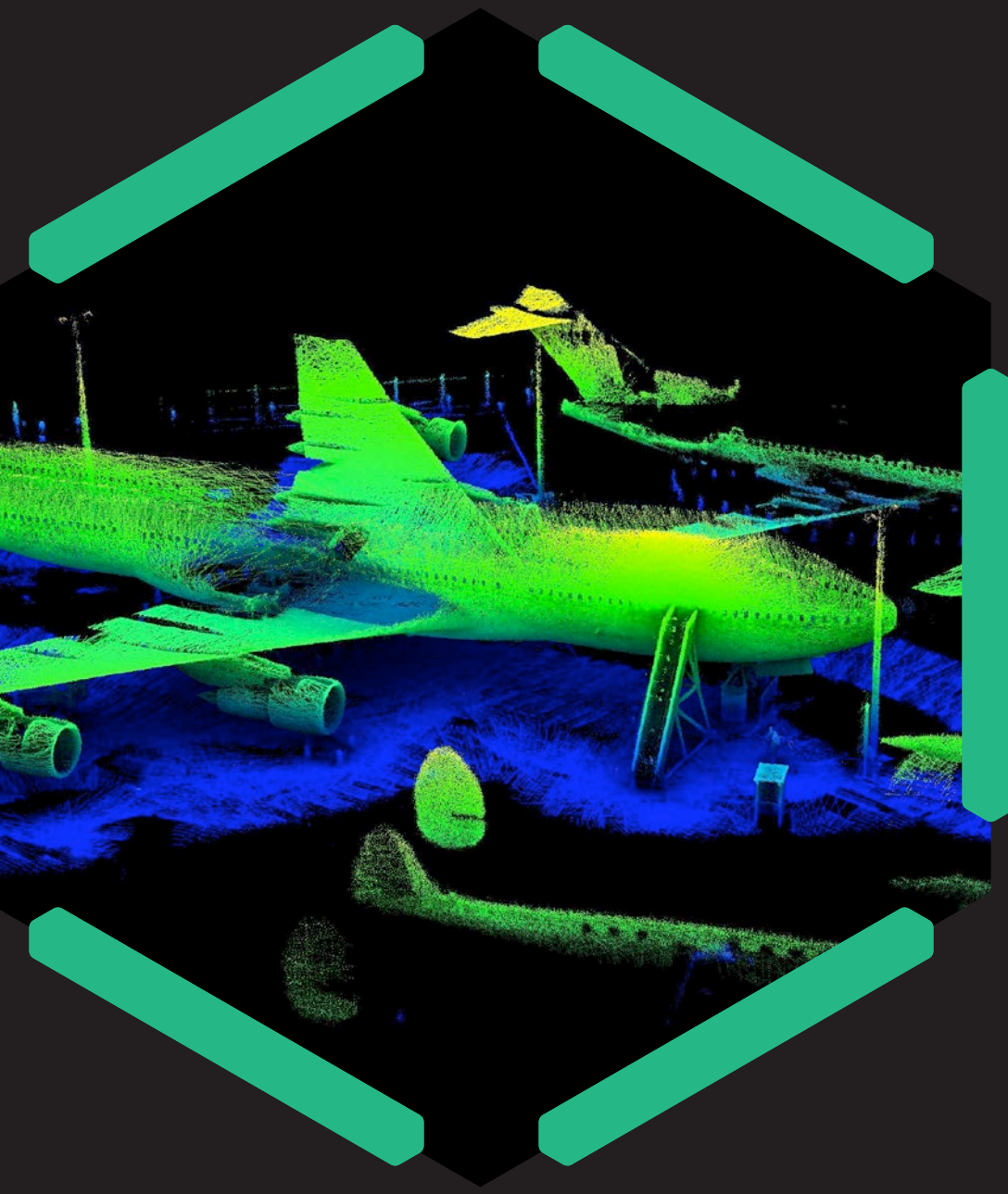

ICT IN **MANUFACTURING**

HIGH PERFORMANCE COMPANY INDUSTRY CONSULTATIONS OUTCOMES

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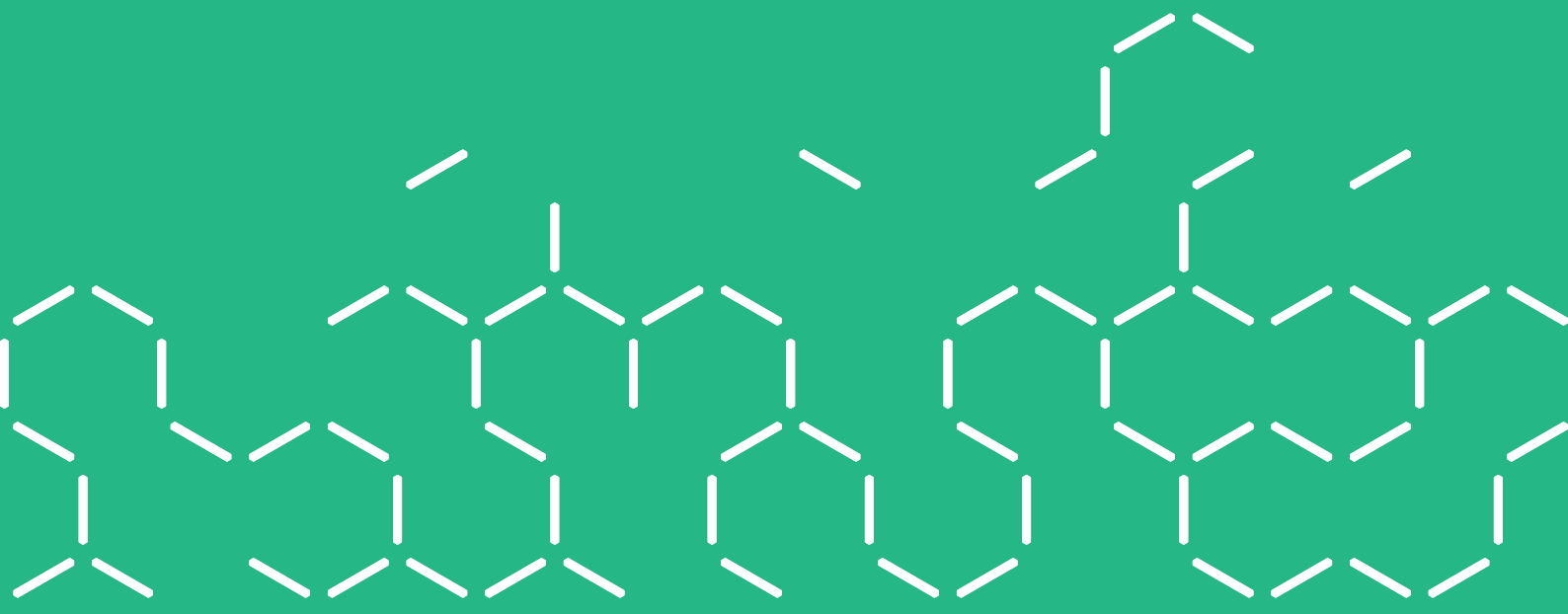

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1 EXECUTIVE SUMMARY

CSIRO has conducted a series of High-Performance Industry Consultations with companies in the manufacturing sector to better understand how to increase manufacturers' productivity through the use of modern ICT technologies. We further wished to understand how these tools could be leveraged to develop new lines of business through the development of digital services around manufactured goods.

Through a series of workshops involving approximately 70 companies in Melbourne, Adelaide, Sydney, Brisbane and Burnie, a number of opportunities have emerged, which – if grasped – would allow for the manufacturing sector to be more competitive:

- **Business Model and Strategy** – manufacturing companies must understand the business models around digital technologies and have a digital strategy for their company
- **Skills** – manufacturing companies need access to a combination of both "classical" manufacturing (engineering)-type and computer-/data science type skills to thrive in the digital economy
- **Internet of Things/Industial Internet Utilisation** – Australian manufacturing companies must take advantage of the Internet of Things/Industrial Internet to increase productivity and to develop new service-based business models
- **Removal of Data Exchange and Interoperability Barriers** – Interoperability barriers for business-to-business data exchange must be removed to increase the productivity of Australian manufacturing companies
