



BRINGING INDUSTRY TO AIRPORTS: HOW THE US EXPERIENCE CAN HELP WESTERN SYDNEY TAKE OFF

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The United States Studies Centre's Innovation and Entrepreneurship Program is a multi-year research initiative, funded by the New South Wales Government, focused on understanding the United States as an innovation leader with a view to developing insight for the benefit of New South Wales and Australia.

Research areas include business, technology and policy trends in the United States in the areas of innovation and entrepreneurship, including in the emerging areas of AgTech, venture capital, cybersecurity and defence industries.



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Executive summary

Industry clusters are seen as critical to economic growth and national competitiveness in the United States.¹ They're deemed so important to the United States that the Department of Commerce, the Economic Development Administration and Harvard Business School maintain more than 50 million data points mapping them.

Research from this US Cluster Mapping² shows clusters increase the productivity and growth of existing companies, create jobs and new companies, drive innovation and support the survival and growth of small businesses.³ Clusters bring together a knowledge-based ecosystem of technology, talent, competing companies, universities and research institutes.

To the west of Sydney all these cluster components will be required if the Australian and New South Wales governments are to fulfil their vision and plan for the 1,700 hectare (4,200 acre) Badgerys Creek Aerotropolis, a self-contained business park built around and integrated into the greenfields Western Sydney Airport. Placed at the heart of the envisioned Western Parkland City that encompasses the established centres of Liverpool, Greater Penrith and Campbelltown-Macarthur,⁴ the Badgerys Creek Aerotropolis is a focus of development and growth for all levels of government.

The governments have set ambitious targets in the area of Western Sydney industrial policy. Early indications are that the investment required is being planned for and made. An examination of some US cluster examples and the policy settings supporting them provide additional food for thought.

The New South Wales Government is looking to create a series of industry precincts focused on aerospace and defence, food and agribusiness, health, research and advanced manufacturing as part of the Badgerys Creek Aerotropolis and is inviting companies to partner with them as anchor tenants.⁵ US defence prime Northrop Grumman is the anchor tenant for the aerospace and defence industries precinct.⁶

As a greenfields area on the outskirts of the metropolitan area of Sydney, attracting the right companies to relocate or establish significant presences will be challenging. Such industry attraction has long been a feature of US regional economic policy to the point where competition between US states is now a feature of industry development.

Looking to 2026, when Western Sydney Airport is due to open, and recognising the rapid nature of technology-driven change, now is the time to focus on the technologically-advanced aspects of these target industry sectors. In the United States clusters are hubs of innovation; by attracting those companies at the leading edge of science and technology, and where proximity to an airport is an advantage, the aerotropolis will be setup to succeed. Aerospace is a natural fit. Additive manufacturing — or three-dimensional metal printing — of customised medical devices brings together health and advanced manufacturing for on-demand delivery for surgical needs. Aeroponic production of organic fruit and vegetables, a highly efficient approach of growing plants indoors without soil, could be the model for agricultural exports from Western Sydney Airport.

Attracting a world-class university, as outlined in the plans for the Badgerys Creek Aerotropolis, will be crucial. Universities are the principal ideas-sharing venues in global cities⁷ and are a key source of future workforce as well. Some of the most famous US clusters, such as Silicon Valley and Boston are as recognisable for their universities as they are for their industry leaders.

Clusters occur organically, reflecting the assets and competencies of a region. The onus therefore on all levels of Australian governments focused on the success of the Western Parkland City is to get the settings right on the mix of technology, talent, competing companies, universities and research institutes. This will give the already nominated precincts within the aerotropolis the best chance to develop into clusters reaping the kinds of economic benefits experienced by the regions where clusters have evolved in the United States.

Recommendations for Australia

1. The Department of Agriculture and Water Resources should work towards concluding pre-clearance protocols with key export markets for future sterile horticultural exports.

Aeroponic production of organic fruit and vegetables, a highly efficient approach of growing plants indoors without soil, could be the model for agricultural exports from Western Sydney Airport. Customs pre-clearance (where goods are processed through the destination country's customs prior to air-freighting) of high-value produce going to key export markets where freshness is prized would support Australia's reputation for high value horticultural products.

2. The Australian Therapeutic Goods Administration should establish guidelines of surgical implants made by additive manufacturing to enable Australia to gain a foothold in this emerging market.

Three-dimensional printing of customised surgical implants for just-in-time delivery to operating theatres around the world is a clear opportunity. With the United States the top export market for Australian medical devices and diagnostics exports,⁸ Australia should be looking to align with the emerging guidelines for customised surgical implants and look to play a role in setting standards for this nascent sub-industry.

3. Australia should set a target in national industry policy to move out of simple components and into complex subassembly work in the aerospace sector.

If Australia is to move up the aerospace supply chain from playing a sustenance and maintenance role into complex subassembly manufacture, the federal government will need to use its industry policy more aggressively in defence procurement. The state government will need to back this effort up with the attraction of US defence contractors and also higher education facilities that can provide a pipeline of skilled graduates.

4. All levels of government around Western Sydney need to examine the range of financial incentives on offer to secure anchor tenants.

Government leadership will be essential to attract the large-scale, long-term investment by businesses that will be required to create an aerotropolis capable of delivering globally at scale.⁹ For American companies, incentives are often an expected part of investment attraction, and while Australian governments appear to be approaching industry attraction on a case-by-case basis, much can be learned from examining the US experience of cluster development.



DEFINITIONS

aerotropolis

John D. Kasarda, one of the world's most prominent thinkers on airport cities defines an aerotropolis as a part of a city centred on an airport, where the layout, infrastructure and economy is planned to maximise the ease of access to air transport.¹⁰

An aerotropolis is thus considered: a planned and coordinated multimodal freight and passenger transportation complex which provides efficient, cost-effective, sustainable, and intermodal connectivity to a defined region of economic significance centred on a major airport.¹¹

cluster

A cluster is described as a geographic grouping of closely related industries, where companies are connected by a shared workforce, supply chain, customers or technology. Clusters occur organically and include core businesses and industries as well as support companies. Together these form a business ecosystem beneficial to all, often reflecting the unique assets and core competencies of the geographic region.¹²

Introduction

“Aerotropolis” or airport cities (interconnected business parks in close proximity to a well-connected airport, characterised by highly sophisticated logistics and supply chain management) have opened up global trade in goods and ideas the way railroads and ports did before them.¹³

The country with the most experience of building airport cities is the United States. For more than 40 years, public policy has led city and state governments to both bolster airport development and also attract advanced manufacturing to their localities. Often there is a symbiotic relationship between air connectivity and high-paid employment: As world-leading aerotropolis expert John D. Kasarda documents, the airport of the

21st century is the seaport of the 19th, an essential part of the global supply chain. But today’s supply chain is in knowledge, so the connectivity of people and ideas is paramount. More than infrastructure plays, airports are policy levers in the United States.

US urban policy since the Second World War has been to stimulate economic growth by co-

locating talented people alongside business, often through government subsidy. A classic example is around Raleigh, North Carolina, where lawmakers gave generous payroll tax exemptions and free land grants to attract IBM in the 1960s, when computer science was in its infancy. This in turn rejuvenated the state’s universities, which provide the bulk of the graduates for the now booming Research Triangle Park business park.

Western Sydney Airport, the greenfield airport site in Badgerys Creek, some 43 km (27 mi) west of Sydney’s central business district and due for completion by 2026 is envisioned as an opportunity to build an aerotropolis from scratch.¹⁴ Constructed on federal government land, the state and national governments are promoting

their joint vision of a new city emerging in the area surrounding the new airport, with a well-educated population supporting advanced manufacturing jobs in aerospace, agribusiness and health.¹⁵

There is already A\$20 billion (US\$14.3 billion) in public funds on the table to develop the airport and its surrounds. Transport experts suggest that getting the road and rail links right will be the single biggest factor in the plan’s success.¹⁶ Yet there are also ambitious plans to use the hand of government to seed the new advanced industries that could co-locate within the airport perimeter itself.¹⁷ The aim is to foster those industries most likely to succeed and set the conditions for their growth. In short, the goal is to create a cluster around Western Sydney Airport where talented workers graduate from universities onsite and go on to develop new products that are manufactured and exported right within the confines of the new precinct itself.

Looking at the US experience, these kinds of clusters tend to rely on three kinds of government intervention: regulation, infrastructure and financial assistance. Of these, the Australian Government has already smoothed the path in the first case, through its assumption of project control. Meanwhile the New South Wales Government is committing time and money to building roads and rail links.¹⁸ Evidence from the United States suggests this needs to be backed up with financial inducements to ensure the right companies take the risk in relocating to any new business precinct.

In Western Sydney, aerospace, medical devices and precision agriculture have been earmarked as the sectors that both benefit from proximity to an airport for just-in-time logistics, and also where Australia has potential competitive advantage. Of these, medical technology appears to be the best fit without further government intervention, with a healthy export sector already in place. AgTech, or next generation agricultural technology, is an area where Australia could also excel. Early analysis would, however, cast doubt on the aerospace sector flourishing in Western Sydney without heavy government intervention.

The goal is to create a cluster around Western Sydney Airport where talented workers graduate from universities onsite and go on to develop new products that are manufactured and exported right within the confines of the new precinct itself.

Alongside government investment, higher education institutions will need to be persuaded to locate a related campus in the Western Sydney Aerotropolis. In the United States and Europe, the existence of researchers and academic topic specialists alongside business is a key attribute of successful industry clusters.

Western Sydney Airport has some excellent policy settings around it: both national and state governments have argued for 24-hour operation, boosting its

chances of being Sydney's leading freight airport within a decade. There is also ample space for the planned aerotropolis to be built with industrial zoning. The focus must now be on the industrial policy that ensures the right talent and the right employers are attracted to set up their facilities in the new airport. Evidence from the United States suggests this will require both policy levers and financial sweeteners to attract and retain the brightest and the best.



Photo: Getty

Industry clusters in the United States

Employment clusters date back almost as far as industrialisation. In 1890, British economist Alfred Marshall noted the phenomenon of agglomerations of small- and medium-sized companies in the same or related industries forming in towns and cities.¹⁹

The importance placed on the knowledge drivers of business clusters — entrepreneurship and innovation — versus the production drivers — suppliers and partners — differs between the United States and Europe.²⁰ Industrial districts in US cities tend to follow the Marshall tradition of laissez-faire economics, with universities and publicly-funded research facilities creating the right conditions for local knowledge spillovers.

In the United States, the Marshall industrial district model explains the tendency of competing firms to colocate in a region, in order to bring about economies of scale of labour, suppliers and distribution networks.²¹ More recent studies by urban economist Michael Porter identify three influences on competitive advantage from clusters: an improvement in static productivity, opportunities for greater innovation in a cluster, and the emergence of new firms and business ideas that expand the cluster.²²

In contrast, much post-war industrial planning in Europe followed a competing vision of clusters from French social scientist François Perroux, who hypothesised that regional 'growth poles' can be created by government policy by locating both the suppliers of parts and components, and also the raw materials infrastructure required to support entire manufacturing industries.²³ In the Perroux model, academic institutions are less important than industrial facilities. Australia has tended to follow the United Kingdom, which in turn follows continental Europe, with regional growth poles. Yet the US model has arguably been more successful in increasing industry clusters.

In the United States, North Carolina Governor Luther Hodges [1954-1961] had a bold solution to halting the decline in his state's fortunes, ranked one of the poorest states in the union in the 1950s. He designated more than 17 square kilometres of national parkland in

the Piedmont region as a scientific research park.²⁴ One of the first of its kind, the Research Triangle was bounded by the state's three main college campuses of Duke University, North Carolina State University and the University of North Carolina.

Initially looking like an expensive folly, with academics and industry sceptical of the wilderness park's purpose, the state government successfully wooed International Business Machines (later IBM) to become a major tenant.²⁵ The firm was attracted by a package that included free land, construction costs and a four-lane highway.²⁶ Meanwhile, its employees and their families were given relocation grants by the state government. Many families saw this as a real hardship posting at the time, swapping prosperous New York State with an underdeveloped town on the edge of the South.²⁷ But the funds dedicated to IBM attraction by North Carolina looks parsimonious by today's state subsidy standards, especially when judged by the results of the experiment.

Today the Research Triangle Park (RTP) has more than 250 companies employing some 50,000 people. More than half of these have bachelors' degrees, making it one of the most highly-educated places in the country.²⁸ Successive state governments have bolstered the position through structural and bespoke financial incentives. The RTP has the lowest combined state and local business tax level of any region in the United States.²⁹

What the RTP proved was that governments could plan and execute industrial clusters through a combination of financial incentive and concentration of academic institutions. Research led by Harvard Business School into US industrial clusters has shown that although clusters are more prevalent in high-income locations, they can also stimulate regional economic competitiveness by encouraging higher rates of job growth, new business formation and innovation in poorer towns.³⁰

The triple helix of industry, academia and government

The confluence of industry, academia and government in the successful generation of cutting-edge research is often referred to as the triple helix model. Its chief proponent, Loet Leydesdorff, posits that the trinity between governments protecting intellectual property and directing research funding, universities promising campuses for research and a talent pool, and private enterprise acting as catalyst and customer, has existed since at least 1870 in Europe and North America.³¹

Brookings Institution, having long studied economic issues facing the United States and the world, defines this further, identifying eight essential dynamics in successful industry clusters.³²

In each of the US cities studied by Brookings, there is this confluence of a highly-regarded university, strong private industry and good government policy settings. Less well understood and less frequently discussed is a fourth factor — the role of direct financial inducements by state and local governments to attract large anchor tenants of planned technology and research parks.

