MARTIN JENKINS

MANUFACTURING MATTERS

Final Report

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PREFACE

This report has been prepared for The Manufacturers Alliance by Stephen Knuckey from MartinJenkins (Martin, Jenkins & Associates Limited).

The Manufacturers Alliance is a collaboration between The Manufacturers Network, Metals New Zealand, Plastics NZ, the Wood Processors & Manufacturers Association and The Maintenance Engineering Society of New Zealand.

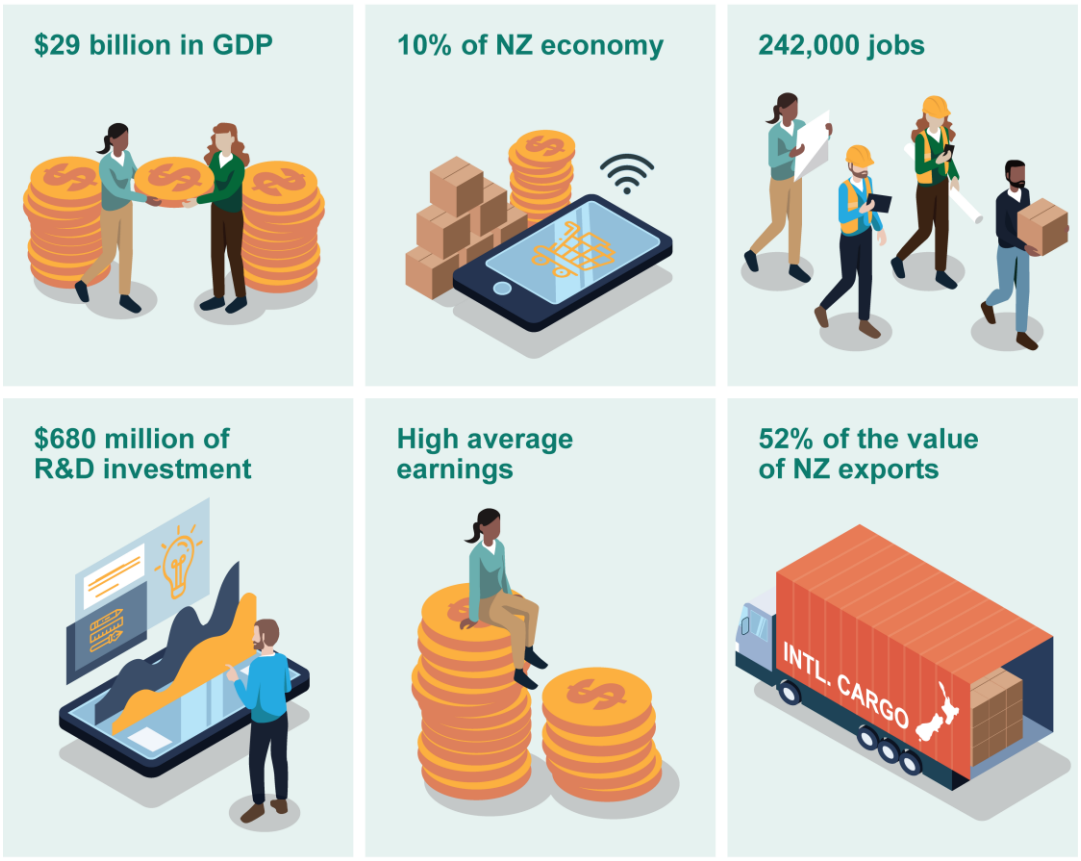
MartinJenkins is a privately-owned New Zealand limited liability company with offices in Wellington and Auckland. MartinJenkins advises clients in the public, private and not-for-profit sectors. We provide advice and support to clients in the areas of public policy, strategy and investment, performance improvement and monitoring, business improvement, employment relations, economic development, financial and economic analysis, and evaluation and research.

Key industry data in this report was provided by Infometrics.

EXECUTIVE SUMMARY

Manufacturing makes a significant contribution to New Zealand

Manufacturing is a significant and diverse sector in New Zealand, making a major contribution to value added, employment, earnings, R&D and exports.



Across developing countries, including New Zealand, the manufacturing share of employment and GDP has been declining over time. This reflects a shift towards the purchases of services (e.g., entertainment, health care) as wealth increases. However, the share of the economy suggested by official statistics understates the actual contribution that manufacturing continues to make. Manufacturing:

- Underpins the performance and growth of a range of other sectors because it is an important supplier and purchaser of goods and services to and from these sectors. For example, 60 percent of the value of the output of the agriculture, forestry and fishing sector in New Zealand is used by the manufacturing industry. Many businesses in New Zealand would not survive without manufacturing.

- Is a significant employer in several regional areas of New Zealand, such as Taranaki, Southland, Marlborough and the Hawke's Bay.
- Has opened up export markets and trade and investment connections for a wide range of New Zealand businesses.
- Is increasingly expanding into service areas, such as applied research, engineering, design, logistics, and customer support. Increasingly, businesses now classified as services are actually embedded in manufacturing value chains.

Even taking this into account, New Zealand has experienced one of the largest falls in the share of manufacturing employment over the last five and ten years in the OECD. The risk is that, without appropriate attention, investment and conducive policy settings, manufacturing in New Zealand will decline. This will have significant flow-on effects to other parts of the economy.

This risk is real, given the pressures facing the industry.

The sector faces major challenges

Beyond the 'normal' challenges facing manufacturing such as the risk of an economic downturn, currency fluctuations, compliance costs etc, major pressures over the next decade and beyond include:

- Consumer and regulatory pressures for manufacturers to reduce emissions, reduce and reuse waste, and manage environmental impacts. The Zero Carbon Act provides a clear timetable for the industry to invest in cleaner energy alternatives but in some areas reducing emissions will depend on radical changes in technology.
- Difficulties that many in the sector face in adopting Industry 4.0 technologies, including a limited understanding of the value of the technologies, a lack of expertise to apply them, and concerns about costs, data security and the impact on staff.
- Growing trade protectionism in key offshore markets, particularly an increase in the use of non-tariff measures, impacting on the costs of accessing markets and the ability of local manufacturers to compete against imports in New Zealand.
- Demographic and technology changes and strong competition for scarce talent making it increasingly difficult for manufacturers to secure required technical and soft skills.
- Having the capability and scale to respond to the pipeline of infrastructure and construction demands that are expected over the next decade.

These challenges also present the sector with a range of opportunities

Major opportunities include:

- The growing demand across multiple sectors for processes, products and packaging that reduce environmental impacts will need to be met by the manufacturing industry. The more that this can be done domestically, the better. Manufacturers themselves can continue to add value to their processes and products by 'low emissions circular economy' activities that use fewer materials, reduce energy use, keep resources in use as long as possible, minimise emissions and that eliminate or reuse waste.
- Industry 4.0 will enable manufacturers to reduce waste, improve working conditions and attract workers, respond to increasing demands for customised and personalised solutions, and to become further integrated into distributed, global value chains.
- A greater range of opportunities for the sector to expand into related services areas, providing additional high value sales avenues. These include operational services (e.g., installation and set-up services, maintenance and repair services, logistics services, recycling services), information services (e.g., monitoring of product performance in real-time), financial services (e.g., leasing, pooling arrangements), and consulting, design and engineering services.
- Within the major pipeline of infrastructure and construction work over the next decade, a particular opportunity that could be met by domestic manufacturing in partnership with the construction sector will be the growing demand for prefabricated housing.

Manufacturers will need to transform and adapt

Ultimately, manufacturing businesses will drive the investment and innovation required to adapt to the challenges and take up the opportunities. Major areas of investment will need to include:

- Building collaborative manufacturing relationships with a range of value chain partners, including customers, suppliers, advisors, research institutions, education & training organisations and government agencies.
- Improving talent management, including better workforce planning, ensuring workplace conditions support diversity, and building capability to implement new technologies and ways of working.
- Continuous and agile innovation or the ongoing development and reinvention of products, processes, business models and marketing, supported by management upskilling and peer-to-peer learning.
- Improving the quality of and processes for gathering and analysing production, product and market intelligence.
- Improving participation in global value networks.

The sector is on the right path but the time and investment required to transform should not be under-estimated – the scope of changes and demands facing the sector rate alongside what was required to respond to the reform period of the late 1980s and early 1990s.

The government is a partner in the transformation process

The Government can better support the manufacturing sector to adapt through an integrated set of policies. Governments across the world have engaged with their manufacturing sectors to develop Manufacturing or Industrial Strategies. A Manufacturing Strategy sets out a vision of how the sector will contribute to the economy over the long-term and commits to a set of mutually reinforcing policies and programmes that enable the sector to achieve this vision. It is not about 'picking winners' – such Strategies:

- recognise the broad role that manufacturing plays in supporting a range of other sectors and in driving environmental and technological improvements across the economy
- are as much about the process in which the private and public sectors jointly assess opportunities and blockages to the development of the sector as whole and jointly identify solutions.

A Manufacturing Strategy would include action in the following policy areas:

- Innovation policy – incentives to increase investment in innovation that complement R&D tax credits, such as through accelerated depreciation, with a particular focus on encouraging the adoption of Industry 4.0 technologies and the development of cleaner production and products.
- Trade policy – a serious commitment to addressing non-tariff measures in trade negotiations, strong enforcement of standards and conformance, and improving the responsiveness of trade remedies investigation processes.
- Skills policy – ensuring the education and training system offers early access to vocational education and pathways and caters for the realities of unstructured skills development, the growing importance of soft skills, and the significant amount of informal and formal learning that takes place in the workplace.
- Environmental policy – moving beyond the setting of targets and standards for environmental improvements to include clear roadmaps for how industries will transition to meet these requirements, including identifying the role that different policy levers will play (e.g., Emissions Trading Scheme, R&D support, trade policy) and options for reducing or eliminating carbon leakage.
- Procurement policy – using the Government's significant buying power to solve environmental and technological challenges and, at the same time, support domestic manufacturing opportunities.
- Investment policy – supporting growth in risk/development capital and having a very targeted approach to attracting high quality foreign direct investment (FDI), which brings the capabilities, networks and innovation that are needed to advance domestic manufacturing. This includes leveraging investment intermediaries, such as industry associations, supporting local investment promotion efforts, and ensuring comprehensive aftercare.

New Zealand is lagging behind its peers in taking such an approach. For the first time the sector has come together as an Alliance across multiple industries to work collaboratively on such a Manufacturing Strategy for New Zealand. The sector calls on the government to work with it in co-developing the Strategy.

1. MANUFACTURING'S CONTRIBUTION TO THE ECONOMY

Key points:

- Manufacturing is an important sector for New Zealand. In 2019, it contributed close to 10 percent of GDP ($29.0 billion) and jobs (242,000) and over 50 percent of exports. It also generates relatively high earnings.
- The sector's share of employment fell by 1.5 percentage points between 2013 and 2018, more than the -0.2 percentage reduction in manufacturing's share across the OECD. However, New Zealand's manufacturing share is higher than several other developed economies and trading partners such as Australia, Canada and the UK.
- The sector is diverse, with food & beverage, machinery & equipment, metals & metal products, and wood & paper each contributing close to 10 percent or more of manufacturing jobs.
- The sector has experienced a recovery over the last five years, with growth in both GDP (2.3 percent annual average growth per year) and jobs (1.7 percent per year). However, the sector's growth, including in value-add and jobs, has been below the New Zealand average.
- Manufacturing provides a relatively high proportion of jobs in some regions (e.g., Taranaki, Southland, Marlborough and the Hawke's Bay). It also contributes to a diverse workforce across the economy, employing a higher proportion of Māori and Pacific people, and technicians, labourers and machinery operators & drivers than industries as a whole.
- The sector is a major contributor to R&D and innovation, representing close to a third of business expenditure on R&D and with 45 percent of manufacturing firms introducing innovation in 2018. It is also the backbone of New Zealand's international performance, with higher proportions of manufacturers generating sales revenue from exports and having inward or outward direct investment relative to industries as a whole. Despite this, increasingly New Zealand has been importing a greater value of manufactured goods than it has been exporting.
- Manufacturing is critical to the success of many other sectors and generates broad impacts through the economy. It uses significant shares of the output of primary industries, wholesale trade, transport & warehousing and utilities. Several manufacturing industries have relatively large direct and indirect impacts on wider economic activity.

Introduction

This section describes the changing nature of New Zealand's manufacturing sector, its performance and its role in contributing to economic growth.

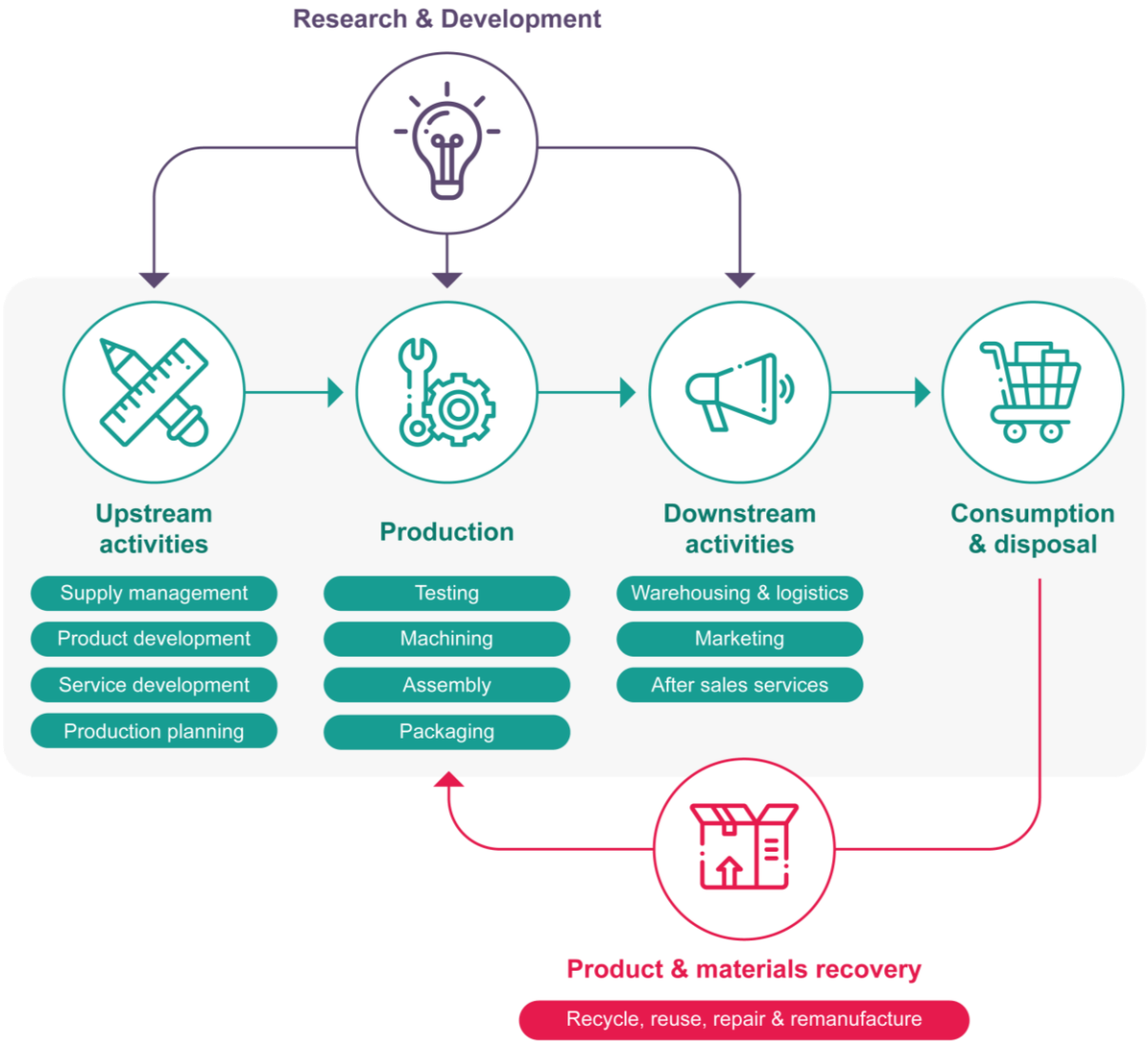
The manufacturing sector comprises all businesses that transform materials and resources into new products. Much of what people consume, use and work with has been manufactured (most food, beverages, clothing, vehicles, furniture, electronics, accommodation etc.). As such, manufacturing intersects all aspects of the economy.

Where possible, the analysis follows the Ministry of Business, Innovation and Employment's breakdown of manufacturing sub-sectors into food and beverage processing, wood and paper product manufacturing, machinery and equipment manufacturing, chemicals and refining manufacturing, plastics and rubber manufacturing, metals manufacturing and 'other' manufacturing (Ministry of Business, Innovation and Employment, 2018a). These broad sub-sectors capture the standard set of manufacturing industries within ANZSIC classifications.

However, the nature of manufacturing is changing and does not always fall into traditional classifications. The manufacturing process has extended from one involving R&D, supplier management, production and distribution to include a broader value chain of logistics management, marketing. after-sale services, and product and materials recovery (Figure 1).

In particular, the boundary between manufacturing and services is becoming blurred. For example, a manufacturer of electronic hardware may also provide software and customer support (both of which would normally fall under 'professional and technical services' in standard industry classifications); a manufacturer of packaging and containers may also provide recovery and recycling (waste services). This means that traditional classifications and the analysis that follows likely underplays the significance of manufacturing.

Figure 1. Modern manufacturing value chain



Source: MartinJenkins based on Foresight (2013) and Queensland Productivity Commission (2016)

Manufacturing remains significant….

The manufacturing sector is a significant contributor to the New Zealand economy, representing $29.0 billion in GDP and supporting close to 242,000 jobs in the year ended March 2019. In the same year, the sector generated exports of over $42.7 billion. The sector accounts for close to 10 percent of New Zealand's GDP and jobs, and 52 percent of the value of the country's exports.

Table 1: Manufacturing, summary indicators, 2019

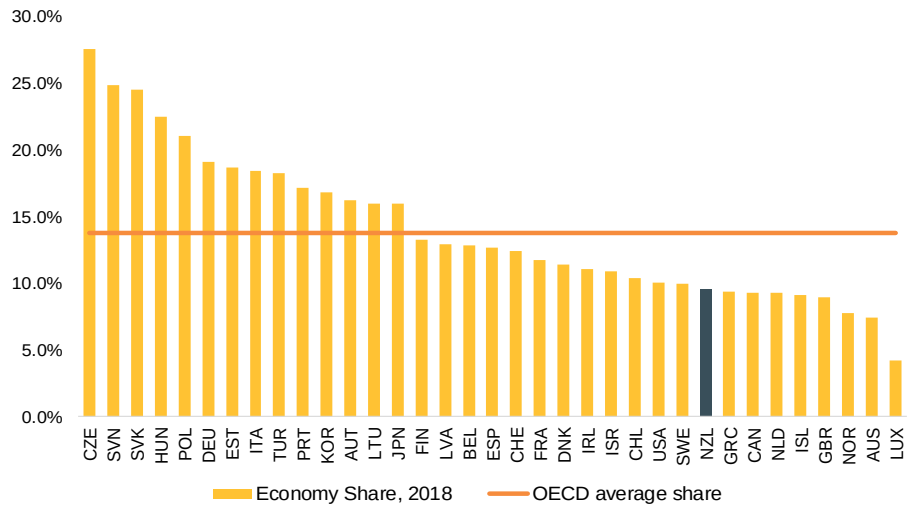
2019	Manufacturing	% of New Zealand
GDP ($m)	$29,016m	9.7%
Filled jobs	241,888	9.5%
Productivity (GDP/filled job) ($m)	$124,277	96%
Exports ($m)	$42,745m	52%

Source: Infometrics database, except for Exports which is calculated from Statistics New Zealand export data. Year ended March 2019.

The sector has reasonable labour productivity, with each employee generating close to $124,000 in GDP in 2019. This was 96 percent of the average GDP per FTE across New Zealand. However, the sector is responsible for relatively high earnings – the annual average earnings level in the sector was $64,400 in 2018 compared to $59,100 across the economy as a whole (this reflects, in part, the relatively high productivity contribution that some sub-industries make – discussed later).

Although manufacturing's share of the New Zealand economy looks relatively small compared to other OECD economies, it is higher than several other developed economies and trading partners such as Australia, Canada and the United Kingdom. In 2018, manufacturing's share of employment averaged 13.7 percent of total employment across the OECD. New Zealand's share of 9.5 percent was in the lower quarter of OECD economies but close to Sweden's and the USA's. (Figure 2). Central and Eastern European economies tend to have the largest share.

Figure 2: Proportion of manufacturing employment to total employment, OECD economies, 2018

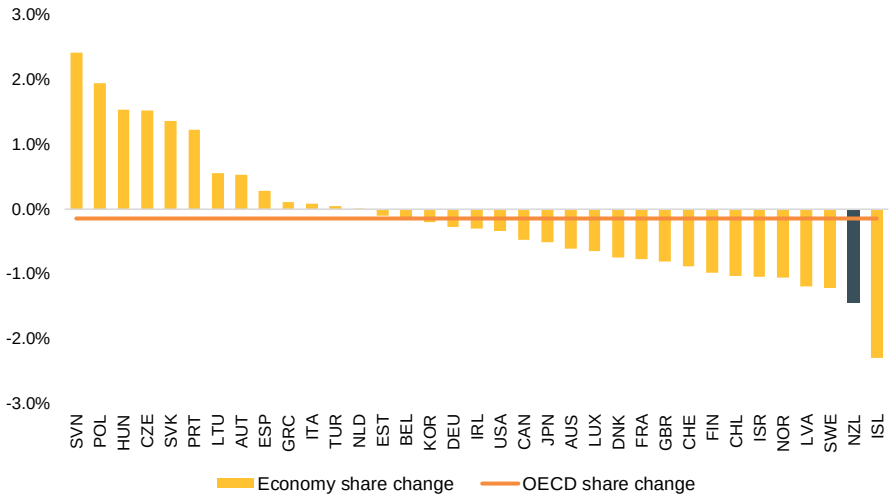


Source: OECD employment data

…despite a falling share of the economy

As is occurring in many developed economies, the estimated contribution of manufacturing to the New Zealand economy has declined over time. This reflects a shift towards services as economies become wealthier and people spend additional income on entertainment, health care, transportation etc. Manufacturing's share of employment has fallen from over 10.9 percent to its current 9.5 percent between 2013 and 2018 (and in 2008 the share was 12 percent). Although similar trends are seen in many other economies as shown in Figure 3 below, the average change in employment share across the OECD has been -0.2 percent over the last five years. Only Iceland saw a larger fall than New Zealand's fall of close to -1.5 percent. Several Central and Eastern European economies have experienced growth in the relative share of manufacturing over the period. The relevant economies entered the European Union in 2004 and this has provided them with access to significant export markets, EU structural funding (for example, for investing in infrastructure) and FDI over the last 15 years, which has stimulated core manufacturing.

Figure 3: Change in manufacturing employment share, OECD economies, 2013 to 2018



Source: OECD employment data

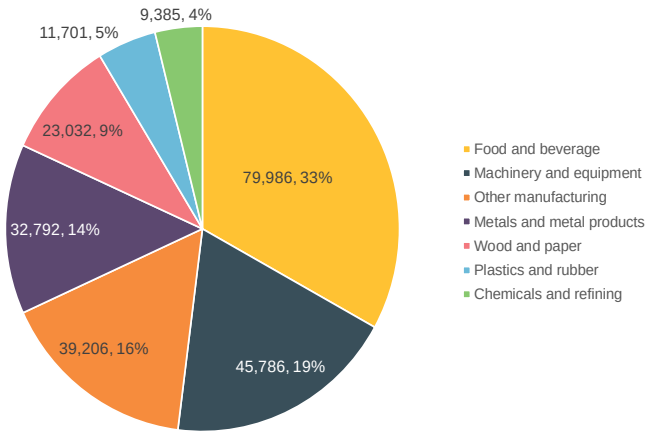
However, the decline in manufacturing's share of the economy in New Zealand may not be as significant as this suggests given, as noted earlier, the nature of manufacturing is changing and 'manufacturing' is expanding into other sectors, including digital and a range of services.

Manufacturing in New Zealand is diverse

These broad indicators mask some key size and contribution differences between sub-sectors in the manufacturing industry.

Food and beverage, machinery and equipment, other manufacturing, metals and metal products, and wood and paper each contribute close to 10 percent or more of jobs in the sector (Figure 4), with food and beverage representing a third of jobs and machinery and equipment close to 20 percent of jobs.

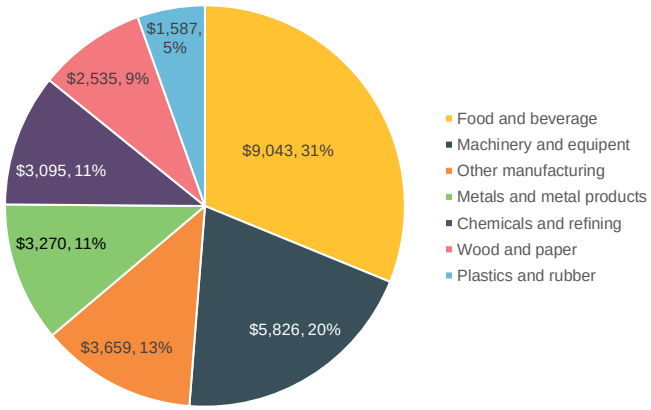
Figure 4: Manufacturing employment by industry, 2019



Source: Infometrics database. Year ended March 2019.

The three largest industries by jobs also contribute the largest proportions of GDP. However, chemicals and refining contributes a much larger share of value add than its employment contribution (11 percent compared to 4 percent).