- **Information Security and Trusted Computing** – information security and trusted computing are key concerns of the industry and must be addressed to remove barriers to adoption of new ICT technologies.

The potential opportunities arising from addressing these issues are significant: removing manufacturing data interoperability obstacles, for example, could increase the productivity of the Australian manufacturing sector by over a billion dollars annually as a crude estimate. In the Internet of Things space, McKinsey has recently estimated that the Internet of Things alone will add between 2.6 and 6.2 trillion USD annually to the global economy.

Opportunities to assist manufacturing companies to take advantage of digital technologies arise through:

- assisting companies to develop digital strategies to lift their digital manufacturing capabilities
- the development of a digital manufacturing maturity model to assist companies with digital strategy and business model development
- the development of a software platform ('national manufacturing cloud') that facilitates better flow of data across supply chains in heterogeneous IT environments
- leading a national conversation around the skill set required to take advantage of data- and internet-driven manufacturing
- engaging in outreach and thought-leadership work in the areas of Internet-of-Things/i-Manufacturing/Industrial Internet/Industrie 4.0 technologies
- developing high profile technology demonstrators in the area of Internet of Things/i-Manufacturing/Industrial Internet/Industrie 4.0 technologies.

For the Australian manufacturing sector and its global reputation for high value, bespoke products, the continued competitive advantage lies in the use of ICT. i-Manufacturing, the Industrial Internet and other digital solutions will also usher in highly flexible production infrastructures, that have 'wise' autonomous functions.

