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A future in manufacturing: Major issues to be resolved by Australia Pty Ltd.

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TITLE: **A future in manufacturing: Major issues to be resolved by Australia Pty Ltd.**

ABSTRACT:

When asked for a view for the prospects for the Australian automotive industry's survival while addressing the Australian British Chamber of Commerce in Melbourne, 11 April 2013, Jac Nasser, current chairman of BHP-Billiton gave a number of concerns that had influenced his change of mind. He cited; an exchange rate at a 30 year high, an above average level of costs in the industry, world-wide excess capacity in the industry, and weak Japanese and Euro Bloc currencies. He suggested that if a major manufacturer was to leave the Australian industry the impact of that on the component supplier infra-structure would be severely damaging resulting in a loss of scale (which is marginal at the moment *–authors' note*) and consequently would be the end of automobile manufacturing in Australia. The automotive industry is not alone in facing this problem; years of outsourcing labour intensive activities abdicated responsibility for the future of Australian manufacturing such that in not many years' time we will be struggling to catch up as Asian manufacturing moves into the high value low volume sectors of high value added industry sectors.

KEY WORDS: ***Manufacturing developments, advanced manufacturing, Supply chains are not value chains, "producibility".***

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1. Introduction

In the recent months it has become clear that Australia can no longer be regarded the so-called lucky country. "It's not that we are about to collapse but our luck has run out. Longer term, we are going to have to be much smarter". And; "Another boom is always possible, but a series of events has taken place during the past year that has turned our good fortune and shows that we have run out of luck -- we are going to need brains". *Gottliebsen R (2012)*

Terms of trade have peaked, mining investment has plateaued, the income Australia earns for the nation's economic output has gone into decline. The IMF notes in its latest report on the Australian economy, is suggesting a larger exposure to volatile global commodity prices. "National Income is falling so everyone must work harder to achieve growth. Welcome to the new normal. The golden days of the mining boom are behind us, as Julia Gillard and Wayne Swan are discovering as their precious budget surplus melts before their eyes. Everyone whose business plan relies on the very high rates of national income growth of the past decade – from the Prime Minister and her minority government to the struggling manufacturers and their unions – must find a new plan. Furthermore OECD contends Australian manufacturing is the least efficient in the developed world. Mitchell A *(2012*). And as will be demonstrated manufacturing, innovation and organisational change are inseparable components of growth.

ANZ Banking Group chairman John Morschel has warned that Australia faces a low-growth environment for the foreseeable future as the mining boom grinds to a halt amid ongoing global uncertainty. "The key challenge is weakening mining investment as softer commodity prices, high labour costs, policy uncertainty and the high Australian dollar all work against new investment projects." "At the same time, there is little evidence of the weaker sectors of the economy such as retail, housing and manufacturing recovering sufficiently to pick up the slack". Liondis and Hobbs: 2012.

The US Bureau of Labour Statistics reported Australia as the least efficient manufacturing nation in the developed world; manufacturing productivity fell 4 per cent last year (2011), placing Australia last among 19 nations. We were close behind Japan, where productivity declined by just under 3 per cent. Italy was the only other nation of the 19 advanced nations surveyed to report a fall in manufacturing productivity last year. Seven nations (including the US, Singapore, Japan and Taiwan) increased by more than 10 per cent as the global economy recovered from the financial crisis. The data measures output in national currencies per hour worked, largely eliminating exchange rate effects. Australian manufacturers blame the commodity export boom and the high dollar for their woes. Economists suggest "Dutch disease" (a high currency driven by strong commodity exports) makes many industries less competitive by pushing up wages. (Potter: 2012)

Roberts (2013) discussed Australia Pty Ltd.'s problems with the CEO of the Advanced Manufacturing Centre Cooperative Research Centre, Bruce Grey. Some interesting views emerged. The AMCRC has a developing interest in additive manufacturing which is an efficient (and an increasingly low investment replacement technology) for traditional manufacturing. Grey sees a world where low-value repetitive manufacturing is still performed in countries with low labour costs, but where high-value operations and their associated high-level services are cemented in advanced economies like our own. Grey is not dismissive of Asia but argues these are' command-driven' economies that will find it hard to move from building others' designs to building intellectual property-based (IP) medical devices and aerospace and car components. Grey argues that Australia Pty Ltd is a high-cost nation and, as such, should not consider competing with low-cost Asian manufacturing but rather focus on innovation and creating intellectual property that is closely linked to the strengths of the capabilities of the research activities that are available. Grey identifies health as a growth industry, proven to offer opportunity by the successes of Cochlear and ResMed. Grey contends that the importance of manufacturing comes in the 25 per cent of innovative activities and 13.2 per cent share of

exports for which it accounts, well ahead of its share of gross domestic product. Both organisations incorporate advanced manufacturing technology (specifically added manufacturing). This more productive technique is one of the answers Australia's key problem; making the transition from low and medium technology-focused industries to high technology, high skill and innovation-based ones where competition is not simply based on cost. High technology is used in only 12 per cent of Australia's manufactured exports, according to the World Bank.