Eight success factors in industry clusters

- | | |
|---|--|
| 1 Achieve a high density of highly-skilled workers | 5 Ensure demand for the region's products |
| 2 Focus on a region's core competency | 6 Provide access to funding |
| 3 Ensure a research culture | 7 Ensure infrastructure provision |
| 4 Build business capabilities | 8 Provide a strong regulatory environment |

Brookings Institution 2017

Competition between US states is a feature of industry development

In 2017 and into 2018, online retailer Amazon engaged in a very public contest to locate its second headquarters after Seattle. Some 238 city governments put in bids to host HQ2, which was then whittled down to 20 candidate cities before Arlington, Virginia was selected. The Virginian state government committed some US\$750 million in economic development subsidies, grants and tax concessions to attract the company.³³ During the process, Amazon was explicit in what it expected state governments to do: the firm used the word “incentive” 21 times in its request for proposals.³⁴

Incentives are usually tax credits or workforce grants and form a central plank of most states’ economic development programs.³⁵ Between 1980 and 2013, state and local governments in the United States awarded corporations more than US\$64 billion in subsidies.³⁶ Table 1 sets out the US subsidies received by the top 80 companies. There are now a multitude of programs, grants, loan guarantees, aid assistance, tax breaks and concessions offered by every level of government in the United States, designed to

encourage investment and the creation or retention of jobs. The most common forms of assistance include state subsidies; federal grants and tax credits; and federal loans, loan guarantees and bailout assistance.³⁷

In a highly-mobile country like the United States, companies move their manufacturing bases more readily than in other developed countries.³⁸ As a result, there is a market for luring corporate headquarters and manufacturing facilities away from one city and to another. The die was cast in 1976 when Pennsylvania crafted a US\$100 million assistance package to convince German automotive giant Volkswagen to build the first foreign car manufacturing facility in the United States in Westmoreland County, 56 km (35 mi) south of Pittsburgh.³⁹ Other European and then Japanese car makers sought — and received — similar sweeteners from rival states keen to emulate Pennsylvania’s reverse from economic decline. US automotive producers received generous packages too, which in turn spilled over to other large manufacturing businesses being able to guarantee jobs in sensitive congressional districts.



The Amazon Spheres in Seattle, Washington (Getty)

Table 1: Top 80 companies receiving US subsidies (federal, state and local awards combined)

Rank	Parent company	Subsidy value (\$US)	Number of awards	Rank	Parent company	Subsidy value (\$US)	Number of awards
1	Boeing	\$14,499m	1,422	41	United Technologies	\$989m	959
2	General Motors	\$6,119m	696	42	Forest City Enterprises	\$984m	79
3	Intel	\$5,986m	140	43	Exxon Mobil	\$952m	125
4	Alcoa	\$5,788m	161	44	Exelon	\$931m	80
5	Foxconn Technology Grp	\$4,826m	71	45	Mazda Toyota Manufact.	\$900m	1
6	Ford Motor	\$4,065m	568	46	Delta Air Lines	\$878m	22
7	NRG Energy	\$3,537m	266	47	Pyramid Companies	\$875m	67
8	Sempra Energy	\$3,362m	39	48	Walt Disney	\$859m	81
9	Cheniere Energy	\$3,293m	22	49	Air Products & Chemicals	\$857m	241
10	NextEra Energy	\$2,396m	55	50	SunEdison	\$800m	112
11	Iberdrola	\$2,288m	105	51	Valero Energy	\$798m	148
12	DowDuPont	\$2,258m	900	52	Goldman Sachs	\$797m	246
13	Tesla Motors	\$2,229m	112	53	E.ON	\$790m	31
14	Fiat Chrysler Automobiles	\$2,199m	215	54	Texas Instruments	\$785m	55
15	Nike	\$2,095m	96	55	Alphabet Inc.	\$766m	43
16	Southern Company	\$1,986m	92	56	Nucor	\$760m	115
17	Summit Power	\$1,980m	8	57	Triple Five Worldwide	\$748m	4
18	General Electric	\$1,898m	1,855	58	AES Corp.	\$737m	73
19	Venture Global LNG	\$1,870m	2	59	EDP-Energias de Portugal	\$734m	13
20	Mubadala Technology	\$1,868m	22	60	Johnson Controls	\$728m	150
21	Sasol	\$1,848m	67	61	Daimler	\$710m	135
22	Nissan	\$1,826m	76	62	Apple Inc.	\$693m	17
23	Cerner	\$1,823m	35	63	Bank of America	\$689m	881
24	Royal Dutch Shell	\$1,740m	114	64	LG	\$687m	37
25	Berkshire Hathaway	\$1,681m	700	65	Verizon Communications	\$664m	247
26	Lockheed Martin	\$1,643m	908	66	Bayer	\$664m	185
27	IBM Corp.	\$1,632m	460	67	Sagamore Development	\$660m	1
28	SCS Energy	\$1,591m	9	68	Caithness Energy	\$652m	22
29	JPMorgan Chase	\$1,578m	1,070	69	Dominion Energy	\$639m	55
30	Amazon.com	\$1,520m	165	70	American Electric Power	\$629m	62
31	Energy Transfer	\$1,414m	65	71	Ameren	\$618m	11
32	General Atomics	\$1,251m	303	72	Bedrock Detroit	\$618m	1
33	ArcelorMittal	\$1,250m	77	73	General Dynamics	\$617m	319
34	Northrop Grumman	\$1,245m	442	74	Archer Daniels Midland	\$608m	1,069
35	Duke Energy	\$1,241m	57	75	FedEx	\$588m	421
36	Continental AG	\$1,234m	86	76	Mayo Clinic	\$585m	1
37	Jefferies Financial Group	\$1,123m	32	77	Wells Fargo	\$580m	400
38	Abengoa	\$1,083m	61	78	Sears	\$572m	77
39	Volkswagen	\$1,071m	65	79	Invenergy	\$571m	19
40	Toyota	\$998m	148	80	Michelin	\$566m	75

Source: Subsidy Tracker, Good Jobs First <https://www.goodjobsfirst.org/subsidy-tracker>

By the 2000s, some 14 large companies moved their operations across state lines after receiving large-scale government subsidy packages, with a further 11 companies paid for relocations to different cities within the same state.⁴⁰ Today, corporate headquarters tend to ebb and flow between the metropolitan centres, while manufacturing is pointed towards distressed neighbourhoods and others deemed 'opportunity zones' by the Tax Cuts and Jobs Act of 2017, opening up certain investments to have tax advantages.⁴¹

Some relocation deals are more controversial than others. In 2010, for example, the video games company 38 Studios received US\$75 million to move to Rhode Island from Massachusetts — where the bulk of its employees were development graduates from the Boston area universities. The state government bet on the company's ability to attract the brightest and the best technology talent to Providence. The gamble failed when 38 Studios went bankrupt and the tiny state is estimated to have lost US\$38 million on the deal.⁴²

Equally common as relocation deals, however, are retention deals made to keep large corporations (and thus large employers) in a state or city. Some 17 retention deals larger than US\$1 million have taken place over the past 30 years.⁴³ Most of these were struck after the company threatened or hinted it would move its base if no subsidy were awarded. A recent example of this practice is the Nike athletic clothing company, which secured tax breaks worth an estimated US\$2 billion over the next 30 years from the state of Oregon after it courted rival states' relocation offers.⁴⁴ However, while Nike was a high profile example of retention policies, media and financial services companies including NBCUniversal, JPMorgan Chase and Wells Fargo have all successfully played up offers to relocate out of New York City to secure multimillion dollar tax breaks from the New York State Government.

A further string to the state government corporate attraction activity is tax rate reductions. Looking at North Carolina's Research Triangle as an example, the state government has had to bolster its already strong position through generous financial inducements to private corporations considering the state. At a flat 3 per cent, North Carolina has the lowest corporate income tax rate in the United States (of the states that still levy the tax), however, this is set to drop to 2.5 per cent this year.⁴⁵ There is also no property tax in the state. Despite lower tax receipts, the state government claims it gets good return on investment in terms of job creation in high-yield industries.⁴⁶

Opportunities for Australia: Western Sydney high-tech export industries clusters

Australia can draw many lessons from the development of export industries located close to well-networked airports in the United States. Airport business parks exist across Australia, with some purpose built, such as Canberra Airport (CBR)'s Brindabella Business Park or the extensive facilities around Brisbane Airport (BNE). However, as a greenfield site at Badgerys Creek in Sydney's western suburbs, Western Sydney Airport has prompted plans for an aerotropolis in the mould of successful US airport cities.⁴⁷

In efforts to emulate US and international airport cities, part of the planned development to the south of the airport is the Western Economic Corridor. Planners hope to attract defence and aerospace activities as well as other advanced manufacturing, health, education and lifescience industries. As set out in

Table 2, these industries are identified in the United States as high-technology industries, in which science and engineering occupations (scientists, engineers, engineering technicians, and science and engineering managers combined) account for at least two times their economy-wide percentage of employment.

There is already some jockeying for position between local government areas as to where each industry best fits. Liverpool City Council has identified logistics and distribution, food manufacturing and defence aerospace as its target industries to attract.⁴⁸ Meanwhile, neighbouring Campbelltown is pointing to the medical research facilities at Western Sydney University and the Macarthur Clinical School as draw cards for medical technology firms.⁴⁹

Table 2: US high-technology industries

High-technology category	Industry	Per cent of industry employment in science and engineering occupations
Very high technology*	Computer and electronic product manufacturing	37.4
	Pharmaceutical and medicine manufacturing	32.2
	Aerospace product and parts manufacturing	31.0
Moderately high technology^	Petroleum and coal products manufacturing	14.5
	Chemical manufacturing other than pharmaceuticals and medicines	12.8
	Transportation equipment manufacturing other than motor vehicles and parts and aerospace	12.7
	Machinery manufacturing	12.5
	Electrical equipment, appliance and component manufacturing	12.3

*Science and engineering occupations as per cent of total industry employment are at least five times the national average.

^Science and engineering occupations as per cent of total industry employment are at least two but not more than five times the national average.

Source: Analysis of Bureau of Labor Statistics Occupational Employment Statistics survey data for 2010 in Susan Helper, Timothy Krueger, and Howard Wial. 2012. *Locating American Manufacturing: Trends in the Geography of Production*, Metropolitan Policy Program at Brookings https://www.brookings.edu/wp-content/uploads/2016/06/0509_locating_american_manufacturing_report.pdf

The first two business parks within the airport perimeter have been designated as the Aerotropolis Core, which is expected to house agriculture and agribusiness, and the Northern Gateway precinct which will be rezoned to accommodate what airport planners expect to be advanced manufacturing.⁵⁰

Attracting a world-class university, as outlined in the plans, will be crucial. Universities are the principal ideas-sharing venues in global cities.⁵¹ Indeed, cities rather than countries are developing stronger

roles as talent hubs.⁵² Scientists, universities and researchers particularly rely on the cross pollination of ideas and fertilisation of concepts that take place in colocation in major cities.

There is clear evidence that universities and research institutions provide significant impetus to industry clusters' growth. Higher education provides research and development possibilities unavailable

in many other settings. It also provides a pipeline of highly-skilled human capital, which is essential in high technology and high value added industries.⁵³ For example, Los Angeles County is a life sciences cluster thanks to research universities such as Stanford producing thousands of bioscience graduates each year.⁵⁴

Today the best-known cluster for high technology and innovation is Santa Clara Valley near San Francisco, better known by its nickname Silicon Valley. Along with access to venture capital funding for entrepreneurs, access to highly-skilled workers from the University of California at Berkeley and Stanford (with its positive disposition to enter commercial partnerships) was crucial in both its formation and ongoing success.⁵⁵

The Western Sydney Aerotropolis Site Plan has several hectares set aside for higher education institutions, among which is a planned aerospace campus. The key will be to persuade existing universities, centred mostly (although not exclusively) in eastern Sydney, to relocate parts of their campuses. Aerospace makes sense, due to the benefits that space could provide, but agricultural faculties from Sydney's major universities are already devolved to regional campuses⁵⁶ and it could also make sense to relocate aerospace manufacturing to purpose-built, spacious sites on the new airport site. Likewise, medical biotechnology schools could establish satellite campuses in Western Parkland City.

Western Sydney in particular has a high degree of multiculturalism that will benefit the recruitment of academic staff, with 64 per cent of the population having at least one parent born outside of Australia. Evidence from around the world has shown that cities with the highest concentrations of talent from different backgrounds are those that go on to produce the most novel inventions.⁵⁷ This is where humans will still have the edge over machine learning, in the fields of cognisance and intuition.

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Aerospace

The aerospace industry is one of the largest high-technology employers in advanced countries, with more than 1.9 million people employed in the industry in 2017.⁵⁸ A significant share of the world's aerospace jobs are concentrated in or around one of four aerospace clusters: Seattle (home to the Boeing Commercial Aircraft final assembly line), Toulouse (home to the Airbus final assembly line), Montreal (home to Aéronautique Bombardier) and the São Paulo-São José dos Campos corridor (home to Brazil's Embraer). Table 3 shows the top 10 aerospace and defence clusters by employment in the United States. Advanced supply chains featuring hundreds of firms as contractors and sub-contractors work to produce the specialised sub assemblies that make up aircraft manufacturing.

For this reason, many countries have actively promoted growth in the aerospace sector. However, Australia has slipped well behind comparable countries in its aerospace industry. Not one of the world's top 100 aerospace companies is Australian, despite firms from smaller countries such as Sweden, Israel, Denmark and Portugal all featuring in the rankings.⁵⁹ Canada,

considered in many ways analogous to Australia, is home to some 7.5 per cent of global aerospace jobs, most concentrated in the province of Québec.⁶⁰

Furthermore, Australia's companies are small. There are no tier 1 aerospace companies (the prime manufacturers of either fuselage or engines), no tier 2 (manufacturers of major subassemblies) and no tier 3 (system integrators). Instead, Australian aerospace companies are machine shops, parts manufacturers and raw material suppliers (tiers 4, 5 and 6 respectively).⁶¹ This is lower down the value chain than other advanced economies.

The Australian and New South Wales governments have a plan to reverse this poor global standing. The sector has been earmarked as the main export manufacturing industry expected to power the future Western Sydney Airport. The state government's defence industry strategy outlines several objectives, including working with small businesses to gain greater access to the global supply chain.⁶²

Many point to the success of the Dulles Corridor of defence-related aerospace companies concentrated around Washington's Dulles International Airport (IAD) in northern Virginia. This is wide of the mark, however, as Dulles has many significant differences from Western Sydney. Firstly, the proximity to national lawmakers in Washington, DC: Dulles sits at one end of a freeway that leads to the Pentagon. In Australia, the Department of Defence is in Canberra, not Sydney.