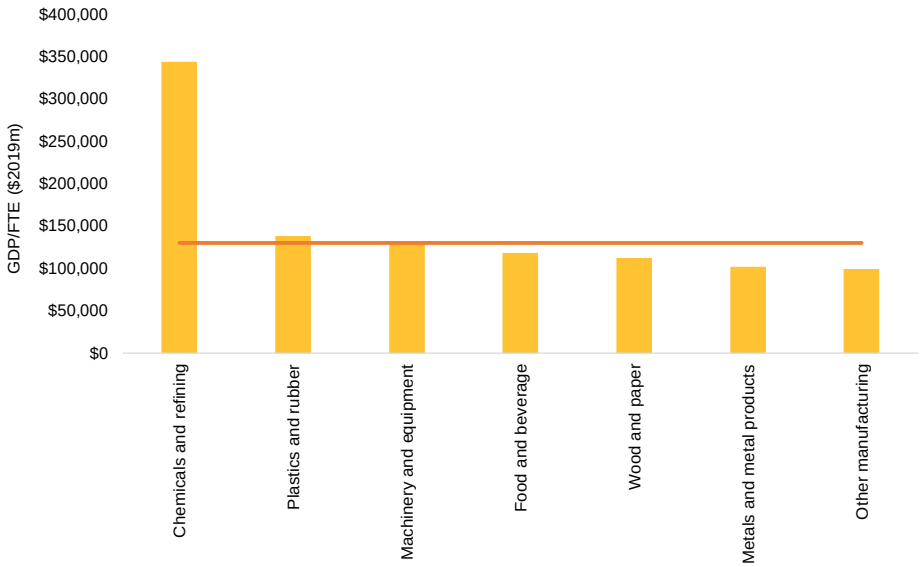
Figure 5: Manufacturing GDP by industry, 2019



Source: Infometrics database ($2019m). Year ended March 2019.

Not surprisingly, the chemicals and refining industry has significantly high estimated productivity levels at close to $343,400 per FTE in 2019 (Figure 6). The plastics and rubber industry also has relative high productivity, at just over $138,000 per FTE. Other manufacturing industries have productivity levels either close to the national average (machinery and equipment) or below (food and beverage, wood and paper, metals and metal products, other manufacturing).

Figure 6: Estimated productivity (GDP/FTE) for manufacturing industries, 2019

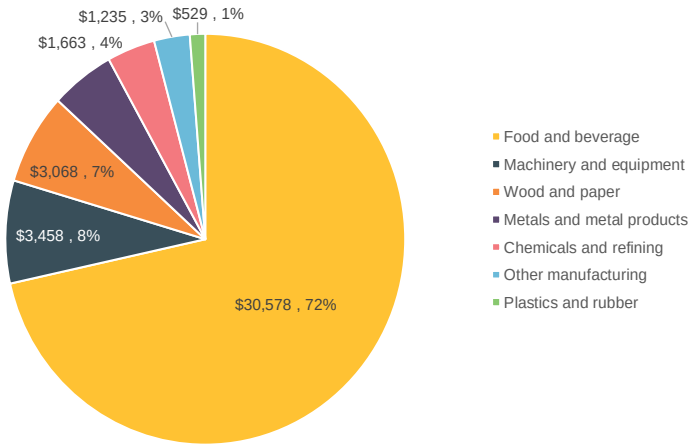


Source: Infometrics database ($2019m). Year ended March 2019.

Chemicals and refining ($78,600), machinery and equipment ($71,600), metals and metal products ($65,800) and plastics and rubber ($65,300) also all contribute relatively high annual average earnings.[1]

The food and beverage industry contributes the most significant proportion of manufacturing exports – just over 70 percent of the estimated value of the industry's exports in 2019 (Figure 7). The machinery and equipment and wood and wood products industries each contribute over 7 percent of manufacturing exports.

Figure 7: Manufacturing exports by industry, 2019 ($m)



Source: Statistics New Zealand export data

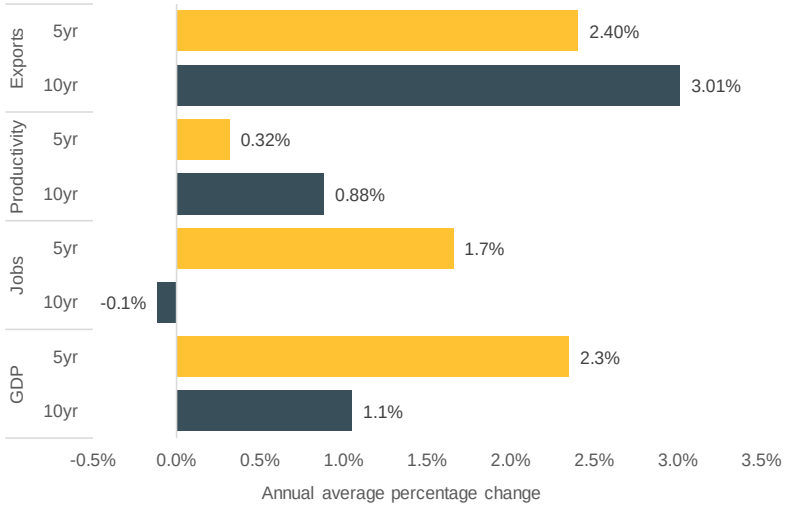
[1] Infometrics database

Manufacturing performance has recovered in recent years

Although GDP in the sector has grown relatively slowly (by 1.1 percent per annum) and employment has declined slightly over the last 10 years (-0.1 percent per annum) (Figure 8), the sector has recovered over the last five years and has experienced reasonable growth in both GDP (2.3 percent per year) and jobs (1.7 percent per year).

However, the rate of manufacturing GDP and employment has been below growth nationally (3.4 percent per year GDP growth and 2.6 percent per year job growth over the last five years).

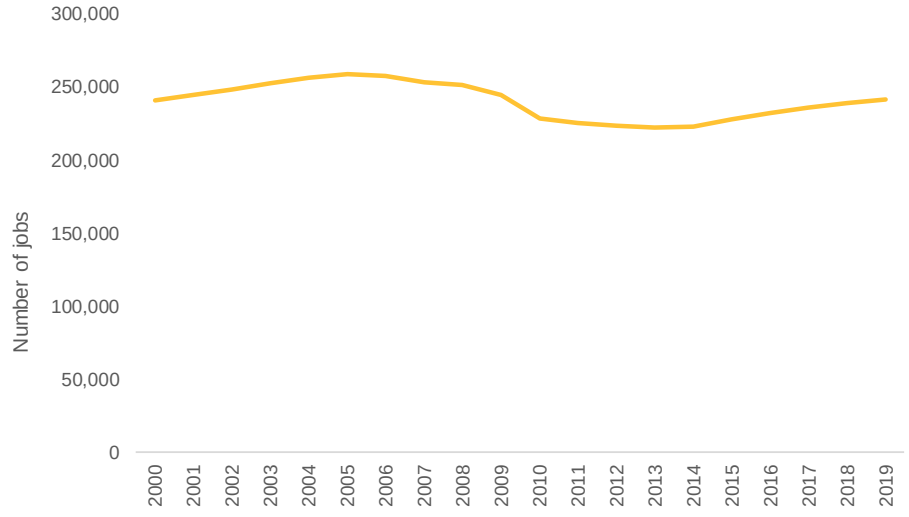
Figure 8: Manufacturing sector, compound annual growth rates of key indicators



Source: Infometrics database except for export growth, which is derived from Statistics New Zealand's export data. Years ended March.

Figure 9 shows the long-term trend in manufacturing employment. The number of jobs in the industry reached a peak in 2005 at close to 259,000 before declining, particularly after the Global Financial Crisis post 2007-2008, and reached a low point of 222,000 in 2013 (a reduction of close to 37,000 jobs over 2005 to 2013). As noted above, manufacturing job numbers have rebounded over the last five years (an increase of around 19,000 jobs over the period).

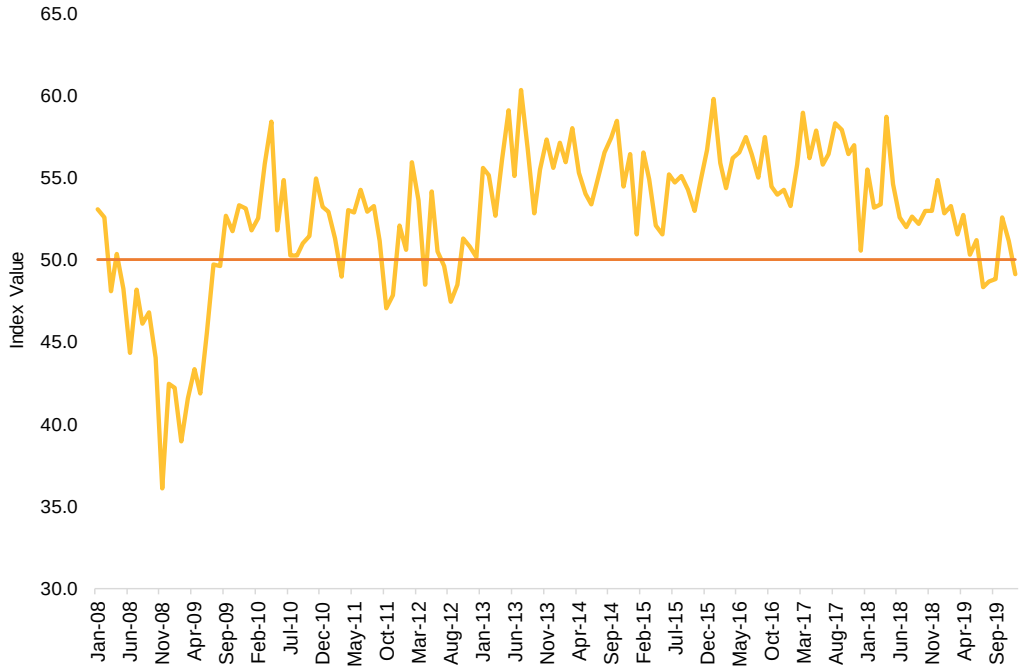
Figure 9: Jobs in the manufacturing sector, 2000 to 2019



Source: Infometrics database. Years ended March.

The recovery over the last five years can be seen by the Performance of Manufacturing Index (PMI). The PMI is a monthly survey of manufacturers asking how a range of performance factors have changed over the month (e.g., inventories, employment, new orders, output etc.) – whether they have improved, deteriorated or not changed. An index value above 50 suggests that manufacturing activity is expanding, while a value below 50 indicates it is contracting. As shown in Figure 10, the PMI declined significantly after the financial crisis, recovered in 2009 and then went through a period of volatility but downward trend until the end of 2012. The index suggests the sector was then largely in expansion mode over 2013 to the first quarter of 2019. However, over 2019 the index declined, signaling a contraction of manufacturing activity over the year (despite a slight rebound towards the end of the year).

Figure 10: Performance of Manufacturing Index (PMI), January 2008 to December 2019



Source: BusinessNZ and BNZ https://www.businessnz.org.nz/resources/surveys-and-statistics/pmi

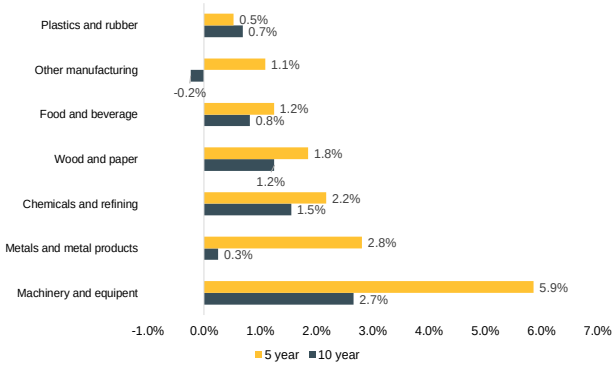
The sector has achieved solid export performance over the long-term, with export growth close to New Zealand's over the last decade (3.0 percent per year growth compared to 3.1 percent export growth nationally). The sector's productivity growth has been positive but low over the last 10 years, similar to national productivity growth (which has been 0.8 percent per year).

Within the sector (Figure 11 and Figure 12):

- machinery and equipment manufacturing has achieved the strongest annual average value growth over the last five years (5.9 percent per year), but relatively low job growth (1.7 percent per year)
- metals and metal products experienced moderate GDP and job growth over the period (2.8 percent and 2.4 percent per year respectively)

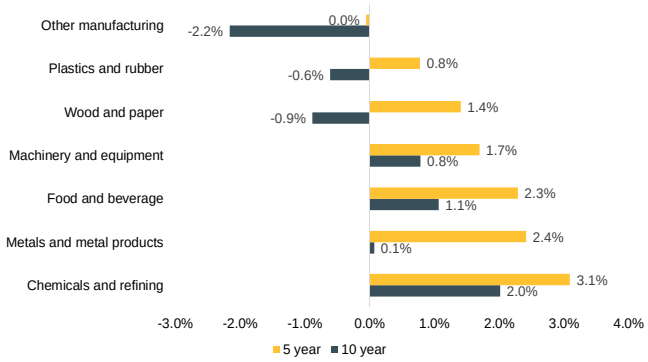
- chemicals and refining has achieved strong job growth (3.1 percent per year) and moderate GDP growth (2.2 percent per year)
- wood and paper achieved relatively low GDP and job growth over the last five years (1.8 percent and 1.4 percent per year respectively).
- food and beverage achieved moderate job growth (2.3 percent per year) but weak value growth (1.2 percent per year)
- other manufacturing has achieved relatively weak GDP growth (1.1 percent per year) and no job growth over the same period
- plastics and rubber experienced low job growth (0.8 percent per year) and low GDP growth (0.5 percent per year) over the five years.

Figure 11: Manufacturing industries, GDP annual average growth rate, 5 and 10 year



Source: Infometrics database

Figure 12: Manufacturing industries, employment annual average growth rate, 5 and 10 years

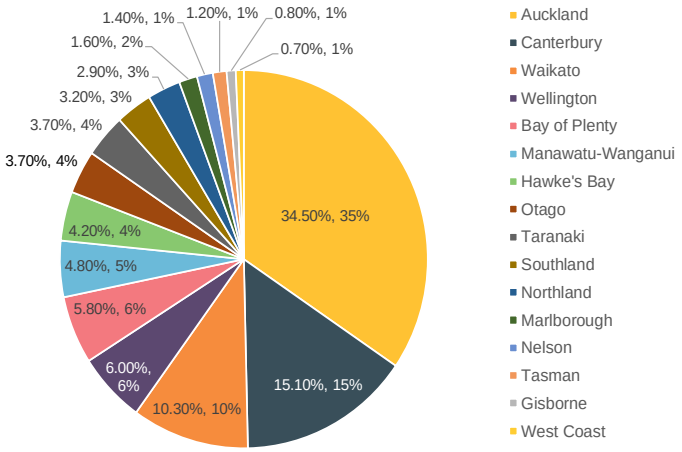


Source: Infometrics database

The sector is a key employer in some regions…

Not surprisingly, Auckland contributes the largest share – over a third – of manufacturing jobs in New Zealand (Figure 13). Canterbury accounts for 15 percent of the sector's jobs and the Waikato another 10 percent. The Bay of Plenty, Wellington and Manawatū-Wanganui all contribute more than 5 percent of jobs.

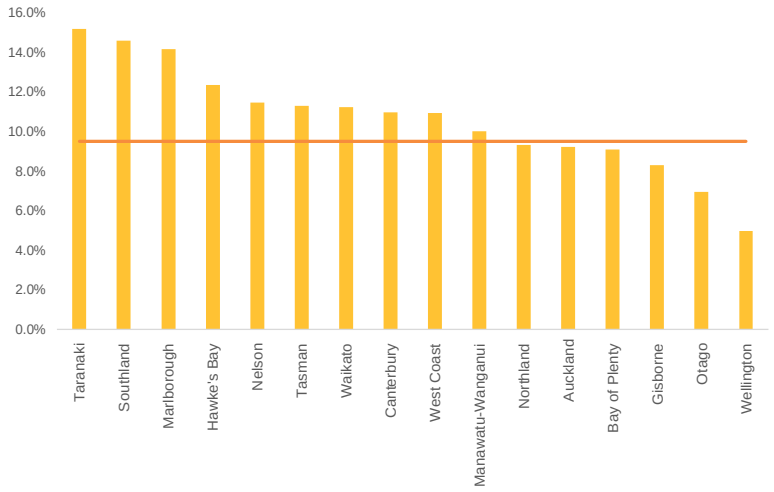
Figure 13: Manufacturing employment by region, 2019



Source: Infometrics database. Year ended March 2019.

However, these absolute numbers mask the significance of the sector in some regions (Figure 14). In Taranaki, Southland, Marlborough and the Hawke's Bay, the sector represents a relatively high proportion of regional jobs.

Figure 14: Proportion of manufacturing jobs to total jobs by region, 2019

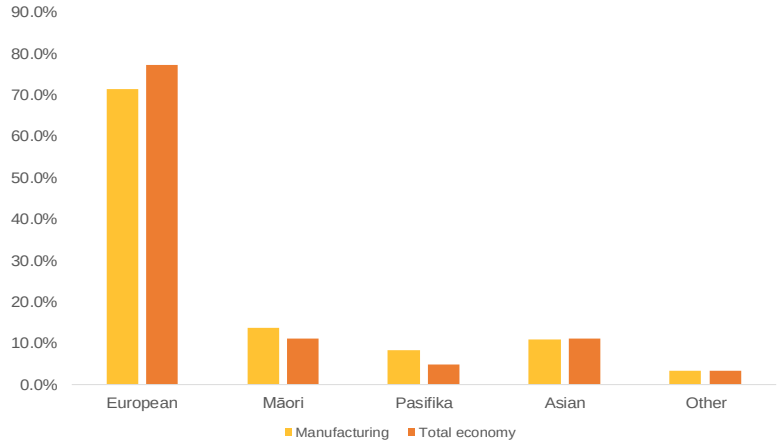


Source: Infometrics database. Year ended March 2019. Orange line is New Zealand average.

…and contributes to a diverse workforce

The manufacturing sector employs a higher proportion of Māori and Pacific people than industries as a whole. In 2013, close to 14 percent of employees were Māori, compared to 11 percent more generally and over 8 percent were Pasifika compared to 5 percent across all industries.

Figure 15: Proportion of manufacturing and total economy employment by ethnicity, 2013



Source: Census 2013

As would be expected, the sector also has a much higher proportion of technicians (close to 23 percent in 2019 compared to 12.5 percent), labourers (over 22 percent compared to just under 11 percent), and machinery operators and drivers (12 percent compared to around 5.5 percent) than the economy as a whole. Professionals (10.5 percent compared to 24 percent) and service workers (1.7 percent compared to 9.3 percent) are less prevalent in the sector.

Figure 16: Proportion of people employed by occupation, manufacturing compared to total economy, 2019

Source: Infometrics database. Year ended March 2019.

Manufacturing drives innovation in New Zealand

The manufacturing sector is a major contributor to R&D and innovation – not surprisingly, given it is fundamentally about transforming materials and resources into new products. In 2018 it was estimated to contribute around 31 percent of New Zealand's business expenditure on R&D or $680 million.[2] Manufacturing businesses that reported R&D expenditure spent an average of close to $31,660 each, much higher than primary businesses ($3,675 on average) and service businesses ($1,515 on average).

The sector's R&D expenditure has been growing over the last decade at over 4.4 percent per year, although this is lower than growth in business R&D across New Zealand as a whole (8.8 percent per year).

A relatively large proportion of businesses in the sector report that they undertake R&D activity. In 2018, around 18 percent of manufacturers[3] reported that they invested in R&D, second only to the information, media and telecommunications sector (20.5 percent) and a higher proportion than the professional, scientific and technical services sector (15 percent).

Similarly, a relatively large proportion of businesses in the sector innovate. In 2018, 45 percent of manufacturing firms[4] reported that they had introduced innovation, compared to 39 percent of firms overall. In 2017, 27 percent of manufacturing firms reported that they had introduced new or improved goods or services and 25 percent reported that they had introduced new or improved processes compared to 19 percent of firms overall.

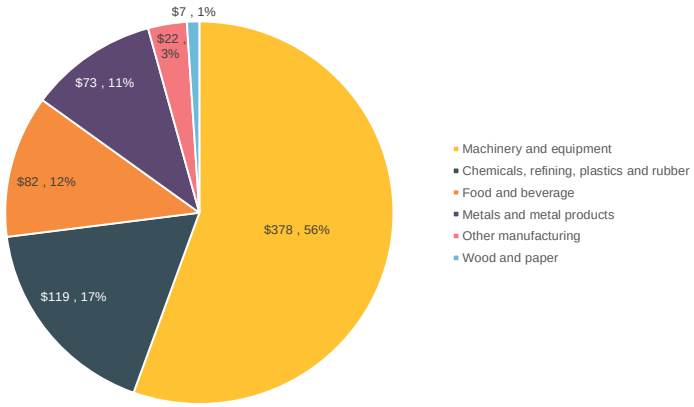
[2] Statistics New Zealand Research and Development Survey

[3] With 6 or more employees

[4] With 6 or more employees

Within manufacturing, machinery and equipment is responsible for the lion's share of R&D expenditure (56 percent in 2018). Chemicals, plastics and rubber is responsible for another 17 percent, followed by food and beverage (12 percent) and metals and metal products (11 percent).

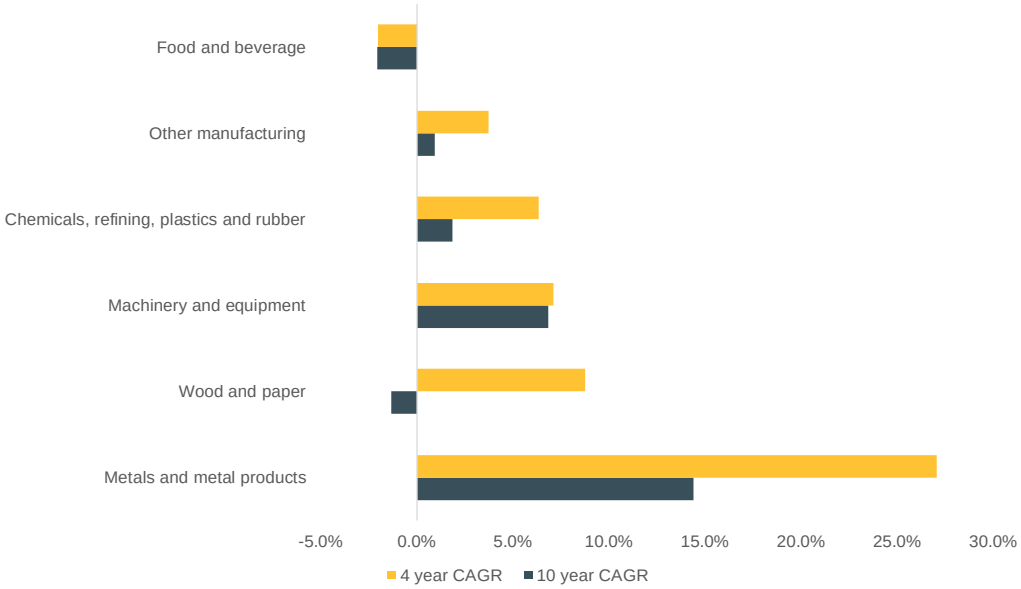
Figure 17: Manufacturing industries expenditure on R&D, 2018 ($m)



Source: Statistics New Zealand Research and Development Survey, 2018

Metals and metal products manufacturing has experienced very high compound average growth in R&D expenditure over the last decade (14 percent per year) and, in particular, the last four years (27 percent per year – R&D expenditure in the industry increased from $28 million to $73 million over 2014 to 2018). Machinery and equipment manufacturing also experienced relatively high growth in R&D expenditure over the long- and medium-term (around 7 percent per year over 10 years and 4 years). Wood and paper (9 percent per year) and chemicals, plastics and rubber (6 percent per year) experienced relatively high growth in R&D spend over the last four years.

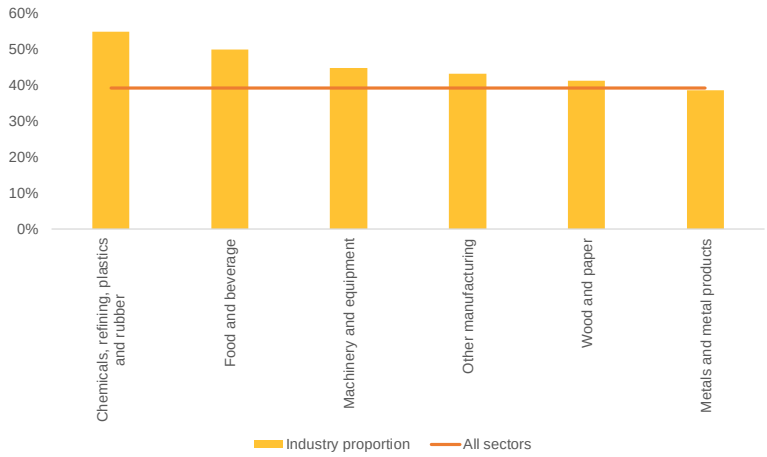
Figure 18: Manufacturing industries expenditure on R&D, 4 and 10 year annual average change (2008 to 2018)



Source: Statistics New Zealand Research and Development Surveys, 2008 to 2018

Despite the reported growth in R&D by the sector, only a moderate proportion of metals and metal product manufacturers (38 percent) reported that they had innovated in 2018. Relatively high proportions of chemicals, plastics and rubber manufacturers (55 percent) and food and beverage manufacturers (50 percent) reported innovation.

