The Future of Work in Australia: Building the third wave of growth

November 2014
Introduction

The pace of innovation is accelerating, driving a dramatic transformation in industry. At GE, we call this transformation the Future of Work. This is a revolution in how we make things that is driven by three fundamental forces: the Industrial Internet, Advanced Manufacturing, and the Global Brain.

1. The Industrial Internet integrates cloud-based analytics with industrial machinery. It merges software and hardware—big data with big iron. Machines are now increasingly able to analyze their environment, react, and interact with each other and with us, generating insights that allow people to operate equipment more efficiently. We can shift from reactive to preventive maintenance—fixing machines before they break, dramatically reducing unplanned downtime, and raising the efficiency of individual machines as well as entire systems, such as reducing delays in hospitals or air traffic or increasing the efficiency of power distribution.

2. The second driving force, Advanced Manufacturing, links all aspects of the manufacturing value chain—design, product engineering, manufacturing, supply chain, distribution, and remanufacturing (or servicing)—into one cohesive and intelligent system. New production techniques like additive manufacturing allow us to accelerate the cycle of design, prototyping, and production, which increases speed and flexibility of manufacturing at lower costs. The “digital thread” connecting all aspects of the manufacturing process also allows real-time adjustments to production and supply and distribution logistics.

3. The third driving force is the Global Brain. This is essentially the collective intelligence of human beings across the globe, integrated by digital communication networks. Open-source platforms and crowd-sourcing are quickly emerging as effective ways to unleash the creativity and entrepreneurship potential of masses of people together, no matter where in the world they sit. Companies gain flexibility, while workers gain greater entrepreneurial control over their skills and talents. The Global Brain is redefining the relationship between employers and employees, to the benefit of both.

As global economic growth brings to millions more people both connectivity to the Internet and the time to take advantage of it, the Global Brain will become vastly bigger and more powerful in the coming decades. Better access to clean water, food and healthcare will free up precious hours—previously absorbed attending to basic survival needs—to both tap and contribute to the global stock of knowledge.

This new wave of innovation is set to radically change design and manufacturing processes, supply chains and distribution channels, and the way work is performed and organized. It is redefining the competitive landscape across industrial sectors and will impact international competitiveness and trade patterns, as well as the distribution of global growth.

It is also transforming traditional industrial assets into interconnected machines, with a much more extensive and powerful range of capabilities. Able to connect seamlessly with each other—and us—through a network we refer to as the ‘Industrial Internet’, interconnected industrial devices are as different from traditional machines as smart phones are from the very first mobile phones.

In a similar way, industrial companies that combine the digital and the physical open entirely new dimensions in the way they operate and in the value they can provide to customers and shareholders. Connecting the digital world of research, design, engineering and manufacturing enables a company to drastically reduce the time needed to introduce new products, leading to faster responses to cus-
customer needs and higher engineering productivity. As real-time factory and supply chain data are translated into insights that operators can act on, factories and supply chains are able to respond much faster to shifts in customer needs and external shocks. With the ability to continuously improve a machine’s performance throughout its life cycle, operators can increase machine uptime, throughput, and inventory turnovers. Increasing responsiveness leads to increasing sales.

Scaled across Australia’s economy, this kind of transformation holds the key to the country’s future. As the mining and resources boom slows, the focus on operating expenditure and productivity will naturally increase.

Australia is at a crossroads, where it needs to identify and develop a new economic model able to generate sustained strong growth in jobs, incomes and living standards over the coming two to three decades.

The Future of Work can reboot efficiency and competitiveness in Australia’s traditional areas of strength, notably in commodities and energy. It can also develop a more diversified advanced manufacturing sector and position the country as a regional hub for high-value-added services. Australia has the right

Figure 1
A technological revolution or an evolution?

Figure 2
Innovation – local or global?
conditions in place, notably a strong business environment, high-quality human capital, and a tradition of excellence in research and development (R&D) in both the private and public sectors.

But Australia’s entrepreneurs underestimate the disruptive potential of these emerging trends. The 2014 GE Global Innovation Barometer, which surveyed senior executives actively involved in their companies’ innovation strategy across 26 markets, showed Australians largely believe the current wave of innovation represents a gradual evolution, rather than a revolution.

Australia also ranked near the bottom of countries that believe companies must encourage creative and disruptive behaviors and processes; Australian entrepreneurs find coming up with radical and disruptive ideas to be more challenging than Canadian, American or Japanese entrepreneurs do. Moreover, Australian entrepreneurs strongly believe that when innovating, the priority should be on protecting core business profitability (only Mexico, Turkey and Germany were ahead of Australia on this dimension). Australia’s entrepreneurs don’t seem to feel a strong sense of urgency to innovate, and they fall right on the average on the trade-off between bringing new technologies to market quickly and spending more time to perfect them.

Overall, GE’s Innovation Barometer suggests a significant degree of risk aversion in Australia’s attitude to innovation. This will need to change if innovation is to play a key role in the coming years.

