Aircraft Manufacturing and Repair Services industry impacts the Australian economy beyond those direct impacts discussed in Section 3. These indirect Aircraft Manufacturing and Repair Services industry impacts can extend across many industries in the economy – from manufacturing, transport, wholesale and retail trade, through to professional services, construction, and education.

## 4.1. Scenario design

To capture these flow-on or indirect impacts of the Aircraft Manufacturing and Repair Services industry on the economy, we investigated the impacts up and down the supply chain. To analyse these impacts, it is necessary to employ modelling techniques that can incorporate these economy-wide linkages. This study utilises an in-house Computable General Equilibrium (CGE) model to identify the linkages across the economy. A more detailed description of the modelling is available in the Appendix.

The analysis uses the direct impacts estimated in Section 3 as inputs into the modelling. For this, the following scenarios were modelled:

- **Baseline scenario** – The baseline for the CGE simulation is a representation of the current size and structure of the Australian economy.
- **Industry scenario** – This scenario investigates a scenario where there is increased activity in the Aircraft Manufacturing and Repair Services industry.

The difference between the Industry Scenario and the Baseline Scenario can be extrapolated to estimate the current economic contribution of the Aircraft Manufacturing and Repair Services industry.

The scenario is modelled at the national level, although in practice, industry enterprises are concentrated in New South Wales, Queensland and Victoria. Despite the geographic dispersion of industry enterprises, modelling the industry at the national level adequately captures its contribution to the nation as a whole.

## 4.2. Results

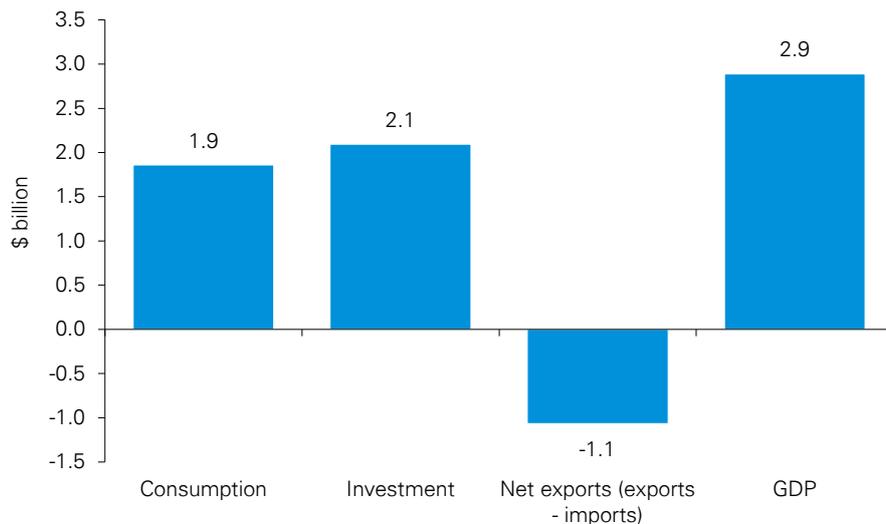
Set out below are the estimated economic impacts of the increased activity in the Aircraft Manufacturing and Repair Services industry, modelled using KPMG-CGE according to the scenario described above.

### Macroeconomic impacts

The presence and activity of the Aircraft Manufacturing and Repair Services industry in Australia generates significant economic benefit for the economy. The impact of the industry's activity on Australia GDP and employment is summarised in Figure 23. Impacts are reported in 2017-18 dollars.

The KPMG-CGE analysis indicates the industry currently contributes around \$2.9 billion to real GDP. Of this, there is \$1.9 billion in household consumption and \$2.1 billion in investment related to activities stimulated up and down the industry's supply chain. By stimulating additional domestic activity, some resources are drawn away from trade exposed sectors (i.e., export oriented sectors of the economy and sectors that produce commodities that compete with imports). This means that net exports are \$1.1 billion lower as a result of this industries activities.

Figure 23: Macroeconomic impacts on the Australian economy



Source: KPMG-CGE simulation

Overall, each year, the industry contributes directly and indirectly around \$2.9 billion to real GDP and supports 18,285 jobs.