Figure 19: Proportion of manufacturing businesses in different industries that report they had developed or introduced new or significantly improved products, processes or marketing methods, 2018



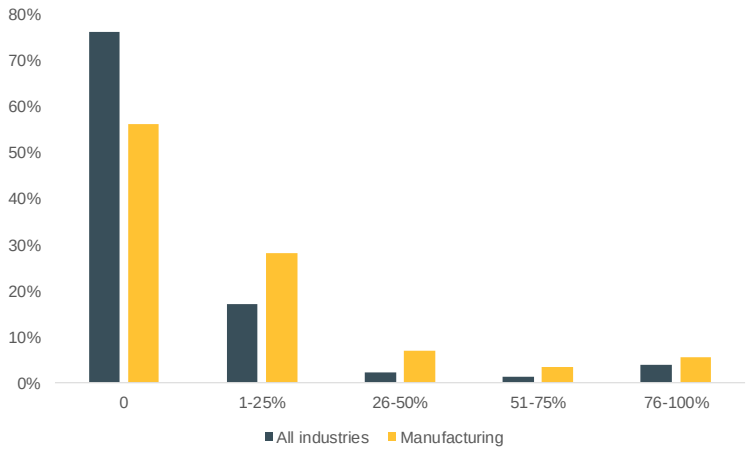
Source: Business Operations Survey, 2018 (businesses with 6 or more employees)

The sector provides the backbone for New Zealand's trade and investment relationships…

As noted earlier, manufacturing provides more than half of the value of New Zealand's exports and manufactured good exports have been growing strongly over the last decade.

Moreover, higher proportions of manufacturers[5] receive a greater proportion of their sales revenue from exports relative to industries as a whole. In 2018, 15 percent of manufacturers received 26 percent or more of their sales revenue from exports compared to 8 percent across all industries.

Figure 20: Proportion of sales revenue from exports, 2018

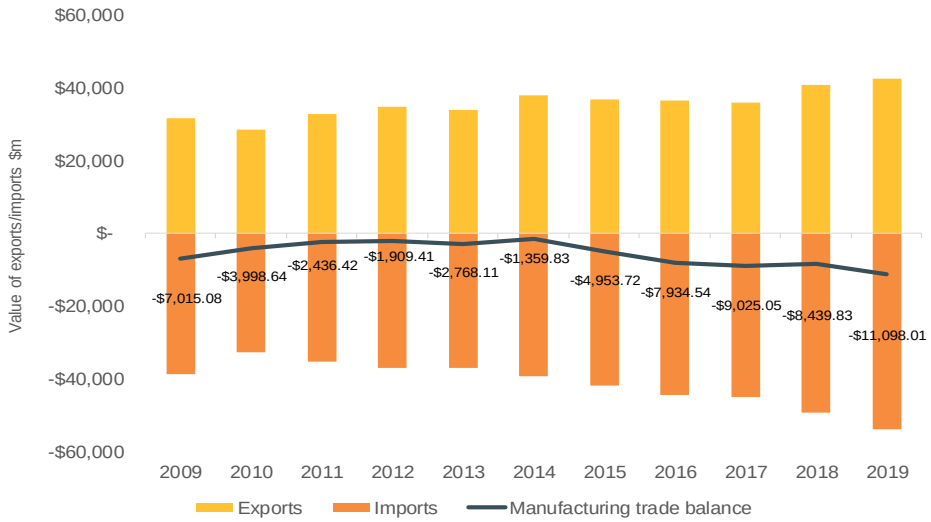


Source: Business Operations Survey, 2018 (businesses with 6 or more employees)

[5] With 6 or more employees

However, New Zealand imports significantly more manufactured goods by value than it currently exports. As shown in Figure 21, the trade imbalance has been growing in recent years – despite the recovery of manufacturing – and it would be desirable to reduce this trend through import replacement manufacturing.

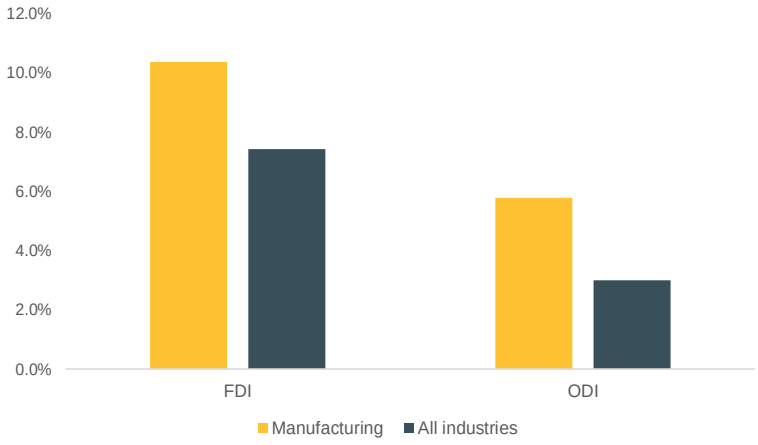
Figure 21: Value of manufacturing exports and imports ($m) 2009 to 2019



Source: Statistics New Zealand exports and imports data. Years ended March.

Manufacturing is also an important source of FDI and outward direct investment for New Zealand. In 2018, over 10 percent of manufacturing firms[6] had overseas interests or ownership in their business compared to 6 percent across all industries and close to 7.5 percent had an ownership interest or shareholding in an offshore business compared to 3 percent across all industries.

Figure 22: Proportion of businesses (with 6 or more employees) with foreign direct investment and outward direct investment, 2018



Source: Business Operations Survey, 2018 (businesses with 6 or more employees)

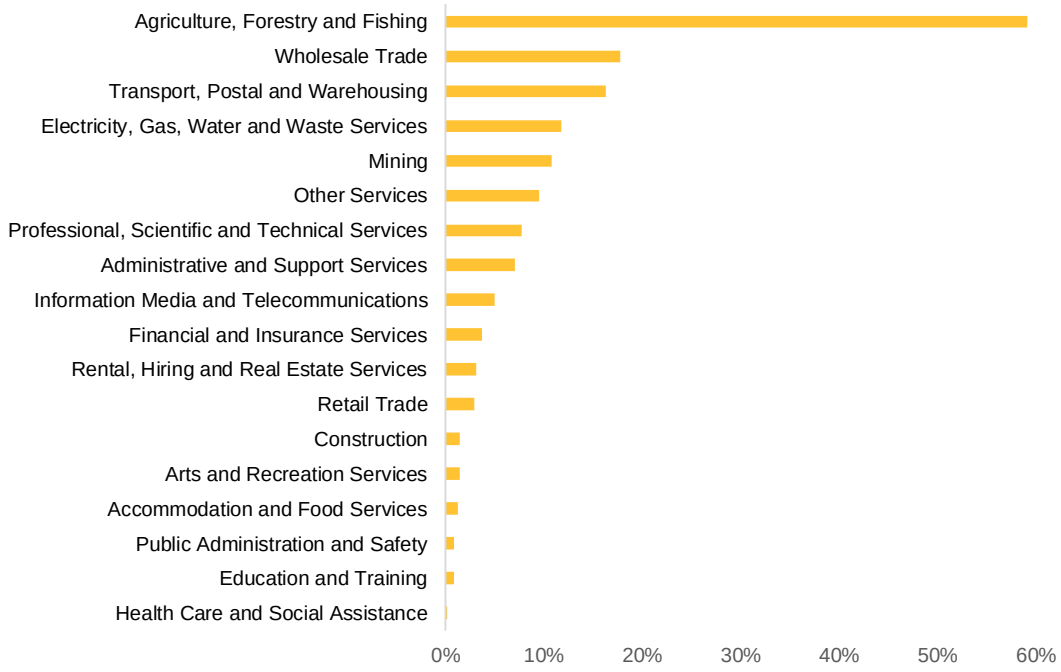
[6] With 6 or more employees

…and has critical linkages with a range of other sectors

Manufacturing uses materials and supplies from a range of other sectors. Figure 23 shows the proportion of the value of each sector's output that is used in manufacturing production.

Close to 60 percent of the output (by value) of the agriculture, forestry and fishing sector are intermediate goods used by manufacturing. Manufacturing also represents 18 percent of the total demand of wholesale trade, 16 percent of transport & warehousing, 12 percent of utilities, 11 percent of mining and 10 percent of other services.

Figure 23: Manufacturing's share of sectors' total demand



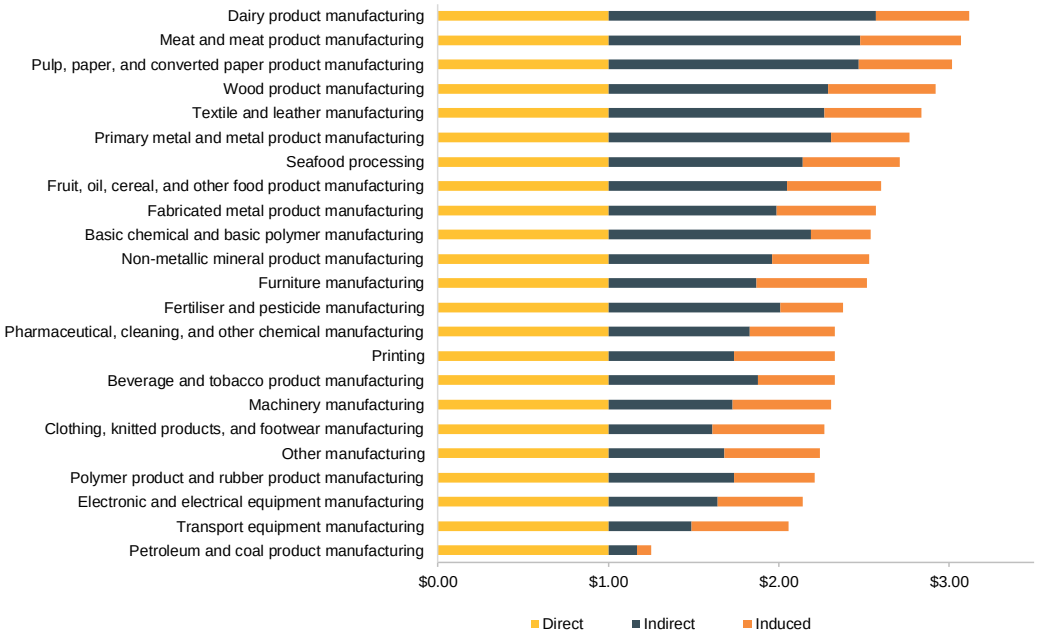
Source: MartinJenkins, using Statistics New Zealand national account input-output tables, year ended March 2013

Hence manufacturing is essential to the success of other key sectors in New Zealand.

In addition, and not surprisingly given the extent to which manufactured products touch virtually every part of people's lives, manufacturing has significant broader economic impacts. Estimates of the flow-on impacts of manufacturing output on other parts of the economy are shown in Figure 24 below. This shows direct, indirect and induced impacts across different manufacturing industries.[7]

[7] Direct impacts – the initial activity generated by the spending of enterprises operating in the industry and selling their products. Indirect impacts – enterprises in the industry purchase materials and services from suppliers, who in turn make further purchases from their suppliers and so forth. Induced impacts – employees in the enterprises and in firms supplying goods & services are paid wages which are then spent on consumption.

Figure 24: The multiplier effect of manufacturing output



Source: MartinJenkins, using Butcher Partners multipliers

Other than for petroleum and coal product manufacturing, which provides a relatively limited multiplier impact, one dollar of additional output in manufacturing industries produces between $2.06 and $3.12 in broader economic activity. Dairy product manufacturing, meat product manufacturing, pulp and paper manufacturing, wood product manufacturing, textile manufacturing and metal product manufacturing have the largest flow-on impacts.

Manufacturing's broad contribution to the economy – Wood processing

New Zealand's wood and paper industry adds significant value to the volume of raw material (logs) emanating from the forestry sector. Overall, the New Zealand wood and paper products industry contributes $2.54 billion to New Zealand's GDP, 23,000 jobs and $3.07 billion in exports. Wood product manufacturing companies are located in all regions and range from small to medium-sized enterprises up to multinational companies.

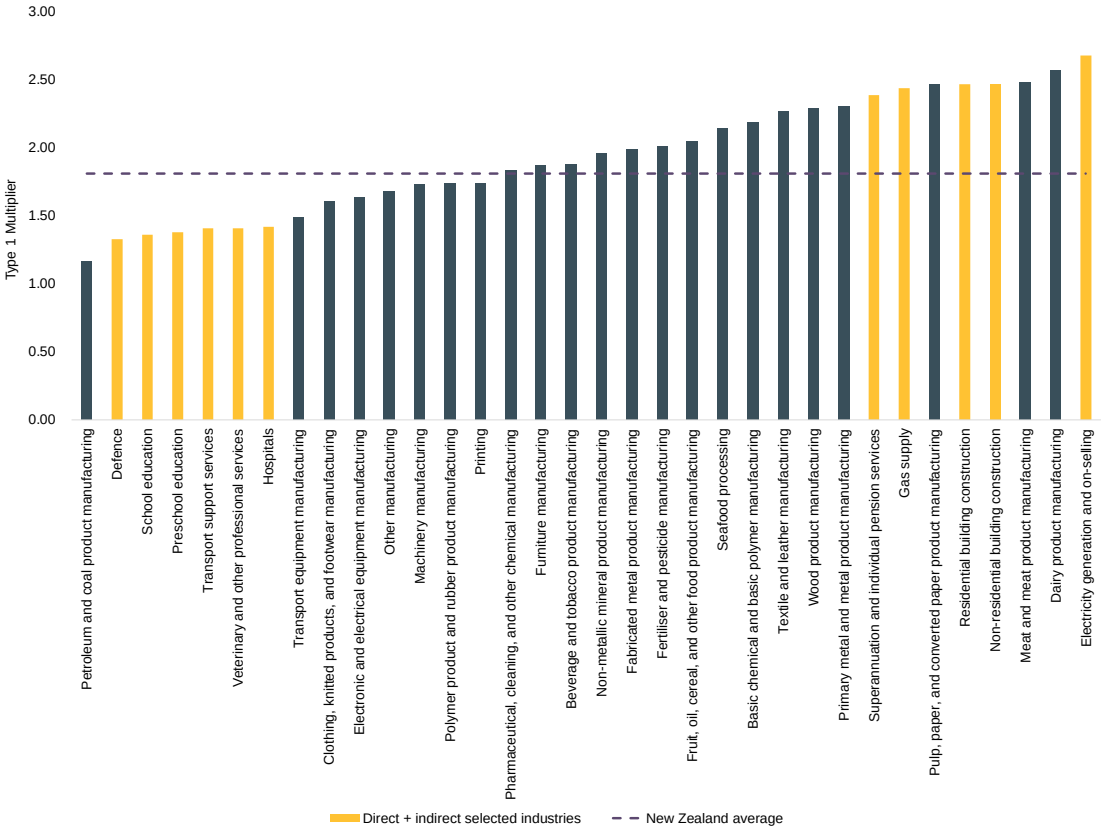
Consumer expectations are such that manufactured wood products not only need to be functional but also fulfil a wide range of social and environmental objectives. As such, 1.24 million hectares of the New Zealand plantation forest estate is independently certified as sustainable and scrutiny of sustainability extends right across the wood manufacturing part of the supply chain. In addition, over 70% of the energy used by the wood manufacturing sector now comes from biofuels (mainly wood residues).

Rapidly increasing consumer demand for health-enhancing and environmentally-friendly buildings, packaging, textiles and fuels is driving innovation in the wood sector. The wood product sector's unrivalled ability to sequester carbon into useful products puts it right at the centre of New Zealand's drive towards a zero-carbon economy by 2050.

Source: Wood Processors & Manufacturers Association based upon Ministry for Primary Industries, Statistics NZ and Infometrics figures.

Figure 25 shows the direct and indirect impact of one dollar of additional output in manufacturing industries relative to selected other sectors. Outputs from the dairy product manufacturing, meat product manufacturing and pulp and paper manufacturing second have the second, third and fourth highest direct and indirect impacts (type 1 multipliers) out of 105 sub-sectors. Several other manufacturing industries have relatively large direct and indirect impacts, including metal and metal product manufacturing, wood product manufacturing, textile manufacturing, chemical and polymer manufacturing. Petroleum and coal product manufacturing has the lowest direct and indirect impact as a high proportion of inputs used in the process are imported.

Figure 25: Direct and indirect multipliers associated with selected industries



Source: MartinJenkins, using Butcher Partners multipliers

Manufacturing's broader impact on the economy – New Zealand Steel

New Zealand Steel makes a substantial contribution to the lives and wellbeing of New Zealanders. The company contributes $600 million per annum to the New Zealand economy. It is also a significant employer in South Auckland, with more than 1,400 people employed directly in well-paid jobs. In addition, New Zealand Steel's operations result in the indirect employment of some 2,500 people.

New Zealand benefits from the skills, knowledge and industry know-how of New Zealand Steel. Their staff, together with the scale and connections that come with being a member of an international corporate group, means that the company provides absorptive capacity to New Zealand.

As the only domestic producer of flat and rolled steel, New Zealand Steel also ensures that local industries have security in the supply of an essential product and is able to ensure prompt delivery of that product. Although imported steel lead times are commonly three months or more, New Zealand Steel's domestic steel production is typically able to deliver product to New Zealand businesses with turnaround times of five weeks or less.

Source: New Zealand Steel (2019). Climate Change Response (Zero Carbon) Amendment Bill – Submission of New Zealand Steel Limited and Pacific Steel (NZ) Limited

2. PRESSURES AND PROSPECTS

Key points:

- Climate change and the resulting demands for manufacturers to meet greenhouse gas emission targets, consumer demands for clean and green goods and associated environmental standards and regulations, and the increasing scarcity of some resources are placing considerable pressure on the manufacturing sector to manage its environmental impacts. Many in the sector are responding to these pressures. The sector is also key to driving improvements in processes, products and packaging that will reduce environmental impacts across other sectors. The major opportunity for the sector is to move towards low emissions circular manufacturing, i.e., activities that minimise the use of and keep resources in continuous use as long as possible, reduce energy use, minimise emissions and eliminate waste.

- Industry 4.0, or the adoption and application of a range of new technologies in manufacturing such as sensors, robotics, 3D printing, AI, augmented reality and advanced materials, presents many opportunities for the sector. This includes a greater ability to: reduce waste, improve working conditions, expand manufacturing into high value service areas, respond to increasing demand for customised solutions, and become part of distributed, global value chains. Several manufacturers are at the forefront of using these technologies in New Zealand. However, the application of Industry 4.0 technologies is still relatively limited. This is due to many manufacturers having a limited understanding of the value of the technologies, a lack of expertise to apply them, and concerns about costs and data security.

- Trade protectionism has been on the rise over the last decade. A growing issue for New Zealand manufacturers has been an increase in the use of non-tariff measures by trading partners (e.g., export subsidies, local content requirements, import license restrictions, product standards) to support the development of domestic industries. This impacts on the ability of manufacturers to access these markets and increases the costs of doing so. Measures such as subsidies can also impact on the ability of local manufacturers to fairly compete against imports in our own market.

- A combination of expected manufacturing growth, population aging, increasing difficulties in securing required skills (e.g., technicians, tradespeople), and growing demands for skills to support Industry 4.0 (e.g., specific skills such as data analytics and soft skills such as problem-solving and creativity) means that manufacturers will face even stronger competition for scarce talent over the next decade. Continued investment in training, stronger linkages with the education, training and immigration system, and improved working conditions will be critical.

- A major opportunity for several manufacturing industries, such as mineral products, metal products, plastic products, wood products and machinery & equipment manufacturing, is the pipeline of construction and infrastructure investment that is planned over the next decade. A particular opportunity will be the growth in prefabricated housing in combination with Industry 4.0 technologies. This will also improve productivity and reduce environmental impacts in relevant industries.

Introduction

This section describes major challenges facing the manufacturing sector over the next two decades and the related opportunities that are emerging and that will underpin the sector's success. While key broad pressures and prospects are discussed, the diverse nature of manufacturing means that different industries and businesses will be impacted by each to a greater or lesser extent.

Growing environmental demands

The manufacturing sector is facing growing pressure to manage its environmental demands and impacts on several inter-related fronts:

i. Climate change and resulting demands to meet greenhouse gas emission targets

In 2017 the industrial processes and products sector in New Zealand, which largely comprises large manufacturing companies producing cement, lime, ammonia, methanol, oil, steel, aluminium and glass, was responsible for 6.1 percent of greenhouse gas emissions and the manufacturing sector was responsible for another 8.6 percent of emissions through the energy sector (Ministry for the Environment, 2019a). Although this is significantly less than the emissions from agriculture (responsible for 48 percent of emissions in 2017), emissions from industrial activities have grown over the long-term (although there has been a recent fall in emissions since 2015).

Over the next several decades, there is likely to be a drive worldwide towards stricter emission targets and pricing of pollution which means that local manufacturers will need to continue to identify ways of reducing emissions. The Climate Change Response (Zero Carbon) Amendment Act 2019, which has put in place targets to reduce carbon dioxide and nitrous oxide to net zero by 2050, is a case in point.

A challenge resulting from the Zero Carbon Act and the Climate Change Response (Emissions Trading Reform) Amendment Bill for manufacturers in industries that are emission-intensive and trade exposed is the planned removal of the current free allocations of ETS units. Such businesses receive 90 per cent or 60 per cent of their emissions obligations for free from the Crown (depending on emission intensity) and affected manufacturing includes cement, aluminium and steel production. The Emissions Trading Reform Bill will phase down the industrial allocation at 1 percent per year over 2021 to 2030, then 2 percent per year over 2030 to 2041, and then 3 percent per year over 2041 to 2050.

Although the timetable provides some clarity for the manufacturers and will encourage them to invest in cleaner energy alternatives, in some areas reducing emissions will be very difficult until there are radical changes in technology. For example, there is no alternative for the use of coal in steelmaking, and this is the major source of emissions for steel manufacturing (New Zealand Steel, 2017). Similarly, there is no way of producing lime or cement without releasing carbon dioxide (Fletcher Building, 2018; Graymont, 2019). Alternative processes for steelmaking and lime and cement production are likely to be decades away. Finally, there is not yet complete clarity about allocation levels as separate reviews of the industrial allocation baseline and electricity allocation factors are being undertaken.

An associated challenge is that New Zealand manufacturers are likely to face strong price competition from manufacturers offshore if their respective economies do not impose similar standards, limits and carbon charging. Domestic manufacturers that currently produce emissions directly already face the costs of permits to emit through the Emissions Trading Scheme (ETS) and modelling suggests that for New Zealand to meet the 2050 emission targets there will have to be a significant increase in emissions pricing (Ministry for the Environment, 2018; Castalia, 2019). The carbon price rates within some of our main trading countries (e.g., Japan, China) are lower than New Zealand's and many of our trading partners (e.g., Australia, India, US) do not have carbon pricing mechanisms at all (Castalia, 2019 and World Bank Carbon Pricing Dashboard).

Some manufacturing sectors will be sensitive to higher costs and may find it difficult to absorb them and remain profitable (Sense Partners, 2018). Although many manufacturers will invest in R&D and innovation to identify ways of increasing productivity in response, estimates from one study suggest that this might not be sufficient to overcome cost differentials (Sense Partners, 2018). The implication is that industrial allocations will remain important for limiting competitiveness impacts if other trading partners do not increase carbon prices (Castalia, 2019).

Moreover, lower limits and charging in our trading partners may result in 'emissions leakage' (or 'carbon leakage') if less emissions intensive New Zealand manufacturers lose domestic market share to more emissions intensive producers offshore (Sense Partners, 2018). That could mean that New Zealand actually increases its contribution to emissions worldwide from importing goods in some areas unless domestic manufacturing is able to adjust.

Although the industrial allocation phase-down schedule will be regularly reviewed to determine whether the phase-down rate should be reduced or accelerated, an issue is that the rate will not differentiate between sectors or business activities to account for different levels of potential emissions leakage or the ability to reduce emissions.

ii. Consumer demands for clean and green goods and associated environmental standards and regulations

Over the last decade, there has been increasing demand for products that use less materials, that produce less waste and that can be recycled and/or re-used, and this demand will only continue. The recent moves to ban plastic microbeads and single-use plastic shopping bags are the most obvious examples.

The disposal of waste at municipal landfills has increased over the last decade and only a small proportion of waste is currently used or recycled (Ministry for the Environment, 2019c). The manufacturing sector is naturally the upstream source of a significant part of New Zealand's waste (directly or indirectly) given the very nature of its activities. Statistics are scarce but the recent consultation document on increasing the landfill levy estimated that industrial, commercial and institutional waste comprised 28 percent of the total waste at municipal landfills and construction and demolition waste comprised another 18 percent, with domestic kerbside waste (most of which is manufactured) representing another 34 percent of municipal waste (Ministry for the Environment, 2019c). Similarly, estimates of waste to landfill in Auckland indicated that paper, plastics, metals, glass, textiles, sanitary products, timber and rubber accounted for close to 60 percent of waste (Auckland Council, 2018).

In addition, industrial pollutants can end up in soil, rivers and on land. A local authority survey identified over 19,500 sites across New Zealand where industries are likely to cause land contamination from the use, storage or disposal of hazardous substances (Ministry for the Environment, 2014 cited in Ministry for the Environment and Statistics New Zealand, 2019).

Consumer demands and concerns about waste are translating into tighter standards and regulations focused on minimising waste from manufactured products, such as the regulation of product stewardship schemes and the proposed increase in landfill levies.