On the other hand, Australia’s attitude to innovation is extremely open, with more than one respondent in five convinced that to be successful innovators, it is necessary to merge and combine ideas, insights, talents and resources from across the world—confirmation of Australia’s very open attitude to business.
The Future of Work: Overview

The pace of innovation is accelerating; creating opportunities at the intersection of data, technology and connectedness that will reinvent industry and transform the way we work.

This transformation affects design and manufacturing processes, supply chains and distribution networks, and the way that work is performed and organised. It is redefining the competitive landscape across industrial sectors, and will impact international trade patterns and the distribution of global growth. It will reshape the labour market and affect the level and distribution of incomes across countries.

We will now discuss the three fundamental forces driving the Future of Work: the Industrial Internet, Advanced Manufacturing, and the Global Brain. These three forces are interdependent and mutually reinforcing.

The Industrial Internet is the merger of software and hardware, of big data and big iron, with the integration of cloud-based analytics with industrial machinery. The rapid decline in the price of electronic sensors today makes it cost-effective to equip industrial machines with a large number of these sensors that make them increasingly able to analyse their environment, react, and interact with each other and with us. Imagine wind turbines working together to optimise their power generation, or a jet engine able to detect and schedule required maintenance. At the same time, lower costs of storing and processing data are enabling us to harvest massive amounts of data from industrial equipment and to process it with increasingly advanced analytics, generating insights that allow us to operate that equipment more efficiently.

The Industrial Internet allows us to shift from reactive to preventive maintenance—fixing machines before they break, dramatically reducing unplanned downtime, and raising the efficiency of individual machines as well as entire systems, such as reducing delays in hospitals or air traffic or increasing the efficiency of power distribution. The second driving force is Advanced Manufacturing. At the core of Advanced Manufacturing is a ‘digital thread’ linking design, product engineering, manufacturing, supply chain, distribution and remanufacturing (or servicing) into one cohesive and intelligent system. This encompasses new production techniques like additive manufacturing, or 3D printing. This allows us to create completely new parts and products with new properties, as well as to accelerate the cycle of design, prototyping and production. Engineers today can ‘print’ a prototype, test it, adjust the digital design as needed, and reprint an improved version—all using the same additive manufacturing machines. This translates to increased speed and flexibility of production at lower costs. Moreover, the digital thread connecting all aspects of the manufacturing process also allows real-time adjustments to the production process and to supply and distribution logistics.

The third driving force is the Global Brain. This is essentially the collective intelligence of human beings across the globe, integrated by digital communication networks. Many of us take for granted the ability to cooperate seamlessly with colleagues in
different locations via email, cloud-based file sharing platforms, teleconferencing and videoconferencing. Today, open source platforms and crowdsourcing are quickly emerging as effective ways to unleash the creativity and entrepreneurship potential of masses of people together, no matter where in the world they sit. Individual companies are starting to gain expertise that extends well beyond their four walls, accessing larger pools of talent whose expertise can vary depending on the problem at hand. Companies gain flexibility, while people gain greater entrepreneurial control over their skills and talents. The Global Brain is redefining the relationship between employers and employees, to the benefit of both.

As global economic growth brings to millions more people both connectivity to the Internet and the time to take advantage of it, the Global Brain will become vastly bigger and more powerful in the coming decades. Better access to clean water, food and healthcare will free up precious hours—previously absorbed attending to basic survival needs—to both tap and contribute to the global stock of knowledge.

The Future of Work is shaping up to be a powerful accelerator for the traditional innovation process. The digital world has long enjoyed the benefits of Moore’s law, manifested in exponential growth of cost-adjusted performance. As digital and physical become intertwined, some of these benefits will accrue to the world of industrial equipment. Of course, physical machines are still subject to physical laws that impose more binding constraints than in the world of software—but as they become increasingly digitised, the pace at which their performance improves will experience a significant acceleration.

The Global Brain is making it possible for millions more people to participate in the innovation process and is enabling new tools for them to collaborate effectively—effectively creating the human equivalent of High Performance Computing. Innovation is disruptive, and faster-paced innovation will be even more so. It will present new challenges for individual companies.

And it will have painful short-term costs in segments of the labour market, as some jobs will be displaced and some skills made obsolete. But for companies and individuals alike, innovation will also be a major source of opportunities, opening up new markets and careers. It is the primary force that can ensure sustainably higher growth in jobs and incomes—especially critical at a time of persistently low economic growth and high unemployment. And, in an increasingly globalised economy, embracing the disruptive forces shaping the Future of Work will be essential to remain competitive and take advantage of the rapid growth of global markets.

As we have argued in a recent paper, the merging of the digital and the physical is giving rise to a new kind of industrial company: one that can capture and leverage the value of interconnectedness, delivering new value to its customers and shareholders. Australia is well positioned to lead this kind of industrial transformation.

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1High Performance Computing leverages the power of “clusters” of interconnected computers, referred to as “nodes.” The coordinated computing power of the nodes delivers much higher performance, enabling to solve large-scale high-complexity problems in business, science and engineering.

An Innovation-Based Growth Strategy

Australia has enjoyed over 20 years of uninterrupted economic expansion, with real GDP growth averaging 3.5 percent in the 30 years to 2013—an unparalleled success among advanced economies. But maintaining this successful performance in the next three decades will require a new strategy.