Secondly, US defence contractors are industry primes. In Australia, the aerospace industry is at the level of subcontractors-to-subcontractors. Australia's relative lack of aerospace companies is to the detriment of potential contracts. For example, British aerospace company BAE Systems, as sole tier 1 partner on the Lockheed Martin F-35 Lightning Joint Strike Fighter (JSF) program, has contracts worth around £1 billion (A\$1.9 billion), which it is able to subcontract down to some 500 aerospace companies in its supply chain. BAE makes around 15 per cent of the JSFs and is the only supplier permitted under the US security and technology transfer agreement to retain its design rights.⁶³

Table 3: Top 10 aerospace and defence clusters in the United States by total employment

Economic area	Employment
Seattle, WA	74,950
Los Angeles, CA	50,733
Dallas, TX	44,374
Wichita, KS	34,959
Hartford, CT	20,765
Boston, MA	19,448
St Louis, MO	19,021
New York, NY	18,916
Washington, DC	17,262
Phoenix, AZ	15,223

Source: US Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

A model of the unmanned “Loyal Wingman” was unveiled at the Australian International Airshow, February 2019

Photo: Boeing



Although Australia is a level 3 partner at a country level on the F-35 program, alongside Canada, Denmark, Norway and Turkey, the titanium vertical tail sections made at BAE's facilities at RAAF Base Edinburgh in South Australia are not part of the global supply chain.⁶⁴ Instead, these parts are made specifically for the conventional take-off and landing variant of the F-35 ordered by the Royal Australian Air Force. This kind of implied quid pro quo workshare for military aircraft orders is enshrined in the industry participation policy of the Australian government.⁶⁵

Many other mid-tier countries have much more explicit policies linking defence contracts with local manufacturing. The process of offset agreements differs from country to country, but a nation like South Africa, whose aerospace industry was well advanced and self-sufficient during the apartheid era, uses offset today to ensure contracts are awarded to its firms.⁶⁶ The policy is a key plank of the country's economic development, black empowerment and job creation activities.⁶⁷

By contrast, most aerospace jobs in Australia are either in maintenance or sustainment. Worse still, for a large proportion of aircraft engineers in Australia, paper-

based certification work has replaced the hands-on work of the 20th century. This is partly due to aircraft manufacturers guarding their intellectual property more closely, allowing peripheral outstations, such as those in Australia, only limited access to design files.⁶⁸ The Australian industry remains concentrated in niche areas, including component manufacture, composites, unmanned air vehicles, hypersonics and air traffic management equipment, rather than participating on large-scale international projects.⁶⁹

Australia has traditionally shied away from mandated workshare as part of its defence procurement.⁷⁰ However, the new expectation is that international industry awarded defence will invest in Australian facilities and employees. As an example, the commissioning of 12 new short-fin barracuda block 1A submarines, to be built in Adelaide by a consortium led by French shipbuilder DCNS, is expected to be worth around A\$50 billion in procurement, a further A\$50 billion in sustainment activities, and pledges to create 2,800 jobs.⁷¹

Australia has mandated workshare for Australian companies under some aerospace contracts, notably the 2006 Eurocopter NH-90 attack helicopter purchase,

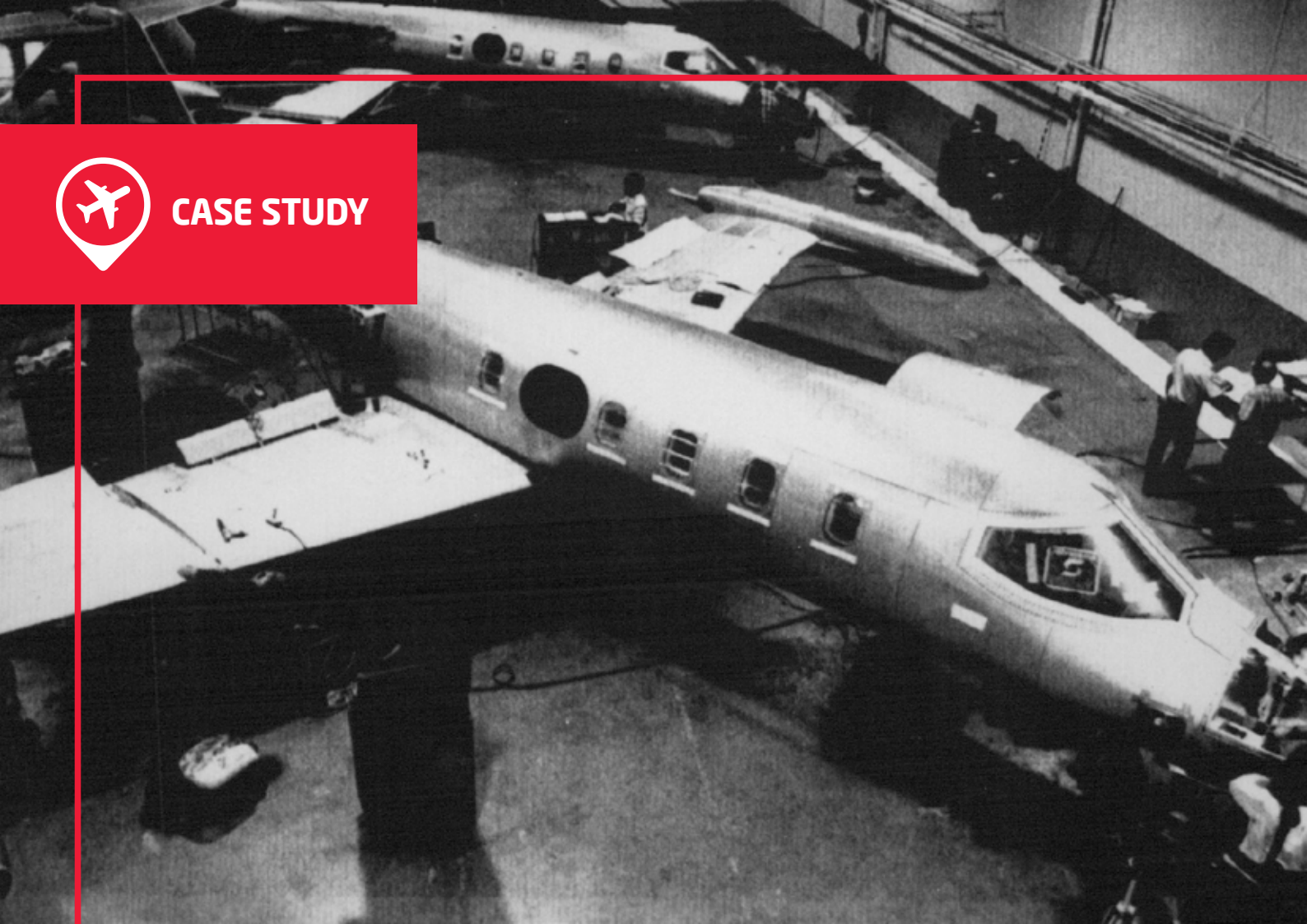
which led to 42 of the 46 procured being built in Brisbane (and re-designated MRH-90 Taipan).⁷² As a result, southeast Queensland has the highest concentration of qualified defence aerospace engineers in the country. Boeing has a large presence in the region and the recently announced the Boeing Airpower Teaming System “Loyal Wingman” unmanned aircraft is to be developed there, with first flight as early as next year. Significantly, this is the first combat aircraft designed in Australia since the 1950s.⁷³

To build on this, the national, state and eight local governments of Western Sydney have committed to the construction of an Aerospace Institute as part of the Western Sydney City Deal. The institute, located on Australian government-owned land close to the new airport, will be a new science, technology, engineering and mathematics facility with a focus on aerospace from high school through to tertiary education.⁷⁴ US prime Northrup Grumman will become the anchor tenant of a new industry park to be built adjacent to the institute. Additionally, the state of Victoria is readying plans to expand the Fishermans Bend aerospace campus currently home to Boeing, increasing the potential skills pool in Australia.

Thus, in seeking to plant the aerospace industry into Western Sydney, the governments’ intentions are good. But with well-developed pockets of aerospace and defence expertise distributed throughout Australia, from Adelaide to Brisbane and Melbourne, it will be a hard task to emulate large aerospace clusters like those that exist around the prime manufacturers in Europe, North America or Brazil.



CASE STUDY



Business jet cluster: Wichita, Kansas

After failing to excite European investors with his plan to refashion a Swiss Air Force jet fighter into a private aircraft,⁷⁵ US inventor Bill Lear brought his idea back to the United States,⁷⁶ and Kansas in particular. At that time, the unassuming Midwest town of Wichita held the title of Air Capital of the World. The entrepreneurs who preceded Bill Lear, Walter Beech (founder of Beech Aircraft), Clyde Cessna (founder of Cessna Aircraft) and Lloyd Stearman (founder of Stearman Aircraft)⁷⁷ had built an aerospace industry from scratch.

This was a combination of geography and local city planning. The city made famous by singer-songwriter Glen Campbell for its long straight roads to nowhere,⁷⁸ exploited its flat terrain to establish a world-class airfield long before anyone had really thought of aerospace as an industry. The city government attracted the first federal government-supported airshow and convention, the National Air Congress, to the city in 1924, at the dawn of civil aviation, attracting more than 100,000 delegates and visitors.⁷⁹ Spurred on, the City

of Wichita and the Chamber of Commerce bet that the city's central location in the United States, together with favourable weather would make a perfect place to site an airfield.⁸⁰ When it opened in 1929, the city's first municipal airport (present day McConnell Air Force Base, IAB) was a state-of-the-art facility with expansive runways.

But then specialisation occurred. Both Cessna and Beech specialise in general aviation (or private aircraft to the layman). So when Bill Lear wanted to commercialise the first mass-produced private jet aircraft, the concentration of general aviation talent in Wichita made it an obvious choice. The eponymous Learjet 23 that launched in 1963 was an eight-seater jet that could fly at 1,000 kilometres per hour at an altitude of 41,000 feet (12,500 metres). By contrast, the most popular private aircraft at that time, the Cessna 172, had a cruise speed of only 226 kilometres per hour.

The Learjet was revolutionary at the time, and derided by most of the industry as a folly. Yet the city of Wichita

celebrated Lear's maverick ways and provided the state's first industrial revenue bond, valued at US\$1.2 million, to help him commercialise the product. It was an investment that paid off: Learjet went on to not only become synonymous with private jets, but lead the market. By 2015, over one-third of all private jets sold that year were manufactured by Canadian aircraft manufacturer Bombardier, which has owned Learjet since 1990.⁸¹

Today, business jets are a lucrative niche of the aerospace industry. Some 22,000 private aircraft have been sold and 55 per cent of the US-manufactured ones were made in whole or in part in Wichita.⁸² Some 35,000 people work in aerospace in the city, from a population of just 600,000, making it the most highly specialised aerospace cluster in the United States.⁸³

Although Seattle, Washington — the largest US aerospace cluster and home to Boeing's main plants — has more than double the total number of jobs of Wichita, the density of aerospace in the Kansas capital is more than 18 per cent of total employment.⁸⁴ Between the prime manufacturers Cessna, Beechcraft and Bombardier and their subcontractors making large-scale aero-structures, small-scale composite parts, specialised tools or designs as part of the aerospace supply chain, some 35,000 people are employed in aerospace in Wichita.⁸⁵

Specialised education is also a key attribute of Wichita as an aerospace cluster. Both Wichita State University and Wichita Area Technical College help to produce both the highly skilled engineers and production workers needed for its operations. The result is that Wichita is an export-driven manufacturing hub unlike many others in the United States.⁸⁶ Its exports account for nearly 20 per cent of its gross metropolitan product, representing the highest such share in the United States.⁸⁷

But this success hasn't come cheap. Kansas had to provide a US\$40 million subsidy in the form of training support in 2011 to keep Textron Aviation (owner of Cessna Aircraft Company since 2014) from moving to Louisiana. In total, Textron is estimated to have benefited from around US\$66 million from various state grants around the United States since 1994 and received a further US\$203 million in federal grants since 2000.⁸⁸ Similar subsidies to Boeing were controversial, leading to a decade-long World Trade Organization dispute with Canada, whose Aéronautique Bombardier first filed complaints over unfair US government assistance to airframers.⁸⁹

Nor is it only state and federal governments expected to subsidise the aerospace cluster in Wichita. Air connectivity is important in the supply of parts for the aerospace manufacturers, leading the Wichita city government to financially underwrite airline services to the city from other parts of the United States in 2009.⁹⁰

While Wichita is currently the leading aerospace and defence cluster by specialisation (Table 4) without as deep pockets as some larger aerospace states, Kansas may not be able to withstand the winds of change blowing against its aerospace manufacturing sector. Between 2012 and 2016, average annual employment in aerospace product and parts manufacturing dropped eight per cent.⁹¹ Boeing ended its 85-year history in Wichita in the middle of 2014, moving work to Texas, Oklahoma and Washington.⁹² Bombardier has likewise increased its use of facilities in its home city of Montreal in the same timeframe.

Table 4: Top 10 aerospace and defence clusters in the United States by specialisation

Economic area	Specialisation
Wichita, KS	18.04
Seattle, WA	8.14
Savannah, GA	7.90
Tucson, AZ	7.60
Charleston, SC	6.91
Cedar Rapids, IA	6.75
Hartford, CT	5.28
Killeen, TX	3.39
St Louis, MO	3.25
Tulsa, OK	3.02

Measured by Economic Area (EA): An economically defined geographic unit of analysis by the US Bureau of Economic Analysis (BEA). EAs are made of counties and encompass all rural and urban US counties. There are a total of 179 EAs and many cross state borders. Specialisation: Measured by the value of a cluster's location quotient. Location Quotient (LQ): Ratio of an industry's share of total state employment in a location relative to its share of total national employment. Measures the specialisation or concentration of a cluster in a particular location relative to the national average, with an LQ > 1 indicating higher than average cluster concentration in a location.

Source: US Cluster Mapping Project, Institute for Strategy and Competitiveness, Harvard Business School

Food, agribusiness and AgTech

Australia should be well placed to serve the growing consumption of high-quality food imports in Asia. The growth of middle-class consumers in Asia is expected to grow from 525 million in 2009 to around 3.3 billion by 2030.⁹³ Much of Asia, especially China, views Australian food as a high-quality product and exports of ambient products such as infant formula or health foods have already seen high growth.⁹⁴ China is already Australia's leading export market for agriculture (Table 5).