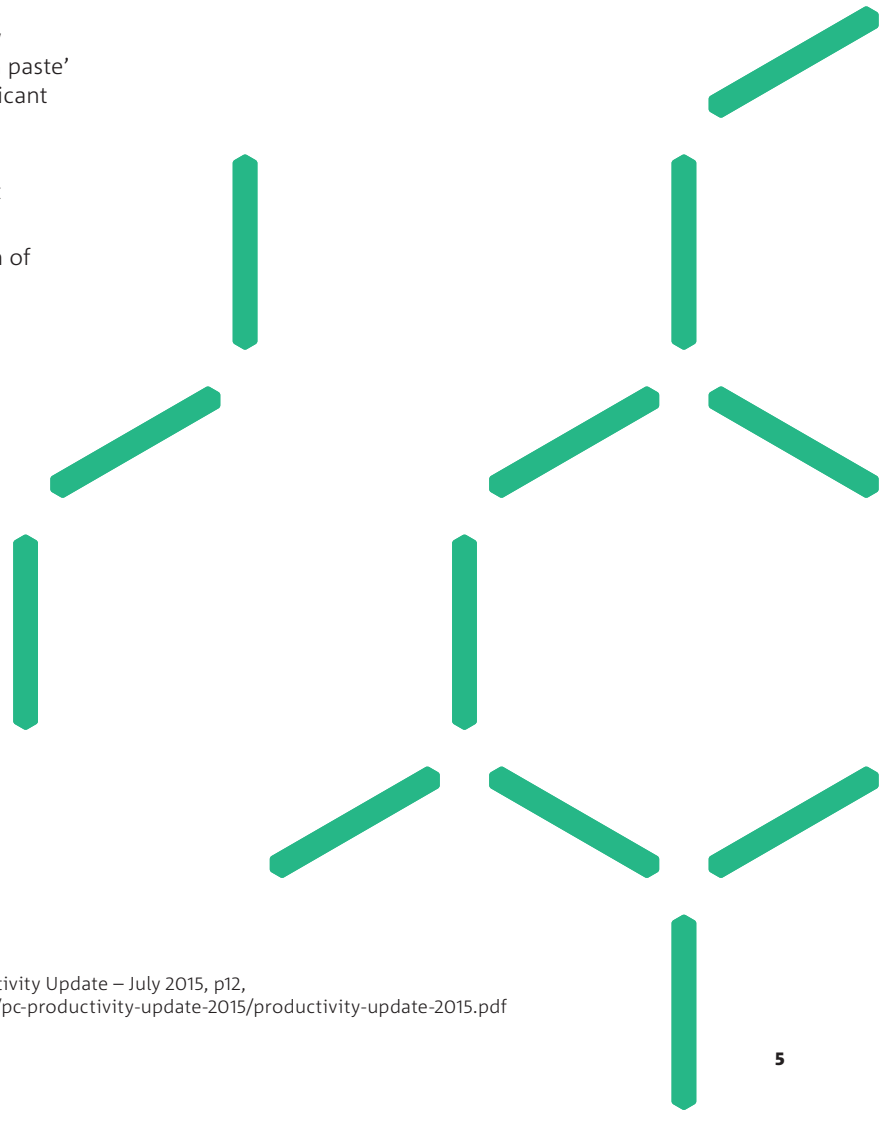
2 HIGH PERFORMANCE INDUSTRY CONSULTATION WORKSHOP BACKGROUND

The Australian manufacturing sector has the opportunity to be globally competitive by addressing a number of factors, including the increasing cost of doing business. Relatively flat productivity growth is also an underlying issue for the industrial sector, especially manufacturing (noting that multi factor productivity for the sector is currently in decline[1]). Over the last few years considerable thought has gone into how we can sustain a competitive manufacturing sector. Apart from measures associated with the macroeconomic and regulatory environment, there is wide acceptance that manufacturing firms need to embrace various forms of innovation. Furthermore, the modern advanced manufacturing workplace is a complex environment, which requires a number of interoperable and seamless information and communication technology (ICT) solutions which present the following exciting opportunities:

- **Access to information** – improve managing of outsourcing which otherwise may cost up to 10x more than doing the task in house.
- **Exchange of information** – increase overall profit by removing non-value adding activities (such as 'cut 'n paste' of purchase order information) accounting for significant portions of profit.
- **Preserve information** – increase yields by avoiding pertinent information (such as tolerances) being lost in data files.
- **Servitization of information** – enabling the creation of new business models and addressable markets.

In order to understand how to assist with these issues and to more rationally decide where to invest ICT research and project funding, CSIRO has sought the guidance of forward looking manufacturing SMEs. We have specifically targeted SMEs which have the necessary scale to invest in business improvements and who supply international markets. We have consulted with them concerning how their industry could best utilise emerging information technologies for competitive advantage, especially interoperability issues experienced in manufacturing supply chains between tactical, executive and strategic information systems.

Approximately 70 companies participated in the consultations across four states.



1 According to the most recent Productivity Commission, Productivity Update – July 2015, p12, http://www.pc.gov.au/research/recurring/productivity-update/pc-productivity-update-2015/productivity-update-2015.pdf

3 WORKSHOP ORGANISATION

Workshop participants were pre-qualified and invitations were only extended to companies considered to be high-performing. Apart from being manufacturing SMEs, companies had to fulfill several other criteria:

- the SME had to be an exporter
- the SME has to be of sufficient size in order to be able to invest in new technology
- the SME's senior management has a known track record of adopting new technology to improve the productivity of their business or develop new business models.

The invitation lists were generally a combination of high performance companies identified by CSIRO and META. The CSIRO SME engagement team worked closely with the project to facilitate the identification and participation of CSIRO identified companies.

Industry consultations were held in Queensland (Brisbane), New South Wales (Sydney), Victoria (Melbourne) and Tasmania (Burnie) and hosted by participating manufacturing companies. The response rate to our invitations per consultation varied between 10 and 70%.

4 OVERALL OUTCOMES AND OPPORTUNITIES

A number of common themes and opportunities can easily be distilled from the feedback received for all four workshops.

4.1 Key enablers: Digital strategies and skills

4.1.1 COMPANIES MUST UNDERSTAND THE BUSINESS MODELS AROUND DIGITAL TECHNOLOGIES AND HAVE A DIGITAL STRATEGY FOR THEIR COMPANY

The vast majority of companies present in the industry consultation sessions have told us that they do not have digital strategies in place for their businesses.