The commodity boom has slowed (though, we believe, not ended), and competition in the global economic arena has become more intense. Australia needs to find new ways to generate strong growth in jobs and incomes, and to bolster its competitive position in the global economy.

This new growth strategy should be based on three pillars:

1. Improve efficiency, profitability and competitiveness in mining, commodities and energy—the sectors that form the backbone of Australia’s economic strength.

2. Broden Australia’s base of high-technology, high-value-added manufacturing activities.

3. Become a regional hub for high-value-added services, from education to healthcare to technology-based business services.

This framework is well aligned with the Australian government’s recently released ‘Industry Innovation and Competitiveness Agenda,’ which outlines a set of policies, reforms and investments targeting growth sectors in the Australian economy, including mining, advanced manufacturing, energy resources, medical technologies and pharmaceuticals. In many sectors, the wheels are already in motion. But all three of these pillars have the potential to record fast and substantial progress by leveraging the disruptive power of the Industrial Internet, Advanced Manufacturing and the Global Brain.

Innovation must be Australia’s ticket to prolonged prosperity. It will be vital that investment in innovation in these key growth sectors include technologies and mechanisms that will better integrate Australia into the global supply chain, help build economies of scale, and ultimately improve the country’s competitiveness. But in what areas can innovation bring the biggest growth benefits, and how should an innovation-based growth strategy be focused?

Macroeconomic context

Australia, while starting from a position of strength, is experiencing its strongest growth engine of the past decade—the commodity sector—shift down a few gears. Weaker commodity prices, high production costs and overcapacity have reduced the number of mining projects. Since early 2012, according to the Economist Intelligence Unit, A$150 billion worth of planned projects were either postponed or cancelled. Data from the

government’s Bureau of Resources and Energy Economics, however, help put this in perspective. Even though the number of projects at the committed stage has been halved since April 2012, the total value of the remaining projects, at A$228 billion, is only 15 percent lower than the peak level reached in early 2013. The bulk of these projects is in hydrocarbons and is expected to significantly contribute to fixed asset investment at least through 2018.

Australia has entered the third phase of the natural resources cycle, where past investment pays off in greater production and exports. The balance of growth has shifted accordingly: a decade-long robust expansion in capital expenditure brought the share of fixed asset investment to 29 percent of GDP in 2012 from 23 percent in 2000. Since the start of 2013, net exports have replaced investment as the main growth engine, as production expanded and capital imports declined (see Figure 3). Net exports have been supported by the much more stable component of private consumption.

It would be a mistake to count on a rapid depreciation of the currency as a quick fix for the country’s competitiveness problems, however, for at least three reasons:

1. Additional substantial depreciation seems unlikely, because most of the factors that supported the strength of the Australian dollar following the global financial crisis are still in place. Good economic performance, low level of debt, positive interest rate differentials relative to most other advanced economies, and the currency’s safe-haven appeal mean that the Australian dollar will remain an attractive option for international investors (particularly if the normalisation of Federal monetary policy causes a rise in uncertainty and market volatility).

2. Nonmining sectors face additional challenges on the road to becoming a more important share of the economy. After a long period of rapid wage growth and limited productivity gains, nominal unit labour costs are 80 percent higher than they were in 2000, considerably more than most of the other large and mid-size advanced economies.

Figure 3
Breakdown of real GDP growth (y/y percent change)

Figure 4
Real effective exchange rate (100 = 2005)
Finally, nominal exchange rate depreciation cannot be a substitute for improvement in productivity, since long-term productivity growth is the most important factor determining prosperity. As we have discussed above, Australia’s extraction industries can leverage advanced technologies to maintain their global leadership position. Despite the downturn in demand for commodities over the past couple of years, the mining sector has consistently been a strong contributor to GDP growth, accounting for over 30 percent of the total (see Figure 4). Although the short-term outlook for commodities remains challenging, prices are still well above historical averages. More important, the fundamentals that drove demand for industrial materials have not dramatically changed over the past three years. The rise in purchasing power of the expanding global middle class is a trend which will last for decades; India, Indonesia and other successful developing economies will continue to industrialise, and even China’s current urbanisation rate of 55 percent is still lower than that of the U.S. during the early decades of the 20th century. The long-term prospects for commodities, in our view, are positive.

Core industrial strengths: Commodities and energy

In revamping its growth model, Australia should first play to its strengths, sharpening its long-standing competitive advantages—starting with its extraordinary endowment of natural resources. Here, Industrial Internet solutions can offer tremendous opportunities for greater efficiency, productivity and profitability.

The slowdown in commodities

Commodities have been the primary engine driving Australia’s ‘second wave’ of strong growth, as rising commodity prices drove a massive improvement in Australia’s terms of trade, which rose by nearly 90 percent between 2000 and 2011. This rise in the terms of trade boosted national income, delivering widespread benefits outside of the natural resources industry. Higher incomes fuelled stronger public and private spending in other areas, like healthcare.

The rise in commodity prices also triggered an investment boom, with capital expenditure in the mining sector more than quadrupling as a share of GDP between 2004 and 2012, to over 8 percent. This investment boom has greatly bolstered Australia’s export capacity, allowing for a strong potential increase in export volumes for iron ore, coal and LNG, among others.