2. A problem for western management?

The growth of globalisation and now regionalisation have extended the boundaries of the organisation to include nationally and internationally based partners. In addition to the changing attitude to strategy, structure and location, the move towards organisations as being partners within networks, operating as providers of specialist product-services within specialist markets is significant. There are important implications here; Asia has become the manufacturing engine of much of the world and businesses in the rest of the world must now accommodate the changes this demands of them. McKinsey (2012) charts the expanding difference between the growths of manufacturing output (as measured by gross value added) between advanced economies at 2.7 per cent annually compared with large developing economies at 7.4 per cent. The rate of progress (or decline) of major advanced economies and large developing economies can be seen in the chart (McKinsey Global Institute (2012), "Manufacturing the future: The next era of global growth and innovation", McKinsey and Company) attached as Appendix One. Given the economists generally agree that manufacturing is an important aspect of living standards within a country, the diagram adds emphasis to the importance of understanding how manufacturing can become the contributor it once was for the advanced economies.

This may be more difficult than it would appear. Majocchi et al (2010), offer an interesting view of current issues and future prospects. In a presentation in New York (10 October 2010) the "Challenges of global manufacturing: improving North American and European competitiveness through cooperation", they identified a number of issues. There is reluctance among NA manufacturers to pursue global growth opportunities particularly in the emerging BRIC economies where dramatic growth is expected as "hundreds of millions" of consumers continue to expend. However this growth may well not be matched by manufacturing capacity. The authors comment on a survey by HSM Americas Inc., suggesting that while European manufacturers have learned how to serve the diverse needs of customers spread across the globe and have developed the know-how to cooperate with other companies in vertically-integrated value chains, North American manufacturing companies, especially small and medium sized enterprises, have not responded similarly and need to refine production capabilities for mass customisation in order to explore the potential overseas. This includes taking advantage of green technologies – before regulations require it – which can help establish a competitive advantage in the global marketplace.

Some major differences between European and North American organisations were found. European manufacturers expressed a greater interest in increasing their production flexibility to attract business than their North American counterparts, who were more focused on reducing labour costs in the last two years, to offset economic challenges. In addition, fewer North American manufacturers were investing in innovation or R&D than the Europeans. And green manufacturing initiatives, which can help drive down material costs and spur needed innovation, were embraced in greater numbers in Europe than in North America. The authors suggest some guidelines to initiate a move towards both effectiveness and efficiency: strengthen mass customization capabilities, leverage the power of partnerships, and, take a chance and learn about export opportunities. They concluded by commenting that it is a difficult transition, requiring cultural and structural change, adding that waiting is not an option, given the fact that

competitors in China, India, Brazil and other emerging economies are moving fast to fill the void.

Germany has a number of family-owned manufacturers competing on value and innovation, making it the world's number two exporter of manufactured products. In Germany the term Mittelstand is sometimes applied to quite small, parochial firms, the most interesting ones are rather bigger and more outward-looking. Most (some 90% of them) operate in the business-to-business market and 70% are based in the countryside (Economist: 2010). They focus on market niches, typically in areas such as mechanical engineering. Dorma makes doors and all things door-related. Tente specialises in castors for hospital beds. Rational makes ovens for professional kitchens. This strategy helps them avoid head-to-head competition with global giants. It has helped them excel in these market niches. Mittelstand companies dominate the global market in an astonishing range of areas: printing presses (Koenig & Bauer), licence plates (Utsch), snuff (Pöschl), shaving brushes (Mühle), flycatchers (Aeroxon), industrial chains (RUD) and high-pressure cleaners (Kärcher). Globalisation has been a godsend to these companies: they have spent the past 30 years of liberalisation working quietly to turn their domination of German market niches into domination of global ones.

An Economist article (2009) reported that Japan also has a number of very successful medium sized organisations – chuken kigyo – strong medium sized firms that have a number of these organisations: Shamano, 60/70 % of world's bicycle gears and brakes: YKK, 50 % of world's zip fasteners: Nidec,75 % of world's motors for hard disk drives in computers: Mabuchi, 90 % of world's micro-motors used to power the adjustment of rear view mirrors in automobiles: TEL, 80 % of the etchers used in LCD panels: Covalent, 60 % of containers that hold silicon wafers as they are converted into computer chips: Murata, 40 % of world's capacitor market (50 % margin): Japan Steel Works, 100 % of the world market for solid steel containers that contain radioactive materials. It is certain that the "New Economy", whatever format that eventually takes, will be influenced by this business model format and it is noticeable that in those countries where manufacturing rapidly migrated to Asia as it became industrialised (to the extent that it now dominates a number of sectors) there are signs (such as those suggested by the Mittelstand model) that being part of a value chain network can reduce the exposure to high volume/low value competition and that profitable opportunities do exist. Both models are suggesting that long-term success requires a competitive advantage that can be globalised by participating as a specialist activity within a relevant value chain network.