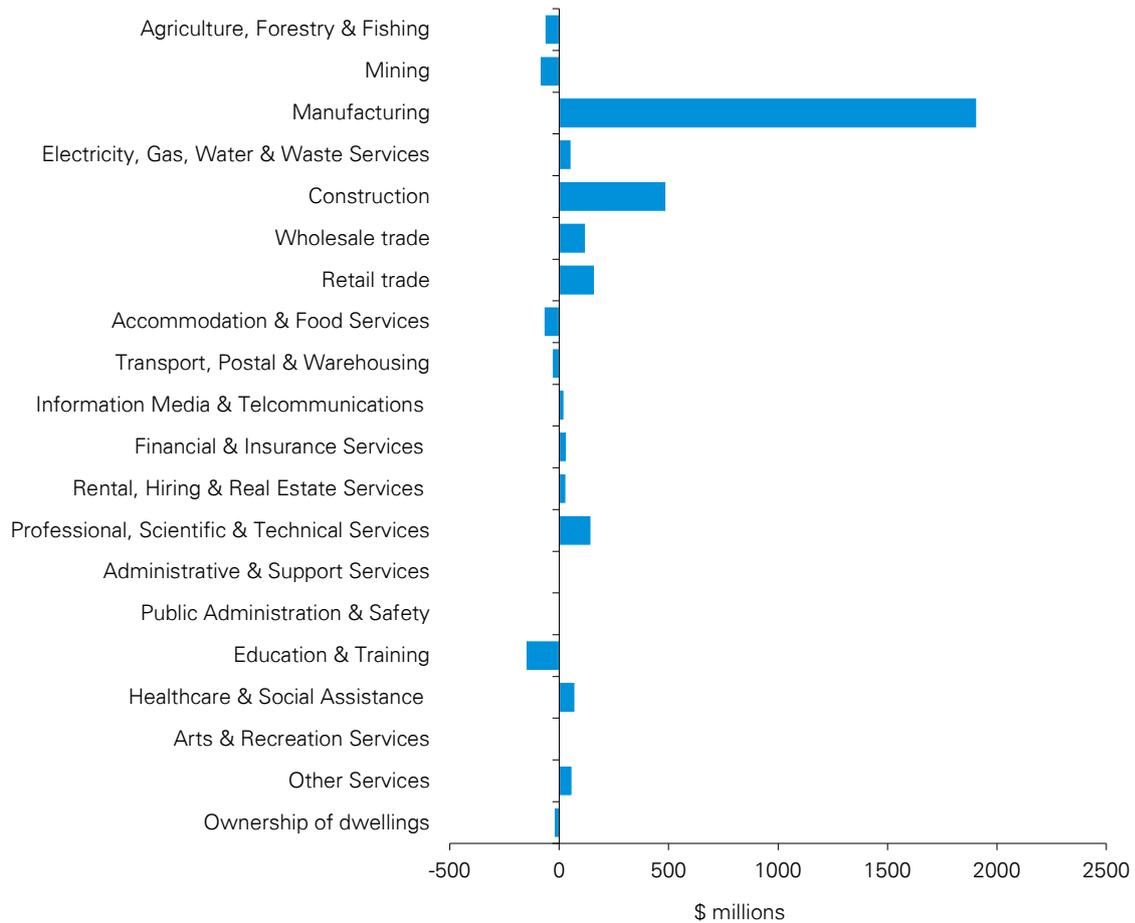
Table 1: Summary of economic impacts of the Aircraft Manufacturing and Repair Services industry on the Australian economy

Economic measure	
Real GDP (millions of dollars)	\$2.9 billion
Employment (persons)	18,285

## Broader industry impacts

The Aircraft Manufacturing and Repair Services industry has varied impacts on upstream and downstream industries. Figure 24 shows the impacts across industry sectors as a deviation from the baseline economy.

Figure 24: Annual industry value added impact (\$ million change from baseline)