Currently there are 14 voluntary product stewardship schemes in New Zealand that encourage industries and businesses to take responsibility for the environmental impacts of relevant products (e.g., for tyres, e-waste, agrichemicals, refrigerants, glass packaging, soft plastics, farm plastics). In a few cases, these schemes have resulted in a reasonable level of recycling, e.g., 1.9 million tonnes of glass containers since 2010 (Ministry for the Environment, 2019b). However, as voluntary schemes, businesses do not have to participate. Moreover, there can be limited incentives for consumers to effectively participate (e.g., ensuring appropriate disposal) even if the costs have been passed on to them in the final product price. In addition, some businesses do not consider it is commercially justified to participate in schemes, particularly if other businesses and importers do not opt in. As a result, in some product areas only limited results are estimated to have been achieved, e.g., it is estimated that only 2 percent of e-waste is recycled (Ministry for the Environment, 2019b), although there is not good data available on the quantity of different waste streams.

In addition, there is now greater pressure on manufacturers (and others) to minimise waste because China, which was the largest buyer of New Zealand's waste and recyclables, has stopped taking a range of waste and recycling items such as plastics and paper from overseas. Although there are other markets that accept waste, growing international competition is putting pressure on prices and will make it less economic for New Zealand to export waste. Moreover, it is likely that other Asian markets will follow suit and restrict waste imports (Wilson et al, 2018). Local waste operators are already having to stockpile materials, mainly mixed plastics.

The government has proposed that product stewardship be regulated under the Waste Minimisation Act 2008 for six priority products including tyres, electrical and electronic products, agrichemicals and containers, refrigerants, farm plastics, and beverage packaging and single-use packaging (consultation on the proposals closed in October 2019). Assuming this will proceed, the government is to work with relevant stakeholders, including manufacturers, to design product stewardship schemes for accreditation for each priority product group.

The government is also proposing higher landfill levies to incentivise the diversion of waste from landfill and to invest in a wider range of recovery and recycling initiatives. The current levy is $10 per tonne and only applies to municipal landfills. Options include raising the levy to at least $20 per tonne across different types of landfills (and for the municipal levy to raise to at least $50 by 2023). It is estimated that this could increase the levy costs to the manufacturing sector from $2.41 million per year to between $12.07 million and $14.49 million per year (Ministry for the Environment, 2019c).

Finally, the Rethinking Plastics in New Zealand report (Office of the Prime Minister's Chief Science Advisor, 2019) has recommended a set of actions to improve the monitoring of plastics use and to incentivise a circular economy for plastics. In response, the government

has already signalled its intention to move away from single-use packaging and beverage containers made of PVC and polystyrene.

iii. Increasing scarcity of some resources

Population growth, particularly in developing nations, is increasing the demand for energy, water and other natural resources resulting in greater competition and likely to increased volatility in supply. The energy consumption of the industrial sector in New Zealand grew by 16 percent from 1997 to 2017 and accounts for nearly 36 percent of national energy consumption (MBIE Energy Consumption Statistics). It is also estimated that manufacturing and industrial activity is responsible for 11 percent of total water demand in New Zealand.

The combined environmental pressures mean that manufacturers will need to continue to identify ways to minimise resource use and reduce and reuse waste from their products (discussed further below).

These demands also create significant opportunities for the sector

However, manufacturing is also key to driving improvements in processes, products and packaging that will reduce environmental impacts across the economy. As such there is likely to be growing demand by other sectors for manufacturing solutions for their environmental issues. There are already several examples of manufacturers that are implementing or developing these solutions as shown below.

A selection of businesses that are manufacturing environmental solutions

- CarbonScape – based in Marlborough, the company has developed a way of turning sawdust into graphite and activated carbon, which can be used for water treatment and industrial pollution control.
- Future Post – based in Waiuku, the business takes domestic and commercial waste plastic and repurposes it into fencing posts. This has included diverting 20,000 four-litre plastic buckets from landfill annually.
- Innocent Packaging, based in Penrose, manufactures disposable food packaging made from plants. Takeaway containers are made from waste left over after wheat production. They have partnered with We Compost and 50 cafes across the Auckland CBD to offer the first public compost collection for food waste and compostable packaging.
- Oji Fibre Solutions has implemented the Fullcircle recycling service to collect paper products from across New Zealand and recycle over 200,000 tonnes through their Penrose and Kinleith paper mills, producing paper board and packaging products for the local packaging industry. The company also collects plastic waste at recovery facilities it operates and is investigating a plastics recycling technology for New Zealand, involving transforming plastics back to the chemicals from which they are made.
- Terra Lana, based in Christchurch, produces insulation and eco-textiles from a mixture of recycled wool off-cuts, virgin wool and non-toxic polyester. Their wool-cuts would otherwise go to landfill and the polyester comes from recycled PET bottles. The insulation is fully recyclable at the end of a building's life.

Sources: Company websites, news articles and relevant member profiles on sustainable.org.nz

‘Standard’ manufactured goods can also help to reduce New Zealand’s carbon footprint overall. For example, although cement production is currently energy intensive, concrete itself removes CO_2 from the air through carbonation. Similarly, steel production enables CO_2 mitigation in a range of areas as it is a core input for geothermal, hydro, solar and wind energy solutions as well as recycling plants and equipment. It is also easily able to be reused and repurposed. Wooden materials extend carbon storage from forests to buildings and this is now recognised in the Harvested Wood Products regulation under the NZ ETS.

In addition, there are many manufacturers, including those that are currently energy intensive, at the forefront of reducing their own environmental footprint and resource use as shown below.

Manufacturing a better environment

- New Zealand Steel continues to make significant progress in reducing energy use, recently increasing site cogeneration of electricity up to 60%. Working with Alinta Energy, New Zealand Steel’s core supplier of steam and co-generated electricity, changes were implemented to improve off-gas and heat recovery in the Multi Hearth Furnace (MHF) afterburners and to increase steam generation in the MHF boilers. These projects have increased electricity generation by 55,000 MWh per annum, reduced annual purchased electricity by 13 per cent and lowered GHG emissions by approximately 6,500 tCO2-e per annum.

  During the nation-wide shortage of natural gas supply at the end of 2018, New Zealand Steel reviewed the operating conditions of the steel slab reheat furnace, which relies on natural gas to fire its burners. The changes implemented and now embedded have resulted in gas savings of equivalent to 3,700 tonnes of CO2 pa.

  Other recent environmental initiatives undertaken by New Zealand Steel include:

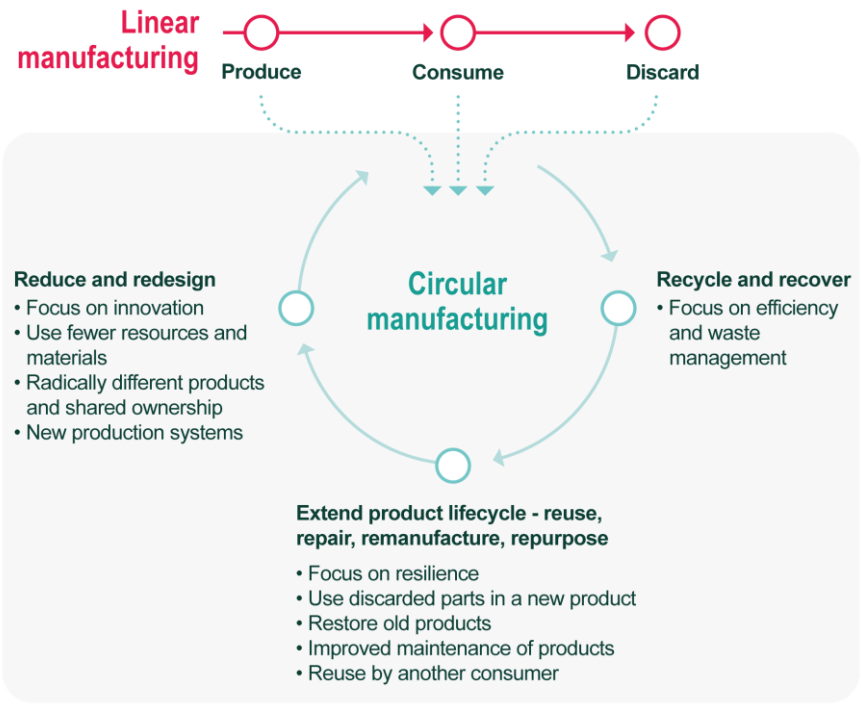
  - A programme to reduce single-use plastic water bottles (around 18,000 water bottles per annum) and poly cups (around 199,000 poly cups per annum) by providing reusable cups and steel water bottles.
  - Issue of Environmental Product Declarations, following completion of a rigorous and externally verified cradle-to-gate life cycle assessment.
  - Improving steel production yield and recovery to the manufacturing process of materials previously landfilled, thereby reducing waste per tonne of steel by more than one-third (in the last 10 years).
- South Auckland Forging Engineering Ltd (SAFE Ltd) in Drury operates a heavy forging plant, a large heat treatment facility, machine shop, metallurgical laboratory and training programmes to produce specialised, customised, high-integrity product for many industries in New Zealand. The company has installed the second largest photovoltaic solar arrangement in New Zealand. The company invested in solar generation to improve its contribution to sustainability and to increase efficiency. The solar installation supplies over 90 percent of the electrical requirements of the plant, with any surplus electricity fed into the National Grid. Although a significant investment was required, the payback period was estimated at 8-9 years, with a return on investment of around nine percent.

- Iplex – based in Palmerston North, the company identified an opportunity to source plastic from used household bottles (e.g., cleaners and shampoo) for use in a land drain product. Following trials, they were able to identify a process to use 25 tonnes of recycled plastic per month to develop a product with the same level of performance and quality as the existing product.
- INEX – based in Hamilton, it is the only aluminium extruder in Australasia to recycle its scrap back to produce aluminium billet through a partnership with Aluminium Smelters Ltd. The recycling process reduces the energy requirement in the manufacturing process without comprising the quality of the product.
- Golden Bay Cement – based in Whangarei, it is New Zealand's only cement manufacturing plant. The plant has reduced its carbon emissions by 52,000 tonnes per annum by using wood waste in its fuel mix. It is also converting its cement kiln to use shredded end of life-tyres as fuel which will reduce carbon by a further 13,000 tonnes per annum. In addition, this will provide capacity for disposing of more than half of New Zealand's waste tyres each year.
- Alto Packaging (a division of PACT Group) – is a rigid plastic packaging manufacturer with several plants in New Zealand. The company owns a recycling business in Auckland, which converts used plastic back to pellets. Alto produces a significant volume of recyclable rigid plastic meat trays, made with recycled product, that have largely replaced foam meat trays in supermarkets.

Sources: Company websites, news articles, company submissions and relevant member profiles from sustainable.org.nz

Overall, the broad environmental opportunity for the sector over the next two decades is to move towards 'low emissions circular economy' manufacturing. This involves moving progressively from producing products where parts can be recycled or recovered to extending the life of products and their parts and then to smarter production that minimises the use of and keeps resources in continuous use as long as possible, reduces energy use, minimises emissions and eliminates waste (so that effectively all material used is re-circulated back into the production system). This not only has environmental benefits but can reduce costs and add value to production. Figure 26 illustrates the journey.

Figure 26: The journey from linear to circular manufacturing



Source: MartinJenkins based on Potting et al (2017); Blick and Comendant (2018).

As will be discussed later, this journey will require incentives for innovation, investment in collection, recycling and processing facilities, improved data collection, and incentive mechanisms to encourage changes in purchasing and disposal preferences.

Impact of Industry 4.0

There has been a lot of publicity and indeed some hype in recent years about the impact of Industry 4.0 on manufacturing and the economy generally. Industry 4.0 (the Fourth Industrial Revolution) originally referred to the application of digital technologies, such as ICT and data analytics, to improve production processes. The term has expanded to include the adoption and application of a range of new technologies to create what are termed ‘advanced manufacturing systems’ or ‘smart factories’. Particular technologies of interest and their potential impacts are noted in Table 2 below:

Table 2: Current and potential use of Industry 4.0 technologies

Technology	Current use in manufacturing	Potential use in future
Sensing and communication technologies	Currently used to remotely monitor specific production attributes such as temperature, pressure, strength and flow rates and to track materials and goods.	Sensors will become even cheaper, smaller, lighter and more energy efficient. Will become pervasive and be able to be applied across the manufacturing value chain, enabling manufacturers to model products and processes, digitally check inventories and the quality of products, undertake proactive maintenance of processes and products by diagnosing issues and faults before failure, and manage energy consumption. Will also enhance and enable new manufactured products in areas such as autonomous transportation, medical devices, environmental and resource monitoring.
Robots and automation	Currently used in some sectors to replace workers for tasks that are complex, repetitive or hazardous.	Wider application across a range of sectors and processes, including assistive robots that work collaboratively with workers and adapt to conditions, that dismantle and sort materials for recycling, and provide autonomous service delivery.
3D printing or additive manufacturing technologies	Current use in metals and plastics manufacturing is well advanced. Across broader industry, tends to be used for prototyping and one-off production or small production runs of customised, high value components and products. Broader use is currently limited because of the relatively high costs of the technology, limited speed, and lack of expertise to use the technology.	Greater adoption due to reduced costs, improved speed etc and will become mainstream. Will speed the development of component parts across the sector, reduce waste, enable inventories to be reduced, and enable the development of a greater range of personalised products.
Artificial intelligence (AI)	Is being adopted in the development of electronic and automotive products, smart control systems, and to improve customer relationship management, financial/billing and management reporting systems.	Wider adoption across the industry to enhance customer experiences, improve R&D through generative design, and improve quality through computer visioning, predictive modelling and just-in-time logistics.
Augmented and virtual reality technologies	Currently largely used by consumer electronic producers with limited use in manufacturing.	Will be applied across the manufacturing sector to improve product design, facilitate remote maintenance and remote control of machinery, and train workers through complex and dangerous tasks.
Advanced materials	Tends to be used to address specific product issues, e.g., to improve durability, reduce weight.	Development and application of new materials will be over a broad range of areas to provide products with novel attributes, e.g., biodegradability, biocompatibility, energy efficiency, self-repair.

Source: MartinJenkins based on Foresight (2013), CSIRO Futures (2016), AI Forum New Zealand (2018); Kota and Mahoney (2018).

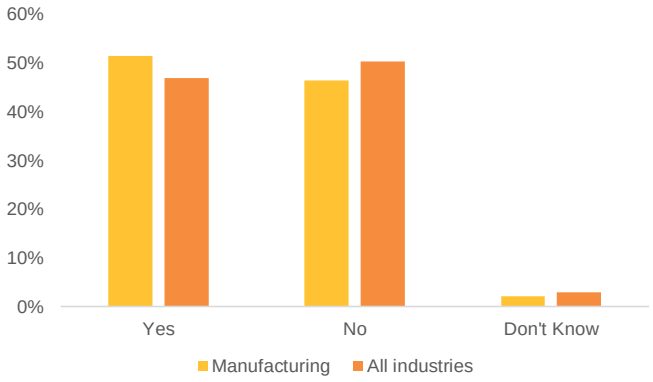
The combination of Industry 4.0 technologies will enable manufacturers in New Zealand to:

- Reduce the level of inputs and waste (thus helping to meet sustainability demands noted above) and hence costs.
- Improve working conditions (e.g., by improving safety, reducing the need to do repetitive tasks).
- Produce unique and customised products on demand, with shorter cycle times and lower costs typically associated with mass production (helping to overcome the challenge of scale).
- Secure new opportunities as part of distributed, global value chains.
- Improve productivity. For example:
  - an estimate of the economic benefits of AI adoption in the manufacturing industry resulting from labour efficiencies by 2035 was between $2.6 billion and $6.3 billion (AI Forum New Zealand, 2018)
  - early adoption of automation could grow productivity by 2.5 percent between 2016 and 2030 compared to 1.4 percent in a mid-point scenario[8] (Prime Minister's Business Advisory Council, 2019a).

Overall, Industry 4.0 may allow New Zealand to expand or re-establish domestic production in a range of areas that have previously declined or gone offshore.

Positively, just over half of manufacturers in 2018[9] reported they had introduced new automation over the previous two years. This was a higher proportion than across industries as a whole. The most common reason for introducing new automation was to increase productivity (18 percent of all responses), followed by reducing human error/improving reliability (14 percent), increasing profitability (13 percent), reducing costs (12 percent), and improving the quality of products and maintaining competitiveness (11 percent each).

Figure 27: Proportion of businesses introducing new automation to tasks or processes over the last two financial years, 2018



Source: Business Operations Survey 2018 (businesses with 6 or more employees)

Again, there are several examples of manufacturers that are either producing Industry 4.0 technologies for use across sectors or that are at the forefront of using these technologies in their production processes.

[8] Early adoption means that 41 percent of workplace activities would be automated by 2030; the mid-point scenario estimates that 21 percent of workplace activities would be automated by 2030.

[9] With 6 or more employees

Examples of manufacturers applying Industry 4.0

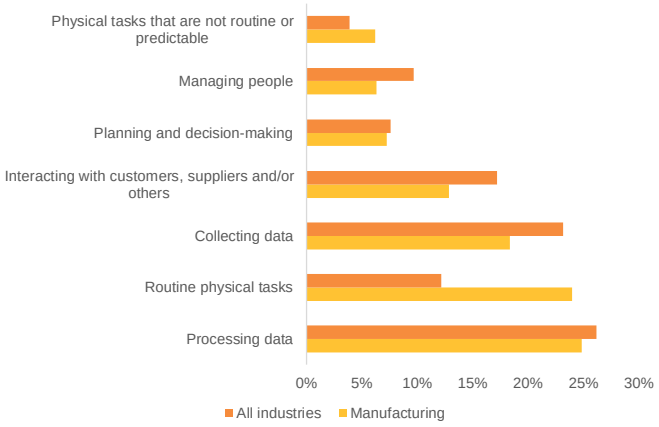
- Facteon is a global specialist provider and integrator of automation, from robotics to custom machinery to software. It provides solutions to a range of businesses as well as within its own Haier group, for example providing information about how production lines are running, if targets are being met and whether maintenance is required.
- Engrich Ltd, a precision engineering and design company, has applied 3D printing to produce body parts for a luxury motorcycle. Additive manufacturing enabled production of the parts at a much lower cost and a faster turnaround.
- Assa Abloy New Zealand, a leader in door and window opening solutions, has deployed robotic arms to perform repetitive tasks such as picking and placing of screws, assembling locks and screwing face plates on a production line. The automation and robotics have increased productivity, ensured a smooth production flow, improved workers' safety, and relieved staff of repetitive tasks.
- Mastip, which manufacturers hot runners (a tool for injection moulding of plastic products), applied automation and AI to collect data from each of the factory's CNC machines and to show staff how they are operating in real-time on a screen. This has helped Mastip to identify which machines are suited to which jobs and to re-route work through the factory.
- Tait Communications applied Industry 4.0 technologies to improve its Surface Mount Technology (SMT) circuit board production lines. This included reconfiguring hardware based on the analysis of the production data generated by the SMT system, smoothing the machine setup and changeover process based on automatic predictive algorithms, and balancing workloads based on real-time analysis of the assembly model. A 21 percent increase in productivity was achieved on the SMT lines.
- H&C Automated Solutions designs, builds and installs automated de-boxing, de-bagging and defect detection systems for dairy, meat and fruit processing plants. For example, for one client the company produced a robotic 'cheese palletising, de-boxing and de-bagging system', which identifies cartons on pallets, lifts blocks of cheese, removes the cardboard and shrink wrapping and checks for mould. The system eliminates manual handling and the associated risk of injury to staff, improves hygiene standards, and improves waste management.
- Rapid Advanced Manufacturing (RAM3D) is a 3D metal printing and manufacturing company based in Tauranga that has developed significant capability in additive manufacturing powder bed technology, focusing on titanium, stainless steel and Inconel metal alloy powders. It provides one of the few selective laser melting (SLM) facilities in the Southern Hemisphere and delivers to customers in the aerospace, defence, marine, consumer and industrial markets.
- Furnware produces ergonomic chairs, tables, desks, lockers and screen dividers for offices and schools. They have applied welding robots at the Hastings factory to replace repetitive work and ensure 100 percent consistency and accuracy. The application of technology has allowed the company to retain staff (to make the robotics system work) and remain in New Zealand.

- Canzac is a Christchurch based manufacturer of concrete products and solutions which include sensors that can be buried in concrete to measure strength and humidity. The sensors are tied to reinforcing steel within the concrete slab or formwork, enabling wireless and continuous monitoring of concrete temperature and strength using Bluetooth technology to transmit data to a smartphone application. This allows contractors to know in real time if their concrete has the required strength and can lead to the formwork being removed earlier than usual, saving in construction time.

Sources: Company websites, news articles and examples from www.callaghaninnovaiton.govt.nz

Although there are several success stories, manufacturers, like New Zealand firms overall, are generally still applying automation in relatively narrow areas. Of those that had introduced automation in 2018, the largest proportions applied it to processing and collecting data and to routine physical tasks. Relatively small proportions applied it to non-routine tasks, managing people, and planning and decision-making.

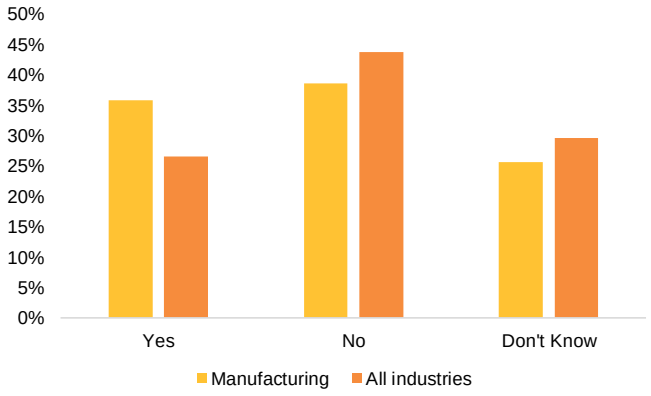
Figure 28: Area of business where the most significant automation occurs, 2018



Source: Business Operations Survey 2018 (businesses with 6 or more employees)

In 2018, just over a third (36 percent) of manufacturers[10] indicated they were likely to introduce new automation over the next two years. This was a higher proportion than across industries as a whole (27 percent). However, 39 percent were not planning to and another 26 percent didn't know.

Figure 29: Proportion of businesses that are likely to introduce new automation to tasks or processes over the next two financial years



Source: Business Operations Survey 2018 (businesses with 6 or more employees)

[10] With 6 or more employees

The ability of more manufacturers to take advantage of the opportunities of Industry 4.0 will be limited by their understanding of the value and application of the technologies. A 2018 study found that although 39 percent of respondent manufacturers had a high or good knowledge about Industry 4.0, a third had a poor or very low level of awareness (Hazmeh, Zhong and Xu, 2018). Similarly, a study of AI found that 78 percent of organisations, including manufacturers, identified that the key barrier to its deployment was that parts of the business did not understand AI or its potential (AI Forum New Zealand, 2018).

More concerning was that 16 percent of respondents in the 2018 manufacturing study considered that IT sectors were the only ones that would benefit from Industry 4.0 and 12 percent did not consider that Industry 4.0 could improve their business (Hazmeh, Zhong and Xu, 2018).

Other barriers to the adoption of Industry 4.0 technologies in New Zealand that have been identified by surveys are:

- Lack of expertise – 38 percent of manufacturers in the 2018 study identified a lack of skilled people as an obstacle (Hazmeh, Zhong and Xu, 2018) and 47 percent in an Employers and Manufacturers Association (EMA) survey identified a lack of qualified staff (Employers and Manufacturers Association, 2018).
- Cost – 66 percent of manufacturers in the 2018 study identified securing initial funding as the key barrier (Hazmeh, Zhong and Xu, 2018) and 42 percent in the EMA survey considered the main barrier was the excessive investment cost (EMA, 2018).
- Lack of time/planning – 41 percent of respondents in the 2018 study identified being busy on their business and not having a plan for Industry 4.0 as a barrier (Hazmeh, Zhong and Xu, 2018).
- Concerns about data security – 29 percent of respondents to the EMA survey identified this as a challenge (EMA, 2018).

Improving the level of information about Industry 4.0 and its benefits and supporting its uptake across the industry (e.g., through capability development) will be required to ensure widespread adoption.

Servitisation of manufacturing

One area of opportunity that will be further opened-up by Industry 4.0 technologies is the ‘servitisation’ of manufacturing or the expansion of manufacturing into service areas. This will provide additional high value opportunities for the sector in New Zealand beyond the production and sale of manufactured goods. These opportunities include providing a greater variety of:

- Operational services for products such as installation and set-up services, after sales services (e.g., helpdesk, training and spare parts), maintenance and repair services, logistics and transport services, disposal and recycling services.
- Value-added information services for products, such as providing customers with real-time information on the status and performance of products to optimally manage their use.
- Product-based financial services, such as leasing, rental, pay-per-use, lending and pooling arrangements for products.

- Consulting, design and engineering services, by providing advice and assistance to customers in developing, using, managing and maintaining products.

There is no information about the extent to which New Zealand manufacturers are already providing services, although estimates offshore indicate that the proportion of servitised manufacturers ranges from over 50 percent in the UK, US and Australia to less than 30 percent in several countries such as India, Vietnam, Poland, Argentina and Brazil (Mastrogiacomo et al, 2018). Machinery and equipment, electronic, motor vehicles and pharmaceutical manufacturers tend to be the sectors that are most servitised. One report suggests that more than 65 percent of manufacturers worldwide will expand from a focus on production to build revenue from services by 2020.[11]

There will be several benefits from New Zealand manufacturers becoming more servitised, including more jobs (firms employ additional people to offer the services), increased customer loyalty, higher revenues and higher profitability.

Responding to the increasing demand for customised solutions

As noted above, Industry 4.0 technologies such as data analytics, 3D printing and sensors are enabling manufacturers to provide customised solutions on demand and at scale. There will be increasing demand for:

- Mass customisation – where products are mass produced but consumers have some options to customise the products (e.g., used in the production and assembly of electronic goods, sport shoes, vehicles). For example, RAM3D has worked with Australian company Bastion Cycles to provide 3D printing of frame parts using titanium and developed the first commercially available 3D printed road bike in the world. This allows each bike to be customised to its rider.
- Personalisation – where customers are involved in the process to create a bespoke product or service within some parameters (e.g., online design, ordering and manufacture of tailored shirts to fit to body measurements, 3D printed jewellery, packaging with personalised designs, artwork and colours).