2.1 The nature of manufacturing has changed

A basic misunderstanding concerning manufacturing is to assume that the large 'smoke stack', vertically integrated organisations of the Mid-1990s continue to dominate industries. Drucker (2001) noted that while the traditional response to market pressures was vertical integration on a large scale, citing Standard Oil and Ford as leading examples, today even the large corporations are leading the changes in strategic posture. General Motors for example are creating a business for the ultimate car consumer - they aim to make available what car and model most closely fits that consumer's preferences. As Drucker noted the changes to facilitate this are not just sales and marketing driven, but encompass design and development, and production. Products and services now have multiple applications and business organisations are redefining their core capabilities and processes. In other words "value chains ", are competing with "value chains". At this macro, industry level value chains can be seen as business network structures, or confederations, that are developing from traditional corporations. Since then the application of technology, particularly information communications technology has resulted in a major dispersal of manufacturing it has become a 'networked' activity: "Value chains involve multiple players in many countries with the key tasks spread globally rather than squeezed into one place" (Maurer: 2011). The result is that a myriad of specialist activities are involved in manufacturing often offering a unique capability; the Mittelstand and the chuken kigyo fulfil this vital role in the value chain network.

2.2 What is manufacturing and advanced manufacturing?

A problem confronting Australia Pty Ltd is to understand what is meant by the term "manufacturing". While this may appear to be a naïve question is one that The US Executive Office of the President, President's Council of Advisors on Science and Technology was asked when considering the future of manufacturing in the US economy. The result was:

> *"Advanced manufacturing is a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. It involves both new ways to manufacture existing products, and the manufacture of new products emerging from new advanced technologies."*

President's Council of Advisors on Science and Technology Report to the President on Ensuring American Leadership in Advanced Manufacturing, July 2012.

An interesting point made by this definition is that for probably the first time the importance of networks and networking is identified and acknowledged. However there is an omission; it does not consider commercialisation and the need for customer involvement.

McKinsey (op cit) suggest a promising future for countries that develop an appropriate response. Their research suggests another 18 billion people will enter the 'global middle class' thereby doubling worldwide global consumption to an estimated $(US) 64 trillion. Developing economies will contribute to this demand for consumer products and services as well as continuing to demand capital equipment. McKinsey's report identifies the importance of developing economies as consumers as well as integral components of the supply chain. Much of the content of the report is relevant to this proposed research topic; its conclusions are of interest to the development of a business model for Australia Pty Ltd (2015/20). It is suggested that to take advantage of the opportunities Australia Pty Ltd will be confronted by challenging environment requiring them to create a new kind of global manufacturing company; … " an organisation that more seamlessly collaborates around the world to design, build, and sell products and services to increasingly diverse customer bases". And "These organisations will be knowledge driven, be lean and agile, and capable of identifying and working with ecosystems of partners within a global value chain network to drive decision making, enhance performance, and manage complexity".

They describe an era of global manufacturing opportunities for both advanced and developing economies. There will be a need for highly agile networked enterprises using information and analytics involving highly talented employees to deliver products and services to diverse global markets. Advanced economies are expected to drive innovation and productivity growth. However, it is essential that countries understand the evolving nature of manufacturing. The add the comment that manufacturing industries have helped drive economic growth and rising living standards for nearly three centuries; for an enlightening account of these "three centuries" see Marsh (2012).

The New America Foundation unveiled its own strategy in April titled "Value Added: America's Manufacturing Future". Authors Lind and Freedman (2012) note the dramatically changing nature of manufacturing in this country emphasizing that our future (i.e. USA) lies in high-value products. They see Germany's applied research, financial assistance to small manufacturers and workforce training as a model for the U.S. government to emulate. At the same time, they share a need to develop a long-term energy and infrastructure policy, fixing the tax and regulatory systems, training workers for a 21st century plant floor, and "promoting mutually beneficial rather than adversarial trade."

But manufacturing is changing, and the contribution of manufacturing to the American economy makes it all the more important for the U.S. to capture the gains of the next generation of manufacturing innovation. Advanced manufacturing encompasses the wave of revolutionary technologies that includes robotics, nanotechnology, photonics, bio-manufacturing, the

synthesis of new materials and additive manufacturing or rapid prototyping, which promises to replace mass production with customized production in many industries. New kinds of business organization, made possible by advanced communication and information technology, are transforming the way manufacturing firms operate. A product-SERVICE strategy perspective (as opposed to PRODUCT-service strategy in which service is an activity that manages warranty and maintenance for customers) is seen as an opportunity to create sustainable competitive advantage. Rolls Royce Aero Engines now sell the productivity their engines offer, they no longer sell the hardware but rather the process by which a product-centered firm adopts a product-service strategy; revenues from services throughout the product's physical lifecycle are as or more important than the sale of the original product. Furthermore the added value for the customer is the opportunity cost of the capital once tied up in hardware. Other innovative attempts at sustainability include recycling components from existing products, refurbishing (extending products' physical life cycles) and retro-fitting (designing the current product with a view to adding update components subsequently). Mercury Marine, a US manufacturer of marine propulsion systems, related products, services and accessories increases part re-use by engineers and designers has extended this concept by using product life cycle management software.