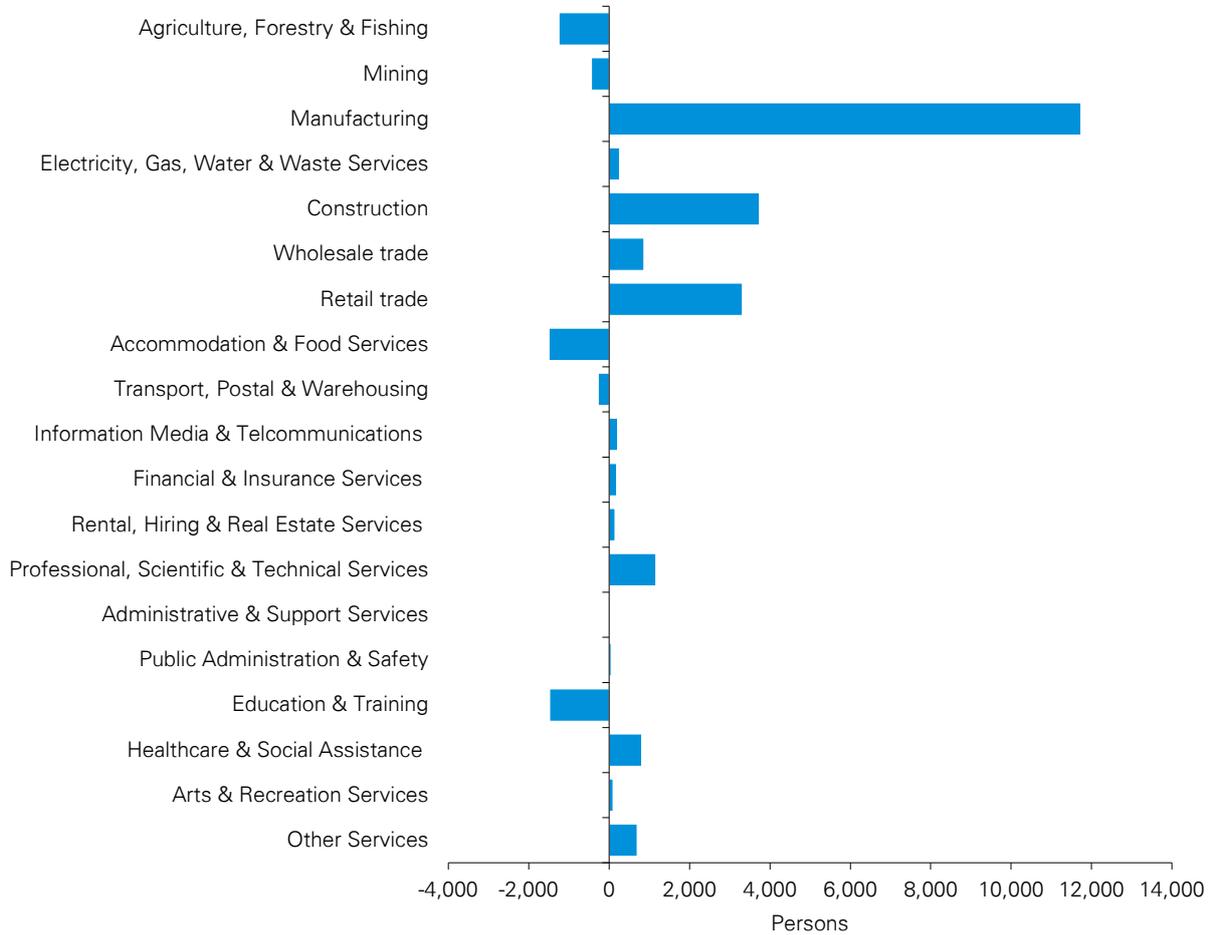


Source: KPMG-CGE simulation

The dominant contribution in industry value added, as expected, is from manufacturing. There is a slight decline in the industries in sectors exposed to international competition, e.g., agricultural, mining, other manufacturing, and accommodation and food services. This reflects the shifting of resources from those sectors to the Aircraft Manufacturing and Repair Services industry, construction sectors and other key suppliers to the Aircraft Manufacturing and Repair Services industries supply chain and employees.

The industry's contribution to employment by industry observes a similar but more pronounced pattern.

Figure 25: Annual industry employment impact (person change from baseline)



Source: KPMG-CGE simulation



## CASE STUDY

### Fountx

A brainchild of CSIRO and branded by TAE Aerospace, fountx\_AsR epitomises how industry-academia partnerships can translate Australia's research excellence into a practical industry device. Qualified by regulatory and funding obstacles, this product bears potential to support remote MRO operations in commercial aviation and defence industries and facilitate knowledge transfer from an ageing workforce across distances.

Set up by TAE Aerospace as a start-up technology company in 2017, Fountx, which stands for fountain of knowledge expert, is run independently in Queensland by a group of young engineers. Bringing together research and technological prowess, fountx\_AsR (Assisted reality) is a collaborative effort between CSIRO and TAE Aerospace.

The fountx\_AsR product is designed to facilitate real-time interaction between technicians on the ground and experts anywhere in the world. The product is a wearable headset with a head-mounted computer and camera. By allowing technicians to work on equipment in front of them whilst receiving guidance via an above-eye display, this can boost productivity and capability while avoiding a common issue associated with augmented reality of reduced situational awareness or increased cognitive load.

With the growth of bespoke manufacturing in Australia, fountx\_AsR is a value proposition, set to dramatically boost maintenance efficiencies in the Aviation and Defence industries, with potential applications across a range of other sectors.