A more productive and competitive mining sector, together with a broader development of high-tech manufacturing and high-value-added services, can support further sustained growth in Australia’s GDP and living standards. In the remainder of this section, we’ll outline how the Future of Work can accelerate this.
Over the last few years, however, commodities have been experiencing a cyclical slowdown, due to both a slowdown in global growth (notably in China) as well as excess capacity from the previous strong investment cycle. This has taken a toll on Australia’s growth performance. Total commodity prices have been declining or stagnant since April 2012, with industrial metals hit especially hard. However, this in our view is a cyclical adjustment, not the inversion of a trend. Looking forward, demand for commodities is set to remain structurally robust. While China is seeking to rebalance its growth model from investment to consumption, the country will still need major infrastructure investment in the coming decades as incomes rise and urbanisation continues. Compared to the U.S., for example, China’s urbanisation rate still has a long way to go. India, whose population is projected to eventually exceed China’s, is even further behind. Sub-Saharan Africa, the continent with the strongest demographic outlook, is still the one with the weakest infrastructure—a gap it will need to address to continue its strong growth performance.

In short, demand for energy, industrial metals, and agricultural products will remain strong for the foreseeable future. To keep things into perspective, it is useful to remember that commodity prices are still between two and four times higher than they were in 2000. The commodity boom has slowed, but there is no reversal of the positive long-term trend.

Creating value in the mining sector

Still, this slowdown in commodity prices, coming at the end of a strong investment cycle, has left the mining sector burdened with excess capacity, and with an urgent need to improve efficiency and margins. Though the pressure varies across a range of producers with different marginal costs of production, raising productivity has become a shared priority.

Industrial Internet solutions play a key role in mining producers’ efficiency-enhancing strategies. At a time when many companies seem fixated on finding the ‘disruption’ premium, others have recognised the immense yet untapped value of incremental advances. Global competition, volatile pricing, economic cycles and rising costs all mean just an extra one percent saving can translate into billions for the bottom lines of some of the world’s biggest companies.  

In mining, Industrial Internet solutions include advanced analytics and software to improve the efficiency of individual pieces of equipment, as well as to optimise the management of the entire mining process, from extraction to transportation to processing. Leveraging sensors and data, new technologies in remote monitoring and diagnostics can improve the performance and extend the lifetime of machinery, allow for a better quality control of the inputs, and optimise throughput. In this area, GE has developed the Mine Performance solutions as part of its Predictivity platform.

"See Annunziata and Evans (2012), “The Industrial Internet: Pushing the Boundaries of Men and Machines.”

7In this area, GE has developed the Mine Performance solutions as part of its Predictivity platform.
Industrial Internet is bringing to transportation, including higher network velocities and reduced yard dwell time.

Rio Tinto has been an early adopter of Industrial Internet solutions. Mine of the Future™, launched in 2008, is Rio Tinto’s programme to find advanced ways to extract minerals while reducing environmental impacts and further improving safety. The multinational established an Operations Centre in Perth that connects all its mines, ports and rail systems to enable fully networked operations from a single location.

This has facilitated sharing of experiences between the group’s various assets, leading to overall system improvements. Operators at Rio Tinto, which is now the world’s largest owner of autonomous haulage system trucks, are using visualisation and collaboration tools to share real-time data, ensuring that the more than 50 autonomous trucks working at its Pilbara sites are moving materials efficiently and safely.

The company launched a new phase of Mine of the Future™ in early 2014 with its Processing Excellence Centre (PEC) in Brisbane. This world-class facility enhances monitoring and operational performance by examining in real-time data from seven Rio Tinto operations spread across the globe. A trial phase has already led to various procedural enhancements, such as adjusting the flotation process to increase copper and gold recoveries at Oyu Tolgoi in Mongolia.

Rio Tinto’s Mine of the Future™ epitomises the effort to identify incremental operational improvements that translate into very significant financial value, through a marriage of engineering and analytics. Industrial Internet innovations like this will raise productivity further, strengthening Australia’s already very competitive position in mining and helping the sector to navigate the current challenge of lower commodity prices and excess installed capacity. This will help Australia’s mining sector boost commodities exports, leverage past investment—and place it in a winning competitive position for a further acceleration in exports once the global economy picks up momentum. Mining accounts for between seven and eight percent of the Australian economy. Productivity-enhancing innovation will play a crucial role in maintaining the sector’s competitive-ness, cushioning the current slowdown, and allowing it to remain an important driver of Australia’s growth in the coming decades.

Energy

The energy sector is another key comparative advantage for Australia, particularly in liquefied natural gas (LNG). Australia’s gas sector is growing rapidly. Gas supplies in Western Australia are rising, thanks to the Gorgon subsea gas project, scheduled for completion in 2015; and there is substantial investment underway to bolster LNG exports from that region.