This is reflected in Australia's modest performance in ICT and total business expenditure in R&D intensities for 2013 and in its lacklustre performance in business R&D expenditure in the ICT sector, 2013.[2] Moreover, companies also do not feel confident to develop such strategies due to a lack of digital skills: attendees of the Sydney workshop even talked of the need to send an external 'tiger team' into companies to assist them in developing digital strategies. During the course of these consultations several requests were made to CSIRO to assist in this area.

Such statements are consistent with findings in a recent Australian Communications and Media Authority Report around SMEs in the digital economy. The report states that 'sixty percent of SMEs indicated that the self-perceived lack of knowledge about the digital environment is preventing them from being more efficient.'[3]

Moreover, in its 2014 Global Information Technology Report, the World Economic Forum ranks Australia at only 18th position in terms of overall network and digital readiness, with business usage, economic or social impact and affordability pulling Australia's ranking down.[4]

This is consistent with this finding that companies seem to be unable to map digital solutions to business problems: while several of the companies we consulted with expressed the desire to better use their data for forecasting and future state prediction (key drivers here are inventory management, estimation of delivery schedules, safety scenarios), the same companies did on the whole not recognise the significant and important role that IoT technologies will have to play in this context.

The availability of a digital strategy is a first and necessary step for companies to take advantage of the productivity increases and new business models that are enabled by digitised value chains and products. A digital strategy guides investment decisions and the development of higher degrees of ICT maturity. Companies have unequivocally requested help in this area.

A digital strategy guides investment decisions and the development of higher degrees of ICT maturity.

However, Australian companies are not alone in their search for appropriate business models: internationally, the search for new and viable business models for these modalities has only just begun.[5]

2 OECD, OECD Digital Economy Outlook 2015, pp 94.95, OECD Publishing, Paris (2015), http://dx.doi.org/10.1787/9789264232440-en

3 Australian Communications and Media Authority, The Australian Communications and Media Authority Communications Report 2012-13 Series Report 1 - Australian SMEs in the Digital Economy January 2014 (2014), http://www.acma.gov.au/~/media/Communications%20Analysis/Report/pdf/Australian%20SMEs%20in%20the%20digial%20economy%20pdf.pdf

4 World Economic Forum, *The Global Information Technology Report 2014 Rewards and Risks of Big Data* (2014), http://www3.weforum.org/docs/WEF_GlobalInformationTechnology_Report_2014.pdf

5 R. Geissbauer et al., *Industry 4.0 – Opportunities and Challenges of the Industrial Internet*, PricewaterhouseCoopers Germany (2014)

AUSTRALIAN MANUFACTURING COMPANIES MUST TAKE ADVANTAGE OF **THE INTERNET OF THINGS/INDUSTRIAL INTERNET** TO INCREASE PRODUCTIVITY AND TO DEVELOP NEW SERVICE-BASED BUSINESS MODELS

4.1.2 MANUFACTURING COMPANIES NEED ACCESS TO A COMBINATION OF BOTH 'CLASSICAL' MANUFACTURING (ENGINEERING)-TYPE AND COMPUTER-/DATA-SCIENCE TYPE SKILLS TO THRIVE IN THE DIGITAL ECONOMY

Companies in all consultation sessions have consistently stated that access to the skills necessary to thrive in the digital economy is a significant issue.

Anecdotally, we observed, that digitisation efforts were most advanced in those companies, where such projects were either initiated or driven by staff with a mechatronics background. Other than the basics, computational thinking and data science are not generally part of 'pure' engineering degrees. Furthermore, manufacturing also suffers from an attractiveness problem: ICT graduates are not usually willing to work in the sector.

Data skills, in particular, were frequently mentioned by the companies we consulted with: understanding how to take advantage of data, how to collect it, curate it and analyse it is a skill set that is largely absent from most manufacturing SMEs and one which companies have difficulties to access. The Melbourne workshop also raised the issue of data quality and the need for data curation: even companies that are more data-driven than others have data quality issues that they often do not recognize.

Australia requires a broad conversation involving all stakeholders (manufacturers, TAFEs, universities, etc.) around how curricula must be evolved or entirely new educational offerings created that develop the skills, which are necessary for both existing and future manufacturing workers to thrive in the digital economy. This becomes even more necessary when considering that the nature of manufacturing work itself is changing. The recent 'Job Creation in the Manufacturing Revival' report for the US Congress impressively illustrates that a steadily declining number of workers will be involved in actual physical manufacturing processes and an increasing number in managerial and professional work.[6] Such professional work will increasingly include a digital skills component.

Addressing both the urgent requirement for manufacturing companies to develop digital strategies as well as developing digital skills across the sector, should be of the highest priority: these two components are inextricably linked and key enablers (one immediately addressable, the other medium- to long-term). Without them, manufacturing in Australia will not thrive in the digital economy. Supporting the notion of digital maturity within business MIT Sloan and Deloitte commented[7]:

'The Ability to digitally reimagine the business is determined in large part by a clear digital strategy supported by leaders who foster a culture able to change and invent the new. While these insights are consistent with prior technology evolutions, what is unique to digital transformation is that risk taking is becoming a cultural norm as more digitally advanced companies seek new levels of competitive advantage. Equally important, employees across all age groups want to work for businesses that are deeply committed to digital progress. Company leaders need to bear this in mind in order to attract and retain the best talent.'