Table 5: Australia's major agriculture export markets (2015)

Agriculture export market	A\$m	Share of total (%)
China	8,906	19.9
Japan	4,500	10.1
United States	3,893	8.7
Republic of Korea	3,410	7.6
Indonesia	3,312	7.4
India	1,881	4.2
New Zealand	1,537	3.4
Vietnam	1,504	3.4
Hong Kong (SAR of China)	1,283	2.9
Singapore	1,190	2.7

Source: Australian Department of Foreign Affairs and Trade <https://dfat.gov.au/trade/organisations/wto/Pages/agricultural-trade.aspx>

But Australia does not export as much high-value fresh produce as it could. Fruit and vegetables make up 19 per cent of Australian agricultural production, but Australia's exports constitute only 1.2 per cent of global fruit exports and 0.3 per cent of global vegetable exports.⁹⁵ This is largely a cultural legacy of a focus on meat and grain export, which account for 25 and 11 per cent of Australian agricultural exports respectively (Table 6).⁹⁶

Table 6: Top 10 agricultural exports of Australia (2015)

Product	A\$m	Share of total (%)
Beef	7,401	16.6
Wheat	4,853	10.9
Meat (excluding beef)	3,575	8.0
Wool	3,021	6.8
Alcoholic beverages	2,587	5.8
Sugars, molasses and honey	2,332	5.2
Vegetables	2,260	5.1
Dairy	2,216	5.0
Live animals (excluding seafood)	1,875	4.2
Fruit and nuts	1,762	3.9

Source: Australian Department of Foreign Affairs and Trade <https://dfat.gov.au/trade/organisations/wto/Pages/agricultural-trade.aspx>

In the studies of functional aerotropolises, facilities for processing time-sensitive goods for export are often considered key. On-airport facilities, combined with road infrastructure linking the airport with agricultural land nearby should allow for advanced food production within the confines of an airport city, rather than a secondary location.⁹⁷

Western Sydney Airport will have a competitive advantage over Sydney Airport when it comes to fresh food export. Due to its night-time flight restrictions, Sydney Airport is unable to accommodate the early morning freight flights required to get fresh food to export markets.⁹⁸

There is huge demand in Asia for Australian produce, particularly if it is organic.⁹⁹ Australian fruit exports to China grew fivefold in the four years to 2018, much of it organic, premium produce.¹⁰⁰ In these high-value horticultural export markets freshness is prized.

Every hour picked fruit and vegetable spends out of refrigerated conditions, can reduce shelf life by two days.¹⁰¹ So access to a climate controlled supply chain and close proximity to an airport will be crucial to any export plan for Western Sydney Airport.

Australia possesses the talent pool to grow AgTech. There are now some 300 Agri-food tech companies operating in Australia, with many support companies. Australia is also home to five of the top 50 global agriculture universities.¹⁰²

The soil quality around Badgerys Creek is relatively poor and present farmers often struggle to keep up with domestic demand, let alone exports.¹⁰³ But the NSW Farmers Association has ambitious plans to pioneer precision, sensor-driven agriculture at Western Sydney Airport. The body wants indoor farming in aeroponic hothouses growing high-value crops within the airport footprint for international export.¹⁰⁴

The Fresh Food Precinct outlined by the farmers encompasses high-technology aeroponic hot houses connected to packing and labelling facilities. Only perfectly ripe fruit and vegetable would be picked, thanks to thousands of sensors in the soils. The aim is to have meal packs delivered within 36 hours of order to Asian consumers.¹⁰⁵ One US example of the vertical farm is Plenty, whose innovative method of indoor farming attracted US\$200 million in Series B venture capital investment led by Japan's SoftBank Vision Fund.¹⁰⁶

If the facilities can be closed, with sterile soil and air, there is an opportunity to go beyond organic and eliminate not only pesticides, but airborne pollution as well. This in turn could open the way to more extensive pre-clearance of crops, avoiding the need for customs checks in the receiving country.

Australian fruit and vegetable exporters already face some of the strictest export security checks in the world before their produce can be loaded into freight holds leaving Australia.¹⁰⁷ This is compounded by the need for customs and phytosanitary inspections in the export market. Although some claim quarantine inspections can be used as a de facto protectionist

measure,¹⁰⁸ delays are just as often due to differences in national laws.

To combat this, New Zealand primary producers have embarked on an ambitious plan to pre-clear exports of fruit including apples, stone-fruit, tomatoes and pears prior to export to key export markets.¹⁰⁹ There are trials too, of Australian citrus being inspected and possibly irradiated prior to export to South Korea.¹¹⁰

Western Sydney Airport presents an opportunity for Australia to accelerate its focus on digital agriculture. Although more than A\$30 million has been delivered to digital agriculture start-ups between 2013-17 from a range of federal and state government sources,¹¹¹ much of this has been directed to increasing productivity from existing paddocks using global positioning satellites, soil sensors and yield monitors to deliver "more from less". In contrast, neighbouring New Zealand is ahead of both Australia and the United States in the maturity of its AgTech sector.¹¹²

In addition to high-value horticulture, premium red meat is another sector earmarked for export from the new airport. The Australian red meat industry is heavily export-focused¹¹³ and beef producers in the Darling Downs area of south-east Queensland are trialling same-day export of premium meat using purpose-built climate controlled facilities at the privately-built Toowoomba-Wellcamp Airport.¹¹⁴ An example of the potential can be found in Cairns, where some 384 tonnes (423 US tons) of live seafood is exported to Hong Kong each year.¹¹⁵

The main target market for Australian red meat is likely to be the Middle East. As live animal exports look to be phased out, there is an opportunity to export freshly slaughtered meat cuts. With significant competition in the airline industry between the United Arab Emirates and Australia, it is likely that a long haul service linking either Abu Dhabi or Dubai and Western Sydney Airport will be present from the earliest days of the new airport.¹¹⁶ Given initial passenger figures will likely be low and increase over time, high value and bulky air freight will be prized by the incoming airlines. Wet meat export can play an important role in filling the belly holds of wide body aircraft.



CASE STUDY

AgTech cluster: Front Range, Colorado

Jeff Olson likes to invoke the Second World War. But unlike many other nostalgics, Olson is a progressive. In fact, he is a leader in the field of hydroponics, the indoor irrigation and lighting system associated with marijuana production.

Olson is the founder of Altius Farms, a new vertical greenhouse garden on the outskirts of Denver. Colorado has taken the expertise it garnered in the previously illicit cannabis production and married it with leading edge high-intensity horticulture pioneered in the Netherlands. The World War Two initiative Olsen likes to reference is the Victory Gardens program, where around 40 per cent of America's fruit and vegetables were grown locally by citizens to help the war effort.¹¹⁷

At present some 97 per cent of leafy greens consumed in Colorado are trucked in from California or Arizona, thanks to the complex interstate produce distribution networks established in the 1950s and 1960s.

The aeroponics movement is championing the sustainability of in-door vertical market gardens supplying local communities. Proponents of tower gardens, where vegetables are grown in hot houses with towering seed beds stacked up to the sky, point to its efficiency. Vertical aeroponics use one-tenth of the land and water of traditional field farming and can deliver yields ten times greater. No chemicals are needed, making all produce guaranteed organic, but with far greater shelf life than produce picked interstate and trucked.

The technology and processes were all largely developed in the Netherlands. The small country produces almost as much fresh vegetables as the United States yet is ten times as productive as US growers with 97 per cent fewer chemicals used.¹¹⁸ Most Dutch aeroponic farms are situated close to Amsterdam Schiphol Airport (AMS). Producers service the just-in-time market for fresh meal kits and ready-to-cook vegetable bags that are commonplace in European supermarkets.

Today the Netherlands is the world's second largest agricultural exporter, with almost €92 billion (US\$106 billion/A\$150 billion) of agricultural produce sent

beyond its borders in 2017¹¹⁹. This is despite having a population of only 17 million (as opposed to 326 million in the United States) and occupying only 0.4 per cent of the almost 10 million square kilometres (3.8 million square miles) of the area of the total United States.¹²⁰ The Netherlands does have access, however, to a European common market of 300 million people and European Union trade deals to a further 200 million.¹²¹

The Netherlands is still behind the United States in total exports, with US exports of food totalling some US\$140.5 billion in the same year. But whereas Dutch exports are high-value, high-margin goods like fresh flowers and produce, US exports comprise mainly of bulk grain products and highly-processed ambient foodstuffs¹²² where the value is in decline.¹²³

This decline in agricultural export values has, in part, prompted clusters of higher-value agricultural export industries to spring up.¹²⁴ Colorado has emerged as one of the leading states engaged in high-intensity, high-value agriculture in the United States. The state's science base is in agriculture, with specialities including agronomy, horticulture and plant sciences.¹²⁵

Colorado's research and development in agriculture and food is highly concentrated within the relatively compact urban corridor running from metropolitan Denver to the northern Front Range around Fort Collins.¹²⁶ In total, there are more than 700 bioscience companies based in Colorado, many with an agriculture focus.¹²⁷ Rural small businesses, including AgTech companies in Colorado, can access state based financing and grants in addition to USDA Rural Development Agricultural/Cooperative Programs.¹²⁸ The US innovation system is characterised by public-private partnerships,¹²⁹ and previous Colorado Governor John Hickenlooper [2011-2019] has been widely recognised as doing much to encourage innovation and increase Colorado's reputation for innovative industries.¹³⁰

The result of this is that although California is the giant of the US AgTech industry, with more than US\$2 billion invested in agricultural and food production technology in 2017,¹³¹ Colorado is in fourth position when ranked by investment (Table 7). Much of the activity is focused on smaller scale natural food development, rather than mass production.



These techniques place the state at odds with US agricultural mainstream, which is engaged in increasingly bitter disputes with potential trading partners¹³² over the safety of previous decades' scientific breakthroughs.¹³³ The European Union, for example, bans a number of US biotech inventions including microbial meat rinses, genetically-modified grains, biotech seeds, chemical flavourings and endocrine disrupters.¹³⁴

But Colorado is siding with the natural food side of the debate.¹³⁵ There is, for example, a growing niche for organic US beef in Europe.¹³⁶ Many of the finest restaurants in Europe prize the flavour of beef from US cattle breeds but only certified organic US beef is permitted into Europe¹³⁷ where hormonal growth promotants are banned.¹³⁸ Similarly, almost all US poultry is prohibited from European markets due to both the high prevalence of salmonella in US chicken¹³⁹ and also the practice of washing the meat in chlorine baths.¹⁴⁰ Instead, near neighbours Canada and Mexico, along with China, are the major US agriculture export markets.

For Olson, the future of agriculture is about people eating increasingly locally. However, increasing demand

for fresh, organic produce grown close to air transport links means Colorado is well placed to provide beyond its local population.

Table 7: US AgTech investment: value of deals by state (2017)

State	US\$m
California	2,206
Massachusetts	817
New York	344
Colorado	133
Illinois	69
Missouri	68
Minnesota	55
North Carolina	40
Other states	864

Source: AgFunder, AgriFoodTech Funding Report, Year Review 2017

Photo: Aeroponic growing technique (Getty)

Medical device manufacture and export

Workers produce
medical equipment
Photo: Getty



Unlike many other high-value manufactured goods, medical devices are very price elastic. In this regard, Australia — where the minimum wage is roughly 75 per cent higher than in most US states — should still be able to find niches to export even if the cost of doing business is relatively high.

Australia's medical devices industry comprises more than 500 companies generating total revenue of A\$11.8 billion, exporting more than A\$2.1 billion each year and producing almost 87,000 surgical products and medical devices.¹⁴¹ Medical devices require a secure supply chain and are not well suited to countries with lower standards of intellectual protection. Australia, like the United States, has a robust regulatory regime and can often fast-track clinical trials.¹⁴²

Additionally, although Australia has a poor reputation for commercialising its research overall,¹⁴³ in the field of medical device patents filed, Australia ranks 13th. Pioneering Australian medical inventions include the ultrasound scanner, the artificial heart valve, multifocal contact lens, the CPAP sleep apnoea machine and the Cochlear bionic ear implant.¹⁴⁴

One known advantage of advanced manufacturing clusters is the knowledge transfer to other industries. A broad hope of the governments involved in planning the Western Sydney Aerotropolis is that investment in aerospace manufacturing will spur other sectors to co-locate in the business park keen to tap into both the expertise and personnel. In the field of additive manufacturing, there is evidence that knowledge transfer is already starting to take place between the aerospace and medical device sector.¹⁴⁵

Additive manufacturing — or three dimensional printing of metal parts — uses metal powders of superalloys like titanium and cobalt-chrome smelted at extremely high temperatures by an electron gun operating in a vacuum chamber. US engine maker GE Aerospace has been deploying additive manufacturing to fashion turbine blades for its jet engines for more than a decade.¹⁴⁶ The metal printing process is particularly well-suited to the production of one-of-kind sterile implants.¹⁴⁷ GE Healthcare, a sister division, is using similar techniques for 3D-printed medical implants.

Unlike aero engine parts, where mass uniformity is the prize, many implants are not only single use, but customised to the patient recipient and produced directly from digital designs without the need for tooling or mould making, resulting in the rapid delivery of customised 3D-printed implants. Since 2014, Anatomics, a Melbourne-based bespoke surgical implant manufacturer has consistently led the field in the successful design and implementation of custom-printed titanium bone replacements.¹⁴⁸

Of all the medical technology innovation taking place in Australia, the subsection best suited to location within an aerotropolis is the microfabrication area that includes additive manufacturing, direct writing and the rapid production of microelectromechanical systems.¹⁴⁹ Before 3D-printed implants, medical device manufacturing was cumbersome and labour-intensive. But additive manufacturing gives Australian companies an opportunity to develop on-demand surgical implant factories located within easy range of an international airport.¹⁵⁰

It is estimated the additive manufacturing industry will reach US\$21 billion by 2020.¹⁵¹ Barriers exist, however, in the widespread adoption of 3D printing of metallic parts: the raw materials required are often slightly different alloys to those used in conventional manufacturing and the process is still slow.¹⁵²

To ensure Australia retains its place at the forefront of innovation in additive manufacturing, the federal government will need to ensure the Australian Therapeutic Goods Administration follows the US Food and Drug Administration in publishing guidelines to additive manufacturers in the medical device sector. The guidelines cover the 3D printing machines themselves, as well as raw material controls, post-processing of the part and revalidation of finalised parts.¹⁵³ Although non-binding, the USFDA guidelines are a world first in this burgeoning industry. Australia can be in the vanguard of defining global standards and regulations for both the proprietary assets involved and the safety of the manufactured parts. In doing so, it can capture a large slice of a future industry and locate it in the heart of the new aerotropolis.