At the same time, substantial technical and financial efforts are focused on developing coal seam gas in Queensland. Three new LNG plants in Gladstone are set to make Australia the first country to turn coal seam gas into LNG, a development that according to some analysts could make Australia the world’s largest LNG exporter, overtaking Qatar.\(^\text{9}\) A recent report by McKinsey argues that Australia could become one of the world’s biggest gas exporters by 2020, and estimates that all LNG projects proposed so far could provide as much as $320 billion in additional GDP and 150,000 jobs over the projects’ lifetime.\(^\text{9}\)

The gas and LNG market has become increasingly competitive, under the pressure of the massive shale gas exploitation in the U.S. Maximising efficiency, reliability and safety in these new projects is therefore paramount.

Industrial Internet solutions can bring substantial value here. In subsea gas operations, new remote monitoring systems can track vibrations and temperature and improve leak detection for well heads, manifolds and production stations, allowing operators to pinpoint potential issues and intervene preemptively.

Similarly, sensors and predictive analytics can improve efficiency and reliability in gas turbines, resulting in increased production at lower costs.

At QGC’s Queensland Curtis LNG plant, off the east coast of Australia, monitoring and diagnostics data is sent to GE Oil & Gas’ global iCenters located in Florence, Houston

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\(^{9}\) See for example Smyth, Jamie, “LNG boom fuels Australia export ambitions.” Financial Times, 02 October 2014.

and Kuala Lumpur. These centers house teams that constantly track and advise on the performance of installed equipment, enabling QGC to optimise plant availability and the life cycle of parts. This ability to ‘predict-and-prevent’ service and maintenance issues has dramatically increased the reliability of equipment, and helped the plant to become one of the most emissions-efficient facilities of its kind in the world.

GE’s oil and gas hub in Australia, based in Perth, has become established as a centre of industry expertise to serve customers across the region. The Jandakot technology and learning complex supports the development of skills for the oil and gas sector and is Australia’s first in-country services and maintenance facility.

The centre is also a remote-access data hub connected to subsea field control and instrumentation facilities around the world. Engineering teams are able to tap into the Global Brain of GE’s global network of people, data and machines. By facilitating local, in-country maintenance, GE’s Jandakot center is reducing production downtime, lowering costs and creating a secondary service industry in the region.

These technological improvements will be instrumental in boosting Australia’s competitive position in the energy sector. They will also help supply keep pace with an increased demand for exports without causing bottlenecks in domestic supply. With gas prices up by over 12 percent in the last five years, there is concern that as more gas is exported, some parts of Australia could experience further increases in prices. Enhanced efficiency in production would mitigate this risk—though stepped-up investment in the pipeline infrastructure might also be needed.

Boosting high-value-added manufacturing

While the commodities sector will remain the backbone of growth, Australia should aim at developing a wider range of high-value-added manufacturing activities. Advanced manufacturing innovations can play an important enabling role in this. Australia’s manufacturing heritage and its strong education and university sector are critical components to transitioning to a high-value manufacturing economy. Other initiatives like the National Broadband Network (NBN) and the establishment of Industry Growth Centres will support the establishment and growth of the next generation of manufacturing.

Later we discuss in some detail the enabling conditions that Australia will need to put in place to broaden its high-tech manufacturing base.

Advanced manufacturing offers three key advantages:

1. It unlocks greater speed and flexibility, shortening the design-prototyping-production cycle;
2. It lowers barriers to entry and redefines economies of scale;
3. It improves the efficiency of supply chains and distribution networks.

These three advantages can help Australia develop a broader range of high-value-added manufacturing activities.

This process could begin by improving efficiency in some of the existing, large scale industrial activities, which could act as a magnet for the development of related technologies and components.

Aviation

A clear example of Australia’s performance in advanced manufacturing is the leading role played by Boeing Aerostructures Australia (BAA), Boeing’s manufacturing footprint in Australia is the company’s largest outside North America, and one of its seven subsidiaries is located there. Over the past decade, Boeing has transferred an estimated $100 million in technological expertise to Australia and invested more than $500 million in plant, equipment, training, and research laboratories.

One of its leading facilities is located in Melbourne, Victoria. BAA has harnessed this co-location of research and development, design, testing, fabrication and assembly activities to produce world-class advanced structures. These include wing control surfaces for the most technically advanced commercial aircraft in the world, the Boeing 787 Dreamliner, Australia’s largest aerospace contract, valued at $5 billion over 20 years. BAA manufactures the 787’s ‘moveable trailing edge’ control surfaces,
using unique carbon fibre production technology—Controlled Atmospheric Pressure Resin Infusion—developed in Australia. The Fishermans Bend plant is recognised within Boeing as a centre of excellence for composite technology. Every part produced by BAA is exported, underscoring the competitive advantage that Australia has secured in this aspect of high-tech manufacturing.

Ecosystems play a crucial part in innovation, and Boeing’s collaborative relationships with Australian organisations enable the evolution of the country’s advanced manufacturing output. Boeing Research and Development’s 24-year long association with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) has been exceptionally fruitful, and in 2011, Boeing named CSIRO its global research and development ‘Supplier of the Year,’ out of 16,000 global suppliers. In May 2012, the two organisations announced a new five-year $25 million research programme to cover innovations in space sciences, advanced materials, energy and direct manufacturing.