4.2 Key disruption: Internet of Things/Industrial Internet/ Industrie 4.0/iManufacturing

4.2.1 WHAT IS IT?

Global manufacturing is on the verge of being disrupted by the Internet of Things (IoT), which, when applied to industry is often referred to as the 'Industrial Internet' (US) or 'Industrie 4.0' (Germany/Europe). Following McKinsey, the Internet of Things can be appropriately defined as 'sensors and actuators connected by networks to computing systems. These systems can monitor or manage the health and actions of connected objects and machines. Connected sensors can also monitor the natural world, people and animals.'[8] For manufacturing this means that all aspects of the production process can be controlled and monitored much more efficiently and data driven improvements can be implemented. Furthermore, service based business models (e.g. predictive and preventative maintenance) around manufactured goods are enabled.

6 M. Levinson, *Job Creation in the Manufacturing Revival*, Congressional Research Service, United States Congress (2013), http://digitalcommons.ilr.cornell.edu/cgi/viewcontent.cgi?article=2149&context=key_workplace

7 G.C. Kane et al., *Strategy, Not Technology, Drives Digital Transformation*, MIT Sloan Management Review and Deloitte University Press (2015)

8 J. Manyika et al., *The Internet of Things: Mapping The Value Beyond The Hype*, McKinsey Global Institute (2015)


HYSTER

INTEROPERABILITY BARRIERS
FOR BUSINESS-TO-BUSINESS DATA EXCHANGE MUST BE REMOVED TO INCREASE THE PRODUCTIVITY OF AUSTRALIAN MANUFACTURING COMPANIES

The Industrial Internet is often likened to the next industrial revolution due to its profound transformative impact on economies. Estimates vary widely, but are in all cases staggering: McKinsey projects that, by 2025, the Internet of Things will have an economic impact of up to 11 trillion USD annually and will be composed of between 25 and 50 billion connected devices.[3]

Australian manufacturing SMEs have the opportunity to take advantage of productivity increases and new service-based business models around manufactured goods

Our consultations have shown that the vast number of Australian manufacturers were either completely unaware of the Industrial Internet or unsure how to leverage these technologies to increase productivity gains or enable new business models.

Such inactivity is astounding as the rest of the world is rapidly leveraging the industrial internet to enable better business outcomes. In a recent study, PriceWaterhouseCoopers Germany expects that, by 2020, German companies will have digitised 80% of their value chains, leading to an expected 18% increase in productivity. By the same time, European companies are expected to have invested approximately 140 million Euros annually into Industrial Internet/Industrie 4.0 technologies, leading to an expected 110 billion Euros of additional revenue for European industries.[9]

Australian manufacturers compete in this world and should at minimum strive to remain competitive both globally and locally. In particular, in the context of our proximity to Asia, this is becoming increasingly important: in their recent 'Management Tools and Trends 2015' Study, Bain and Company demonstrated that investment in IT and data science tools in emerging countries such as China and India is outstripping comparable investment in Europe and North America.[10] These regions – our competitors in close physical proximity – are relying heavily on the tools of the digital economy to drive growth and productivity gains.

However, there are also significant opportunities to develop leadership positions: there is still a lot of uncertainty around business models enabled by the Industrial Internet, which translates into a real opportunity for innovation and the development of leadership positions in this space.

The Internet of Things also allows manufacturers to develop new service-based business models. One such example centres around proactive/predictive maintenance: Daimler Trucks North America manufacture and sell trucks with engines that are constantly monitored by sensors. The sensor data is sent back to a service centre to be analysed. When a fault is predicted or occurs, the truck can be directed to the next service station and information about the fault communicated to the garage.[11] In this example, in addition to selling the truck, a manufacturer is also able to sell a (maintenance) service. Another example is new toilet bowls, which, through the use of sensors and analytics can sample human waste and report on medical parameters (e.g. infections, early pregnancy detection, alcohol consumption) via a smartphone app or website.[12]

The potential impact of new hybrid product-service business models has the potential to be 'game-changing', offering opportunities to be more competitive within a quickly changing business environment. This observation was recently supported by GE and Accenture in their recent 'Industrial Internet Insights Report for 2015'.[13]

9 R. Geissbauer et al., *Industry 4.0 – Opportunities and Challenges of the Industrial Internet*, PriceWaterhouseCoopers Germany (2014)

10 D. Rigby, B. Bilodeau; Management Tools & Trends 2015, Bain & Company (2015)

11 G. Westerman, The Internet Connected Engine Will Change Trucking, Harvard Business Review (2014), https://hbr.org/2014/11/the-internet-connected-engine-will-change-trucking

12 G. Crouch, *The Toilet and Its Role in the Internet of Things*, Wired Magazine (2014), http://www.wired.com/2014/04/toilet-role-internet-things/

13 GE and Accenture *Industrial Internet Insights Report for 2015*, https://www.gesoftware.com/sites/default/files/industrial-internet-insights-report.pdf

4.3 Key productivity enhancement: Removing interoperability barriers that exist in the business-to-business exchange of manufacturing information

4.3.1 BUSINESS DATA

Companies have consistently and emphatically confirmed that the business-to-business (B2B) exchange of business process data is a significant cost factor, which by all but the most aware companies is simply accepted as the cost of doing business. For one company we consulted with, the cost of purchase order processing alone amounted to approximately 1.4% of the company's annual turnover.