2.3 The factory of the future?

The forgoing suggests some major structural changes in the notion of what manufacturing is, what it is, and how it operates. Barkai and Manenti (2011) argue that current market trends require the future production environment to be highly adaptable and reconfigurable to respond to rapid changes in market demand, technology innovation and changing regulations. Flexible manufacturing technologies employed by most automakers are a critical ability in this process and the foundation for profitable growth, but these alone will not suffice in a long term strategy to fend off the competition. The authors suggest a practical "design anywhere, make anywhere, sell anywhere" strategy is needed, and propose, arguing that:

> *"Factories of the future will be a global network of production facilities managed as single virtual factory. This type of manufacturing network consolidates multiple resources and capabilities to form an end-to-end fulfillment network that we call fulfillment execution system (FES)."*

FES is an approach to a coordinated management of demand, capacity and resources, and outbound order fulfillment across the entire network of manufacturing plants and along the supply chain. Data gathered will be connected to corporate-level intelligent decision support tools, creating visibility and intelligence on operational data. It enables manufacturers identify problems, isolate root causes, understand the state of execution processes, and adopt corrective actions quickly across multiple plants. The authors' proposal takes us beyond the marketspace/marketplace work of Rayport and Sviokla (1994) in which they suggested the traditional marketplace interaction between physical seller and physical buyer are being eliminated. In the marketspace the content of the transaction becomes information, the marketplace becomes a screen interaction using electric media. Costs are lower, convenience increased and the process more transparent. IDC Manufacturing Insights' introduced Global Plant Floor model in October (2012) following much the same approach: a network of factories, managed as a unique virtual factory that consolidates the number of different manufacturing plants in terms of resources, processes, and products with the ability to harmonize, supervise and coordinate execution activities across company's and suppliers' manufacturing operations, with greater level of real-time visibility; and, with Centres of Operational Excellence and plant-floor IT seen as essential to this transformation. Together these concepts propose a coordinated international multi-plant operation that may located anywhere by using ICT facilities.

3. The supply chain ≠ the value chain

It is of particular interest to note that in a number of industries their structures have become fragmented; large vertically integrated organisations have divested many of the activities they once considered to crucial to their success to specialist organisations with who they work very closely, sharing confidences and decisions. Normann (2001) discussed "a new strategic logic", suggesting that:" …managers need to be good at *mobilizing*, *managing*, and *using* resources rather than at formally *acquiring* and necessarily *owning* resources. The ability to reconfigure, to use resources inside and particularly outside the boundaries of the traditional corporation more effectively becomes a mandatory skill for managements". These comments identified much of what was becoming common practice. Earlier McHugh et al described the holonic, or virtual, organisation structure is a model finding favour; the holonic organisation or network is:

> *"…a set of companies that acts integratedly and organically; it is constantly re-configured to manage each business opportunity a customer presents. Each company in the network provides a different process capability and is called a Holon". McHugh et al (1995)*

Marsh and others have commented upon the flexibility of the value chain network; (Porter: 1985, Rayport, and Sviokla: 1995, McGuffog T and N Wadsley:1999, Normann R and R Ramírez 1993, Walters D and G Lancaster, 2000, Gereffi, G., Humphrey, J., Kaplinsky, R. and Sturgeon, T. J. (2001), and Walters D and M Rainbird (2012). Marsh qualifies the value chain network as innovative with; "… in the early years of the twenty-first century, the realization grew that making products is just one part of the 'value chain' of company operations. Others include design and development, and the way products are maintained or 'serviced' after installation. And: "*To be considered a great manufacturer, companies do not need to make anything, even though they will almost certainly know a lot about what this entails"*. Increasingly, elements of the value chain are being left to a variety of businesses in different countries. The management of this mix is becoming a highly prized skill". Porter (1980, 1985) introduced the notion of the value chain suggesting it to be more than the sum of its activities; rather he saw it as an interdependent and interconnected network of activities. Its focus was on efficiency rather than an effective customer centric structure that optimised costs, rather than minimising them, to ensure customer satisfaction. It is suggested by this author that the essential difference between the value chain and the supply chain concepts is very simple: the value chain takes the end-user as its focus whereas the supply chain is concerned with structuring its activities and processes within the context of a budget. The value chain is a *strategic concept* seeking to identify an *acceptable customer focused value proposition* with the end-user customer and to organise its activities (and those of its supplier partners) around this objective: the supply chain is an *operational response* that optimises its activities to meet a specific customer focused value proposition. Within the context of the value chain network this requires an involvement by each of the stakeholders in defining a value proposition and in its effective delivery: *Value chain networks* are a means by which customer desires are translated into deliverable product-services; supply chains are the constructs that are used to deliver them.

There are examples of Australian and International organisations that have seen and accepted the need to adapt to the changing business environment by focusing on their core capabilities to work as components of international value chain networks these include:

GKN Aerospace & Engineering; has designed more than 1000 parts for the Lockheed-Martin F-35 Lightning ll Joint Strike Fighter

Peregrine Australia; manufactures a radio frequency sapphire water chip combining antenna and amplifier for manufacturers of 'top-end 'mobile phones.