This demand will be driven by the rise of millennials who want to shape what they purchase, social media that enables ready product comparisons, the proliferation of digital devices and growth in disposable incomes. International research has shown that in some product categories (e.g., clothing, furniture, fashion accessories, footwear, electrical products, health & wellness products), more than a third of consumers are interested in purchasing customised products and would be willing to pay more for them (Deloitte, 2019).

In addition to adopting appropriate technologies that can respond promptly to product specifications at a competitive price, manufacturers will need to spend more time and resources understanding differences in customer preferences across locations, demographics and other elements (e.g., to cater for special needs).

[11] https://www.themanufacturer.com/articles/servitization-helping-business-rise-value-chain/

The rise of protectionism

After many decades of increasing international trade liberalisation, protectionist policies have emerged over the last decade and particularly over the last two years. Since 2009, the number of new protection measures across world economies has exceeded the number of liberalising measures (Australian Productivity Commission, 2017). The United States has introduced a range of trade barriers since 2018, including tariffs on imports of steel and aluminium, resulting in retaliatory measures by trading partners such as China and the EU. Public support for trade liberalisation has also declined in several economies, as evidenced by the US withdrawal from the Trans-Pacific Partnership, Brexit, and opposition in Europe to the Trans-Atlantic Trade and Investment Partnership.

For New Zealand manufacturers, a significant issue has been the growth in non-tariff measures by trading partners such as through the use of export subsidies, local content requirements, government loans, import license restrictions, sanitary and phytosanitary restrictions, product standards and price control measures. Some measures are of course required for protecting consumer health and safety and environmental quality. However, others are focused on supporting the development of domestic industries.

For example, a study of trade barriers facing the New Zealand forestry and wood processing industry identified a range of non-tariff measures in different economies that support their local producers, including (Maplesden and Horgan, 2016):

- China: Differential import VAT for logs compared to sawn timber; an import VAT on pulp and paper; regional subsidies/refunds on log costs to local producers; access to credit for China state-owned enterprises.
- India: a significant import tariff on sawn timber imports compared to logs; requirements for methyl bromide fumigation of logs; foreign investment restrictions on sawmilling.
- Canada: policies which restrict the export of logs; programmes that promote domestic use of wood.

In this industry, non-tariff measures have impacted on (Maplesden and Horgan, 2016):

- the ability of domestic manufacturers to access offshore markets
- the incentives facing the forestry industry to supply logs domestically and the prices that local producers have to pay for raw material (with forest owners selling logs at ‘export parity’ prices to domestic sawmills, effectively increasing the costs facing local wood processing companies relative to offshore competitors),

and have undoubtedly contributed to the long-term growth in imported sawn timber and special purpose timber products into New Zealand.

A more recent study (Sense Partners, 2019) estimated that the introduction of non-tariff measures related to logs and timber products is associated with a reduction of trade of between 13 percent and 81 percent, depending on the measure and the product.

Concerns about the domestic impact of non-tariff measures have also been raised by the metals industry, with investigations being sought into whether subsidies are allowing competitors in China to sell certain metal products in New Zealand at prices lower than they are sold in their country of origin. Investigations by MBIE have so far indicated that offshore subsidies on these products have not been material (MBIE, 2018b; 2019b; 2019c).

More generally, NZIER (2016a) found that the number of non-tariff measures within APEC economies increased by 74 percent over 2004 to 2015. They estimated that the highest cost of non-tariff measures fell on the machinery and equipment sector. Other manufacturing sectors facing high costs were electronic equipment, chemical, rubber & plastics and food products. The overall cost of non-tariff barriers on New Zealand's exports was estimated at $5.9 billion, although a significant amount of that was on primary sector exports.

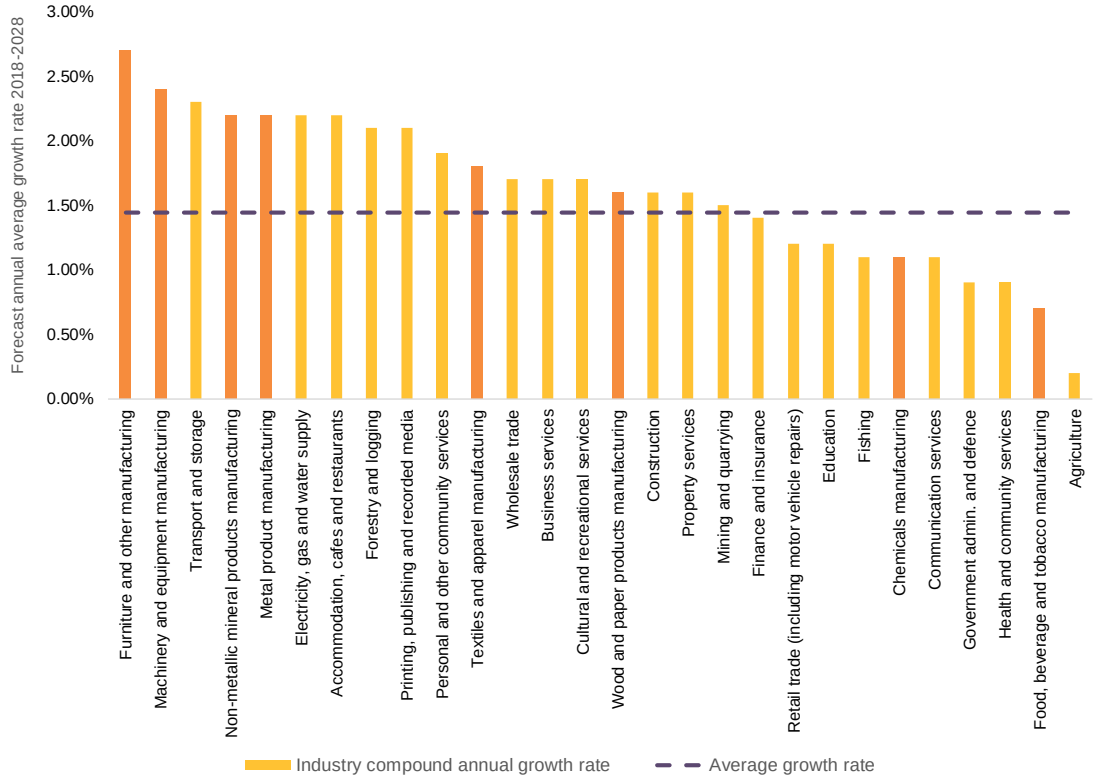
It is likely that non-tariff measures and, potentially, tariff protection in some markets will continue to grow over the next decade and affected New Zealand manufacturing industries will need to identify new market opportunities and ways of working with the New Zealand government to minimise the impacts.

Competition for skills

Four major inter-related pressures will impact the skills available and required by manufacturers over the next decade:

i. **Continued demand for manufacturing workers:** As noted, the manufacturing sector has been in a recovery phase and MBIE forecasts that moderate labour growth in the sector will continue over the long-term (even with the spread of automation and other Industry 4.0 technologies).

Figure 30: Forecast employment growth by industry, 2018-2029



Source: Medium to long-term employment outlook (MBIE, 2019a). Orange bars are manufacturing sectors.

The forecasts suggest that the sector will grow by around 42,500 jobs over 2018-2028 (Ministry of Business, Innovation & Employment, 2019a). This represents 11 percent of the total forecast increase in employment across the economy. Some manufacturing sectors are expected to experience relatively high employment demand over the period, particularly furniture & other manufacturing (2.7 percent per year compound growth in employment), machinery & equipment manufacturing (2.4 percent per year), non-metallic mineral products manufacturing (2.2 percent) and metal product manufacturing (2.2 percent per year). The actual number of jobs in manufacturing that will need to be filled will be much greater as people retire or leave the sector.

ii. **The aging population.** New Zealand's population, like in other developed economies, is aging, with the proportion of people aged 65 and over forecast to increase (from 15 percent in 2018 to 23 percent in 2038) and the proportion of the working age population decreasing (from 65 percent to 60 percent).[12] By 2038, it is expected there will be an additional 550,000 people aged 65 and over, compared to around an additional 305,000 people of working age. Many of these older aged people will want to continue working – the labour force participation rate of 65 to 69-year olds increased from 30 percent to 45 percent over 2007 to 2017 and one survey found that 46 percent of New Zealanders want to keep working past 65.[13]

When last reported[14], the manufacturing sector had a smaller proportion of older workers in employment than across all sectors as a whole (4.9 percent of 65-year olds and over compared to 5.5 percent). In particular, food and beverage (3.4 percent) and chemicals and refining (4.4 percent) had a relatively small proportion of older workers. Manufacturing will be challenged to make working conditions more attractive to the growing cohort of older workers relative to other sectors, for example by providing part-time work and training on new technology (Infometrics, 2018). Around half (51 percent) of manufacturers in a 2018 EMA survey considered that an aging workforce will have an impact on their business although, positively, 72 percent said they are prepared for an aging workforce (EMA, 2018). 20 percent were encouraging employees to work beyond 65 years (up from 13 percent in 2017).

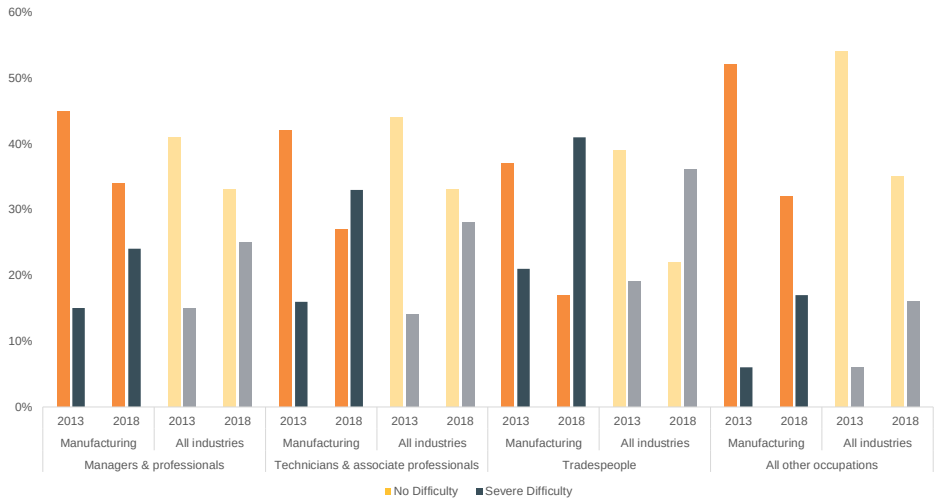
iii. **Growing skill shortages.** Manufacturers have found it increasingly difficult over the last five years to secure the talent they need. As shown in Figure 31, higher proportions of manufacturers reported severe difficulties in recruiting all skill types in 2018 compared to 2013. This is generally consistent with the increasing difficulties faced across industries in New Zealand. However, in 2018 a greater proportion of manufacturers than across all industries reported severe difficulties in recruiting technicians and associate professionals (33 percent compared to 28 percent) and tradespeople (41 percent compared to 36 percent). There were particularly large increases in the proportion of manufacturers reporting severe difficulties in recruiting technicians (from 16 percent to 33 percent) and tradespeople (from 28 percent to 41 percent) over the five years.

[12] Statistics New Zealand's population projections (medium projections)

[13] https://www.bnz.co.nz/about-us/media/2018/the-unexpected-secret-to-a-happy-retirement

[14] Census 2013

Figure 31: Proportion of businesses reporting recruitment difficulties, 2013 and 2018



Source: Business Operations Surveys (businesses with 6 or more employees)

These figures are consistent with industry surveys. 70 percent of respondents to the 2018 EMA survey indicated that they found it difficult or very difficult to recruit staff compared to 61 percent in the 2017 survey. 71 percent considered there was, or soon would be, a skills shortage in their industry.

Manufacturers will need to continue to respond to shortages by a combination of investing in training, strengthening linkages with the education and training system, improving working conditions and through immigration. Positively, over half (55 percent) of the employers to the 2018 EMA survey were planning on meeting their skill needs by employing people and upskilling them. Over a third were seeking skilled migrants in 2018, compared to 23 percent in 2017. However, relatively few were seeking to employ more youth (6 percent). Indeed, 57 percent were dissatisfied or very dissatisfied with the work readiness of school leavers, and only 4 percent were at least satisfied.

iv. **Industry 4.0 and skill demands.** There have been several reports suggesting that automation and other new technologies will reduce the need for thousands of manufacturing jobs in New Zealand. For example, one study predicted that close to 32,500 manufacturing jobs were at a high risk of automation in Auckland alone, particularly labourers, machinery operators and clerical workers (NZIER, 2017). Similarly, another report suggests that there will be a net 38,000 jobs displaced in the manufacturing sector across New Zealand (Prime Minister's Business Advisory Council, 2019a).

However, other studies suggest more modest potential reductions in jobs and that Industry 4.0 will do more to change the job and skill mix required (Nedelkoska and Quintini, 2018; PWC, 2018b; MartinJenkins, 2019). Indeed, a recent study found that the uptake and impact of Industry 4.0 was likely to be slower than might technically be possible or anticipated due to, as noted earlier, the relatively high capital investment required and insufficient in-house capability, as well as concerns that the technology did not fit well with the culture of organisations (MartinJenkins, 2019).

Although there will be growing demands for specific skills in manufacturing, such as data analytics, machine work and digital design, Industry 4.0 will also demand more in terms of softer skills such as critical thinking, problem-solving, creativity and communication (Centre for the New Economy and Society, 2018; MartinJenkins, 2019; Prime Minister's Business Advisory Council, 2019a). Employers have expressed concerns that these types of skills are not being actively taught as part of education and that businesses will need to help develop these skills in staff.

Taken together, continued manufacturing growth, the aging population, growing skill shortages and the impact of technology means that manufacturers will face significant competition for talent both across the industry and up against other industries. Most are already responding, at least in part, to the pressures but they will not be able to ease up.

Long-term investment in construction & infrastructure

A major opportunity for several industries within the manufacturing sector is the forecast level of construction activity over the next decade and beyond. This includes housing, commercial buildings, and civic and transport infrastructure.

Almost all elements of a building, a house, road or bridge are manufactured. For example, a house typically includes concrete foundations, wooden and/or steel framing, roofing materials, spouting, cladding, glass windows, insulation, carpet and flooring, wallboards, floorboards, fabrics, cabinetry, plumbing, doors, electrical wiring and items, wallpaper, paint etc. Construction is also a major user of a variety of equipment and hardware, which are all manufactured.

This means that growth in construction has positive flow-on effects for relevant manufacturing industries, particularly non-metallic mineral product manufacturing (56 percent of the value of the sub-sector's output are intermediate goods used by the construction sector), fabricated metal product manufacturing (34 percent of the value of the sector's output) and wood product manufacturing (23 percent of the value of the sector's output). Around 25 percent of the value of the construction sector's purchases of intermediate goods are domestically produced manufactured goods.

The value of New Zealand's construction activity was $39 billion in 2018. The value of activity is forecast to grow to $43 billion in 2021, with only a slight drop to $42 billion by 2024. The value is being held up by the strong growth forecast for residential building activity, from $23 billion to $27 billion over 2018 to 2024 (BRANZ and Pacifecon, 2019)

Looking further ahead, an estimated $129 billion is expected to be spent on infrastructure projects in New Zealand over the next ten years (The Treasury, 2019). This includes hospital upgrades, schools, correctional facilities, airport upgrades roads and highway improvements.

The extent of the impact of this on New Zealand manufacturing will depend on how much of the construction sector's inputs continue to be sourced from domestic manufacturers versus imports. Based on input-output tables, direct imports make up around 8 percent of intermediate inputs into the construction sector.

There are certainly opportunities for manufacturing's contribution to construction to grow, for example, through prefabricated housing in combination with Industry 4.0 technologies (e.g., automation, additive manufacturing).

As noted above, strong growth in residential building is forecast. A combination of the growing population, particularly in Auckland, growing incomes, cheaper credit and an inability to build enough housing has resulted in a significant shortage of housing (estimates suggest that the current shortage is over 70,000 homes). In response, a variety of initiatives have been established to accelerate housing construction and to build thousands of homes over the next decade, such as through KiwiBuild and Kāinga Ora's Auckland and regional housing programmes.

A significant increase in the pre-fabrication of homes, where walls, floors, roof panels, modules and even complete buildings are built offsite and then transported to the site and installed, will be one way of addressing the housing shortage. KiwiBuild has already called for expressions of interest from companies interested in setting up large-scale prefabricated housing factories, with over 100 responses received. A survey by PrefabNZ suggests that the New Zealand prefabricated building manufacture industry could currently build 3000-4000 houses per year, with the ability to scale up to around 7,000 houses per year (PrefabNZ, 2018). Scaling up prefabricated housing in New Zealand will, however, depend on scale in demand (to achieve economies of scale in production).

Prefabricated building manufacturing will also result in productivity and environmental benefits, as it reduces build time, improves quality (due to enhanced production control), reduces health and safety issues (due to the enhanced ability to control working conditions), and reduces greenhouse gas emissions from the build (due to significantly less waste and generally lower transport costs).

3. HOW SHOULD THE SECTOR RESPOND?

Key points:

- The manufacturing sector has a proven ability to adapt to significant change and will continue to respond to the major environmental, technological, trade, skill and infrastructure challenges and opportunities emerging. Based on the previous period of major change – the 1980s reforms – the adaption and transformation of the sector will take many years.

- Beyond transitioning to circular manufacturing and smart (digitised) manufacturing through Industry 4.0, the sector can ensure it is fit for the future by investing in:

  - Collaborative manufacturing relationships with customers, suppliers, advisors, government agencies, research and education & training organisations. These should include a combination of tactical relationships to tackle operational challenges; innovation relationships to develop new ideas, products, processes etc; strategic relationships to secure joint opportunities; and collective relationships to address shared challenges. New Zealand manufacturers have traditionally not been great collaborators, except at a transactional or informal level.

  - Talent management, including through workforce planning, committing to the ongoing improvement of workplace conditions to support greater diversity, building capability to implement new technologies and ways of working, and working with other organisations (businesses, industry groups) to identify collective skills needs and to engage the education & training system to cater for those needs.

  - Continuous and agile innovation, by committing to the ongoing development and reinvention of products, processes, business models and marketing methods. Improving management capability and capacity will be central to this.

  - Intelligence-driven manufacturing and improving the quality of and processes for gathering and analysing production and market intelligence. Developing AI-ready workplaces and collaborative relationships will support this.

  - Improving participation in global value networks, by developing strategies for marketing, licensing and selling products and services to these networks; using international forums and missions to promote local capabilities to network participants; and collaborating with local network participants to learn from their experiences.

Introduction

Given the key pressures and prospects facing manufacturing include:

- environmental demands and the need to identify ways of reducing and reusing waste
- Industry 4.0 and the need to improve capability to improve productivity, secure new market opportunities and expand the level of customisation and servitisation
- growing trade protectionism and the need to identify ways of minimising the impact of trade barriers
- competition for and changes in skill demands and the need to cater for demographic changes, proactively work with the education and training system, and commit to workforce development over the long-term, and
- the long-term programme of investment in construction and infrastructure and identifying ways in which manufacturing can leverage this investment,

it is clear that the sector will need to continue to adapt and transform over the next two decades. This section highlights the major implications of these pressures and prospects and the key areas of transformation that will be required.

Transformation takes time

New Zealand manufacturing has already gone through substantive change over the last several decades and has a proven ability to adapt. This was particularly the case over the period of deregulation and liberalisation in the 1980s and early 1990s (see box below). What this demonstrates is that the sector can and will respond to significant shocks and changes in policy. But it also demonstrates that adjustment takes many years and can have unforeseen costs, and that needs to be factored into business decision making and policy-making.

Manufacturers' response to New Zealand's reforms

Up until the 1970s, New Zealand's manufacturing sector was well protected by successive governments' commitment to import substitution and protection through import licensing and our long-term trade partnership with the UK. As such, domestic manufacturing grew strongly – over 1952 to 1972, manufacturing employment grew by around 108,000 jobs – but there was a limited amount of manufactured exports.

Leading up to the UK joining the European Community in 1973 and in response to balance of payments crises and the changing nature of world trade, the government began to actively encourage exporting through tax incentives and industry assistance. However, throughout the 1970s and the two periods of oil price shocks, exporting was still a minor element of most manufacturing sectors and, for most exporting firms, exports represented a small proportion of total sales. In addition, the vast majority of exporting manufacturers at the time were trading mainly with Australia. Up to and through this period, manufacturers were able to build up their businesses and produce broad product lines, irrespective of efficiency or comparative advantage.

From 1983, following the introduction of Closer Economic Relations, the economy was progressively and very quickly reformed and opened-up to international competition. This involved the deregulation of factor markets, the removal of international credit controls and widespread industry deregulation.

It included the removal of regulatory barriers to entry, removal of controls on wages, prices and interest rates, removal of ownership restrictions, the phasing out of import licensing, reductions in tariffs, the removal of export subsidies, the floating of the New Zealand dollar, and removal of protections for specific sectors. The situation was not helped by the stock-market crash of 1987 and subsequent recession.

It is fair to say there was an over-optimistic view about how fast manufacturers (and firms generally) would be able to respond to the radical changes in their operating environment. Manufacturers' long-term isolation from international competition and limited scale meant that, in many cases, products lacked customer appeal and/or were relatively expensive compared to competing offshore products. Much manufacturing was consequently not sustainable.

With protection removed and reforms underway, the focus of manufacturers in the mid-to-late 1980s was on cost-cutting and rationalising product lines. By the late 1980s several had started to emphasise quality (including reliability, low defects) as a competitive differentiator as they could no longer compete on price. However, a lack of exposure to international competition meant that many did not know how to respond or could not respond, at least on their own. Over the ten years between 1980 and 1990, a large number of manufacturers went out of business and many were sold to overseas interests. Manufacturing employment declined by 90,000 jobs over the ten years (which represented 27 percent of manufacturing employment). It has also been estimated that the proportion of manufacturers that were New Zealand owned reduced from over 50 percent at the start of the period to 15 percent by 1990.

A second phase of adjustment took place over the early to mid-1990s as the labour market was reformed and trade and investment linkages grew, and some leading manufacturers expanded from competing on quality to compete on product innovation and marketing. These developments were often associated with an expansion of exporting. However, the frequency of these approaches was not extensive – quality improvement was still the dominant focus of manufacturing strategy although a greater emphasis was being placed on improving customer relationships and supply chains. Within manufacturing operations, attention was being made to improving management systems, with a movement away from administrative leadership to more participative leadership. The increasing focus on quality was supported by an emphasis on teamwork, training, multi-tasking and improved communication. Despite all these changes, the majority of manufacturers still had a long way to go to adapt to the open market environment.

However, by the late 1990s and early 2000s the redesign of manufacturing operations and practices was well established across the sector. The focus of strategies expanded to include flexibility and, in some cases, innovation. More firms were exporting and to more markets (although exporting was still a minor part of the business for most firms). There had also emerged at least a few hundred manufacturers that were competing internationally with distinct, innovative products and services. Although there was a slight dip in manufacturing activity due to the Asian crisis over 1997-98, the sector was more resilient and manufacturing employment increased by around 50,000 jobs over 1999 to 2003.

Sources: Wills (1994); Campbell-Hunt and Corbett (1996); Yeabsley (2001); Knuckey et al (2002).

Although manufacturing is always evolving in response to changing conditions, the combination and significance of the current pressures and prospects means that the sector is facing what is almost an unprecedented level of upheaval – at least since the reform process.

Manufacturing that is fit for the future

At a business level, some of the operational implications of the pressures and prospects were discussed in Section 2 and Figure 32 summarises these. They include a transition of manufacturing operations from:

- linear to circular manufacturing
- relatively inflexible workplace arrangements to diverse, flexible workplaces
- product focused, large scale manufacturing to bespoke solutions
- automatised production to digitised, smart and connected manufacturing.

Figure 32: Expected requirements for future manufacturing

Manufacturing	Typical current features	Future requirements
Environmental practices	Some recycling and recovery	Reduced energy intensity, circular manufacturing
Technology and innovation	Limited use of automation, 3D printing, AI; mostly focused on product & process innovation	Integration of a range of Industry 4.0 technologies; agile, continuous innovation of all types (incl. market, organisational)
People	Predominantly labourers and technical workers, limited flexibility	Diverse workforce (older female), multi-skilled (digital and soft skills), flexible working arrangements
Product servitisation	Product focused, with some operational services	Range of operational, information, financial, consulting services offered
Product customisation	Mass production with some mass customisation, limited personalisation	Mass customisation commonplace; range of products are personalised
Market focus	Several manufacturers part of global value chains, most largely domestic; predominantly final goods; Australia, US core export markets	Many manufacturers supply niche solutions and components within global value chains

Sources: MartinJenkins based on McKinsey Global Institute (2012); Foresight (2013); CSIRO Futures (2016)

Beyond these, at an industry-wide level there are five major, inter-related themes and related activities that will define a New Zealand manufacturing sector that is fit for the future.

1. Collaborative manufacturing

Managing collaboration has become so important that an international standard to guide businesses about how to establish and improve relationships, within and between organisations, was released in 2017 (ISO 44001).