A typical example is the exchange of purchase order data across supply chains. We have found that even in cases where two companies in a supply chain use an Enterprise Resource Planning (ERP) system by the same vendor, these systems cannot exchange data 'out of the box'. Companies have to make further investments to integrate their systems together using a one-on-one approach, which, given the limited ability of Australian SMEs to invest in such integration activities does not scale. Such integrations are usually provided by the systems vendor or an external consultant: the software industry has no a *priori* interest in making integration easy across systems data silos. We have also encountered companies which run more than one ERP system so that they can integrate with their most important customers. The interoperability issue has also been identified by McKinsey in a recent article.[14]

Another challenge is the IT systems heterogeneity of supply chains: larger SMEs in a supply chain manage their business data using sophisticated ICT systems such as ERPs or Product Lifecycle Management Systems (PLMs) while other companies in the same supply chain use Excel.

This finding presents an admittedly challenging opportunity to develop technical solutions that allow data exchange between companies without forcing them to make significant new investments.

Technological solutions exist in principles however, the problem is too large to solve for an individual SME alone and would require the collaboration of many SMEs or industry associations to develop shared (national) resources akin to a 'manufacturing cloud', which could be used to establish business process data interoperability and exchange in supply chains with very heterogeneous IT environments.

Before tackling the technical issues, however, companies need to perceive such data non-interoperability as a significant loss of productivity that should be addressed and not just accepted as the standard cost of doing business. Building on this observation, the OECD recognised in its recent report on the digital economy that 'a greater level of interoperability for connected devices [...] will be key in building a trusted and reliable IoT ecosystem'.[15]

4.3.2 EXCHANGE OF ENGINEERING DATA

A very similar issue has presented itself for the B2B exchange of engineering data. Companies have confirmed that there is currently no guarantee that engineering data can be exchanged across supply chains without loss of information/ fidelity. There is therefore no guarantee that a supply chain can make a product to the original specifications, which, in turn results in significant added cost due to, for example, the need for post-processing.

4.3.3 THE VALUE THAT CAN BE DERIVED FROM IOT SYSTEMS CAN ONLY BE MAXIMISED THROUGH INTEROPERABILITY

One significant outcome of an extensive McKinsey study around value creation through the Internet of Things was that without interoperability between IoT systems, at least 40% of the potential economic benefits of such systems cannot be realised.[14] Apart from ensuring technical interoperability of these systems, this also requires a cultural shift: to make supply chains more efficient and plannable, for example, manufacturers must be willing to share significantly more data about their manufacturing processes than they are currently willing to do. Associated analysis by GE and Accetone has found that one of the top three changes faced by companies implementing 'big data analytics initiatives' was 'system barriers between departments prevent collection and correlation of data for maximum impact'.[13]

14 J. Nanry et al., *Digitising the Value Chain*, McKinsey Quarterly (March 2015)

15 OECD, *OECD Digital Economy Outlook 2015*, p. 271, OECD Publishing, Paris (2015) http://dx.doi.org/10.1787/9789264232440-en

MANUFACTURING COMPANIES MUST UNDERSTAND THE BUSINESS MODELS AROUND DIGITAL TECHNOLOGIES AND HAVE A **DIGITAL STRATEGY** FOR THEIR COMPANY

4.4 Key enabler: IT and data security

With the increasing move of manufacturing information systems to the cloud, the issue of data and systems security was raised several times by attendees. There seems to be a perception that systems maintained in-house are more secure than those on cloudbased infrastructures. However, a move to the cloud will be a key enabler for both productivity gains and is also a prerequisite for taking advantage of Industrial Internet/Industrie 4.0/iManufacturing technologies.

Australian companies are not alone in this – the 2015 Bain & Company management tools report also identified this as a significant issue for the companies it surveyed.[10]

Manufacturing companies will have to be guided in the area through (a) significant education and trust-building and (b) through the development of secure computing technology in order to embrace both the cloud and the Internet of Things more fully.

4.5 Miscellaneous commentary

Several further opportunities were raised in one or two workshops but did not emerge as global issues.

4.5.1 ASSISTIVE ICT SOLUTIONS AND VIRTUAL DESIGN/TESTING ARE OF VALUE

Companies represented at the round table agreed that assistive ICT solutions, which can monitor processes and predict failure modes or which can assist human workers carry out a particular task, are of great value. Much of this is also part of the Industrial Internet space, but wasn't recognized by companies as such. The importance of virtual product and manufacturing process design (including virtual testing) was also emphasized. The latter very much corresponds to the iManufacturing[16] concept developed by CSIRO and also clearly overlaps with the discussion around data interoperability and exchange across both functions in a factory and supply chains as well as the use of IoT technology.

4.5.2 USE OF ICT TECHNOLOGIES TO FIND MARKET NICHES

In one workshop, there was vigorous discussion about the use/utility/usability of social media for product design. One of the attending companies stressed the utility of social media as a source of information/inspiration for the design of customised products. Furthermore, social media was perceived as a useful tool for customer engagement and interaction, both in the consumer space as well as in the medical device space (e.g. tweeting sonograms of babies). In general, though, social seems to be mainly of relevance to manufacturers of consumer products. However, further opportunities exist to understand the role that social media (data) can play in a manufacturing context.