Industrial Internet innovations are already delivering substantial benefits to the aviation sector. GE has developed a Flight Efficiency Services tool that uses smart software tools and analytics algorithms to help airlines to achieve higher levels of efficiency in four areas: fuel management, flight analytics, navigation services and fleet synchronisation. This results in fuel savings and fewer flight delays and cancellations. In addition, advanced manufacturing techniques are enabling significant improvements in the resilience and efficiency of jet engine components; for example, using new materials and 3D printing, GE engineers have devised jet fuel nozzles that are 25 percent lighter and five times more durable than previous versions, as well as being cheaper. 10

Positioning Australia as a regional services hub

Together with commodities and high-tech manufacturing, services should be the third pillar of Australia’s new growth strategy.

By harnessing the Future of Work, Australia can both better position itself as a regional hub for value-added services like education and healthcare (leveraging Asia’s strong growth potential), as well as improve the efficiency of nontradable services.

Education

As Australia looks to improve its service economy, aligning the education system to better meet the needs of industry should be the country’s top priority. International education is already Australia’s largest service export, with the highest ratio of overseas students to domestic students. Young people from all over the world are attracted by the very high standards and lower costs than those in many other countries. The quality of Australia’s education system is very high, and there is a very strong vocational training system.

Over the past several years, however, the performance of Australia’s education system as measured by the PISA OECD rankings has been deteriorating. In an increasingly competitive global environment, this deterioration should be addressed quickly.

The accelerating speed of innovation is set to rapidly transform industry, and change the composition of jobs. Making sure that the supply of skills matches a rapidly evolving demand will be a major challenge for the education system in the coming years. The best way to meet this challenge includes two lines of action:

1. The education system should focus on fostering problem-solving abilities and independent thinking, as well as raising the bar on science, technology, engineering and mathematics;

2. The education system and industry should foster closer lines of dialogue. These efforts could be helped by faster adoption of technological innovation in education, along the lines of massive online open courses. Action along these lines could position Australia as the leading education provider in Asia and one of the best in the world; this would boost Australia’s human capital, and underpin Australia’s successful integration into the global economy.

We will explore the dynamics of these in more detail later.
Software

Australia must bolster its software development capabilities as the worlds of digital and physical technologies continue to merge. The development of advanced analytics and software solutions tailored to industry is set to be a high-growth area, as well as an accelerator of industrial growth.

Building a stronger software sector could help Australia bolster its industrial competitiveness, and become a point of reference for other economies in the region aiming to implement Industrial Internet solutions. Given the open, collaborative nature of this new wave of innovations, domestic software capability should be developed in an inclusive, cooperative way, co-opting global industry players and establishing a structured cooperation with centers of excellence across the globe.

Healthcare and Biotech

The healthcare sector deserves a special place in Australia’s growth strategy. Like other advanced economies, Australia faces the challenge of an aging population, which will put additional pressure on the healthcare system. At the same time, the slowdown in the windfall benefit of resource-related revenues to the government budget will strengthen the need to make the healthcare sector more efficient and cost effective.

Australia is already the world’s fifth-largest center for biotech, with strong capabilities in areas ranging from bio-discovery to human therapeutics, agricultural biotechnology, diagnostics and medical devices. The sector has tremendous growth potential, given the strong need for application in agriculture, pharmaceutics and medical devices.

Industrial Internet innovations are already delivering important efficiency gains in the healthcare sector. GE has developed a hospital operations management solution, which allows real-time tracking of equipment, enabling the optimisation of patient flow and procedures scheduling, resulting in reduced wait times. Other Industrial Internet solutions focus on the quality of specific medical procedures.

For example, GE’s Dosewatch application gives hospitals a Web-based radiation dose monitoring system that tracks a patient’s exposure to radiation from any imaging device. That means clinicians can potentially reduce the cumulative radiation dose produced by a series of imaging procedures, while still delivering the high image quality needed to diagnose and treat diseases such as cancer.

Other services

Finally, attention should be given to improving competitiveness in domestic services ranging from finance to logistics to real estate services, communications, retail and wholesale trade. Most of these sectors have lower levels of efficiency and competitiveness than in the U.S., in some cases because they are shielded from global competition. All of these are key enabling sectors for domestic economic growth, and some of them are especially important to allow the new wave of technological innovation to unfold and spread through industry—notably communications and logistics.

These applications are ripe to be leveraged over a large and fast-growing market across Asia—where Australia already has well-established trade links—especially if it can realise powerful efficiencies from Industrial Internet applications, like we described above in mining and energy.

11 See, for example, http://investinaustralia.com/industry/biotechnology/australia-biotech-sector
Enabling conditions

To allow the Future of Work innovations to unfold their full potential in Australia, some key enabling conditions need to be in place. While Australia starts in a strong position, additional work is needed.

Infrastructure

The electricity network in Australia is characterised by high transmission and distribution costs; reducing these costs through greater network efficiency would help reduce energy prices to both residential and industrial consumers, boosting competitiveness. Power generation is still heavily reliant on coal; innovation could be instrumental in making investment in alternative energy more cost-effective, which could help rebalance the power generation mix in the long term and improve sustainability.