Collaborating to compete is not a new concept and there are many examples in New Zealand of manufacturing projects involving groups of businesses, or businesses with universities or research institutions. Indeed, our leading manufacturers view cooperative relationships as part of their core business. However, overall, New Zealand manufacturers have traditionally not been great collaborators, except on a transactional or informal basis. In 2017 around 27 percent of manufacturers collaborated for innovation[15], which was a moderate level of collaboration (it was a lower proportion than businesses in the health care, wholesale, information media & telecommunications, professional services, transport & warehousing sectors, although higher than the utilities, financial, agriculture, construction and accommodation & food services sectors). Generally, a smaller proportion of businesses in New Zealand collaborate on innovation compared to other economies (e.g., when last assessed, 15 percent of New Zealand SMEs collaborated on product or process innovation with suppliers, compared to 40 percent in the UK, 28 percent in Finland and 27 percent in Denmark – although this was a slightly higher proportion than in Australia (13 percent)).

Business collaboration in New Zealand can be challenging due to a combination of factors, such as a dominant culture of self-reliance, the limited scale and resourcing available to most firms, the promotion of competition following the reforms, and the relative isolation of New Zealand manufacturers compared to their counterparts offshore. However, the pressures and prospects facing the sector mean that collaboration across suppliers and customers, and with research organisations and government agencies, will become essential to maintain and build market share. It will enable manufacturers to:

- Make the most of opportunities arising from digitisation, servitisation and customisation as manufacturers increasingly rely on others to add value to their core offerings.
- Develop and access collective resources such as talent pools, market insights, funding support and R&D expertise.
- Adapt quickly to new and improved products, processes and technologies by learning from others.
- Develop collective responses to demands for less energy-intensive processes and materials and products that can be recycled and reused.

The future of manufacturing will see businesses investing in a range of collaborative relationships – tactical relationships to address specific operational challenges; innovative relationships to test and develop new ideas; strategic relationships to identify ways in which advantages and opportunities can be developed collaboratively; and collective relationships to tackle shared challenges. The sector will also need to consider how investing in collaborative relationships will affect business competitiveness, for example in relation to managing IP.

[15] Business Operations Survey, 2017.

2. Managing talent

The forecast changes in skill requirements and increased competition for skills means that talent strategies and practices will become an even more important part of manufacturing in the decades ahead. Successful manufacturers will:

- **Proactively plan for their own workforce needs** – the term 'workforce planning' sometimes has negative connotations associated with it because it can suggest a rigid, quantitative approach to thinking about workforce needs and as being only relevant to very large businesses. However, it is fundamentally about each individual business understanding how changes in demand, demographics and technologies will impact on their labour, skill and broader workplace requirements in the future, how this aligns (or not) with what the business has now, and ensuring that there are approaches in place to retain, acquire and/or develop the required skills and workplace settings. Workforce planning also better enables individual manufacturers to work with recruitment companies, education providers, other businesses and Immigration New Zealand to secure the skills at the time they are needed.

  In 2018, just under a quarter of manufacturers[16] indicated that the changing demographics of the New Zealand labour force had influenced how their business was run by 'a moderate amount' or 'great deal' over the previous two years, although 42 percent indicated that it had not influenced them at all (Business Operations Survey, 2018). Almost a third indicated that the availability of new technology had such an influence, although just over a quarter indicated that it did not influence them at all. Previous research suggests that only a small minority of manufacturers actually have a workforce plan and most only consider workforce needs when planning for the year ahead. However, five years plus may be required to train people in complex and technical skills and to establish well-functioning training, recruitment and retention practices.

- **Commit to the ongoing improvement of workplace conditions.** As noted, changing demographics will mean that manufacturers that can support greater diversity within the workforce (e.g., younger people, older people, Māori, Pacific people), for example by offering flexible working arrangements, transport for workers, and being culturally competent will be able to draw on a greater pool of talent. In addition, manufacturers that create an environment that supports analytical thinking, creativity and emotional intelligence (e.g., through recruitment and performance systems) will better provide for the adoption of Industry 4.0 technologies. Similarly, research has found that the adoption of new technologies is more effective when employees can effectively participate in the transformation of businesses, for example, through increased decision-making and collaboration (Wagner, 2019).

  The sector has some way to go in adopting relevant practices. Although 54 percent of manufacturers in 2018 indicated they offered flexible start and finish times (close to the average of 57 percent across all industries), only 42 percent offered the option of part-time work (compared to 53 percent of firms overall); 17 percent had practices in place to support an aging workforce (compared to 25 percent); and 23 percent had practices to support a diverse and inclusive workplace (compared to 45 percent) (Business Operations Survey, 2018).

[16] With 6 or more employees.

- **Build capability to implement new technologies and ways of working.** As noted, research suggests that many organisations who see value in implementing new technologies and ways of working are being held back because do not have the internal capability. For larger manufacturers this could be achieved by bringing in specialist expertise or upskilling staff in relevant technical (e.g., digital literacy) and soft skills. For smaller manufacturers, the costs associated with developing internal capability may be prohibitive on their own but could be reduced by partnering with members of their value chain and/or industry groups. In 2018, although a healthy 62 percent of manufacturers indicated they had training or mentoring practices in place for non-managerial employees, this was less than the 72 percent of firms overall.

- **Work with value chain partners, other manufacturers and industry associations to identify future skill needs and collectively engage the education and training system** to cater for these needs and bring the future of work closer to the classroom**.** Effectively this is sectoral based workplace planning, which has been used in New Zealand for some sectors (e.g., construction) and in some regions (e.g. in response to the Christchurch earthquake). Elements of sectoral workforce planning have also traditionally been undertaken by ITOs (e.g., Competenz), although following the Review of Vocational Education this will in future become the role of a combination of Workplace Development Councils, Centres of Vocational Education and Regional Skills Leadership Groups (discussed later in this paper).

Examples of manufacturers investing in talent management

- Huhtamaki, a food manufacturer in Auckland, has several hundred staff working three separate shifts to produce products every hour of the day. The company considered training options for its diverse workforce (with a high proportion of Māori and Pasifika staff) to address issues associated with communication, quality and health and safety processes. They supported a workplace literacy and numeracy programme across the business and identified emerging leaders to support shift supervisors. The programme resulted in operators becoming more proactive and communicative, with the changeover process between shifts becoming smoother, reducing down-time and improving efficiency.
- Buckley Systems, a manufacturer of precision electromagnets for silicon chips, found that graduates had strong theoretical knowledge but limited practical experience. It expanded its apprenticeship programme to support growth, looking ten years ahead. This included a pre-apprenticeship programme so that potential apprentices could understand the various trades available and what would suit them best. During the six-month course, pre-apprentices get exposed to fabricating, machining, computer numerical control, electrical and maintenance trades.
- Oji Fibre Solutions instituted a training programme to support staff to achieve Level 3 qualifications. This included training sessions delivered in small groups using real-life forms and processes to ensure the programme was providing practical skills. The company allowed the programme to take place during working hours, checked in weekly with staff and employed a full-time training advisor to engage with tutors and participants. It also developed a financial wellbeing programme, with groups encouraged to complete a project to improve the company in some way, with all being evaluated and implemented by internal focus groups.

Sources: News articles and success stories from skillshighway.govt.nz

3. Continuous and agile innovation

Manufacturers will need to act fast to anticipate and adapt to changes in customer preferences, including for a greater variety of products, shorter product development lifecycles, faster delivery and improved services. A successful manufacturing sector in New Zealand will be characterised by firms undertaking innovation activities regularly and routinely, over the long-term. This will include a combination of gradual or incremental improvements and more significant or radical innovations. In sum, businesses will need to continuously learn and reinvent products, processes, business models and marketing methods.

As discussed earlier, a large proportion of manufacturers, 45 percent, undertook innovation in 2018. Although this is a good base and the proportion has been slowly growing over the last five years (from 41 percent in 2014), manufacturers' innovation practices are middling to weak compared to manufacturers offshore (Green and Agarwal, 2011). Moreover, the level of investment in R&D and new to market innovation is low relative to some comparable economies. For example, when last compared, close to 13 percent of New Zealand manufacturers reported that had implemented new to market product innovation, compared to 18 percent in Australia, 25 percent in Finland and 31 percent in Ireland – although the proportion was very similar to the UK and US (OECD, 2017).

New Zealand manufacturers (as with other sectors) are hampered in their innovation efforts by several external factors such as our small domestic market, which limits the availability of local sources of expertise and investment; our distance from major markets which hampers our ability to obtain a broader set of customer/supplier know-how, technologies and to test innovation; and the fragmentation of R&D, innovation and related support and infrastructure across the country. However, unless manufacturers adopt innovation as a key element of their competitive strategy in future, many will lose out to competitors as environmentally friendly products, processes & practices, customisation, servitisation and niche market opportunities become prevalent.

A key factor that is within manufacturers' control is management and there is considerable qualitative evidence that management capability and capacity is a weakness impacting on manufacturing innovation in New Zealand. Moreover, a lack of management resources is consistently cited as one of the major factors hampering innovation activity by manufacturers in official surveys, with 62 percent of manufacturers[17] in 2017 indicating that this was a barrier to innovation at least 'to some degree', and 43 percent indicating this was a barrier 'to a high degree' or 'moderate degree' (Business Operations Survey, 2017). Only two other sectors – professional services and information media – had a larger proportion of firms identifying it as a barrier. Management upskilling will need to be key element of workforce plans and peer-to-peer learning a key element of collaborative relationship development to ensure manufacturers are able to continuously innovate.

4. Intelligence-driven manufacturing

How manufacturers deal with the challenges and take up the prospects will depend significantly on the quality of their production and market intelligence and the processes they have for gathering and analysing this intelligence. For example, they will increasingly need to understand:

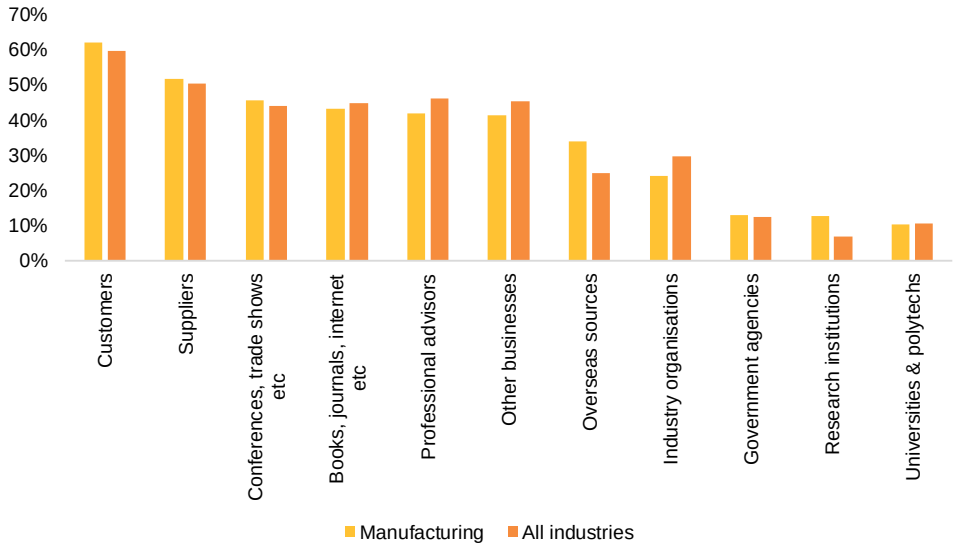
[17] With 6 or more employees.

- the environmental credentials of their inputs and material components and the impacts of their production
- changes in their workforce and the broader labour market
- the potential of new technologies and how to access them,

and be able to interpret and respond to the real-time information on products and market demands that Industry 4.0 technologies can provide.

There is very limited research or data on manufacturers' information management practices available in New Zealand. However, the regular Business Operations Survey suggests that manufacturers have traditionally had fairly average external intelligence gathering practices compared to other industries. As shown in Figure 33, although relatively high proportions of manufacturers in 2017 used research institutions (including associations and Callaghan Innovation) and overseas sources to inform their innovation activities, relatively low proportions used other businesses, professional advisors and industry organisations as sources of information.

Figure 33: Sources of information and ideas for innovation, 2017



Source: Statistics New Zealand, Business Operations Survey 2017

As noted earlier, artificial intelligence in combination with other Industry 4.0 technologies (e.g., sensors), allows manufacturers to analyse data at every stage of the production process and even after a product has been delivered to customers, enabling predictive maintenance, reductions in waste, improved quality testing, better supply chain management and more responsive support functions. Although the level of AI use in the manufacturing sector is not known, one study suggests that most New Zealand businesses currently lack cultural traits required for AI adoption (such as through encouraging employee empowerment) and most do not have plans about how to develop an AI-ready workplace (Microsoft, 2019).

The management of intelligence is an area where increased cooperation across manufacturers (particularly with counterparts offshore), between businesses and manufacturers' associations, and between businesses, associations and government agencies (including education and research organisations) will make a significant difference to the insights that are able to be obtained.

5. Participation in global value networks

With a small domestic market and the emergence of increasingly distributed manufacturing worldwide, New Zealand manufacturers that have not done so will need to shift their thinking from local to global competitors and, often, customers.

There has been growth in global value networks over the last 20 years – these are networks in which businesses across different countries produce different elements of a final product (e.g., research, design, components, assembly, distribution). Growth in these networks has been due to the combined effect of improved communications technologies, trade liberalisation agreements and improvements in transport, which have lowered the cost of coordinating different parts of value chains over long distances. Industry 4.0 and the increasing demand for customised products will encourage further growth in global value networks.

The share of New Zealand's value added in world exports and hence forward participation in these networks is currently very small. When last measured it ranged from around 1.5 percent of value added in food product exports to 0.7 percent in wood and paper products to less than 0.2 percent in machinery, electrical equipment, transport equipment and chemicals manufacturing (OECD, 2017b). This reflects the traditional approach of manufacturers to produce at home and then export, our small scale and our distance from markets.

Despite this, it is expected that a growing number of local manufacturers will have access to and will take up opportunities to design services, undertake R&D and manufacture niche parts and components of final products that are assembled and completed elsewhere. This could have several benefits - participation in global value networks is associated with increased innovation and access to new technologies, skill development, management capability improvements and productivity growth due to the transfer of know-how across network participants (OECD, 2013).

However, the value that will be generated will depend more on the quality of manufacturers' participation in these networks than just increasing the number of local participants (NZIER, 2016b). For manufacturers this means (CSIRO, 2016):

- Developing strategies for marketing, licensing and selling products to global value networks.
- Developing services (e.g., quality control software) for use across networks.
- Promoting capabilities to serve global networks by participating in international industry forums and missions.
- Collaborating with other manufacturers (and other businesses) that are part of global value networks to learn from their experiences.

4. WHAT SHOULD BE THE POLICY RESPONSE?

Key points:

- Governments across developed and developing economies have placed a priority on building strong manufacturing sectors and have adopted industrial or manufacturing policies/strategies to do this. These typically include a vision or objectives for the future role of the sector and a set of mutually reinforcing policies and programmes to achieve the vision. They are established through a co-development process between the public and private sectors, with a focus on aligning efforts to take up opportunities for and remove blockages to investment.

- New Zealand has lagged behind other countries in developing a cohesive manufacturing or industrial policy, with the results that (i) manufacturing has not been particularly well understood or promoted in policy by successive governments and (ii) relevant policies and interventions have been disjointed. The recent release of an Industry Policy framework and intention to develop Industry Transformation Plans for selected industry segments are positive steps. However, the sector is calling for the co-development of a broader Manufacturing Strategy that focuses on a coherent set of horizontal policies that will help the sector to adjust to the significant pressures and prospects emerging.

- Key policy areas/initiatives that should be included in the Manufacturing Strategy include:

  - Additional support to increase investment in innovation to complement the R&D tax credit, with a particular focus on encouraging the adoption of Industry 4.0 technologies and the development of cleaner production and products, for example through accelerated depreciation and investment incentives.

  - A serious commitment to address non-tariff measures in the government's programme of trade negotiations, including ensuring support is put in place for any product testing and certification requirements, improving the monitoring of non-tariff barriers, and identifying ways to improve the responsiveness of trade remedies investigation processes.

  - Stronger enforcement of standards and conformance to prevent the importation of substandard products and improved intelligence on global value network opportunities should also be considered.

  - Measures to ensure that the ROVE implementation process caters for the realities of unstructured skills development paths, the growing importance of soft skills for the effective use of Industry 4.0, the significant amount of informal and work-based learning that takes place in manufacturers, and the need for infrastructure that genuinely supports lifelong learning. Lessons from European and Scandinavian countries, which offer early access to vocational education and pathways, should be considered. To prepare for a potential economic downturn, an employment adjustment scheme to keep workers on and upskilled would be of value.

- The development of decarbonisation roadmaps for key manufacturing industries to more clearly identify the transition paths that the Zero Carbon Act implies and the role that different policy levers, including the ETS and industrial allocations, R&D and innovation, trade and skills initiatives, will play. Work could also be undertaken on options for a border carbon adjustment mechanism, given the US and EU have signalled interest in introducing such a system.

- Options for building on the improvements that have been made to Procurement Policy and the revised Government Procurement Rules, such as pre-commercial procurement and a programme focused on using government as a first customer to solve challenges and support domestic manufacturing opportunities.

- Support for growth in risk/development capital and a very targeted approach to attracting high quality FDI for manufacturing opportunities. This includes leveraging investment intermediaries, such as industry associations, supporting local investment promotion efforts, and ensuring comprehensive aftercare.

Introduction

The preceding sections already signalled that the successful evolution of manufacturing in New Zealand will not only require an industry response but also conducive policy across a range of areas relevant to the environmental, technology, trade, skill and infrastructure pressures and prospects facing the sector. This section identifies policy priorities for the sector.

The fact is that the government significantly impacts on the incentives and potential returns that manufacturers face in considering whether and how much to invest and how to respond to the identified pressures and prospects. The influence spans well beyond these areas of course – tax, regulatory, monetary, investment policies etc. all significantly affect the environment in which businesses operate. Government can either proactively work with industry to determine the combination of policies and initiatives that will maintain and build a manufacturing sector in New Zealand – one that is fit for the future – or it can sit back and let the chips fall where they may under current policy settings.

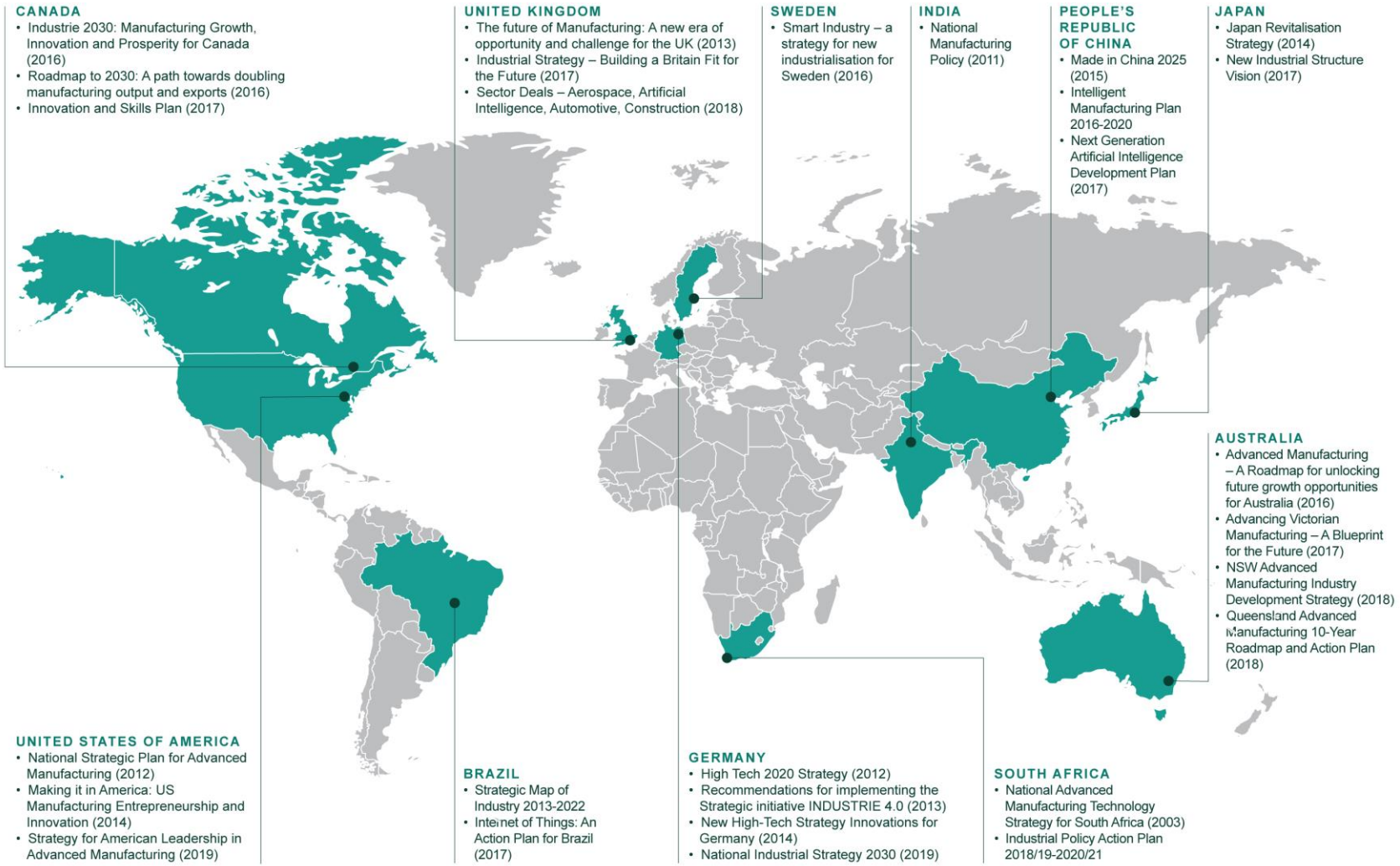
Policy responses in other countries

What we know is that almost every developed country and many developing countries have placed a priority on building a strong manufacturing sector and have adopted industrial/manufacturing policies or strategies over the last decade. This reflects not only a recognition of the role that manufacturing plays in supporting innovation, exports and other sectors (as discussed in Section 1) but has also been a response to the impact of the GFC over 2008-2009, which significantly impacted on manufacturing in many economies and resulted in questions being raised about the extent to which free market mechanisms result in quality investment. Many of the initial industrial policies are also now evolving to explicitly account for the pressures and opportunities resulting from climate change, global competition for talent and Industry 4.0. Figure 34 illustrates a selection of these.

Despite the contextual differences, the approaches to industrial policy and strategy across economies have shared some common elements:

- A position/vision on the role of the industrial and/or manufacturing sector in the economy.
- The identification and development of a coherent, mutually reinforcing set of policies and programmes to fulfil the vision.
- A typically highly consultative development process between the public and private sectors, often including an industry/manufacturing advisory group.

Figure 34: Industrial and manufacturing strategy and policy initiatives in selected economies



These types of industrial/manufacturing policies are typically 'horizontal' in nature, focused on policies and initiatives that support a range of industrial sectors rather than selecting particular segments. A key element is the last point above – at their core they involve a process in which the private and public sectors jointly assess opportunities and blockages to investment and development and jointly identify solutions. Effectively they aim to align private sector efforts and government priorities.

The combination of policy areas and initiatives that are typically covered by industrial or manufacturing strategies/policies include:

- A significant commitment to investment in/incentives for innovation and R&D, often including initiatives to encourage investment in clean production and Industry 4.0 initiatives. Often there is also a focus on using government procurement to encourage innovation.
- Investment in STEM (including digital) skills throughout the education system and in ensuring that vocational training systems anticipate and respond to skill demands.
- A very targeted approach to attracting high quality FDI (FDI that complements existing sectors and brings capabilities, networks and innovation to the host economy).
- Investment in infrastructure, including transport infrastructure to facilitate distribution and exporting and industrial infrastructure to support digital connectivity, clean technology and Industry 4.0 (e.g., telecommunications, research institutions and training facilities).
- Increases in support for risk/development capital.
- Programmes to deepen and diversify international connections for trade, investment and technology through bilateral and multilateral deals.
- Initiatives to strengthen the connections between businesses, research expertise, industry groups and other support organisations to encourage the formal and informal sharing of knowledge.

As noted above, these policies and initiatives are often developed in concert to be mutually reinforcing.

In addition to these horizontal policies, several economies have gone further and taken a 'vertical approach' to develop actions plans to support the development of industry segments that reflect the underlying advantages of their economies (examples are provided in Annex 2).

How does New Zealand compare?

Although successive governments have adopted economic agendas over the last 15 years, it is fair to say they have been broad frameworks for presenting government work programmes and budget announcements in a consistent way rather than driving a coherent set of policies and programmes towards a common vision for industry development as has been the case overseas. They have also largely been government led and developed rather than involving a co-development process with the private sector. Overall, New Zealand has lagged behind its peers in presenting a cohesive industrial policy approach.

There have been two policy consequences due to the lack of a cohesive industry policy/strategy and process in New Zealand. First, manufacturing (other than the food and beverage sub-sector) has not been particularly well understood or promoted in policy or programmes by successive governments since the early 2000s. This is in stark contrast to the consistent promotion of agriculture, tourism and screen/digital sectors since then and the significant amount of work and research that government undertook to understand and work with manufacturers in the 1990s. Second, there has not been a joined up or mutually reinforcing approach to policy and programmes that impact on the sector. The range of distinct policy and programme reviews, consultations and announcements impacting on the sector over the last 18 months are a case in point (see Annex 1 for a selection) – it doesn't look like the cumulative impact of these and how they interact is being well considered (e.g., climate change & Zero Carbon, R&D incentives, future of work, education reforms, immigration, tax review, petroleum & mining/just transitions, infrastructure, Provincial Growth Fund etc).