GPC Electronics, Sydney; Superior quality of systems and management (flexibility and complexity) has resulted in negotiated supplier lead times of 2 weeks and order response times for customers of 4 weeks.

Bosch Melbourne; R&D led customised manufacturing that requires extensive *knowledge IP inputs* provides customers with market exclusivity/differentiation without extensive R&D expenditure

Codan communications equipment supplier, Adelaide; **p**roducts are designed on standard modules/platforms, thereby reducing inventory holding for both Codan and their customers; and also reduces order lead times providing a 5/10 day order response time in comparison with competitors' 4 weeks or more.

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International examples of collaborative strategies are also available and include:

Endo Pharmaceuticals/UPS (Healthcare Division): After acquiring DuPont's drug division positioned itself in the value chain network (VCN) to distribute prescription and other drugs in the US from contract manufacturers in overseas locations. Endo has a partnership in which leases space and UPS's expertise at handling controlled substances

Lego launched a "Classroom of the Future" project with US university to teach children about science & technology; launched "LegoFactory.com" a "Lego Digital Designer" that offers an opportunity to design and order a unique Lego model, and; a joint venture with the ***MIT Media Lab*** that introduces robotic Lego

IKEA and ***Skanska*** have a successful partnership, ***Boklok*** that manufactures, sells, and erects prefabricated homes and hotels.

Dow Chemical: locates manufacturing close to the cheapest sources of energy (Middle East & Russia) and from where it can contain the supply chain costs in servicing 'booming' markets in Asia and China

Philips: team up with academic & industry with comparable research interests and capabilities to work on industry standardisation and technology developments

TomTom (GPS): identified its capabilities to be in 'innovating' in a particular area of technology and its understanding of consumer needs in the area. It established a manufacturing outsourcing capability – rather than a manufacturing expertise. It has become a 'design only' and a marketing organisation, relying upon strong manufacturing partnerships to produce the *TomTom* product at a level of quality, cost, and in the required quantities.

Hewlett-Packard: Outsources 90 per cent of its manufacturing volume to some 40 suppliers. HP's core capability is now focused on 'managing contract manufacturing

Boeing and ***Embraer*** (Brazilian aircraft manufacturer of regional short range aircraft) have announced that they have agreed to jointly develop new aircraft features and technologies and pursue several areas of cooperation, including commercial-aircraft features that enhance safety and efficiency, research and technology, and sustainable aviation biofuels.

UPS Inc.: provides resources that enable both small (and some large) organisations to operate as *large organisations* in large global markets by:

Linking ***eBay*** and ***PayPal*** processes with those of UPS to facilitate a 'track and trace service for eBay users.

Managing the repair service processes for Toshiba in the US.

Undertaking a complete redesign of Ford's automotive distribution system in North America; to reduce inventory holding by reducing the inventory cycle from one month to ten days, and by; improving the accuracy of orders/deliveries.

These are but a few of the examples providing evidence that network partnerships offer the benefit of offering synergistic performance Each partner invests only the capital and specialist

capabilities required to produce or process its specialist contribution to the network product-service output. Friedman (2006) identified a number of other international examples.

4. Producibility and the value chain network

To arrive at a 21st century concept of manufacturing it is necessary to build on the concept Boothroyd et al (1982). Increasingly the end-user customer is working with the network that is attempting to maximise the customers' satisfaction. Both are involved in an extensive internet dialogue that results in a value proposition that is acceptable to the customer and a product specification and a manufacturing process that is economically viable to value chain network. Essentially this is *producibility;* it considers not just the operational processes involved in delivering value to the end-user customer but takes account of what, how, where, when, and who will be using the product-service, in order that the end-users objectives will be met at the end-users budgeted costs.

Producibility is a total design activity that includes all relevant activities within the value chain network and creates intra and inter-organisational partnerships by applying *total cost analysis* to evaluate an optimal structure to achieve end-user satisfaction. It is a management process whereby the product-service design process is integrated with the manufacturing process in an attempt building *strategic effectiveness* into the value proposition by integrating both design and manufacturing processes to achieve *production efficiency* (I. e; manufacturing business model, quality specifications, volume and delivery targets at target costs and commercial prices), (Boothroyd et al: op cit). However to be an effective network model the concept requires expansion:

Producibility is the *total design* activity that includes all relevant activities and processes within the value chain network and creates intra and inter-organisational partnerships to achieve *stakeholder* satisfaction. It is a management process whereby the *product-service-design* process is integrated with the design of manufacturing processes and the subsequent the operational processes of physical distribution and service support management that are aligned with the *end-user application* of the product and a customised program of service support.

Integrating product-service design processes and operations management processes (manufacturing and physical distribution, and service processes creates *strategic effectiveness.* Coordinating the processes achieves operating *efficiency* (i e; manufacturing model, quality specifications, volume and delivery targets at target costs).