Additional investment is also needed in the communication infrastructure, to bolster the National Broadband Network. The Future of Work innovations are data driven and enabled by communication and collaboration. In Australia, 63 percent of Global Innovation Barometer respondents said that the revenue generated from collaborative innovation has increased over the last year. Australian entrepreneurs also understand that innovation is a global game, with 82 percent saying that to be successful innovators, it is necessary to merge and combine talents, ideas, insights and resources across the world. Greater investment in fast Internet connections will be a crucial condition to accelerate this collaboration and, therefore, the adoption and benefits of the Industrial Internet, Advanced Manufacturing, and the Global Brain.

Figure 9
Revenue and profits generated by collaborative innovation have increased over last year

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<th>Country</th>
<th>2013</th>
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<td>Turkey</td>
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The business environment

Australia already has a strong environment for entrepreneurs and R&D. It should work to preserve and strengthen these key advantages in an increasingly competitive global economy in two ways:

1. Strong intellectual property protection, data security, support and funding for entrepreneurs remain essential conditions for faster innovation;

2. Selected government support to encourage R&D investment in the country can also play an important role.

An encouraging sign in this respect comes from the Global Innovation Barometer, which recorded a very significant increase in the share of respondents who think that government and public authorities are allocating an adequate share of their budget to support innovative companies.

Respondents, however, still feel that the government does not do enough to support SME's in their innovation efforts.
Human capital

This element is especially important to allow Australia not only to benefit from the Global Brain, but also to be an integral part of it, to accelerate the benefits of the Industrial Revolution and Advanced Manufacturing, and to achieve fast growth in high quality jobs and incomes. Key steps in this area include:

1. The education system should give greater emphasis to science, technology, engineering, and mathematics (STEM). As technology is set to play a growing role in the economy, STEM occupations will grow at a much faster rate than the rest. The bar on basic scientific literacy needs to be raised, starting at a very young age. Additionally, the next generation of innovators won’t know a world without Internet, Google or smart phones. Our education system needs to help channel that into a strong STEM skillset;

2. Business must continue to invest in this skills gap, working closely with governments and each other to create opportunities across industries. At GE, we know we have a role to play in this. Since our Jandakot technology and learning complex opened in Perth in 2012, we have provided more than 45,000 hours of critical training and skills development to our people and our customers in the oil and gas, mining and transportation sectors;

3. The education system should focus on problem-solving skills, critical thinking and creativity. These will make people more complementary to intelligent machines—which will be able to perform an increasing range of tasks;

4. Education and skills development needs to align with the future needs of the Australian economy—a closer dialogue between education and industry will be essential to align the demand and supply of skills;

5. Education and workplace training should evolve towards a culture of lifelong learning, re-skilling and adaptability, to thrive in a fast-changing economic environment. To this purpose, they should also leverage new education technologies like open online courses, and encourage stronger employer-provided training;

6. Education and training should build more flexible skills that can allow people to operate productively across multiple industries in order to keep pace with the increasing pace of change in the economy. At the same time, the flexibility of the labour market should be maintained and enhanced, to facilitate the rapid allocation of human talent to job openings.

Enabling strong jobs growth in an environment characterised by faster innovation-driven change and disruption is one of the most important challenges of the coming decades, for Australia and for the world. Meeting this challenge will require coordinated action across education and labour markets, as well as innovation, competition and immigration policies. The recent report of the B20 Human Capital Taskforce, established by the Australian Prime Minister in the run up to the G20 meeting in Brisbane, provides a comprehensive and articulated analysis of the challenges and corresponding recommendations.

In GE’s 2014 Global Innovation Barometer, Australia saw the largest year-over-year drop in the share of respondents who feel that it is very important to attract and retain the most talented and skilled individuals. While the share is still high, at nearly three-quarters, the change runs counter to the trend we see emerging in this fast-changing economy. As innovation accelerates, attracting, developing and retaining talent will be an increasingly important condition for success.

Free trade

Australia’s openness to international trade (measured as the value of exports and imports as a percent of GDP) has increased sharply over the past three decades: it has quadrupled since 1983 and doubled since 1993. Nonetheless, its degree of openness is still lower than that of other mid-sized economies. Further increasing openness should be a priority, especially when considering that export sectors have higher productivity than non-export sectors. Priorities in this area should include:

1. To improve the trade relationships with key partners (e.g., Japan and South Korea) to reduce regulations and barriers to services

2. To strengthen Australia’s global supply chains and distribution channels, leveraging the innovations of advanced manufacturing

17 See the B20 Human Capital Taskforce Policy Summary, July 2014. The Taskforce was established under the leadership of Steve Sargent, President and Global CEO of GE Mining. Free trade
Figure 12
The importance to attract and retain talent
Conclusions

A new wave of innovation, the Future of Work, is bringing a dramatic transformation in industry. The Future of Work is driven by three fundamental forces: the Industrial Internet, Advanced Manufacturing, and the Global Brain. It is centered on the convergence of the digital world of software and analytics with the physical world of industry.

Through the power of digital connectivity, industrial equipment acquires a much broader and more powerful range of capabilities—we enter the age of brilliant machines. Industrial companies that combine the digital and the physical to produce interconnected industrial devices open entirely new dimensions in the way they operate and in the value they can provide to customers and shareholders. This results in greater speed, efficiency and productivity, substantial costs savings and enhanced competitiveness.