CASE STUDY

Biomedical cluster: Minneapolis, Minnesota

Up in the frozen north of the Midwest, Minnesota can look (and sound) a little like Scandinavia. More than 1.6 million Minnesotans claim Scandinavian descent and Lutheranism has left its mark in the way business is done.¹⁵⁴ There is a strong presence of cooperative businesses from fuel networks to telephone services not found to the same extent in any other state.¹⁵⁵

Earl Bakken and Palmer Hermundslie both came from Norwegian heritage.¹⁵⁶ When the brothers in-law founded Medtronic in a Minneapolis garage in the post-war years, they brought with them a sense of fairness and equality uncommon in corporate America.¹⁵⁷ Bakken invented the first wearable, battery-powered cardiac pacemaker at a time when heart regulators were powered by mains electricity, requiring hospitalisation.¹⁵⁸ Bakken changed people's lives by giving them back mobility.

Bakken is described as the "reluctant millionaire" who strives to return profits back to employees and the people of Minnesota.¹⁵⁹ Medtronic manufactures some 40 per cent of the 1.5 million pacemakers sold around the world today, but still lives by the modest strategic vision of making "fair profit on current operations to meet our obligations, sustain our growth, and reach our goals."¹⁶⁰ The company, whose ethos was described by Bakken as "high tech, high touch" places being a

"good citizen as a company" among its seven guiding principles.¹⁶¹

Today some 40 per cent of pacemakers sold globally are designed and manufactured in the Twin Cities of Minneapolis–St Paul. The agglomeration is now recognised as one of just four tier one medical technology clusters in the United States (the others being the Boston-Cambridge area of Massachusetts, Southern California and the San Francisco Bay Area). Today some 27,000 people in Minnesota (or 22 per cent of the workforce) are directly employed in medical device manufacture at almost 200 establishments.¹⁶²

Despite its relatively small size compared to the other leading medical research clusters, the Twin Cities have the highest concentration of medical technology workers in the United States.¹⁶³ The Minneapolis-St Paul International Airport (MSP) is key to the export success of the sector. Although scheduled passenger flights do depart from the airport, the main reason for customs clearance is for export of high technology medical devices. China is the largest single buyer of medical devices and optical supplies from Minnesota, for example, with exports worth around US\$700 million per year to this one market alone.¹⁶⁴

The Twin Cities' medical and life sciences concentration is known as Medical Alley. Medtronic has attracted dozens of companies to establish alongside it in Medical Valley, notably Boston Scientific, Smiths Medical, Ecolab, Takeda Pharmaceuticals and Upsher-Smith Laboratories. The cluster has attracted a further 800 associated healthcare companies such as insurers.¹⁶⁵

Of the 6,500 medical device companies in the United States, more than 80 per cent are small or medium-sized. Medical technology, unlike many other manufactured goods, is a high-tech industry where quality is more important than reducing production costs.¹⁶⁶

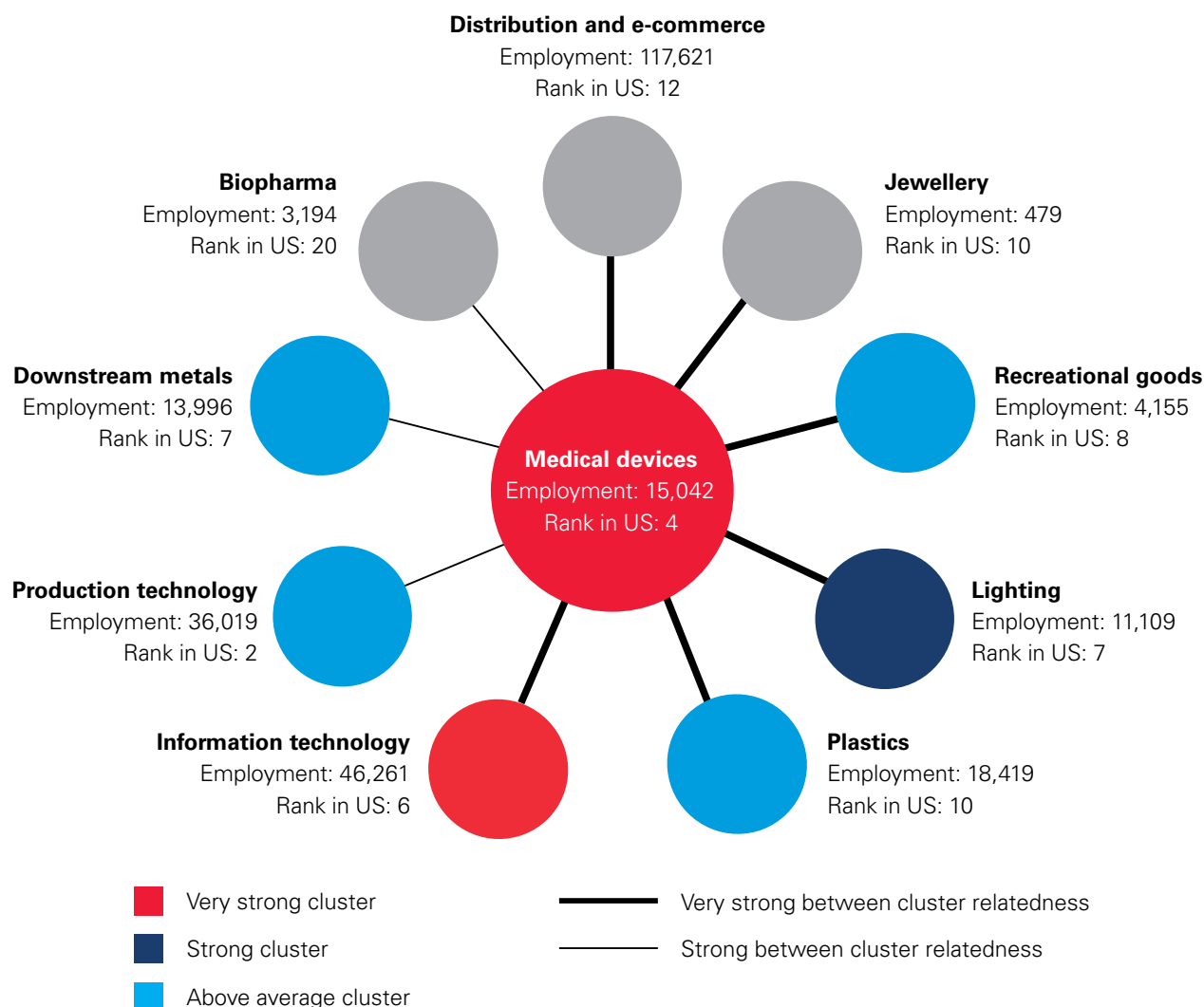
In addition to strong companies, Medical Alley is also home to the Mayo Clinic, one of the most well-known medical research centres in world. The hospital is Minnesota's largest employer and is a strong reason for the catalysing of the region's strong medical cluster. This cluster includes University of Minnesota, which ranks ninth among public universities in the United



Photo: The Micra Transcatheter Pacing System is manufactured by Medtronic (Getty)

Figure 1: Medical devices cluster linkages, Minneapolis, MN Economic Area, 2016

Adapted from the U.S. Cluster Mapping Project



States for research spending, one of seven universities and seven state colleges in the state. This has led to Minnesota being one of the most highly-educated states in the union, with the second highest rate of adults with a bachelor's degree.¹⁶⁷ This level of education, again consistent with Scandinavian levels, is viewed by many as crucial to the Minneapolis region retaining its medical device specialisation.

Minnesota proudly touts its top 10 rankings against other US states on measures of business climate, workforce, innovation, infrastructure and quality of life in addition to education. Being a pioneer in medical devices and bioscience technology with particular strength in patenting appears to have spilled over into Internet of Things, water, food and agricultural innovation.¹⁶⁸

Figure 1 shows the cluster linkages in the Minneapolis Economic Area. Medical devices and IT in this economic area are strong clusters where the concentration of employment in that particular industry is high compared to both the total employment in the state and total US employment in that industry. Additionally cluster relatedness between the medical devices cluster and a number of other industries is strong measured on correlation of employment and establishments, input-output flows and occupational overlap.

And while the outputs of innovation are strong for Minnesota, it is clear the state government is seeking to build on this by providing small business assistance, emerging entrepreneur loans and R&D tax credits; and more importantly taking an active role in building networks and links to investors and other groups active in their innovation ecosystem.¹⁶⁹

Persistent innovation policy challenges may impact aerotropolis success

In the study of aerotropolises, experts tend to agree that a focus on either high-value products for air freight or high-value people flying for business is the way to ensure the sustainability of an airport city ecosystem. These rely on access to road and rail infrastructure for the former and a highly-skilled labour pool for the latter.¹⁷⁰ To what extent the transport infrastructure projects planned for Western Sydney Airport transpire is budgetary. However, state and federal governments agree on their priority.

The initial plans for the Western Parkland City appear to be following the advice of industry cluster experts by defining a set of priority industries and planning for an aerospace institute connected to a university, a vocational college and selective high school to ensure a pipeline of educated workers and research partnerships.¹⁷¹ The New South Wales Government

is predicting 200,000 new jobs will be created over two decades in the region. Only 13,000 of these will be directly related to air transport.¹⁷²

To develop a highly-skilled workforce, Western Sydney must be able to attract and retain top global talent. Although Australia is ranked the

seventh most attractive place to work among highly-educated global professionals, its attractiveness is principally driven by lifestyle and leisure pursuits rather than professional challenge.¹⁷³ Indeed, international scientific collaboration is in decline among Australian universities. In 1998, Australia and Japan were the only two Asia-Pacific countries in the main international academic papers co-authorship networks.¹⁷⁴ Today, researchers from institutions in South Korea, Taiwan, India and Singapore are all highly active in the academic paper authorship networks, reducing the share of research collaboration being undertaken by Australian universities.¹⁷⁵

Specific policy recommendations in relation to target industries of aerospace, AgTech and medical device additive manufacturing as set out in this paper will require New South Wales and Commonwealth governments and government agencies to work together. And while there is evidence of this inter-government collaboration in the Badgerys Creek Aerotropolis planning and promotion, challenges are persistent in collaboration between Australian industry and researchers for innovation.¹⁷⁶ This is one area where the United States does much better than Australia — a key characteristic of US clusters is the persistent interaction between industry, research organisations and educational institutions.

A major challenge is that although Australia's research system is strong it is not very efficient at translating research or innovation inputs into commercial outcomes¹⁷⁷ and yet this will be critical in the development of successful industry clusters.

Additionally Australia lags other OECD nations in terms of investment in research and development, at 1.94 per cent of gross domestic product (GDP) — less than half that of the leading countries¹⁷⁸ — and well below the United States at 2.74 per cent of GDP expended on research and development.¹⁷⁹ The difference between Australia and the United States is driven by much lower business expenditure on R&D.¹⁸⁰ The innovation benefits resulting from the links between business research and development, commercialisation and start-ups has led to recommendations to create incentives for multinational corporations to establish major R&D operations in Australia.¹⁸¹

Increasing collaboration between industry and researchers, increasing business investment in research and development and reversing this lack of innovation commercialisation will take effort. However, given successful industry clusters are characterised by the concentration of research organisations, educational institutions and related industries working together to drive economic benefit through jobs and wage growth; the success of industry, governments and universities in solving these challenges will define the success of the Badgerys Creek Aerotropolis.

Although Australia's research system is strong it is not very efficient at translating research or innovation inputs into commercial outcomes and yet this will be critical in the development of successful industry clusters.

Recommendations for Australia

1. The Department of Agriculture and Water Resources should work towards concluding pre-clearance protocols with key export markets for future sterile horticultural exports.

In agriculture, despite significant exports, relatively little of high value-add is shipped from airports in Australia. The United States is a world leader in AgTech, the nascent sub-industry at the intersection of agriculture and technology¹⁸² and as such can provide much insight into the emerging opportunity of high value, high tech agriculture. Aeroponic production of organic fruit and vegetables, a highly efficient approach of growing plants indoors without soil, should be the model for agricultural exports from Western Sydney Airport. Customs pre-clearance (where goods are processed through the destination country's customs prior to air-freighting) of high value produce going to key export markets where freshness is prized would support Australia's reputation for high value horticultural products.

2. The Australian Therapeutic Goods Administration should establish guidelines of surgical implants made by additive manufacturing to enable Australia to gain a foothold in this emerging market.

Australia has a well-developed medical technology industry with exports worth more than A\$2.1 billion each year.¹⁸³ Price doesn't drive purchasing decisions, which is a positive for high-cost Australian manufacturers. Three-dimensional printing of customised surgical implants for just-in-time delivery to operating theatres around the world is a clear opportunity. With the United States the top export market for Australian medical devices and diagnostics exports,¹⁸⁴ Australia should be looking to align with the emerging guidelines for customised surgical implants and look to play a role in setting standards for this nascent sub-industry.

3. Australia should set a target in national industry policy to move out of simple components and into complex subassembly work in the aerospace sector.

Aerospace presents an obvious opportunity given the creation of a new airport. Yet the industry is in a poor position in Australia relative to other economies of comparable size. If Australia is to move up the aerospace supply chain from playing a sustenance and maintenance role into complex subassembly manufacture, the federal government will need to use its industry policy more aggressively in defence procurement. With a stated goal of becoming one of the top ten global defence exporters within the next decade,¹⁸⁵ Australia will need to leverage its long-term military alliance with the United States for defence industry collaboration. The state government will need to back this effort up with the attraction of US defence contractors and also higher education facilities that can provide a pipeline of skilled graduates.

4. All levels of government around Western Sydney need to examine the range of financial incentives on offer to secure anchor tenants.

In a highly-mobile country like the United States, companies move their manufacturing bases more readily than in other developed countries.¹⁸⁶ As a result, there is a market for luring corporate headquarters and manufacturing facilities away from one city and to another.

Government leadership will be essential to attract the large scale, long-term investment by businesses that will be required to create an aerotropolis capable of delivering globally at scale.¹⁸⁷ For American companies, incentives are often an expected part of investment attraction, and while Australian governments appear to be approaching industry attraction on a case-by-case basis, much can be learned from examining the US experience of cluster development.