Examples of applications of producibility practices include; *John Deere* and *Harley Davidson* have leveraged DFMA (design for manufacturing and assembly) over the years to achieve impressive results, including cost reductions of 50 per cent, shortened product development cycles in the neighbourhood of 45 per cent and part count decreases of nearly half. *Whirlpool's* management deemed DFMA as central to the firm's strategy to be the number one cost leader in all of its product categories at each of its price points (according to James D. Bolton, global lead, value engineering and DFMA). Now some years into the program, DFMA is now part of the company's process for product development and is used equally to redesign existing products as well as to optimize new product designs.

Clearly not all of the activities are performed by any one organisation but given the assets, capabilities, capacities and processes of current and potential network members, together with the end-user expectations, it is now possible to design the product-service, the manufacturing processes, the physical distribution processes, and the maintenance service activities concurrently. By identifying the 'value-added intensity profiles' within each network member it is possible to construct *industry value-adding chains* (*McKinsey Global Institute)* op cit. If a *producibility-approach* is taken it is possible that structured -value - adding chains can be constructed and their efficacy be evaluated. This is becoming economically viable with the more recent ideas of Barkai and Manenti; (2011), the *Fulfilment Execution System* (FES) and IDC Manufacturing Insights' *Global Plant Floor* model introduced in October of this year.

Together these concepts propose a coordinated international multi-plant operation that may located anywhere by using ICT facilities.

4.1 Technology, education and manufacturing

An important factor that is frequently discussed is the increasing rate at which technology is replacing repetitive tasks in manufacturing. Robot technology is changing the structure of manufacturing; robots are now 'multi-skilled'; and are now able to perform sequences of manufacturing processes and their cost is reducing rapidly. This has been noted in the US.

Luce (2013) reporting on the small increase in US manufacturing employment highlighted the impact of technology on manufacturing, he reported; "With each month, the US economy becomes steadily more automated. In January the US economy added just 4,000 manufacturing jobs, and the net increase since July is zero. Yet last month, manufacturing activity rose by its fastest rate since April, according to the Institute for Supply Management. The difference boils down to robots, which pose an increasingly nagging paradox: the more there are the better for overall growth (since they boost productivity); yet the worse things become for the middle class. US median income has fallen in each of the last five years". And; "Manufacturing employment is shrinking around the world. Among other countries, China is moving even faster towards industrial robotics, an area in which German and Japanese manufacturers dominate. Last year Foxconn, the Shenzhen-based assembler for Apple, Nokia and others, announced it was considering purchasing one million robots during the next three years to substitute for workers performing repetitive manual tasks. At the other end of the spectrum, a restaurant in Harbin, northern China, last year became the first to be entirely waited on by robots.

"We still think about manufacturing in the U.S. as yesterday's economy as opposed to the vanguard of innovation in our economy," Katz, (Brookings Institution), pointed out at a Brookings Institute Event manufacturing accounts for "9% of jobs, 11% of GDP, 35% of engineers, 68% of private R&D, and 90% of our patents. *We may be the only economy to decouple production and innovation."* Pisano and Shih (2012) make a convincing case for the strong relationship between manufacturing and innovation being positively correlated. Fischer, a former manufacturing CEO, told the conference that when GE was hiring for its appliance factory in Louisville, it needed 1,000 employees. Some 12,000 applied for jobs, Fischer said, but only a quarter of them were qualified for the jobs. He said the U.S. needs to not only promote technical skills but also soft skills such as the ability to work in teams. Fischer echoed other speakers that a cultural change needs to take place in the United States so that manufacturing jobs are valued and young people see them as desirable career paths. As an example, he pointed to industrial maintenance technicians as one of the important positions in manufacturing, with incomes reaching $80,000 to $100,000. While they are "absolutely necessary" to keep factories running, Fischer said, their ranks have been diminished by 10 to 15 years of outsourcing and an aging workforce.

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There is an international problem being identified here: Tony Shepherd, president, (The Business Council of Australia) at a National Press Club address, called for increased efforts for; "... all (Australian) young people should complete at least 12 years of education or training to

prepare them for the workplace, or further vocational or university qualifications," suggesting the Government's target of 90 per cent should be exceeded. Currently only the ACT exceeds this total (90.1%) with the remainder of the States in the mid-eighties with the exception of Tasmania at 78.2 per cent.

Concluding remarks

Industrial and other informed commentators have a variety of views of the performance of manufacturing in Australia Pty Ltd and how this may be improved. Equally there are views on how government policy could assist competitiveness. This is unlikely to change unless we agree an acceptable understanding of what 21st Century manufacturing comprises; the global network structures that operate in contemporary manufacturing, the implications these have on investment, and on developing working relationships with partners who may well be across the world as well as those in Australia. Among the issues to be considered are:

The necessity of identifying a realistic understanding of manufacturing in order that Australia Pty Ltd may compete in the global business environment by evaluating the opportunities for Australia Pty Ltd to create added-value in viable network: *Value chain networks* are a means by which customer desires are translated into deliverable product-services; *supply chains* are the constructs that are used to deliver them.