To be fair, the government has recognised this – a recent Cabinet paper noted: "In New Zealand our prevailing approach to industry policy in recent years has been characterised by a number of different interventions, but with less emphasis on how they work collectively. Many existing interventions seek to support economic development or specific sectors, but the cohesiveness and overall strategic direction is less clear. There is limited confidence (among Ministers, officials and the private sector) that these initiatives are working consistently together and pushing in the same direction." (Minister for Economic Development, 2019).

In response, the Government has recently released an Industry Policy. The stated aim of the Policy is to drive productivity growth, sustainability and diversification through:

- Moving from volume to value – looking for productivity growth in our high-volume sectors.
- Levering opportunities in adjacent sectors: opportunities arising from our points of expertise and comparative advantage.
- Backing emerging sectors: being prepared to seize opportunities in new sectors of the economy.

The Industry Policy is largely an organising framework rather than driving a new set of policies or initiatives. It describes broad horizontal foundations for achieving the above aims, including innovation, trade and international connections, investment, regional economic development, skills and the future of work and notes existing government work programmes that sit within these. However, a core component is a 'vertical' approach – the development of 'Industry Transformation Plans' for selected industry segments. It is through these Plans that there will be a more strategic and co-development process with the private sector. The Policy identifies food and beverage, agritech, digital technology, and forestry & wood processing as four priority industries for new Industry Transformation Plans. The Construction Sector Accord also formed the basis for a recently released Construction Sector Transformation Plan.

The Industry Policy and the proposed Industry Transformation Plans are a positive step to achieve a more coordinated and focused policy approach. But, reflecting the significance of the pressures and prospects facing manufacturing and the more directive approaches used in other economies, it would be desirable for government to work with industry to develop:

a) A broader Manufacturing Strategy that has a vision for the future of manufacturing in New Zealand and that focuses on horizontal issues and policies that impact on the ability of the sector as a whole to achieve that vision. As noted, this should involve a co-development process. The strategy and mix of policies should also be evaluated and updated regularly over time as conditions change.

b) A larger set of manufacturing-based Industry Transformation Plans over time, given the significance of a range of sub-industries that are important for New Zealand's future, such as advanced materials and machinery & equipment.

The Manufacturing Alliance, covering a large range of manufacturing industries (e.g., metals, plastics, wood processing, building materials, equipment), would welcome the opportunity to work with government agencies and other manufacturing groups to develop such a strategy.

Some of the key policy areas that should be considered as part of the development of a Manufacturing Strategy, given the key challenges and opportunities facing the sector over the next decades, are discussed below.

Innovation policy

As noted in Section 3, manufacturers will need to support continuous and agile innovation to be best placed to take up the opportunities that are emerging over the next 20 years, such as environmental solutions, Industry 4.0 and construction opportunities. There are good reasons for the government to support further business investment in innovation and R&D (including due to the broader public benefits that innovation brings) and it is positive to see the additional support that has been introduced in the last two years, including:

- The introduction of the R&D tax credit of 15 percent of up to $120 million of eligible expenditure.
- The Budget 2020 funding for an Industry 4.0 demonstration network and for up to two smart factories.

- The increase in funding from the 2019 Budget for commercialisation of innovation (e.g., the Pre-Seed Acceleration Fund) and for Industry Futures initiative (Produce Accelerator and Bioresource Processing Alliance)
- The announcement of the plan to allow businesses to deduct feasibility expenditure from their tax bills, including for projects that do not proceed.

A constraint with the R&D tax credit and R&D grant support that is available from Callaghan Innovation (e.g., start-up grants, project grants) is that the measures support 'formal' R&D and more radical innovation rather than broader innovation and technology acquisition. These schemes also tend to support large or high-tech manufacturing firms (i.e., those already spending significant amounts on R&D) rather than small firms or low to medium-tech firms. However, incremental innovation and the acquisition of new technology builds up what is known as the 'absorptive capacity' of businesses and this capacity has a significant influence on subsequent innovation, exporting and productivity (Harris and Le, 2018). In addition, the economic returns to innovation and R&D in low to medium-tech firms can be significant (Hansen and Winther, 2014).

Although there is other support available that can assist manufacturers to build absorptive capacity and that is relevant to a larger range of businesses, such as Callaghan Innovation's programmes (Lean, Build for Speed, Driving Innovation, support for trialing collaborative robots, support for trialing additive manufacturing), NZTE's services (e.g., Design Thinking, Strategy for Growth, Digital Strategy, International Growth support) and the Regional Business Partner Network support (capability vouchers), the reach of these initiatives is relatively limited and they are focused largely on exporters and businesses undertaking product development.

Other countries are also supplementing R&D tax credits and business grant support with measures to explicitly encourage the uptake of Industry 4.0 technologies and the development of cleaner production and products in a broad base of businesses. For example:

- Canada has introduced an Accelerated Investment Incentive, including allowing manufacturers and processors to immediately write off the full cost of eligible machinery and equipment and full expensing for clean energy investment.
- Singapore has introduced tax depreciation on computers and machinery that meet automation and clean manufacturing standards and tax incentives of up to 10 percent on qualifying income for industry 4.0 and advanced manufacturing investment.
- Italy has introduced super depreciation (40 percent) and hyper depreciation (150 percent) capital allowances for the cost of qualifying tangible and intangible Industry 4.0 assets.
- Australia has introduced a Manufacturing Modernisation Fund over 2019/20 to 2021/22 to support SME manufacturers to modernise and adopt new technologies by co-funding capital investments and associated reskilling (individual grants of between $50,000 and $1m).

If the government is serious about New Zealand adapting to the future of work and meeting its climate changes goals, such incentives should be considered. In addition, although the Industry 4.0 demonstration network funding from the 2020 Budget is welcomed, it is relatively small and, assuming successful implementation, will likely need to be scaled up to achieve significant reach.

Trade policy

There is no doubt that, overall, the opening-up of markets benefits the manufacturing sector through providing access to a much larger pool of customers, suppliers, know-how, technology and investment. However, as discussed earlier, the sector is facing the increased use of non-tariff barriers and a rising level of protectionism in many markets. These will impact on opportunities for manufacturers to position themselves effectively within global value networks.

The sector appreciates that New Zealand is a very small player in global markets and the government has limited influence on the trade policy of other nations. Multilateral trade liberalisation is preferred but it is clear that the WTO process has been slowing and the WTO's dispute settlement system is at risk of being inoperable if appointments to the Appellate Body are not made. The implication is that bilateral and regional trade and dispute resolution arrangements, which are already growing in number, will become more important to New Zealand.

In this context, the sector supports the government's current programme of trade negotiations, including the European Union-New Zealand FTA, Regional Comprehensive Economic Partnership, New Zealand-Pacific Alliance FTA, AANZFTA upgrade and the recent announcement of the New Zealand-China FTA upgrade. However, all of these must address non-tariff barriers in order to make it easier and cheaper for manufacturers to do business in the relevant markets. For example, in the original negotiations for the China FTA, certification and testing regimes were not adequately considered in the negotiation stages. This hampered New Zealand's exports of electrical and electronic products to China as there were not accessible testing and certification regimes in place. This issue took around five years to resolve. In addition, the experience from one review of an FTA suggests that once an agreement has been signed, incentives to make further concessions and consider 'behind the border' measures are greatly reduced.

The recent NZ-China FTA upgraded agreement makes some positive steps in this respect, including improvements in customs procedures, reducing red tape in relation to certificates of origin and goods in transit, and making labelling easier for exporters. However, all potential barriers for manufacturers need to be considered across trade negotiations and support should be put in place for manufacturers to meet any requirements, for example a proactive approach to developing testing regimes, product codes and standards. Moreover, improved monitoring of non-tariff barriers is required in key markets where New Zealand has negotiated trade agreements. The recently released Trade for All report notes that currently there is only limited means for industry to give input to officials on potential barriers and for distributing information that is gathered by the Government's offshore network to industry (Trade for All Advisory Board, 2019).

The Government has adopted a Technical Barriers to Trade (TBT) Strategy, which notes that policy officials will engage industry bodies early in the development of policy positions on TBTs; and that MBIE and MFAT will monitor and evaluate the implementation of TBT chapters and sector specific annexes, develop a methodology for analysing the impact of TBT chapters on manufacturers, monitor likeminded countries' TBT work programmes and strategies and, where appropriate, incorporate lessons learned from these programmes. An update on how the strategy is being implemented would be welcomed by the sector.

As noted earlier, one type of non-tariff measure that has the sector concerned is the use of subsidies by trading partners that enable offshore manufacturers to sell their products in New Zealand at prices below what they charge in their own countries. Although recent subsidisation investigations have judged most of the cases put forward as not material enough to damage New Zealand industry, the investigation approach taken in New Zealand is not particularly responsive. The recent introduction of a public interest test in trade remedies investigations, which can add time, cost and uncertainty to the investigation process, is a case in point.

There have also been cases of manufactured goods being imported into New Zealand that do not meet our own standards and requirements, with several of these related to construction products such as piping, electrical wiring, glass and steel. BRANZ estimated that the annual cost of repairing or replacing non-conforming building products could be up to $230 million for residential and commercial construction, excluding costs associated with redesign, council fees and disruption to business (Dowdell, Page & Curtis, 2017) – issues are often found on failure, when it is costly in terms of remediation and time delays. This is particularly concerning given the significant investment being made in infrastructure and construction over the next decades and the rise of prefabricated housing. Although the current review of the Building Act is proposing several measures to improve the level of information about building products, to clarify the responsibilities of manufacturers and suppliers for products, and to strengthen the framework for product certification, this will only cover relevant building products.

In terms of a broader range of substandard imported manufactured goods, MBIE's conformance policy and infrastructure review found that a significant proportion of stakeholders are not confident in overseas-based conformity assessments of products imported into New Zealand (Ministry of Business, Innovation & Employment, 2018c). The Conformance System Strategy that resulted from the review includes actions for MBIE to provide information to importers to help carry out due diligence on products and to support accreditation bodies to lift the effectiveness of overseas conformance. These are positive steps but there also needs to be stronger enforcement of standards to prevent the importation of substandard products. The electronic traceability of at-risk products could also be considered. Substandard products not only result in mitigation costs for affected parties but are typically cheaper than equivalent domestic products, undercutting local producers.

Finally, section 3 noted the growing importance of global value networks and for manufacturers to improve the quality of their participation in such networks. A broader approach to export promotion efforts to support this could include (NZIER, 2015):

- MFAT and NZTE tracking relevant network opportunities and disseminating the intelligence to the sector.
- Focusing trade missions on setting up relationships with potential networks.

Skills policy

Section 2 emphasised that manufacturers are facing increasing competition for talent. Although this issue is becoming more significant due to demographic and technology changes, it is unfortunately not a new issue. The skills systems in New Zealand – education, training and immigration – has not been able to supply sufficient specialist or generalist skills to meet manufacturing demands for close to three decades. A range of manufacturing research has pointed to skill shortages as a major constraint on business performance since the 1990s. For example, one manufacturing study in 1999 noted:

> "education and training has emerged from research over the last five to seven years as a critical issue for firm capability….A pre-requisite is an education system that successfully equips people with the basic tools for learning….The issue of "skill shortages"…seems to be a great deal wider than the number of graduates with particular qualifications…the real issue is about getting and building good combinations of specialist, generalist and enterprise skills – such as literacy, numeracy, a willingness to learn, motivation, teamwork and communication and the flexibility to adapt to new technologies" (Knuckey, Leung-Wai and Meskill, 1999, p 107).[18]

The sector appreciates that labour and skills issues involve communities, employment and training providers, government agencies and industry. Hence any strategy to resolve the issues requires ownership by and coordinated action from all. The manufacturing sector is prepared to play its role, as described in section 3. We need communities to recognise that, in some cases, negative attitudes to work exist and that social problems underpinning labour market issues are sometimes deep-seated. Communities can develop and implement initiatives to positively shape the attitudes of young people away from social problems, and identify and support programmes that are working to assist unemployed people into paid employment.

On the part of government and education and training providers, manufacturers recognise that a number of initiatives have been put in place over the last two years to improve the responsiveness of the skills system. These include:

- The changes made to the employer-assisted work visa framework.
- Increased investment to reduce the number of young people not in education, employment and training (NEETs).
- the Future of Work Tripartite Forum, which is investigating opportunities for New Zealand to transition to new ways of working, including the Skills Shift in Manufacturing Initiative led by the NZ Manufacturers Network.
- The re-design of the National Certificate of Education Achievement (NCEA) to make it more accessible to all learners and develop clearer pathways between school and further education and employment.
- The reform of Tomorrow's Schools system to put more frontline staff in schools.
- Expanding the Mana in Mahi – Strength in Work Apprenticeship pilot.

[18] This period covered the years following the second round of education reforms over 1991-1992 (including the enactment of the Industry Training Act, removal of the standard tertiary fee and establishment of the Student Loan Scheme).

- He Poutama Rangatahi, which is connecting young people with employers and further training in regions where there are high rates of NEET.
- The sector workforce engagement programme and establishment of jobs and skills hubs.

However, as noted above, there are clearly long-standing systemic issues that need resolving that will not be fixed by a series of tweaks or expansions of existing initiatives.

In this context, the greatest opportunity, and potentially the greatest risk, is the implementation of the Reform of Vocational Education (ROVE). The reform represents radical change and may initially exacerbate the skill challenges as the changes, including the establishment of a single, networked Institution of Skills and Technology, the creation of Workforce Development Councils and Regional Skills Leadership Groups, and the establishment of Centres of Vocational Excellence, could sidetrack providers from existing delivery. Moreover, it risks being a structural solution to what are systemic problems and may see employers disengage from formal training.

Manufacturers need a system that meets their different skill needs, from management to operational staff, across all skill levels, and that includes formal and informal skill development. The ROVE implementation process needs to recognise and cater for the fact that:

- Individuals do not move through skill levels in a structured way – they move through different levels and through different types of training according to their needs and aspirations.
- Creative thinking, problem-solving, emotional intelligence and collaboration are becoming central to effective manufacturing with Industry 4.0 but these attributes cannot easily be taught in a traditional learning (e.g., classroom) environment and there are still limited ways in which businesses can work with teachers and schools.
- Risk assessment and management is growing in importance as a core competency for employees in order to manage health and safety and ensure wellbeing (consistent with the Government's Health and Safety at Work Strategy 2018-2018). Education and training on risk management should start before young people enter the workforce to enable them to start work able to identify risks and hazards, do risk assessments, confidently raise issues with supervisors and managers, and be responsible for improving health and safety in the workplace.
- There is a significant amount of informal and formal learning that takes place in the workplace that isn't traditionally part of the vocational education system, provided by a combination of advisors and industry groups (e.g., job shadowing, internships, on-the-job training). This learning can be even more effective when integrated with formal education and training. Incentives for employers to support this form of learning are often part of skills systems overseas, including through direct subsidies, tax breaks and arrangements to share the costs of training between groups of businesses. The Prime Minister's Business Advisory Council (2019a) suggested that tax credits could be introduced to encourage business investment in workforce training and staff to undertake further education while they work.

- Lifelong learning is now critical for employees (young to old) to remain relevant and adapt due to changes in technology but there is not a culture or infrastructure in New Zealand to support this. For example, access to non-traditional learning such as micro-credentials is still in its early stages (and current funding and approval rules may be overly restrictive (New Zealand Productivity Commission, 2019)) and education-work transition opportunities are still relatively limited. The Prime Minister's Business Advisory Council (2019a) recommended that the introduction of lifelong learning accounts be considered, which would enable individuals to acquire new skills throughout their careers.

The recently announced Workforce Development Council for Manufacturing, Engineering, Logistics and Technology, that will assess which programmes for manufacturing are fit for purpose and what combination of in-the-workplace and outside-the-workplace training is appropriate, will be essential to ensure that these issues are actually dealt with. Similarly, the proposed Regional Skills Leadership Groups and Regional Workforce Plans will be important to provide advice about the manufacturing skill needs of the regions and potential mechanisms for improving the system.

In this context, there are lessons from the broader education systems of other countries, particularly in continental Europe and Scandinavia, which offer students with an option of early access to vocational education and pathways through combining on-the-job apprenticeship training with classroom-based general education, that should be considered.

Finally, skills support policy needs to be flexible to cater for changes in demand. When economic conditions are good, manufacturers, like all businesses, are able and willing to invest in the further development of their workforce. During a downturn, however, they have more limited ability to make this investment and, of course, can be forced to lay off workers. There have been warning signs that the world economy is entering a recessionary period (particularly given the emerging impacts of the coronavirus), although it is not inevitable. If it does happen, measures to support the retention and ongoing development of workers should be considered. For example, a transition unemployment benefit could be implemented, which would pay employers a partial wage subsidy if they agree to keep un(der)employed workers on at least part-time and train them to meet future skill needs (rather than paying out a benefit). This would not only support workers but enable businesses to recover more quickly when conditions improve. Although there are potential deadweight and displacement costs associated with such employment adjustment schemes, there are several examples of schemes that have been successful in other economies, such as Japan and Germany. The OECD noted that although the re-employment rates of displaced workers post the GFC was relatively high in New Zealand, the wage losses to these workers was also relatively high (OECD, 2017c). They recommended that the government consider an employment adjustment scheme to prepare for any future major economic downturn (OECD, 2017c).

Environmental policy

The manufacturing sector recognises the need to reduce its carbon footprint and environmental impacts and the opportunities that the growing demand for environmental solutions brings. Most manufacturers support the Government's objective of transitioning to a low emissions economy and net zero emissions by 2050. A clear timetable for reducing carbon provides certainty but needs to take account of the real risk that, in the absence of some radical technological changes, measures that ultimately reduce our domestic production and increase costs in some areas may result in New Zealand contributing more to climate change over the medium- to long-term through the importation of higher emission products from offshore.

Manufacturers want to understand the transition paths that the Zero Carbon Act implies and the role that different policy levers, including the ETS and industrial allocations, R&D and innovation, trade and skills initiatives, will play and options for reducing or eliminating carbon leakage. A way to do this would be to follow the UK approach and to develop decarbonisation roadmaps with industries (e.g., starting with energy intensive manufacturing industries) that identify the current emissions profiles of the industries and what the emissions profiles would look like in 2050 under different scenarios, applying varying levels of investment in low-carbon technologies and with manufacturers facing different incentives. This will then allow government and industry to understand the emissions-abatement potential of the industries, the relative costs of different abatement options and barriers and opportunities. Such roadmaps will create a shared evidence base to then identify a cohesive programme of actions to achieve decarbonisation within and across the manufacturing industries. The sector would welcome the opportunity to work with the government's Just Transitions Unit in scoping such an approach as part of a Manufacturing Strategy process.

Beyond roadmaps and agreed decarbonisation programmes, two policy areas that the manufacturing sector consider deserve further attention are targeted support for innovation that reduces industrial carbon emissions and border carbon adjustment mechanisms.

On innovation, as noted above, the government is investing in a range of initiatives to grow general R&D and innovation investment, such as the R&D tax credit. Some of this investment will undoubtedly encourage New Zealand manufacturers to invest in the development of cleaner production processes and products. There are also other relevant investment vehicles. For example, the Government's Endeavour Fund has supported several industry-focused projects aimed at reducing emissions (e.g., in relation to materials); a proportion of the Provincial Growth Fund has been ringfenced for projects that convert waste into materials and products; the Green Investment Fund will likely invest in some manufacturing ventures; and EECA also contributes funding to support the cost of demonstrating technology or process improvements that improve energy efficiency or reduce carbon emissions through its Technology Demonstration programme. However, these are cross-sectoral initiatives and there is currently only limited national level support for emission reduction projects focused on the manufacturing sector. The bulk of relevant R&D and innovation funding is directed towards developing methods and technologies to reduce the agricultural sector's emissions.

At one level, this is understandable given the manufacturing sector is a relatively small contributor to New Zealand's emissions compared to agriculture. However, as noted above, many other economies are extending their traditional support for R&D and innovation through the introduction of incentives and programmes to specifically encourage R&D in clean technologies by manufacturers. This reflects the broader role that the manufacturing sector plays in transforming agricultural outputs and in developing environmental solutions for a range of other sectors. The Productivity Commission's final report on a Low-emissions Economy (2018) noted that although stronger emissions pricing will incentivise more innovation in clean technology, "…relying on pricing and direct regulation alone – without subsidising innovation – would be sub-optimal" (New Zealand Productivity Commission, 2018, p 148). The report also noted that support for clean technology innovation should not be delayed as it risks a longer and harder transition period.

Given this, additional options to encourage a significant increase in clean technology and emissions-reducing R&D and innovation in the sector should be explored (noting that how such options interact with the ETS would need to be considered). This would also be consistent with the recommendation in the Rethinking Plastics in Aotearoa New Zealand report to develop a specific innovation fund to 'reimagine plastics' (Office of the Prime Minister's Science Advisor, 2019). The Parliamentary Commissioner for the Environment has also suggested that the government could consider allocating some of the auction revenues from the ETS to support R&D in abatement technologies (Parliamentary Commissioner for the Environment, 2019).

As a very small, distant economy, New Zealand largely relies on adapting and using innovations developed offshore and the majority of clean technologies, processes and product ideas that will be adopted by manufacturers will come from overseas. But our scale and distance also make it difficult to rapidly identify these concepts and to ensure early and rapid diffusion across the sector. There is no proactive, coordinated way of doing this (universities and research institutions do this in specific fields). A national capability to scan and assess low-emissions and environmentally friendly technologies and innovations offshore and to disseminate the findings to manufacturers would be of value (a similar idea was proposed by the New Zealand Productivity Commission (2018)).

The concerns about carbon leakage and the phasing out of free ETS unit allocations for emission intensive industries were noted in Section 2. Assuming that the Climate Change Response (Emissions Trading Reform) Bill will not incorporate a provision to align the phase out of allocations according to the extent to which trading partners adopt carbon pricing and will not differentiate sufficiently between industrial activities to account for different levels of emissions leakage (as suggested by several submitters to the Bill), a policy option that should be considered further is a border carbon adjustment scheme. Under such a scheme, importers would be expected to incur the same emission pricing for emissions embedded in the imported products as New Zealand producers would for equivalent goods (e.g., cement, steel, aluminium). This means that international competitors selling in New Zealand would not achieve a cost advantage due to the absence of carbon pricing in their economy, which would likely minimise carbon leakage. Such a scheme would be technically difficult to design and implement but there has been strong support for the introduction of border carbon adjustment systems in the EU and the United States (over 3,500 economists endorsed such a scheme in the Wall Street Journal last year). The Parliamentary Commissioner for the Environment also suggested that such a scheme be considered as an alternative way of mitigating emissions leakage (Parliamentary Commissioner for the Environment, 2020).

Finally, the recent release of the report on Rethinking Plastics in Aotearoa New Zealand (Office of the Prime Minister's Science Advisor, 2019) proposes the development of a National Plastics Action Plan. The report usefully recognises that action will need to come from a combination of government, industry, community and researchers and that systems and infrastructure need to be put in place to enable a transition towards circular economy plastic use (e.g., R&D investment, improved data collection, new recycling and container disposal schemes). The co-design of such a Plan will be an important element within the broader Manufacturing Strategy this paper proposes.

Procurement policy

Central and local government, with significant purchasing power and the need to procure a wide range of goods and services, have the potential to support growth in the manufacturing sector and incentivise innovation as demanding customers. Central government alone spends around $41 billion each year on goods and services.

Traditionally, central government procurement policy in New Zealand has been focused on ensuring good commercial outcomes and value for money, rather than supporting growth and innovation. New Zealand practice has been much more passive than in other countries where public procurement has been leveraged to achieve economic, social and environmental benefits.

However, last year the government expanded the range of outcomes it was seeking from procurement to include increasing New Zealand businesses' access to government procurement, increasing the size and skill level of the domestic construction sector workforce, improving conditions for workers and future-proofing the ability of New Zealand business to trade, and supporting the transition to a net zero emissions economy. Revised Government Procurement Rules to reflect this approach came into force on 1 October 2019. All of this is a significant step forward.

As previously discussed, a major opportunity for the manufacturing sector over the next decade is the large pipeline of construction and infrastructure projects. Much of this will be driven by a combination of central and local government purchasing. Positively, the government has identified major construction contracts and buildings & building materials as purchasing areas it wants to target to achieve the broader outcomes (e.g., skills development and lower emissions). However, there is a risk that the skills outcomes that are being sought for construction will be undermined where there are sub-contracting arrangements. Under Rule 18, government purchasing agencies *must* evaluate suppliers on their skills development practices – effectively suppliers *must* demonstrate what they will do over the course of the contract to improve or build skills. However, under Rule 25, prime contractors only *should* ensure their subcontractors also have good support for training and skills development and offer good conditions for workers, so these are not mandated requirements.

Moreover, recent research points to barriers in construction and infrastructure procurement processes that will need to be overcome, including too much focus on securing the lowest price at the expense of quality and other goals; a lack of thought given to broader outcomes being sought; a lack of trust between purchasers and suppliers; excessively stringent submission requirements; purchasers not having a sophisticated understanding of whole of life costs associated with projects; weaknesses in central and local government procurement capability; and a lack of a long-term plan and coordination across agencies for procuring the pipeline of work (Singer, 2018; AECOM, 2019). On the last two points, it is positive that the government has established the new Infrastructure Commission to support the delivery of major infrastructure projects across central and local government, including advising on the pipeline of projects and supporting infrastructure project procurement and delivery. The establishment of the Commission has drawn on approaches used in other jurisdictions to improve the planning and procurement of infrastructure (e.g., UK, NSW, Victoria).

Although there are no studies in New Zealand, overseas research shows that the impact of poor procurement practices can be significant. There are additional approaches used by other countries that could be adopted by the government when it comes to operationalising its procurement policy. These include:

- using outcomes-based procurement (specifying the outcomes that are being sought rather than specific products or services)
- increased support for competitive dialogue (engagement with industry prior to procurement to work together on defining the problem – the government has guidelines for this but in practice it is seldom used)
- pre-commercial procurement (procurement of novel products, validated by field tests, where the risks and benefits of product development are shared between the supplier/s and the purchaser/s)
- design contests to incentivise local innovation through procurement.