#### The first steps

A desire to minimize costs and resources involved, while meeting the highest safety standards, led to the translation of CSIRO's research in augmented reality into a novel industry tool. fountx\_AsR was wholly designed and predominantly manufactured in Australia, using a combination of the availability of skilled personnel and access to the technology's intellectual property under TAE Aerospace's licensing agreements with CSIRO. The product has been developed to not only save companies like TAE Aerospace the significant costs associated with providing ground support in different areas, but also helps mitigate risks in potentially hazardous areas by reducing the number of people required onsite.

Fountx encountered several hurdles getting the technology together and establishing a market for its product. For example, as the Australian market did not meet all input needs, some components needed to be sourced from international markets. One of the major hurdles was the requirement for Li-ion batteries to no longer be allowed to be airfreighted, which increased the US's delivery times of smart batteries from 5 weeks to 3 months, thus delaying product development.

Fountx also met some resistance to change during initial product discussions with different businesses. However, Fountx found that developing the product in consultation with industry users, combined with the financial benefits associated with its use, helped overcome these challenges.

### **Incredible applications, but roadblocks on the way**

Fountx\_AsR was developed to initially support the Maintenance, Repair and Overhaul (MRO) activities of the aviation and defence industries. The prevalence of time-critical situations in areas with restricted access in the aviation industry presents the perfect opportunity to showcase this product's utility in complex industrial environments. In addition, with the aviation industry's aging workforce, fountx\_AsR opens doors for transfer of knowledge and skills to the emerging workforce from experts located miles away.

However, regulatory requirements pose potential challenges in entering the aerospace industry. For example, while opportunities exist for a product like fountx\_AsR to be used by licensed engineers to release aircraft remotely, domestic regulations stipulate that engineers have to be physically present. If an airline is still required by regulation to deploy personnel to sites for such tasks, this negates a number of the benefits associated with the Fountx technology. This, however, is not the case with European regulators, who appear more open to embracing such developments, thus paving the way to international aerospace markets.

Being based on a windows application, fountx\_AsR is extremely easy to use, but start-up supply constraints and potential software issues resulting from updates to the platform used (mobile phones, tablets) may be some of the initial obstacles for Fountx. Nevertheless, going forward, this product has readily imaginable applications in a range of industries including manufacturing, mining, automotive and medical.

### **Achieving the commercial reality**

The potential time and money saved by adopting this technology has sparked strong interest from Defence as well as local government bodies. There has been large scale global outreach of the product, with

major Original Equipment Manufacturers (OEMs) such as Panasonic, Mitsubishi and Boeing expressing interest. In Australia, Fountx notes the scope for application could extend into industries such as mining, oil and gas, and emergency services. The practical efficacy of fountx\_AsR is currently being trialled with Boeing, Japan Air, Singapore Air, and Lion Nathan to name a few.

While there has been a high response from buyers, Fountx does recognise economic and government policy barriers on its path to commercialisation. Company policies that provide a small travel budget go a long way to help sell a product like fountx\_AsR. However, there may be some further regulatory hurdles, including unresolved questions around legal liability in case of an accident. There are also the usual commercial challenges, such as maintaining cash flow until the product takes-off. Since the product's introduction in 2016, there have been several rounds of product refinements and testing with different sized prototypes, to achieve the right balance between convenience to carry and clear displays.

Fountx was an award-winner at the 2017 City of Ipswich Business Awards for Innovation, and with a recent partnership with Singapore's ST Aerospace trialling the technology in its operations, fountx\_AsR is aiming to position itself globally into the future.

# Conclusion



05

## 5. Conclusion

This report examines the role of the Aircraft Manufacturing and Repair Services industry in the Australian economy. The economic profile of the industry reveals that there's a large presence of small sized businesses, which are either non-employing or employ fewer than 20 workers. Businesses in this industry operate across the civil and defence sectors, are involved in the manufacture of small and light aircraft, aircraft parts and components, engines, and also undertake maintenance and repair activities for domestic as well as international airlines. The Aircraft Manufacturing and Repair Services industry is majorly concentrated in NSW, Victoria and Queensland, due to the presence of manufacturing facilities and large scale commercial activities in these regions.

Australia is renowned globally for its expertise and engineering and technical capabilities. It is home to some of the best technological universities like the University of Sydney and the Royal Melbourne Institute of Technology, which produce graduates who are well-qualified and equipped with essential job skills. However, there are challenges for the industry to maintain a competitive edge globally with a declining number of apprenticeships and trainees in the industry. Industries like Air and Space Transport, Metal Manufacturing and Mining compete with this industry to hire skilled engineers, and high attritions in the industry due to retirements or migration pose serious challenges for the industry in accessing a skilled workforce. This calls for increased efforts to pass down knowledge and increase training to address an imminent skill shortage in the industry.