Endnotes

1. The U.S. Cluster Mapping Project is led by Professor Michael E. Porter at the Institute for Strategy and Competitiveness, Harvard Business School and funded by the U.S. Department of Commerce, Economic Development Administration. 2018. *U.S. Cluster Mapping*. <http://clustermapping.us/about>
2. The U.S. Cluster Mapping Project is led by Professor Michael E. Porter at the Institute for Strategy and Competitiveness, Harvard Business School and funded by the U.S. Department of Commerce, Economic Development Administration. 2018. *U.S. Cluster Mapping*. <http://clustermapping.us/resource>
3. Mercedes Delgado, Michael Porter, and Scott Stern, "Clusters and Entrepreneurship," *Journal of Economic Geography* 10, no. 4 (2010): 495-518.; Mercedes Delgado, Michael Porter, and Scott Stern, "Clusters, Convergence, and Economic Performance" (NBER Working Paper No. 18250, National Bureau of Economic Research, 2012); Adrian T.H. Kuah, "Cluster Theory and Practice: Advantages for the Small Business Locating in a Vibrant Cluster," *Journal of Research in Marketing and Entrepreneurship* 4, no. 3 (2002): 206-28.
4. Greater Sydney Commission Western Parkland City vision <https://www.greater.sydney/portal/metropolis-three-cities/vision-metropolis-three-cities/western-parkland-city-vision>
5. NSW Government Department of Industry 2019, Western Sydney, Envisage the future, starting here. https://invest.nsw.gov.au/invest/locate/western-sydney-aerotropolis?utm_source=industry&utm_medium=website&utm_campaign=redirect
6. Northrop Grumman Corporation media release, May 15, 2017, Northrop Grumman Announces \$AUD 50 Million Investment in Electronic Sustainment for the Commonwealth of Australia
7. Wastnage, Justin. 2016. "Attracting Talent, Growing Prosperity - The Role Of Business Events In Cities". Canberra: Association of Australian Convention Bureaux.
8. Austrade Medical Devices and Diagnostics Industry Capability Report 2016. <https://www.austrade.gov.au/International/Buy/Australian-industry-capabilities/Health-and-Wellbeing>
9. Poole, Robert, Henry Brunekreef, and Peter Liddell. 2017. "Think Big, Think Fresh - A Fresh Food Precinct At The Heart Of Western Sydney". Sydney: KPMG. <https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/western-sydney-fresh-food-precinct.pdf>.
10. Kasarda, John D. 2015. "Welcome To Aerotropolis, The City Of The Future". *New Perspectives Quarterly* 32 (3): 43-45. doi:10.1111/npqu.11527
11. House of Representatives. 2011. "Bill 658, Aerotropolis Act 2011". Washington, DC: United States Congress
12. Building Strong Clusters for Strong Urban Economies: Insights for City Leaders from Four Case Studies in the U.S. June 2017, Initiative for a Competitive Inner City http://clustermapping.us/sites/default/files/files/resource/JPMC-Cluster-Report_Building-Strong-Clusters_FINAL_v2.pdf
13. Kasarda, John D. 2015. "Welcome To Aerotropolis, The City Of The Future". *New Perspectives Quarterly* 32 (3): 43-45. doi:10.1111/npqu.11527.
14. Kasarda, John D. 2015. "A Western Sydney Aerotropolis - Maximising The Benefits Of Badgerys Creek". Sydney, NSW: NSW Business Chamber. <https://www.nswbusinesschamber.com.au/NSWBC/media/Policy/Thinking%20Business%20Reports/A-Western-Sydney-Aerotropolis.pdf>.
15. NSW Department of Industry and Commonwealth Department of Prime Minister and Cabinet. 2018. "Western Sydney Aerotropolis Investor Guide - Envisage The Future, Starting Now". https://www.industry.nsw.gov.au/__data/assets/pdf_file/0009/161694/Western-Sydney-Aerotropolis-investor-guide.pdf
16. Woods, George, Barry Abrams, David Borger, Peter Thornton, Graham Millet, and Christopher Brown. 2018. "Delivering An Efficient Airport Access System: How To Ensure Western Sydney Airport Is Fit For Purpose". In *CAPA Australia Pacific Aviation & Corporate Travel Summit*. <https://centreforaviation.com/analysis/video/delivering-an-efficient-airport-access-system-how-to-ensure-western-sydney-airport-is-fit-for-purpose-812>.
17. NSW Department of Industry and Commonwealth Department of Prime Minister and Cabinet. 2018. "Western Sydney Aerotropolis Investor Guide - Envisage The Future, Starting Now". https://www.industry.nsw.gov.au/__data/assets/pdf_file/0009/161694/Western-Sydney-Aerotropolis-investor-guide.pdf
18. Transport for NSW 2018. "Future Transport Strategy 2056 and Greater Sydney Services and Infrastructure Plan - Western Parkland City" Sydney NSW Government
19. Marshall, Alfred. 2009. *Principles Of Economics*. 8th ed. New York: Cosimo Classics.
20. Meardon, Stephen J. 2001. "Modeling

- Agglomeration And Dispersion In City And Country: Gunnar Myrdal, Francois Perroux, And The New Economic Geography". *American Journal Of Economics And Sociology* 60 (1): 25-57. doi:10.1111/1536-7150.00053.
21. Porter, Michael E. 1998. *The Competitive Advantage Of Nations*. 4th ed. New York: The Free Press.
 22. Porter, Michael. 2003. "The Economic Performance Of Regions". *Regional Studies* 37 (6-7): 549-578. doi:10.1080/0034340032000108688.
 23. Perroux, François. 1950. "Economic Space: Theory And Applications". *The Quarterly Journal Of Economics* 64 (1): 89. doi:10.2307/1881960.
 24. "The Transformative Impact Of The Research Triangle Park — A Case Study". 2018. *The Research Triangle Park*. <https://www.rtp.org/transformative-impact-research-triangle-park-case-study/>.
 25. "The Transformative Impact Of The Research Triangle Park — A Case Study". 2018. *The Research Triangle Park*. <https://www.rtp.org/transformative-impact-research-triangle-park-case-study/>.
 26. Wessner, Charles W. 2013. *Best Practices In State And Regional Innovation Initiatives: Competing In The 21st Century*. Washington, D.C.: National Academies Press.
 27. Sedaris, David. 2001. *Me Talk Pretty One Day*. New York: Little, Brown & Company.
 28. van Agtmael, Antoine W, and Alfred Bakker. 2016. *The Smartest Places On Earth: Why Rustbelts Are The Emerging Hotspots Of Global Innovation*. 1st ed. London: Hachette UK.
 29. Excluding South Dakota and Wyoming, which do not levy a corporate income or gross receipts tax: EY. 2017. "Total State And Local Business Taxes - State-By-State Estimates For Fiscal Year 2016". Council On State Taxation. New York: Ernst & Young LLP.
 30. "Clusters 101". 2018. *U.S. Cluster Mapping*. <http://www.clustermapping.us/content/clusters-101>.
 31. Leydesdorff, Loet. 2005. "Synergy In Knowledge-Based Innovation Systems At National And Regional Levels: The Triple-Helix Model And The Fourth Industrial Revolution". *International Journal Of Contemporary Sociology* 42 (1): 16. doi:10.3390/joitmc4020016.
 32. Baily, Martin Neil, and Nicholas Montalbano. 2017. "Clusters And Innovation Districts: Lessons From The United States Experience". Economics Studies At Brookings. Washington, DC: The Brookings Institution. https://www.brookings.edu/wp-content/uploads/2017/12/es_20171208_bailyclustersandinnovation.pdf.
 33. McCartney, Robert. 2019. "Virginia House Approves \$750 Million In Amazon Subsidies After 9 Minutes Of Debate". *Washington Post*. https://www.washingtonpost.com/local/virginia-politics/virginia-house-approves-750-million-in-amazon-subsidies-after-9-minutes-of-debate/2019/01/28/ac1a40ac-2334-11e9-90cd-dedb0c92dc17_story.html?noredirect=on&utm_term=.a51215338542.
 34. Weise, Elizabeth. 2018. "Amazon Second Headquarters: Some Expect Another Round Of Finalists Before Winning Bid". *USA Today*. <https://www.usatoday.com/story/tech/news/2018/04/30/could-we-waiting-not-winner-but-round-two-amazons-mulls-game-changing-decision-its-second-headquarte/554045002/>.
 35. Jensen, Nathan M, and Edmund Malesky. 2018. *Incentives To Pander. How Politicians Use Corporate Welfare For Political Gain*. 1st ed. Cambridge: Cambridge University Press.
 36. Mattera, Philip, Kasia Tarczynska, and Greg LeRoy. 2013. "Megadeals: The Largest Economic Development Subsidy Packages Ever Awarded By State And Local Governments In The United States". Washington, DC: Good Jobs First.
 37. Chokshi, Niraj. 2015. "The United States Of Subsidies: The Biggest Corporate Winners In Each State". *The Washington Post*. https://www.washingtonpost.com/blogs/govbeat/wp/2015/03/17/the-united-states-of-subsidies-the-biggest-corporate-winners-in-each-state/?noredirect=on&utm_term=.042f447695d4.
 38. Jensen, Nathan M, and Edmund Malesky. 2018. *Incentives To Pander. How Politicians Use Corporate Welfare For Political Gain*. 1st ed. Cambridge: Cambridge University Press.
 39. Kiley, David. 2002. *Getting The Bugs Out: The Rise, Fall, And Comeback Of Volkswagen In America*. New York: Wiley.
 40. Mattera, Philip, Kasia Tarczynska, and Greg LeRoy. 2013. "Megadeals: The Largest Economic Development Subsidy Packages Ever Awarded By State And Local Governments In The United States". Washington, DC: Good Jobs First.
 41. Wiens, Jason. 2019. "Entrepreneurship Must Be At The Heart Of Economic Development". Kauffman.Org. <https://www.kauffman.org/currents/2018/03/entrepreneurship-must-be-at-the-heart-of-economic-development>.

42. Anderson, Patrick. 2018. "Austrian company purchases rights to 38 Studios games". *Providence Journal*. <https://www.providencejournal.com/news/20180906/austrian-company-purchases-rights-to-38-studios-games>.
43. Mattera, Philip, Kasia Tarczynska, and Greg LeRoy. 2013. "Megadeals: The Largest Economic Development Subsidy Packages Ever Awarded By State And Local Governments In The United States". Washington, DC: Good Jobs First. http://www.goodjobsfirst.org/sites/default/files/docs/pdf/megadeals_report.pdf.
44. Mattera, Philip, Kasia Tarczynska, and Greg LeRoy. 2013. "Megadeals: The Largest Economic Development Subsidy Packages Ever Awarded By State And Local Governments In The United States". Washington, DC: Good Jobs First. http://www.goodjobsfirst.org/sites/default/files/docs/pdf/megadeals_report.pdf.
45. Scarboro, Morgan. 2018. *State Corporate Income Tax Rates And Brackets For 2018*. Ebook. Washington, DC: The Tax Foundation. <https://files.taxfoundation.org/20180717150707/Tax-Foundation-FF5711.pdf>.
46. "The Transformative Impact Of The Research Triangle Park — A Case Study". 2018. *The Research Triangle Park*. <https://www.rtp.org/transformative-impact-research-triangle-park-case-study/>.
47. Wastnage, Justin, "American airport cities: Lessons for Western Sydney Airport," United States Studies Centre at the University of Sydney, May 2018
48. PWC 2017. Liverpool: the gateway to Sydney's Aerotropolis. <https://www.pwc.com.au/agendas/cities/liverpool-sydneys-aerotropolis.pdf>
49. City of Campbelltown. 2018. "The Health And Education City". City Growth And Economy. Campbelltown: City of Campbelltown.
50. Saulwick, Jacob. 2018. "Land Around Western Sydney Airport To Be Rezoned By 2019". *The Sydney Morning Herald*. <https://www.smh.com.au/national/nsw/land-around-western-sydney-airport-to-be-rezoned-by-2019-20180821-p4zyul.html>.
51. Wastnage, Justin. 2016. "Attracting Talent, Growing Prosperity - The Role Of Business Events In Cities". Canberra: Association of Australian Convention Bureaux.
52. Lanvin, Bruno, and Felipe Monteiro. 2019. *The Global Talent Competitiveness Index*. Ebook. 1st ed. Fontainebleau: INSEAD. <https://gtcistudy.com/wp-content/uploads/2019/01/GTCI-2019-Report.pdf>.
53. McDearman, Brad, and Joseph Parilla. 2017. "The 10 Traits Of Globally Fluent Metro Areas". *Brookings Institution*. <https://www.brookings.edu/research/the-10-traits-of-globally-fluent-metro-areas/>.
54. "LAEDC Powers The Bio And Life Science Industry In L.A.". 2018. *Los Angeles County Economic Development Corporation*. <https://laedc.org/industries/biomed-biotech/>.
55. Saxenian, AnnaLee. 1994. *Regional Advantage: Culture And Competition In Silicon Valley And Route 128*. Cambridge, MA: Harvard University Press.
56. University of Sydney Veterinary Science and Agriculture students and researchers can access an extensive network of farms and research units on Camden campus in Sydney's south western suburbs. <https://sydney.edu.au/about-us/campuses/campus-locations.html>.
57. Robertson, Shanthi and Aquino, Kristine. 2017. "Blaming migrants won't solve Western Sydney's growing pains". *The Conversation*. <https://theconversation.com/blaming-migrants-wont-solve-western-sydneys-growing-pains-77403>.
58. Lineberger, Robin S. and Hussain, Aijaz. 2018. "2018 Global aerospace and defense industry financial performance study," *Deloitte*, p.6. <https://www2.deloitte.com/content/dam/Deloitte/global/Images/infographics/gx-eri-global-a-d-industry-financial-performance-study-2018.pdf>.
59. "Top 100 Aerospace Companies — 2017". 2018. *Artillerymarketing.Com*. <https://www.artillerymarketing.com/fs/top-100-aerospace-companies-2017>.
60. Niosi, Jorge, and Majlinda Zhegu. 2005. "Aerospace Clusters: Local Or Global Knowledge Spillovers?". *Industry & Innovation* 12 (1): 5-29. doi:10.1080/1366271042000339049.
61. Bales, R.R., R.S. Maull, and Z. Radnor. 2004. "The Development Of Supply Chain Management Within The Aerospace Manufacturing Sector". *Supply Chain Management: An International Journal* 9 (3): 250-255. doi:10.1108/13598540410544944.
62. NSW Government. 2017. "New South Wales: Strong, Smart And Connected - The NSW Government Defence And Industry Strategy 2017". Sydney: NSW Government. https://www.industry.nsw.gov.au/__data/assets/pdf_file/0011/98624/NSW-Strong-smart-and-connected-defence-strategy.pdf.
63. Reuters. 2007. "UPDATE 2-UK Signs Memo With US On Joint Strike Fighter". *Reuters*. <https://www.reuters.com/article/britain-jsf/update-2-uk-signs-memo-with-us-on-joint>