Identifying and coordinating the emerging applications of technology to manufacturing and the opportunities offered to Australia Pty Ltd of advanced management.

Identification of the relevant research issues confronting manufacturing for Australia Pty Ltd. Some may be easily identified such as government policy and assistance, a trained labour force capable of understanding the technology now being applied to manufacturing and working with it. Identifying these issues is not sufficient, doing something about them is important.

Reviewing what the new manufacturing model means for productivity and the scope of the application of producibility by Australia Pty Ltd and its major competitors in North America, the EU and Asia

In conclusion it is worthwhile revisiting the press interviews given by Mr Jeff Immelt during a recent visit to Australia Pty Ltd. Mr Immelt sees the next notable trend that will shape strategy as the "industrial internet" which is connecting smart machines and equipment such as jet engines that generate a stream of data on their condition and their efficiency. Using this data to predict failures and reduce equipment downtime will ultimately pay off for users. General Electric is well down the path of advanced manufacturing technology. The company has' re-shored' its white goods business, having overcome the competitive wage rates of Asia by 'robotising' the GE manufacturing facility of the South Carolina plant.

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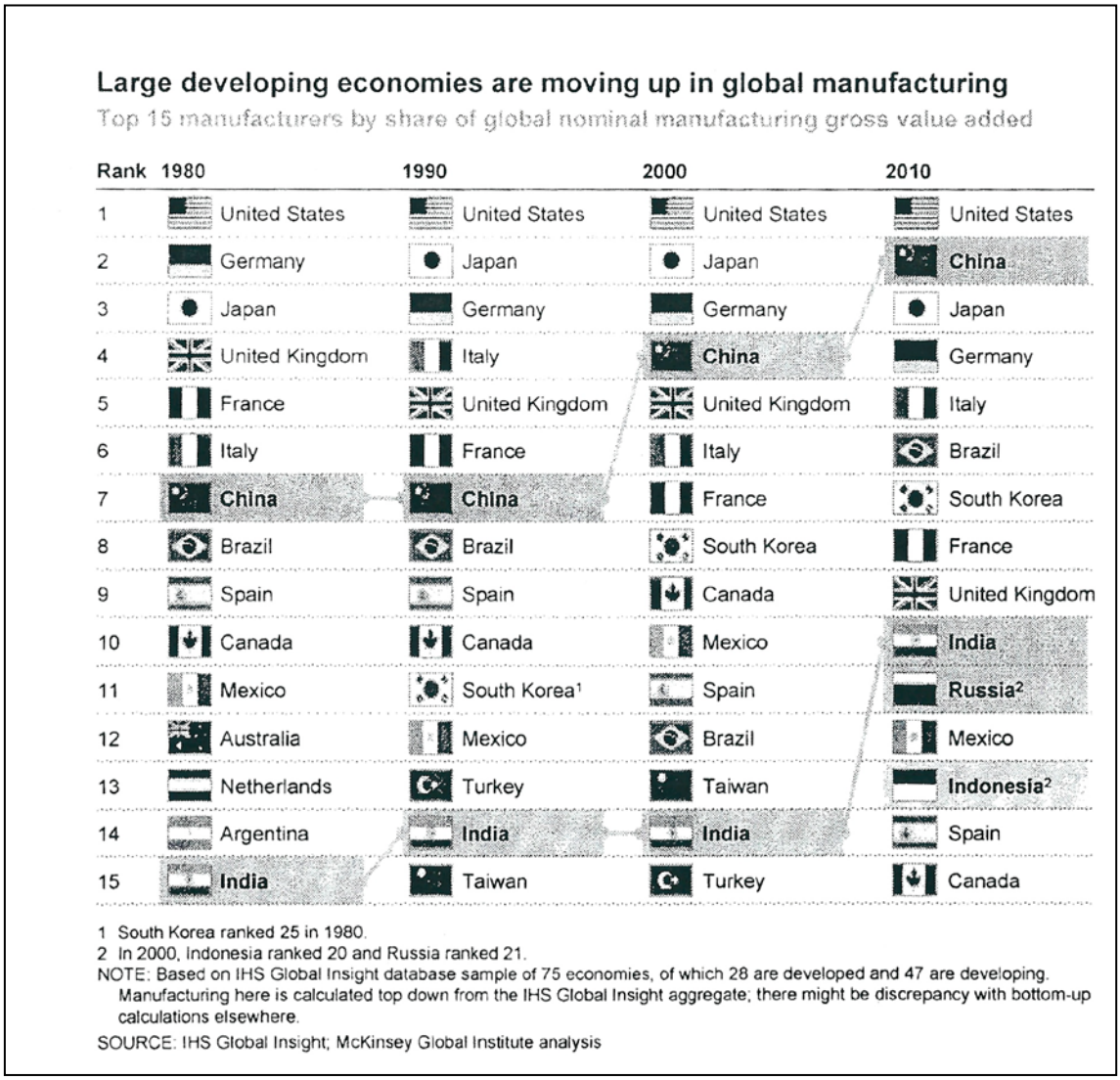
Appendices