Moreover, the Aircraft Manufacturing and Repair Services industry is highly regulated, with extensive national and international regulatory requirements believed to be burdening the industry. Industry representatives feel there is a need for increased government support in promoting the domestic Australian Aircraft Manufacturing and Repair Services industry in export markets and to take a strategic approach to securing more work and long term Defence partnerships.

There is regard for Australia's bright minds and the top-quality research work done in this industry. As traditional manufacturing is becoming harder to sustain in an expanding competitive global marketplace, the industry sees future Australian opportunities evolving in the newer sectors such as UAV's, sports aviation and the space sector. It is believed that leveraging Australia's research excellence and transforming it for industry use can simulate these new sectors and help Australia enter some niche untapped markets. Further, as the start-up culture in Australia is gaining momentum, collaborative partnerships between industry and research organizations (like universities and the CSIRO) are starting to bear fruit, expanding the industry's capabilities.

R&D activities are important to maintain the Australian industry's relevance and competitiveness in the global aerospace market. Feedback from industry stakeholders has highlighted that R&D investment is mostly undertaken by larger businesses, as these businesses generally have a broad technological base as well as enough resources to sustain the business before a new product/service starts bearing a return on investment. Many SMEs also have strong technological capabilities, but hit roadblocks on the path to commercialisation, mostly due to a lack of adequate funds. While the level of R&D investment made by Australia in the aerospace sector has been pared down since the early 2000s, the 'R&D intensity index' classifies Australia as a high R&D intensity industry based on average industry investments across OECD countries. Australia's high technological standards and innovation is highly regarded in the global aerospace market. Further, the industry's increasing collaboration with Australian universities and other research organisations is paving paths for the Australian industry in newer segments within the aerospace practice.

Analysis of the Aircraft Manufacturing and Repair Services industry's activities in the international market and integration in global supply chains indicates a strong global position for the industry. While a significant proportion of the industry's supply to the domestic market (including commercial aircraft as well as aircraft parts) is sourced from overseas, there has been a spike in exports of aircraft

components to both civil and defence sectors in the past decade. USA is our largest trading partner, accounting for nearly half of our imports and exports in this sector.

A further understanding of the economic contribution of the Aircraft Manufacturing and Repair Services industry as well as its interactions with other industries was provided through an economic modelling simulation. The simulation results indicate that the industries contribution to the Australian economy extends beyond its direct impacts. The industry's annual direct and indirect contribution to GDP is estimated to be nearly \$2.9 billion on average and 18,285 jobs across Australian industries.

Fundamentally, Australia's Aircraft Manufacturing and Repair Services industry is driven by its business capabilities and technical expertise, rather than high volumes in the global aerospace market. Reforming the industry to meet changing demands is vital for its sustenance.

# Appendix



# Appendix: KPMG-CGE Model Description

KPMG-CGE is a computable general equilibrium (CGE) model that represents the Australian economy across producers, households and government.

## Model theory

KPMG-CGE models the economy as a system of interrelated economic agents operating in competitive markets. Economic theory is used to specify the behaviour and market interactions of economic agents, including consumers, investors, producers and governments operating in domestic and foreign goods, capital and labour markets. Defining features of the theoretical structure of KPMG-CGE include:

- Optimising behaviour by households and businesses in the context of competitive markets with explicit resource constraints and budget constraints;
- The price mechanism operates to clear markets for goods and factors such as labour and capital (i.e. prices adjust so that supply equals demand); and
- At the margin, costs are equal to revenues in all economic activities.

## Model data

The key data input used by KPMG-CGE is an input-output table that quantifies the flows of goods and services between producers and various users (e.g., intermediate inputs to other producers, inputs to capital creators, households, governments and foreigners) and the flows associated with primary factor inputs (i.e., labour, capital, land and natural resources). In KPMG-CGE the input-output database is combined with the model's theoretical structure to quantify sophisticated economic behavioural responses, including to:

- Price and wage adjustments driven by resource constraints;
- Price and tax and/or government spending adjustments driven by budget constraints;
- Allow for input substitution possibilities in production (e.g., allowing the combination of labour, capital, and other inputs required to produce a particular output to vary in response to relative price changes);
- Capture a wide set of economic impacts driven by the responses of consumers, investors, foreigners and other agents to changes in prices, taxes, technical change and taste changes; and
- Detailed modelling of state and federal government fiscal accounts and balance sheets, including the accumulation of public assets and liabilities.

## Why use a CGE model?

The theory described above is necessary to quantify impacts across the entire economy. Models without general equilibrium linkages can miss feedback effects that occur from economic agents. For example, input-output multipliers (which are often used for these types of analysis) over-estimate impacts by ignoring relevant economic constraints.

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