This wave of innovation holds the key to Australia's future. As the long boom in commodity prices has lost steam, Australia needs a new growth model for the coming decades. The innovative power of the Future of Work can make Australia's economy more competitive, resilient and balanced, enabling a new growth strategy based on three pillars:

1. Improving efficiency, profitability and competitiveness in mining, commodities and energy—the backbone of Australia's economy

2. Broadening the base of high-technology, high-value-added manufacturing

3. Becoming a regional hub for high-value-added services, from education to healthcare to technology-based business services

This transformation is already underway. In mining, Industrial Internet solutions are bringing advanced analytics and software for remote monitoring and diagnostics that help improve the efficiency of individual assets and optimise the management of the entire mining process. GE’s oil and gas hub in Perth has established itself as a centre of excellence for advanced technologies in gas and LNG. Flight management services are helping the aviation sector reduce fuel consumption as well as delays and cancellations. Industrial Internet applications are enabling the healthcare sector to deliver better health outcomes faster and at lower cost.

To fully leverage the potential of these innovations and translate them into sustained strong growth in the coming decades, Australia needs to accelerate progress in establishing key enabling conditions:

1. Strengthen infrastructure, from power distribution to communication

2. Develop the right quality and mix of human capital by strengthening the education system and bringing it closer to industry

3. Further improve the business environment to foster innovation and entrepreneurship

4. Maintain a strong focus on free trade

Australia already has a competitive business environment, high-quality human capital and a tradition of innovation, driven by both private industry and top-notch government research. It benefits from its strategic location in Asia, the fastest-growing region in the global economy. It is ideally positioned to reap the full benefits of the Future of Work. Innovation holds the key to Australia’s future growth, and can deliver strong growth in high quality jobs, higher incomes and living standards, a stronger competitive position in the global economy, and environmentally sustainable economic growth. Reaping these benefits will require significant investment and unwavering focus from both private industry and the public sector—but the rewards ahead are well worth it.
Appendix

Australia’s record growth performance to date

Australia has experienced a remarkably long period of economic expansion, registering 23 consecutive years of positive growth, unrivaled by any other advanced economy in the past half century. The first wave of economic growth was spurred by structural reforms launched in the 1980s to increase openness to international trade and allow greater immigration as well as the transition to a stable price environment, which was achieved following the 1991 recession. Even before commodity prices started taking off in the early 2000s, the Australian economy was rewarded with an exceptional decade of strong productivity growth, in which output per employed person increased at an annual rate of two percent.

The second wave of growth was driven by the strong commodity cycle started in the 2000s. Perhaps no other advanced economy was as well positioned to benefit from the rapid development of emerging markets and, in particular, by the rise of China and its apparently limitless demand for raw materials. The value of Australia’s exports to China grew from $2.4 billion in 1998 to $91.4 billion 15 years later. Roughly 30 percent of Australia’s total exports find their way to China, up from below five percent before 2000. No other major commodity—or non-commodity for that matter—exporter has undergone such a dramatic shift in its trade patterns with China in relative terms (a few small countries with undiversified economies, such as oil-exporting Angola, are the main exception).

Underlying this trend was the structure of Chinese development with its emphasis on commodity-intense investment and its increasingly global scale since the 2000s, which contributed to rising prices of natural resources. China’s rapid growth was a boon for all export-oriented economies, but especially so to the producers of coal, iron ore and other materials, which saw the prices of their products rise along with expanding volumes. Australia’s proximity to China and other key Asian consumers has been advantageous, but the country’s generally high-grade mineral deposits, top-rate mining legislation and favorable business environment have also helped.

The combination of rising export prices and volumes created considerable prosperity over the past decade, via a dramatic increase in the terms of trade from 2002 to 2011 (see Figure 13). This drove a surge in standards of living that looks impressive even compared to some of the most successful economies in the world, such as Korea and Singapore. In both countries, real GDP grew faster than Australia, but their terms of trade broadly declined since the early 1990s. Over the past quarter century, Korea’s per-capita GDP increased from 27 percent of the U.S. level to 53 percent in 2014, and Singapore’s level rose from 53 percent to a few percentage points above the U.S. level. Australia’s per-capita GDP over the same period increased from 78 percent of the U.S. level in 1990 to about 15 percent higher.

13 The improvement in terms of trade means that a unit of Australia’s exports could pay for twice as many imports at the end of that period relative to its beginning.
14 Though, when adjusted to purchasing power, standards of living in Australia still fall short of those prevailing in the U.S.
Australia’s terms of trade peaked in mid-2011, around the same time that metal prices started their descent. The fall in the price of iron ore—the country’s biggest export commodity, accounting for roughly 40 percent of commodity revenues over the past year—has been rapid. At its current price of just above US$80 per ton, iron ore is roughly 50 percent cheaper relative to its 2011 average, though still a third higher in comparison to the level reached at the bottom of the global financial crisis. While some other commodities have generally remained firmer, especially those of agricultural products, energy prices are also well below their peak as of mid-October 2014, such as coal (Australia’s second most important commodity) and oil.

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