4.5.3 HUMAN CENTRICITY OF ICT SYSTEMS

'Human Centricity' here can be understood in a number of ways: (a) usability of ICT systems for various operators, (b) ICT systems complementing and augmenting the human worker rather than replacing them and (c) driving the cultural change that is necessary to become a data- and ICT driven organisation. Companies emphasised the importance of usability of ICT systems across an organisation (appropriate user interfaces for different types or work/workers, different modes of interaction with ICT systems (e.g. on a machine, on a tablet, mobile etc.) as an unsolved problem. Furthermore, they emphasized that ICT systems should not replace human workers but rather make them more productive and assist them in decision making. Particularly the latter point overlaps with the above discussion around the Internet of Things and assistive technologies within manufacturing. Furthermore companies stated that one of the biggest obstacles to the successful implementation of data and ICT tools is often not of a technical nature, but rather in shifting the culture of the company.

ICT systems should not replace human workers but rather make them more productive and assist them in decision making.

16 N. Adams et al., *Equipping Australian Manufacturing for the Information Age*, CSIRO (2014)

5 RECOMMENDATIONS

Based on the outcomes of the consultations, three significant opportunities to increase the productivity of the Australian manufacturing industry and to position it to become a leader in the digital manufacturing economy have been identified. These focus on (a) digital strategies and skills, (b) the Industrial Internet and (c) B2B exchange of business and engineering data.

5.1 Strategy and skills

5.1.1 ASSISTING COMPANIES TO DEVELOP DIGITAL STRATEGIES AND BUSINESS MODELS

Several companies have expressed a desire to work with organisations like CSIRO to develop digital strategies for their businesses. Furthermore, based on the literature research for our iManufacturing discussion paper[11] and one-on-one consultations with companies, it is becoming apparent that a set of questions and metrics can be defined, which can be used to benchmark the digital maturity of a company and to develop a digital strategy framework. Such a framework can then be used to benchmark the existing digital maturity of a business, define a future state and to develop an implementation path.

5.1.2 LEADING A NATIONAL CONVERSATION CONCERNING THE FUTURE OF MANUFACTURING SKILLS

Feedback from the participating companies also indicated that companies do not currently feel that education providers are 'teaching the right things': manufacturing companies wishing to make greater use of data and ICT in their business are finding it difficult to access staff combining 'classical' manufacturing/engineering expertise with computer- and data-science skills.

This outcome clearly indicates the need for a national conversation involving all stakeholders in the manufacturing and education sectors (universities, TAFEs etc) concerning how education providers and industry can work together to deliver more targeted education to manufacturing workers.

Furthermore, there is a significant need to conduct research into the educational requirements of the manufacturing worker of the future: which skill sets will both highly educated and less educated manufacturing workers need, to remain productive and successful in the employment market place?

5.2 Raising awareness of Internet of Things/iManufacturing/Industrie 4.0/Industrial internet opportunities

It is critical for the survival of the Australian manufacturing sector to take full advantage of the opportunities offered by the Internet of Things/Industrial Internet. As discussed, Australian manufacturers are currently largely unaware or not considering the opportunities available through the adoption of new technologies in the IoT/i-Manufacturing/Industrie 4.0/Industrial Internet space.

However, these technologies are beginning to significantly disrupt manufacturing in Europe and the United States. All stakeholders in the Australian innovation ecosystem should make a concerted and significant effort in facilitating the adoption of these technologies through (a) outreach and thought leadership and (b) high-profile technology use cases developed together with companies.

5.2.1 OUTREACH AND THOUGHT LEADERSHIP

CSIRO, as a science translation agency, could be a lead voice in outreach and thought leadership around the Internet of Things/ Industrial Internet. This can be done through, for example, discussion papers, the development of communities of practice and partnering with both private and governmental entities wishing to develop the use of Industrial Internet technologies for improved business outcomes. CSIRO's iManufacturing discussion paper,[16] the launch of the iManufacturing hub together with META and the establishment of Lab22 and the Industrial Internet Innovation Hub (I3Hub) are beginning examples of such activities.

5.2.2 DEVELOPING HIGH PROFILE TECHNOLOGY USE CASES

The development of high-quality technology demonstrator use cases will be imperative to further acceptance and uptake of these technologies by Australian manufacturers. Experience over the last year has shown that even those companies that see the potential for these technologies in their business are reluctant to make cash investments in research projects.

In response to this, CSIRO's Data61 is developing the Industrial Internet Innovation Hub, which, through its three pillars of demonstration (the hub will demonstrate Industrial Internet enabled business scenarios of relevance to manufacturing companies), collaboration (the hub is developing an extensive network of technology users, technology providers, government, industry bodies and investors) and co-creation (through colocation with CSIRO scientists) aims to address this.