- strike-fighter-idUSL1278309720061212.
64. "F-35 - Production". 2017. *BAE Systems Australia*. <https://www.baesystems.com/en-aus/product/f-35>.
 65. *Defence Industry Policy Statement*. 2016. Canberra: Australian Government.
 66. Wastnage, Justin. 2003. "Building Blocks - South Africa's Aerospace Industry Profile". *Flight International*. <https://www.flightglobal.com/news/articles/building-blocks-175321/>.
 67. Traebert Cavallini, E., and David Johannes Fourie. 2013. "Offset Agreements In The Defence Arena : International Practices And South African Legislation And Policies". *School Of Public Management And Administration*. <http://hdl.handle.net/2263/41038>.
 68. Le Fevre, Alexandra. 2018. "Airbus Defence Aerospace In The Australia Pacific Region". Presentation, University of New South Wales, , 2018.
 69. Kelly, Emma. 2011. "Australian Aerospace Targets International Appeal". *Flightglobal.Com*. <https://www.flightglobal.com/news/articles/australian-aerospace-targets-international-appeal-353372/>.
 70. Karanikolas, Eugenia. 2015. "Industry Policy In An Open Economy". Canberra: Parliamentary Library.
 71. Gallois, Dominique, and Caroline Taïx. 2016. "Sous-Marins Vendus Par DCNS À L'Australie: Les Coulisses D'Un Contrat « Historique »". *Le Monde*, 2016. https://www.lemonde.fr/entreprises/article/2016/04/26/le-francais-dcns-remporte-un-megacontrat-de-sous-marins-a-34-milliards-d-euros-en-australie_4908510_1656994.html; "Lockheed Martin signs \$700 million contract to design combat system for future submarines". 2018. *ABC News*. <https://www.abc.net.au/news/2018-01-25/lockheed-martin-signs-700-million-contract-for-subs-weapons/9360216>.
 72. Bergmann, Kym. 2010. "Global Supply Chains | Australian Aerospace". *Asia Pacific Defence Reporter*. <https://www.asiapacificdefencereporter.com/Global-Supply-Chains-Australian-Aerospace>.
 73. Hatch, P. 2019. "Pyne unveils secret plan to build military drone to take enemy fire". *The Sydney Morning Herald*. <https://www.smh.com.au/business/companies/pyne-unveils-secret-plan-to-build-military-drone-to-take-enemy-fire-20190227-p510ky.html>.
 74. Smart Cities Unit. 2018. "Skills And Education". Western Sydney City Deal. Canberra: Department of Infrastructure, Regional Development and Cities. <https://cities.infrastructure.gov.au/22446/documents/72486>.
 75. The Flug- und Fahrzeugwerke Altenrhein FFA P-16 ground attack fighter jet
 76. Paur, Jason, Pia Ceres, Jack Stewart, and Lauren Goode. 2018. "The Lear Jet Turns 50 — But It Almost Didn't Make It Off The Ground". *WIRED*. <https://www.wired.com/2013/10/lear-jet-50th/>.
 77. Beech Aircraft is now Beechcraft, a Textron Aviation subsidiary. Cessna Aircraft is now also a subsidiary of Textron Aviation. Stearman Aircraft was later sold and subsumed into Boeing Commercial Aircraft.
 78. Campbell, Glen, and Jimmy Webb. 1968. *Wichita Lineman*. 7" vinyl. Hollywood, California: Capitol Records.
 79. D'Orcy, Ladislav. 1924. "The National Air Congress At Wichita". *Aviation Week*, 1924. <http://archive.aviationweek.com/issue/19241027>.
 80. "Wichita - The 10 Traits Of Globally Fluent Metro Areas". 2016. *Brookings Institution*. <https://www.brookings.edu/wp-content/uploads/2016/07/Wichita-2.pdf>.
 81. Knappen, Leo. 2003. "Bombardier Aerospace Celebrates Learjet's 40Th Anniversary In The Middle East". *Bombardier.Com*.
 82. *Export Nation 2012, Wichita, KS Metro Area Profile*. 2012. Ebook. 12th ed. Washington, DC: The Brookings Institution. <https://www.brookings.edu/wp-content/uploads/2015/05/ExportNation2013Survey.pdf>.
 83. "Wichita, KS Economic Area". 2018. *Clustermapping.Us*. http://www.clustermapping.us/region/economic/wichita_winfield_ks.
 84. "Wichita, KS Economic Area". 2018. *Clustermapping.Us*. http://www.clustermapping.us/region/economic/wichita_winfield_ks.
 85. "Wichita, KS Economic Area". 2018. *Clustermapping.Us*. http://www.clustermapping.us/region/economic/wichita_winfield_ks.
 86. *Export Nation 2012, Wichita, KS Metro Area Profile*. 2012. Ebook. 12th ed. Washington, DC: The Brookings Institution. <https://www.brookings.edu/wp-content/uploads/2015/05/ExportNation2013Survey.pdf>.
 87. "Wichita - The 10 Traits Of Globally Fluent Metro Areas". 2016. *Brookings Institution*. <https://www.brookings.edu/wp-content/uploads/2016/07/Wichita-2.pdf>.
 88. "Textron Subsidies And Loans". 2015. *Subsidy Tracker*. <https://subsidytracker.goodjobsfirst.org/parent/textron>.

89. Pritchard, David, and Alan McPherson. 2004. "Industrial Subsidies And The Politics Of World Trade: The Case Of The Boeing 7E7". *The Industrial Geographer* 1 (2): pp. 57-73. <https://pdfs.semanticscholar.org/25a6/4f988ea9b91a28cb4205447a3cd51d2273b4.pdf>.
90. Olson, Elizabeth. 2009. "Small Cities Pay To Keep Air Travel". *New York Times*, 2009.
91. Trabert, Dave. 2017. "Tax Cuts And The Kansas Economy". *Kansas Policy Institute*. <https://kansaspolicy.org/tax-cuts-kansas-economy/>.
92. McMillin, Molly. 2014. "End Of An Era: Boeing In Final Stages Of Leaving Wichita". *Kansas.Com*. <http://www.kansas.com/news/business/aviation/article1153168.html>.
93. Kharas, H. 2010. "The emerging middle class in developing countries". Working Paper No 285. OECD Development Centre.
94. Mitchell, Sue, and Lisa Murray. 2015. "The \$84 Tin Of Bellamy'S Organic: How 'Australian Made' Now Means 'Luxury' In Asia". *Australian Financial Review*. <http://www.afr.com/it-pro/the-84-tin-of-bellamys-organic-how-australian-made-now-means-luxury-in-asia-20150323-1m5k91>.
95. Bennett, Mark. 2018. "Future Of Fresh - Australian Horticultural Industry". *Infocus*. Sydney: ANZ Banking Corporation.
96. van Delden, Ben, and Michael Dean. 2018. "Going Dutch: Opportunities For The Australian Agri-Food Sector". Sydney: KPMG. <https://assets.kpmg/content/dam/kpmg/au/pdf/2018/australian-agtech-lessons-from-the-netherlands.pdf>.
97. Kasarda, John D. 2009. "Airport Cities". *Urban Land*, 56
98. Stewart, Jon, and Justin Wastnage. 2015. "Sydney's Aviation Future - Meeting The Challenge Of Growing Demand". TTF Aviation Research. Sydney: Tourism & Transport Forum. <http://www.ttf.org.au/wp-content/uploads/2016/06/TTF-Growing-Australias-Key-Aviation-Hub-2015.pdf>.
99. Poole, Robert, Henry Brunekreef, and Peter Liddell. 2017. "Think Big, Think Fresh - A Fresh Food Precinct At The Heart Of Western Sydney". Sydney: KPMG. <https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/western-sydney-fresh-food-precinct.pdf>.
100. Bennett, Mark. 2018. "Future Of Fresh - Australian Horticultural Industry". *Infocus*. Sydney: ANZ Banking Corporation.
101. Despommier, Dickson D. 2011. *The Vertical Farm*. New York: Picador
102. van Delden, Ben, and Michael Dean. 2018. "Going Dutch: Opportunities For The Australian Agri-Food Sector". Sydney: KPMG. <https://assets.kpmg/content/dam/kpmg/au/pdf/2018/australian-agtech-lessons-from-the-netherlands.pdf>.
103. Bennett, Mark. 2018. "Future Of Fresh - Australian Horticultural Industry". *Infocus*. Sydney: ANZ Banking Corporation.
104. Poole, Robert, Henry Brunekreef, and Peter Liddell. 2017. "Think Big, Think Fresh - A Fresh Food Precinct At The Heart Of Western Sydney". Sydney: KPMG. <https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/western-sydney-fresh-food-precinct.pdf>.
105. Poole, Robert, Henry Brunekreef, and Peter Liddell. 2017. "Think Big, Think Fresh - A Fresh Food Precinct At The Heart Of Western Sydney". Sydney: KPMG. <https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/western-sydney-fresh-food-precinct.pdf>.
106. Plenty Attracts Largest-Ever Agriculture Technology Investment Led by the SoftBank Vision Fund to Solve Global Fresh Produce Shortages, 2017, *Company News*, <https://www.plenty.ag/company-news/plenty-attracts-largest-ever-agriculture-technology-investment-led-by-the-softbank-vision-fund-to-solve-global-fresh-produce-shortages/>
107. Laskie, Alexandra. 2017. "Airport Check To Add \$19 Million In Costs To Industry". *Australian Horticultural Exporters And Importers Association*. <https://www.ahea.com.au/news/782-airport-check-to-add-19-million-in-costs-to-industry>.
108. Barker, Neil. 2018. "Australian Government Delays Imports". *Fresh Plaza*. <http://www.freshplaza.com/article/191827/Australian-Government-delays-imports>.
109. "Pre-Clearance Programmes". 2018. *Ministry Of Primary Industries | Manatū Ahu Matua*. <https://www.mpi.govt.nz/exporting/food/fruit-and-vegetables/official-assurance-programmes/pre-clearance-programmes/>.
110. Daniels, David. 2018. "South Korean Inspector Eyes Aussie Citrus". *Citrus Australia*. <https://www.citrusaustralia.com.au/news/latest-news/south-korean-inspector-eyes-aussie-citrus>.
111. Nolet, Sarah. 2018. "Seeds Of Success: Advancing Digital Agriculture From Point Solutions To Platforms". Innovation And Entrepreneurship. Sydney: US Studies Centre at the University of Sydney. <https://www.ussc.edu.au/analysis/advancing-agtech-and-digital-agriculture-in-australia>

112. Fox, Andrea. 2018. "New Deals Give Kiwi Agritech Access To Deep US And European Pockets". *NZ Herald*. https://www.nzherald.co.nz/business/news/article.cfm?c_id=3&objectid=12117009.
113. Wastnage, Justin. 2018. "Impediments To Business Faced By The Australian Red Meat And Livestock Industry". Canberra: Red Meat Advisory Council. http://rmac.com.au/wp-content/uploads/2018/07/Final_RMAG-Submission.pdf.
114. Chong, Jordan. 2018. "Cathay Pacific And Wellcamp Airport Encouraged By First Year Of Freight Operations". *Australian Aviation*. <http://australianaviation.com.au/2018/01/cathay-pacific-and-wellcamp-airport-encouraged-by-first-year-of-freight-operations/>.
115. BITRE. 2013. "International Airline Activity 2009-2013". International Airline Activity. Canberra: The Bureau of Infrastructure, Transport and Regional Economics.
116. Wastnage, Justin. 2014. "Tourism Trade With The Middle East". TTF Aviation Research. Sydney: Tourism & Transport Forum. <https://www.aph.gov.au/DocumentStore.ashx?hearingid=26379&submissions=true>.
117. Olson, Jeff. 2014. *Victory Gardens, The Sequel — New Urban Ag, Scaling Locally Grown Food*. Video. Denver: TEDxMileHigh.
118. Viviano, Frank. 2017. "This Tiny Country Feeds The World". *Nationalgeographic.Com*. <https://www.nationalgeographic.com/magazine/2017/09/holland-agriculture-sustainable-farming/>.
119. "Nederlandse Landbouwexport Op Recordhoogte". 2018. *Centraal Bureau Voor De Statistiek*. <https://www.cbs.nl/nl-nl/nieuws/2018/03/nederlandse-landbouwexport-op-recordhoogte>.
120. Simpson, Stephen D. 2017. "Top Agricultural Producing Countries". *Investopedia*. <https://www.investopedia.com/financial-edge/0712/top-agricultural-producing-countries.aspx#ixzz5NgY3oLts>.
121. European Commission - Negotiations And Agreements - Trade". 2018. *Ec.Europa.Eu*. <http://ec.europa.eu/trade/policy/countries-and-regions/negotiations-and-agreements/>.
122. Regmi, Anita, Mark Gehlhar, John Waino, Thomas Vollrath, Paul Johnston, and Nitin Kathuria. 2005. "Market Access For High-Value Foods". *Agricultural Economic Report*. Washington, DC: United States Department of Agriculture. <https://ageconsearch.umn.edu/bitstream/33999/1/ae050840.pdf>.
123. Dobbs, Richard, Jeremy Oppenheim, and Fraser Thompson. 2013. "Resource Revolution: Tracking Global Commodity Markets". New York, NY: McKinsey Global Institute.
124. Baily, Martin Neil, and Nicholas Montalbano. 2017. "Clusters And Innovation Districts: Lessons From The United States Experience". *Economic Studies*. New York: The Brookings Institution.
125. Gruff, Gregory D, Annabelle Berklund, and Kathay Rennels. 2014. "The Emergence Of An Innovation Cluster In The Agricultural Value Chain Along Colorado's Front Range". *Nwc-Cac.Com*. <http://www.nwc-cac.com/2016-02-25NWCACMeeting/CSU%20Agricultural%20Innovation%20Study.pdf>.
126. Austrade. 2018. "US Agtech Clusters: Advancing Agribusiness And Food Processing". Canberra: Australian Department of Trade and Industry.
127. Colorado Bioscience Association. 2018. "Bio Science In Colorado Fact Sheet". Bio Science Colorado Statistics. Denver: Colorado Bioscience Association. <https://www.cobioscience.com/resources/Bio-Science-in-Colorado-Fact-Sheet>.
128. USDA Rural Development Colorado Program Matrix, June 2017 <https://www.rd.usda.gov/files/USDACOProgGrid.pdf> and Colorado Department of Agriculture Business Development Tools, Financing and Grants <https://www.colorado.gov/pacific/agmarkets/publications-2#business-development>
129. Scott-Kemmis, D. 2018. Myths, crises and complacency: Innovation policy in the United States and Australia, <https://www.usssc.edu.au/analysis/innovation-policy-in-the-united-states-and-australia#technology-transfer-and-enterprise-development-in-the-us-innovation-system>
130. Sealover, E., 2018. Ahead of final state address, Hickenlooper reflects on public-private partnerships, <https://www.bizjournals.com/denver/news/2018/01/10/on-eve-of-final-state-address-hickenlooper.html>
131. Austrade. 2018. "Advancing Agribusiness and Food Processing - US clusters". Canberra: Australian Government.
132. Office of the United States Trade Representative. 2018. "2018 National Trade Estimate Report On Foreign Trade Barriers". Washington, DC: Executive Office of the President of the United States.
133. "Export Requirements For The European Union". 2018. *Food Safety And Inspection Service*. <https://www.fsis.usda.gov/wps/portal/fsis/topics/international-affairs/exporting-products/export-library-requirements-by-country/European-Union>.