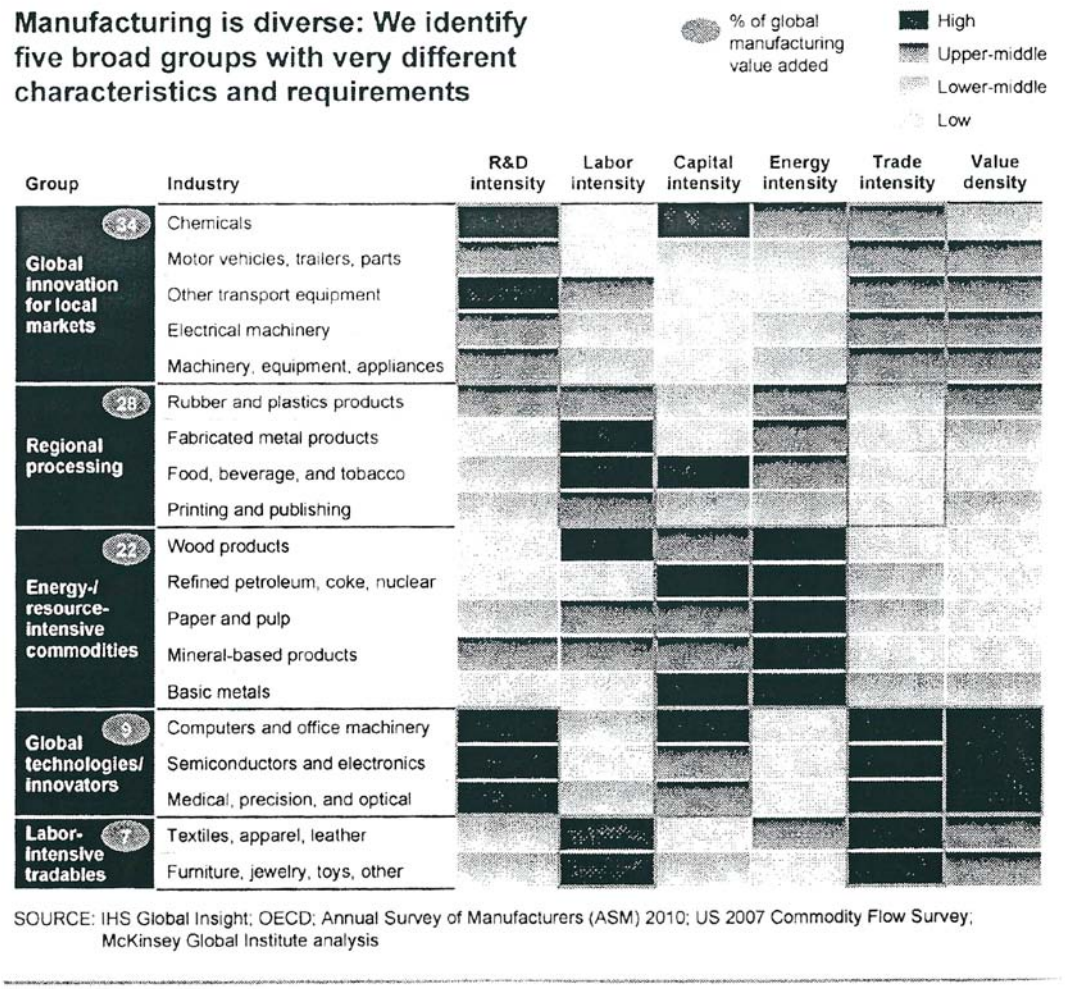
Large developing economies are moving up in global manufacturing

Top 15 manufacturers by share of global nominal manufacturing gross value added

Rank	1980	1990	2000	2010
1	United States	United States	United States	United States
2	Germany	Japan	Japan	**China**
3	Japan	Germany	Germany	Japan
4	United Kingdom	Italy	**China**	Germany
5	France	United Kingdom	United Kingdom	Italy
6	Italy	France	Italy	Brazil
7	**China**	**China**	France	South Korea
8	Brazil	Brazil	South Korea	France
9	Spain	Spain	Canada	United Kingdom
10	Canada	Canada	Mexico	**India**
11	Mexico	South Korea[1]	Spain	**Russia**[2]
12	Australia	Mexico	Brazil	Mexico
13	Netherlands	Turkey	Taiwan	**Indonesia**[2]
14	Argentina	**India**	**India**	Spain
15	**India**	Taiwan	Turkey	Canada

1 South Korea ranked 25 in 1980.
2 In 2000, Indonesia ranked 20 and Russia ranked 21.
NOTE: Based on IHS Global Insight database sample of 75 economies, of which 28 are developed and 47 are developing. Manufacturing here is calculated top down from the IHS Global Insight aggregate; there might be discrepancy with bottom-up calculations elsewhere.
SOURCE: IHS Global Insight; McKinsey Global Institute analysis

Appendix one



Appendix two