For example, several countries (e.g., Canada, US, UK, Norway) have specific procurement programmes focused on using government as a first customer to solve challenges and support domestic firms, e.g., Innovative Solutions Canada has launched procurement challenges to make roads safer, to create energy from new sources, to make materials more environmentally sustainable and to apply AI and additive manufacturing. In some cases, offshore government agencies with significant procurement budgets are required to spend a proportion of their budgets (e.g., 2.5 percent) on procuring local solutions to these challenges.

Investment policy

Transforming manufacturing in New Zealand will require access to capital to support investment in the required capabilities and technologies. New Zealand has a shallow capital market and has relied on government seeding angel and venture funding to help build up the local base of capital. FDI has also been an important source of capital and can bring in expertise, networks and technologies that New Zealand lacks.

It is positive to see that the government has recognised that there is a funding gap in New Zealand at the early stage end of the market, particularly following the angel and seed stages. This gap has meant that several high-growth manufacturers have had to seek capital from offshore and have either sold their interests or left New Zealand earlier than they otherwise might have. To help fill the gap, it is investing $300 million in a Venture Capital Fund (as a fund of funds) that will be administered by the Guardians of New Zealand Superannuation. Success will depend on the Fund actively developing the capability of the venture capital community in New Zealand.

The Small Business Council has also recommended that the Government facilitate the establishment of Small Business Growth Fund to provide debt and non-controlling equity investment, based on funds operating in the UK, Canada and Denmark (Small Business Council, 2019). In response, the Government has indicated that this should be considered as part of an overall strategy to change New Zealand's investment patterns and to ensure that investment capital flows to the most productive areas of the economy. Cabinet will be considering this later in 2020.

In terms of FDI, New Zealand has had a mediocre performance over the last decade. As the Treasury pointed out in its consultation document on the Reform of the Overseas Investment Act, our FDI stock as a proportion of the economy is below other small advanced economies and FDI inflows as a proportion of GDP are also relatively low (The Treasury, 2019). Moreover, the bulk of FDI has not been generating the broader economic benefits New Zealand and the manufacturing sector requires, such as lifting levels of innovation.

There are several barriers that are difficult to overcome to lift this FDI performance, including our distance from markets, scale and the ability of domestic firms to get the most out of the skills, technology and international connections that FDI can bring. However, there are two key policy levers that can influence the attractiveness of New Zealand and the manufacturing sector as investment opportunities and be additional potential barriers: the investment screening regime and investment attraction efforts.

Despite New Zealand's open trade environment, we are regarded as having a restrictive investment environment. The OECD rates New Zealand as having the seventh most restrictive FDI regulatory environment out of 68 economies[19] due to the wide range of investments that need to be screened by the Overseas Investment Office and the requirements for investments involving sensitive land. Most other economies don't have such requirements. The screening requirements result in additional costs and delays for potential investors in New Zealand.

[19] https://data.oecd.org/fdi/fdi-restrictiveness.htm

In this context, several of the recently announced decisions on the second phase of the reform of the Overseas Investment Act are aimed at reducing some of these hurdles, for example removing screening requirements for transactions that pose little risk (e.g., companies that are majority owned and controlled by New Zealanders) and ensuring assessments of applications are completed within agreed timeframes. However, at the same time, the reforms will strengthen the screening of investment in certain types of assets (e.g., overseas ownership of more than 25 percent in a company worth more than $100m, investments of more than $100m, sensitive land, infrastructure), providing for Ministerial discretion to determine that the investment is consistent with national interests. This will result in more uncertainty for relevant investors and may discourage investment. Having more clearly specified criteria to consistently assess such investments, with decision-making by the Overseas Investment Office, would provide greater certainty.

New Zealand has also traditionally had a relatively low-key approach to active investment attraction compared to other economies, such as Ireland, UK, Singapore, Hong Kong and Canada. This has changed in recent years. NZTE has a team of investment advisors and has built up its attraction efforts over the last five years (over 2018/19 it reported that it facilitated 75 investment deals, representing $645 million of capital (NZTE, 2019)). Some EDAs and local authorities also undertake investment attraction activities and have achieved some successes. However, it is not apparent that the manufacturing sector, beyond food and beverage, has benefited significantly from these efforts. For example:

- NZTE reported that the potential direct economic impact of investment for manufacturing over 2018/19 was only around 5 percent of all its investment projects (NZTE, 2019).
- FDI trends indicate that most FDI in New Zealand since 2003 has been in software and IT services, business services, financial services and communications (together representing around 60 percent of FDI projects) (fDiMarkets.com, 2019). Food and beverage manufacturing represented 7 percent of FDI projects over the period and industrial equipment another 3 percent.

Much of New Zealand's investment attraction efforts also appear to have been reacting to opportunities as they arise, rather than being built on an understanding of the innovation and industry capabilities that New Zealand has that could be of value to foreign investors, followed by targeting of specific investors geared around those capabilities. Such efforts would benefit from the insights of industry groups.

This is reflected in international perceptions of investment opportunities. Bloomberg's Nation Brand Tracker Study found that New Zealand was not top of mind as an FDI destination. We ranked 13th out of 15 countries on a ranking for FDI consideration, behind most ASEAN markets (Bloomberg Media Group, 2019). Moreover, our largest city, Auckland, ranked 19th out of 21 cities as being on the radar for investment opportunities. Although food and beverage and medical technology stood out in investors' minds as key industry opportunities in New Zealand, several other manufacturing sectors did not (e.g., electronics manufacturing, general manufacturing, advanced manufacturing).

The Government's Investment Attraction Strategy is designed to be more proactive with investment opportunities. It includes priorities on attracting high-quality foreign direct investment (i.e., investment that enhances access to export markets, brings new technologies, processes and know-how to NZ firms and industries), attracting overseas investment in R&D, and attracting investors and entrepreneurs to New Zealand. Priority sectors were identified for investment and included specialised manufacturing.

Although the Strategy ticks all the right boxes, the outcomes of the Strategy to date have not been published and it is currently being reviewed. It would be useful for any update of the Strategy to consider innovations that are occurring in FDI attraction efforts in other economies, such as (Loewendahl, 2018; OECD, 2018):

- Leveraging investment intermediaries – intermediaries, such as advisors, accountants, banks, legal firms, and industry associations have a major influence on investment decision-making and location selection. World-leading investment attraction agencies adopt 'multiplier strategies' to generate leads from these networks.
- Local investment promotion – investment facilitation activities at the local level can be very important to potential investors (e.g., for understanding local conditions, potential incentives, resources, skills). Investment attraction activities overseas can include programmes to develop the investment capability of and provide resourcing for local/regional agencies.
- Aftercare – aftercare can be the most effective method for attracting additional investment from foreign investors that already have commitments in the host country but is often not a focus in investment attraction activities. High performing investment promotion efforts include comprehensive post-investment services.

The Prime Minister's Business Advisory Council has also recommended that the Government undertake an investigation into investment attraction models overseas (Prime Minister's Business Advisory Council, 2019b).

Other areas

Although key policy areas are noted above, there are a range of other policy issues that the Manufacturing Alliance has identified that could be considered during the development of the Manufacturing Strategy. Table 3 highlights a combination of these, ranging from incremental to more radical policy responses.

Table 3: A fuller range of policy options

	Incremental	Moderate	Radical
R&D and Innovation	• Fund enabler initiatives for Industry 4.0 above and beyond the current allocation of $6.5m • Direct more effort in national science system to firm-based innovation • Set up a manufacturing incubator, following the mHUB model (https://mhubchicago.com/page/our-story)	• Turn R&D tax credit into an R&D and Innovation tax credit, which includes non-R&D innovation • Accelerated depreciation in specified equipment and plant	• 50% capital grants for capital purchases
Capital/ Investment	• Mobilise capital – set up an aggregator to support existing manufacturers seeking capital to innovate their processes or reinvent their business models	• Overseas Investment Act direction to support investment in manufacturing	• Reduce corporate tax • Invest sovereign funds in NZ manufacturing capability
Trade		• Taskforce to address control of non-conforming products • Enforcement of standards at the border to prevent importation of substandard products which undercut the local market and cause costly compliance issues further down the track • Government funding of standards setting processes recognising trade value and public good value	• Trade agreements that augment NZ manufacturing. Emphasis on subsidy elimination and simplify recourse to dispute settlement. Significantly strengthen anti-dumping powers • Currency control
Skills	• Strengthen government support to provide strategic advice, grants, leadership development and training placements • H&S – WORKSAFE to deliver on engagement & education as well as being a regulator. • ROVE reforms deliver: – Support for on-the-job training – Demand creation by putting in place incentives for employers to train • Careers focus on manufacturing ('making') and better links with vocational education pathways from Yr 11 (or earlier)	• Transition unemployment benefit • Risk assessment taught in schools & tertiary institutions	

Environmental/ Low emissions	• Programme to decarbonise Manufacturing – short-term: initiate a programme to support all manufacturers who want to obtain an assessment of their current carbon footprint (baseline), using internationally recognised methods	• Programme to decarbonise Manufacturing – medium-term: support for the adoption of proven, more efficient technology to improve baseline • Rewards for use of bioenergy or greater use of renewable energy	• Programme to decarbonise Manufacturing - long term: investment in manufacturing research to deliver zero carbon
Procurement		• Leveraging procurement • NZ-preferred procurement rules	• Government agencies commit % of budgets to procuring local solutions to problems which there is no current solution • Fuelling the Infrastructure Pipeline, with focus on local procurement

Source: Manufacturing Alliance

Annex 1. A selection of policy, regulatory and programme initiatives and consultation over the last 18 months

December 2019

- Next Minimum Wage rise announced
- Fair Trading Amendment Bill introduced
- Announcement of six industry-led Workforce Development Councils, including one for Manufacturing, Engineering, Logistics and Technology
- Passing of the Venture Capital Fund Bill
- Discussion document on Accelerating renewable energy and energy efficiency released for consultation
- Consultation on Reforming the New Zealand Emissions Trading Scheme: Proposed Settings begins
- Productivity Commission "Training New Zealand's Workforce" draft report released for consultation
- Report from the Office of the Prime Minister's Chief Science Advisor on Rethinking Plastics in Aotearoa New Zealand released
- Rethinking Plastics in Aotearoa New Zealand report released

November 2019

- Discussion document on Better protections for contractors released for consultation
- Changes from reforms of Tomorrow Schools announced
- Kiwi Business Boost initiative launched
- Consultation on Reducing Waste: A more effective landfill levy begins
- Productivity Commission report on "Employment, labour, markets and income" released for consultation
- Future of Work Tripartite Forum Strategic Assessment report released
- Consultation on Feasibility and non-deductible "black hole" expenditure: detailed design begins
- Issues and options paper on Transforming the Resource Management System: opportunities for change released
- Consultation on New Zealand Emissions Trading Scheme: Modelling the electricity allocation factor begins
- Report of the Trade for All Advisory Board released
- Upgrades for the New Zealand-China Free Trade Agreement announced

October 2019

- New education-to-employment brokerage service to strengthen connections between local employers and schools

- Funding for more trades-focused speed dating events to connect schools with employers
- Promotional campaign to raise the profile of vocational education
- Public consultation commences on a new regime to require companies to assess and report on their climate-related financial risks
- Expansion of Trades Academy and Gateway announced
- Consultation document on addressing temporary migrant worker exploitation released
- Consultation document on how to design a Fair Pay Agreements system released

September 2019

- Release of Government's Economic Plan
- Announcement that the Taxation Bill to be introduced in 2020 will include proposals that businesses can deduct feasibility expenditure from their tax bill as well as changes to loss continuity rules and R&D tax loss cash out rules
- Announcement that New Zealand is in negotiations on the Agreement on Climate Change, Trade and Sustainability
- Government releases national voluntary emissions offset guidelines
- Launch of School Leavers' Toolkit
- Process for regularly updating the national curriculum announced
- Shaping a Stronger Education System with New Zealanders discussion document released
- Public consultation on RMA reforms begins
- Capital Markets 2029 Report released
- New temporary work visa process announced
- New Zealand's Research, Science and Innovation Strategy draft released for consultation
- Productivity Commission report on "New Zealand, technology and productivity" released for consultation

August 2019

- Reforms of Vocational Education announced
- Additional funding for employer-led workplace literacy and numeracy announced
- New Centre of Excellence for Vocational Education for the construction sector announced
- Launch of Prime Minister's Vocational Education Excellence Awards
- Pilot for using VR to prepare people for jobs in construction businesses announced
- Expansion of Mana in Mahi programme announced
- Release of the Government's Employment Strategy, including the Youth Employment Action Plan
- Small Business Council report "Empowering small businesses to aspire, succeed and thrive" released

- Climate Change Action Plan released
- Consultation on proposed priority products and priority product stewardship scheme guidelines begins
- Consultation on Trade (Anti-dumping and Countervailing Duties) Act 1988: Applying the public interest test begins
- Consultation on Hazardous substance assessments: Improving decision-making begins
- Government Response to the Productivity Commission Low Emissions Economy report released

July 2019

- Consultation on options to improve regulations for working with plant, structures, at heights and on excavation work released.
- Lift in maximum weekly rate for paid parental leave payments
- Improvements to the R&D Tax Incentive announced
- Comprehensive reform of the RMA announced
- Third set of reforms to the ETS announced, including phasing down of industrial allocations
- Single-use plastic shopping bags ban commences

June 2019

- Three micro-credentials approved for funding for the forestry sector and building and construction industry
- Taxation (Annual Rates for 2019-20, GST Offshore Supplier Registration, and Remedial Matters) Act 2019 passes into law

May 2019

- Regionalisation of skills shortages lists announced
- Aotearoa New Zealand Skills Pledge launched
- Business Advisory Council report on “A Future that Works: Harnessing Automation for a More Productive and Skilled New Zealand” released
- Climate Change Response (Zero Carbon) Amendment Bill introduced
- Second set of improvements to the NZ ETS announced
- New Zealand-Singapore Enhanced Partnership announced
- Issues paper on aligning GST with international best practice and principles released

April 2019

- Increase in Minimum Wage rate
- R&D Tax Incentive introduced
- Reduction in ACC levies introduced

- National Planning Standards for RMA plans released
- Skills Assessment Tool launched
- Consultation on second phase of Overseas investment Act reforms begins
- Consultation on proposed reforms to building regulation begins
- Construction Sector Accord signed
- Government responds to Tax Working Group report
- Consultation on timeframes for dumping and subsidy investigations begins
- Productivity Commission paper on “Technological change and the future of work” released for consultation

February 2019

- Te Ārā Mahi (Pathways to Work) announced
- Proposals on the Reform of Vocational Education announced for consultation
- Tax Working Group report released
- Australia New Zealand Electronic Invoicing Board established

January 2019

- Fair Pay Agreement Working Group report released
- Investment by ACC into workplace injury prevention grants and subsidies announced
- Public consultation on the Review of Section 36 of the Commerce Act on measures to strengthen the law protecting consumers and small business from anti-competitive behaviour begins
- Consultation on the Government Procurement Rules 4th edition draft begins
- Technical paper on Process Heat in New Zealand – Opportunities and barriers for lowering emissions released for consultation

December 2018

- Launch of New Zealand Green Investment Finance Ltd
- Employment Relations Amendment Act becomes law
- Taxation (Annual Rates for 2019-20, GST Offshore Supplier Registration, and Remedial Matters) Bill introduced
- Consultation on Our Schooling Futures: Stronger Together begins
- New Work and Earners ACC Levies announced
- Discussion paper on protecting businesses and consumers from unfair commercial practices released
- Announcement of initial changes to the NZ Emissions Trading Scheme
- Phase down of the use of HFCs from 2020 announced

- Health and Safety at Work Strategy announced
- Therapeutic Products Bill released for consultation
- Mandatory phase out of single-use plastic shopping bags confirmed for 1 July 2019
- Consultation on measures to improve employer-assisted work visas and regional workforce planning begins
- Technical paper on Process Heat in New Zealand: Opportunities and barriers to lowering emissions released

November 2018

- Two stage process to improve the resource management system announced
- Upgrades for the Closer Economic Partnership (CEP) with Singapore announced
- KiwiBuild's Invitation to Pitch for Offsite Manufacturing closed

October 2018

- Design of the R&D tax incentive announced
- Construction Skills Action Plan launched
- Government blueprint to improve freshwater quality announced
- Launch of second phase of the reform of the Overseas Investment Act
- Proposed new rules for GST on low value imported goods announced
- New Zealand ratifies the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP)
- New Zealand signs the New Plastics Economy Global Commitment
- Sustainable Food & Fibres Future Fund opened for applications

September 2018

- Feedback sought on Tax Working Group interim report

August 2018

- Announcement that NZQA will consider applications for the approval of micro-credentials
- Launch of Trade for All Agenda and consultation
- Government announces intended phase out of single-use plastic shopping bags over 2019 and consultation begins
- Consultation on proposed changes to the Emissions Trade Scheme begins
- Improvements to Trades Training programmes announced
- Revised 2019-2021 Endeavour Fund Investment Plan released
- Consultation on Holidays Act 2003 Review begins

Prior to August 2018, the following consultation processes had commenced

- Consultation on R&D Tax Incentive
- Consultation on Construction Skills Action Plan
- Consultation on Zero Carbon Bill
- Consultation on the Conformance policy and infrastructure review
- Consultation on Health and Safety at Work Strategy
- Productivity Commission inquiry into a Low Emissions Economy

Annex 2: Key components of Industry or Manufacturing Policies/Strategies in selected economies

	United Kingdom	Canada	United States	Japan	Victoria
Strategy/policy	Industrial Strategy – Building a Britain fit for the future (2017)	Innovation and Skills Plan (2017)	Strategy for American Leadership in Advanced Manufacturing (2018)	Future Vision Towards 2030s (2017)	Advancing Victorian Manufacturing – A Blueprint for the Future (2017)
Background work and process	• Manufacturing Foresight process 2012-2013. This included the development of a range of issues papers • Industry strategy green paper 2017	• Industries 2030: A National Strategy for Canadian Manufacturing in the Digital Age 2016. An industry-led strategy, its development included a set of detailed issues reports (on labour, advanced manufacturing technologies, fostering innovation, competitive business environment, access to markets) • Mobilising Canadians for an inclusive innovation approach through visits and roundtables (2016) • Diagnostic review of Canada's high growth sectors (2017) • Interim reports for each growth sector (2018)	• National Strategic Plan for Advanced Manufacturing (2012). • Making in America: US Manufacturing entrepreneurship and innovation (2014) • Manufacturing Prosperity – A Bold Strategy for National Wealth and Security (2018). Developed by the Alliance for Manufacturing Foresight and through a series of roundtable discussions and expert interviews	• Japan Revitilisation Strategy (2015) • Interim Report by New Industrial Structure Committee (2016)	• Establishment of an Advanced Manufacturing Council (2016)
Vision/strategic objectives	Grand challenges for the UK: • UK at the forefront of AI and data economy • World leader in the way people, goods & services move • Maximise the advantages from the global shift to clean growth • Harness innovation to meet the needs of an aging society	Overall aim is to grow the economy, create middle-class jobs, and provide Canadians with the skills they need to succeed. Includes a series of goals, for example: • Increase the number of professional, science and tech-related jobs as a share of total employment to 40% by 2025 • Increase coding and other digital skills training available to students across Canada's K-12 school system by 2025, reaching 500,000 students by 2019 • Bridge the digital divide by increasing household internet use to 100% by 2025	American leadership in advanced manufacturing across industrial sectors to ensure national security and economic prosperity		Designing, creating and Manufacturing in Victoria for the World Victoria will be home to internationally competitive manufacturers creating value from design, engineering, data and services to grow economic opportunity and jobs for Victorians

	United Kingdom	Canada	United States	Japan	Victoria
		• Grow up to 5 world-leading superclusters in Canada by 2025 • Increase BERD to $30b by 2025 • Double the number of high growth firms in Canada by 2025 • Grow the value of Canada's goods and services exports by 30% by 2025 The Advanced Manufacturing Table has key manufacturing goals: • Increase manufacturing sales by 50 percent by 2030 • Increase manufacturing exports by 50 percent by 2030			
Horizontal policies/ initiatives	5 foundations with key policies: • Ideas, e.g., raise total R&D investment; increase rate of R&D tax credit, invest in new industrial fund • People, e.g., establish a technical education system, invest more in STEM skills, new national retraining scheme • Infrastructure, e.g., increase National Productivity Investment Fund, investment in EV infrastructure, investment in digital infrastructure • Business environment, e.g., new investment in innovative and high potential businesses, review of actions for improving productivity in SMEs	Four pillars: • People and Skills, e.g., CanCode, PromoScience, Work-integrated learning, Global skills strategy, Pan-Canadian AI Strategy, Connect to Innovate • Building ecosystems: science, technology and superclusters, e.g., Fundamental research, Granting Councils, Science Infrastructure, Science advice, Innovation Superclusters initiative, Intellectual Property Strategy, National Research Council • Investment, scale-up and growing companies, e.g., Innovative Solutions Canada, Women Entrepreneurship Strategy, Indigenous Entrepreneurs, NRC-IRAP, Regional growth strategies, Strategic Innovation Fund	Three elements: • Develop and transition new manufacturing technologies – capture the future of intelligent manufacturing systems; develop world-leading materials and processing technologies; assure access to medical products through domestic manufacturing; maintain leadership in electronics design and fabrication; strengthen opportunities for food and agricultural manufacturing. • Educate, train and connect the manufacturing workforce – attract and grow tomorrow's manufacturing workforce; update and expand career and technical education pathways; promote apprenticeship and access to industry-recognised credentials; match skilled workers with the industries that need them	Seven policy areas: • Develop the environment for promoting data utilisation, e.g., facilitating utilisation of personal data, formulating new strategies on IP, building an ecosystem that produces security technology • Enhance flexibility in the human resource/employment system, e.g., building the educational system in response to new needs, acquiring talent globally, enhancing flexibility in the labour market • Accelerate innovation and technological development (Society 5.0), e.g., develop innovation bases/centres that lead the world (e.g. in AI), promote strategic IP management	• Prepare for the jobs of the future, e.g., target specific skills needs and support the development of needs-driven training packages for the next generation of manufacturing jobs; promote and link opportunities for STEM graduates and other high-skill professionals within manufacturing; support industry associations to deliver manufacturing leaders forums to enhance management capability • Innovate to capture high-value manufacturing opportunities, e.g., strengthen links between industry and research, design and engineering capabilities and facilitate uptake of transformative technologies; facilitate improved access to risk capital for scale-up and start-up advanced manufacturing businesses; strengthen procurement processes to better support manufacturing; secure

	United Kingdom	Canada	United States	Japan	Victoria
	• Places, e.g., local industrial strategies, new Transforming Cities fund, Teacher Development Premium	• Program simplification and reorganization, e.g., horizontal review of innovation and cleantech programmes, Innovation Canada, Digital single-window, Accelerated growth service, Clean growth hub	• Expand the capabilities of the domestic manufacturing supply chain – increase the role of small and medium-sized manufacturers in advanced manufacturing; encourage ecosystems of manufacturing innovation; strengthen the defence manufacturing base; strengthen advanced manufacturing for rural communities.	• Strengthen financial capabilities – encouraging investment in intangible assets, improving the supply of risk capital • Facilitate a shift of industrial/employment structure – develop systems and environments to enable swift and flexible business revitalization/ reorganisation • Spread effect of fourth industrial revolution into SMEs and regional economies – introduce IOT etc into SMEs and regional economy • Ensure sophisticated system of economy and society for the Fourth Industrial Revolution – improve administrative services using data, ensure optimal regulatory reform in line with the Fourth Industrial Revolution	Victoria's global position as a leader in engineered materials • Build scale, capability and supply chain excellence, e.g., help SMEs to enhance their business capabilities to capture more market and supply chain opportunities; drive the digital transformation of manufacturing through training, demonstrations and knowledge exchange; work with industry to create place-based economic development plans • Foster a globally competitive business environment, e.g., boost manufacturers' capabilities to export and secure global supply chain opportunities; prioritise attraction of advanced manufacturing investment; work with industry to manage exposure to volatility in energy markets
Vertical policies/ initiatives	Sector deals – partnerships between government and industry aimed at increasing sector productivity. First deals in: • Aerospace • Artificial Intelligence • Automotive • Construction • Creative Industries • Life Sciences • Nuclear • Offshore wind • Rail • Tourism	Economic Strategy Tables - a model for collaboration between industry and government, focused on turning Canadian economic strengths into global advantages. Focused on: • Advanced manufacturing • Agri-food • Clean technology • Digital industries • Health/bio-sciences • Resources of the future	Range of Technical Priorities, e.g., • Intelligent Manufacturing Systems • Advanced Industrial Robotics • Artificial Intelligence • Cybersecurity in Manufacturing • High Performance Materials • Additive Manufacturing	Four vertical strategies: • Mobility – of people and products, e.g., automated transportation, drones • Supply chain – smart supply chains, e.g., robot production, advanced supply chain systems for factories at 50 sites, remotely-monitored autonomous farm machines • Healthcare – health, medical and nursing care, e.g., allow aging individuals to remain the workforce, reduce the number of nursing care patients • Living – development of new cities, sharing economy	Future Industries Initiative: Supporting investment in high growth industries through industry excellence and development projects, including collaborative networks and building supply chain readiness capabilities. Future industry sector strategies have been developed for: • Construction technologies • Defence technologies • Food & fibre • Medical technologies and pharmaceuticals • New energy technologies • Transport technologies

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