5.3 Business-to-business exchange of business and engineering data

5.3.1 ECONOMIC PROJECTS

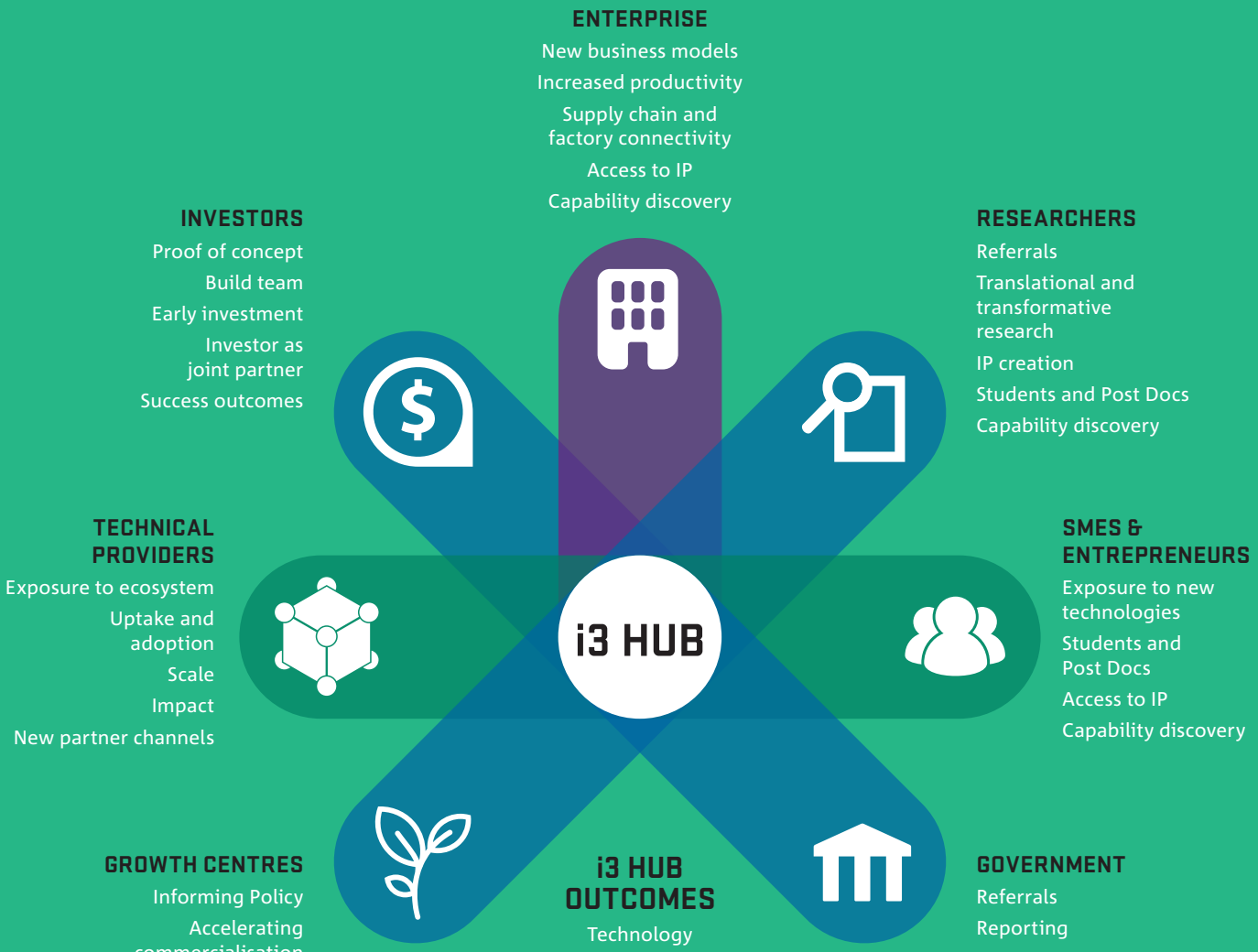
All companies participating in the consultation have confirmed that they incur significant costs due to business or engineering data non-interoperability. However, with several notable exceptions it has been difficult to quantify the economic impact of improved interoperability for both the individual manufacturer and at a national level.

There is therefore significant scope to develop a better understanding the economic impact that the partial or full removal of interoperability barriers may have on businesses and the Australian economy at large. If found to have a significant impact on the Australian economy, this could provide a business case for developing a software platform for the improved interoperability and exchange of manufacturing business and engineering data.

5.3.2 TECHNICAL RESEARCH – BUSINESS AND ENGINEERING DATA INTEGRATION ACROSS SUPPLY CHAINS

Our consultations have shown that the IT environment across the manufacturing supply chain is heterogeneous, with more advanced companies typically running sophisticated ERP and PLM systems while smaller members of the supply chain sometimes run a company on Excel spreadsheets. Building a software platform (a 'National Manufacturing Cloud'?) that would ensure seamless data flow across such a heterogeneous environment – a 'system of systems' – without forcing end users to make significant investments beyond those they have already made is a significant research challenge. If validated by a business case, however, tackling this challenge could add significantly to the Australian economy.

CONNECTED INNOVATION MARKETPLACE



CSIRO and key partners have established a connected innovation marketplace for businesses to exploit new business opportunities enabled by the industrial internet, through membership of International communities such as the Industrial Internet Consortium (IIC).

6 CONCLUSION

Australian manufacturing companies have the opportunity to significantly increase their productivity and to develop new business models around manufactured goods through the aggressive adoption of modern ICT technologies.
The development and adoption of new customer focussed business models to realise the potential benefits from applying the IoT is also essential.

In a first step, Australian manufacturers need to build their understanding of how the application of digital technologies can transform their competitiveness. It will then be necessary to develop digital strategies and supporting business models to improve performance and optimise their use of resources and develop new/improved products and services and associated markets.

CSIRO can play a significant role in this by helping companies to develop digital strategies, through thought leadership and through building a digital manufacturing ecosystem.


acer

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Cover A 3D laser map of aeroplanes by our handheld 3D laser mapping system, Zebedee.

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