134. Doward, Jamie. 2018. "Secret Brexit Deal Could Threaten Scotch Whisky". *The Guardian*. <https://www.theguardian.com/politics/2018/may/20/secret-brexit-deal-scotch-whisky-threat-us-imports>.
135. Sexton, Josie. 2014. "Food Cluster Reaches For Solid Footing". *The Coloradoan*. <https://www.coloradoan.com/story/news/local/2014/11/19/food-cluster-reaches-solid-footing/19305825/>.
136. Rader, Leif. 2018. "EU Organic Boom Brings Opportunities For U.S. Exporters". *Global Agriculture Information Network*. https://gain.fas.usda.gov/Recent%20GAIN%20Publications/EU%20Organic%20Boom%20Brings%20Opportunities%20for%20U.S.%20Exporters_Berlin_Germany_2-6-2018.pdf.
137. Congressional Research Service. 2015. "U.S.-EU Poultry Dispute On The Use Of Pathogen Reduction Treatments (Prts)". Washington, DC: US Congress.
138. Sciolino, Elaine. 2014. "Your Imported Beef Is Served". *Nytimes.Com*. <https://www.nytimes.com/2014/03/05/dining/your-imported-beef-is-served.html>.
139. "Export Requirements For The European Union". 2018. *Food Safety And Inspection Service*. <https://www.fsis.usda.gov/wps/portal/fsis/topics/international-affairs/exporting-products/export-library-requirements-by-country/European-Union>.
140. Schlanger, Zoë. 2017. "Will Post-Brexit UK Swallow America's "Chlorinated Chicken" For A Trade Deal?". *Quartz*. <https://qz.com/1037737/will-post-brexit-uk-swallow-americas-chlorinated-chicken-for-a-trade-deal/>.
141. Austrade. 2016. "Australia: Destination Innovation". Canberra: Australian Trade and Investment Commission. <https://www.austrade.gov.au/ArticleDocuments/1358/Australia-Destination-Innovation-Brochure.pdf.aspx>.
142. Austrade. 2016. "Australia: Destination Innovation". Canberra: Australian Trade and Investment Commission. <https://www.austrade.gov.au/ArticleDocuments/1358/Australia-Destination-Innovation-Brochure.pdf.aspx>.
143. Scott-Kemmis, D. 2018. Myths, crises and complacency: Innovation policy in the United States and Australia, <https://www.ussc.edu.au/analysis/innovation-policy-in-the-united-states-and-australia>
144. "Medical Technology In Australia, Key Facts And Figures 2014". 2014. *MTAA*. <https://www.mtaa.org.au/shop/medical-technology-in-australia-key-facts-and-figures-2014>.
145. Liu, Peng, Samuel H. Huang, Abhiram Mokasdar, Heng Zhou, and Liang Hou. 2013. "The Impact Of Additive Manufacturing In The Aircraft Spare Parts Supply Chain: Supply Chain Operation Reference (Scor) Model Based Analysis". *Production Planning & Control* 25 (13-14): 1169-1181. doi:10.1080/09537287.2013.808835.
146. "Medical Additive Manufacturing". 2018. *GE Additive*. <https://www.ge.com/additive/additive-manufacturing/industries/medical>.
147. "Medical Additive Manufacturing". 2018. *GE Additive*. <https://www.ge.com/additive/additive-manufacturing/industries/medical>.
148. Austrade 2016. "Medical Devices and Diagnostics"; "Trust Me I'm A Doctor - How 3D Printing Could Revolutionise Surgery". 2018. TV program. BBC Two: British Broadcasting Corporation. <https://www.bbc.co.uk/programmes/articles/1f8l2ZwmWJ4m64Dm6ft0TQT/how-3d-printing-could-revolutionise-surgery>.
149. "Medical Additive Manufacturing". 2018. *GE Additive*. <https://www.ge.com/additive/additive-manufacturing/industries/medical>.
150. Vaezi, Mohammad, Hermann Seitz, and Shoufeng Yang. 2012. "A Review On 3D Micro-Additive Manufacturing Technologies". *The International Journal Of Advanced Manufacturing Technology* 67 (5-8): 1721-1754. doi:10.1007/s00170-012-4605-2.
151. Columbus, Louis. 2015. "2015 Roundup Of 3D Printing Market Forecasts And Estimates". *Forbes.Com*. <http://www.forbes.com/sites/louiscolombus/2015/03/31/2015-roundup-of-3d-printing-market-forecasts-and-estimates/#5d185db11dc6>.
152. Giggacher, James. 2017. "Just-In-Time 3D Implants Set To Transform Tumour Surgery". *RMIT News*. <https://www.rmit.edu.au/news/all-news/2017/oct/just-in-time-3d-implants-set-to-transform-tumour-surgery>.
153. U.S. Food and Drug Administration. 2017. "Technical Considerations For Additive Manufactured Medical Devices". Washington, DC: United States Government.
154. "Total Ancestry Report - 2006-2010 (B04003)". 2010. *American Factfinder*. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_10_5YR_B04003&prodType=table.
155. King, Hannah. 2017. "Scandinavian Immigration And Influence In Minnesota". *Stevens County Historical Society & Museum*. <http://www.stevenscountyhistoricalsociety.org/>.

- stevenshistorymuseum.com/2017/03/06/scandinavian-immigration-influence-minnesota/.
156. The "New American" *Fortune 500*. 2011. Ebook. New York: Partnership for a New American Economy. <https://www.newamericaneconomy.org/sites/all/themes/pnae/img/new-american-fortune-500-june-2011.pdf>.
157. Brøndal, Jørn. 2014. "The Fairest Among The So-Called White Races: Portrayals Of Scandinavian Americans In The Filiopietistic And Nativist Literature Of The Late Nineteenth And Early Twentieth Centuries". *Journal Of American Ethnic History* 33 (3): 5-36. doi:10.5406/jamerethnhist.33.3.0005.
158. LaVigne, Pamela. 1985. "Earl Bakken: Pacemaker Engineer Leads Industry Giant". *ITEMS From The Institute Of Technology, University Of Minnesota*, 1985.
159. Finn, Bernard, Robert Bud, and Helmuth Trischler. 2003. *Exposing Electronics*. 2nd ed. Amsterdam: Harwood Academic Publishers.
160. "Medtronic Mission Statement". 2018. *Medtronic.Com*. <http://www.medtronic.com/us-en/about/mission.html>.
161. Molella, Arthur P, and Anna Karvellas. 2015. *Places Of Invention*. Washington DC: Smithsonian Institute. Note Medtronic has come under criticism for moving its official headquarters to Ireland following the acquisition of Dublin-based competitor Covidien in 2015, defining it's Minnesota location as "Medtronic Operational Headquarters".
162. "Overview Of Medical Devices". 2016. *Minnesota Department Of Employment And Economic Development*. <https://mn.gov/deed/business/locating-minnesota/industries-sectors/biosciences/medical-devices/innovation-action.jsp>.
163. Austrade. 2017. "Medical Technology And Life Sciences US Clusters". Canberra: Australian Trade and Investment Commission. <https://www.austrade.gov.au/ArticleDocuments/5085/US-Medical-Technology-Clusters.pdf>.
164. Carlson, Joe. 2018. "Prospect Of China Trade War Sends Chill Through Minnesota Med-Tech". *Star Tribune*. <http://www.startribune.com/prospect-of-china-trade-war-sends-chill-through-minnesota-med-tech/486490201/>.
165. Buntz, Brian. 2013. "Minnesota's Life Science Ecosystem Retains World-Class Status". *Medical Device And Diagnostic Industry*. <https://www.mddionline.com/minnesotas-life-science-ecosystem-retains-world-class-status>.
166. Austrade. 2017. "Medical Technology And Life Sciences US Clusters". Canberra: Australian Trade and Investment Commission.
167. Thriving in the North, Talent Grows Here. Education and Apprenticeships. Minnesota Department of Employment and Economic Development <https://mn.gov/deed/ed/talent-grows-here/education-apprenticeships/>
168. Thriving in the North, Innovation: Minnesota businesses lead the way. Minnesota Department of Employment and Economic Development, <https://mn.gov/deed/ed/innovation-technology/>
169. Minnesota Department of Employment and Economic Development, Resources for Innovators and Entrepreneurs <https://mn.gov/deed/business/innovatemn/resources/> and Minnesota Innovation in the News <https://mn.gov/deed/business/innovatemn/news.jsp>
170. Appold, Stephen J., and John D. Kasarda. 2012. "The Airport City Phenomenon: Evidence From Large US Airports". *Urban Studies* 50 (6): 1239-1259. doi:10.1177/0042098012464401.
171. NSW Department of Premier & Cabinet. 2018. "Western City Deal". Sydney: Commonwealth of Australia.
172. NSW Department of Premier & Cabinet. 2018. "Western City Deal". Sydney: Commonwealth of Australia.
173. Strack, Rainer, Carsten von der Linden, Mike Booker, and Andrea Strohmayer. 2014. "Decoding Global Talent". Boston, MA: Boston Consulting Group.
174. Leydesdorff, Loet, Caroline S. Wagner, Han-Woo Park, and Jonathan Adams. 2013. "International Collaboration In Science: The Global Map And The Network". *El Profesional De La Información* 22 (1): 87-95. doi:10.3145/epi.2013.ene.12.
175. OECD. 2013. "Knowledge Economies: Trends And Features, Science And Innovation Today". OECD Science, Technology And Industry Scoreboard. Paris: Organisation for Economic Cooperation and Development.
176. Only 5.1 per cent of the expenditure on R&D by the higher education sector is financed by industry, placing eight of 11 peers according to Innovation and Science Australia 2017, *Australia 2030: prosperity through innovation*, Australian Government, Canberra.
177. McFarland, Claire, Jared Mondschein, and Zoe Meers. 2017. "Failure To Launch: Australia, The United States And The Threat Of Inefficient Innovation". Sydney: United States Studies Centre

- at the University of Sydney. <https://www.ussc.edu.au/analysis/australia-the-united-states-and-the-threat-of-inefficient-innovation-failure-to-launch>.
178. Israel (4.25 per cent) and Korea (4.23 per cent)
179. OECD. 2010. "Main Science And Technology Indicators". Paris: Organisation for Economic Cooperation and Development.
180. Australia's expenditure on research and development compared with peers, 2015 as set out in Figure 7 of Innovation and Science Australia's 2017 report, *Australia 2030: Prosperity through Innovation* shows Australia and the United States have similar levels of government and other expenditure on R&D as a percentage of GDP but the United States has double the Australian business expenditure on R&D as a percentage of GDP. <https://www.industry.gov.au/data-and-publications/australia-2030-prosperity-through-innovation>
181. Maughan, S., McFarland, C., Mondschein, J., Saling, B., Meers, Z., and Herrmann, A. 2018. Australian AgTech: Opportunities and challenges as seen from a US venture capital perspective. <https://www.ussc.edu.au/analysis/australian-agtech-opportunities-and-challenges-as-seen-from-a-us-venture-capital-perspective#policy-recommendations>
182. Maughan, S., McFarland, C., Mondschein, J., Saling, B., Meers, Z., and Herrmann, A. 2018. Australian AgTech: Opportunities and challenges as seen from a US venture capital perspective. <https://www.ussc.edu.au/analysis/australian-agtech-opportunities-and-challenges-as-seen-from-a-us-venture-capital-perspective#policy-recommendations>
183. Austrade Medical Devices and Diagnostics Industry Capability Report 2016. <https://www.austrade.gov.au/International/Buy/Australian-industry-capabilities/Health-and-Wellbeing>
184. Austrade Medical Devices and Diagnostics Industry Capability Report 2016. <https://www.austrade.gov.au/International/Buy/Australian-industry-capabilities/Health-and-Wellbeing>
185. Australian Government Department of Defence Media Release 29 January 2018, Launch of job-creating Defence Export Strategy, <https://www.minister.defence.gov.au/minister/christopher-pyne/media-releases/launch-job-creating-defence-export-strategy>
186. Jensen, Nathan M, and Edmund Malesky. 2018. *Incentives To Pander: How Politicians Use Corporate Welfare For Political Gain*. 1st ed. Cambridge: Cambridge University Press.
187. Poole, Robert, Henry Brunekreef, and Peter Liddell. 2017. "Think Big, Think Fresh - A Fresh Food Precinct At The Heart Of Western Sydney". Sydney: KPMG. <https://assets.kpmg.com/content/dam/kpmg/au/pdf/2017/western-sydney-fresh-food-precinct.pdf>.

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