Introduction: manufacturing matters: space, place, time and production

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Manufacturing has undeniably transformed the world; from new inventions and technical improvements in machinery and manufactured products to the development of new production systems (Best, 2001; Owen, 2000). Manufacturing has played a critical role in creating the evolving global or international economy and in economic development. The ongoing formation of a global economy would be impossible without products produced by manufacturing production systems. The development of global commodity chains required innovations in logistics and the introduction of containers and container ports. While manufacturing dominated the 19th and early to mid 20th centuries as a significant component of developed market economies, it is sometimes considered to be of less importance from the 1970s. From the 1970s, developed market economies underwent a process of deindustrialization which involved a relative decline in industrial employment and a rise in service employment (Bazen and Thirlwall, 1991; Bluestone and Harrison, 1982).

Many accounts of developed market economies assume that manufacturing no longer matters. In a recent British guide for parents, written by an award-winning teacher, it is claimed that: “Britain’s manufacturing industry is spent. We are in an age where our chief export is intellectual property. To design fantastic things that people will want to buy, we need a nation of people who can dream things up, not simply regurgitate and obey” (Beadle, 2007: 10). This claim misrepresents the role that manufacturing continues to play in developed market economies. Knowledge-based employment has become important, but making rather than just designing products is still important for developed market economies. Employment in manufacturing has declined with productivity improvements and the development of capital- and knowledge-intensive production, but manufacturing still forms a major element of exports from developed market economies and in the creation of gross domestic product (Bryson *et al.*, 2013; Cohen and Zysman, 1987; Fingleton, 1999; Moretti, 2013).

Accounts of the decline of manufacturing in the US and UK (Bluestone and Harrison, 1982) and the transfer of production to lower-cost production locations have tended to focus too much on the decline in employment. Much of the academic debate has emphasized the emergence of new global commodity chains and the continued fragmentation of production (Dicken *et al.*, 2001). Deindustrialization was explained by differentials in factor inputs with a focus on labor costs and the transfer of production from high- to low-cost labor locations. Nevertheless, labor is only one production input and not all manufacturing is labor intensive (Loch *et al.*, 2007).

While 1966 is etched in the United Kingdom’s historical consciousness due to exploits with a football, it is also significant as the highpoint of manufacturing employment in the country. In 1966 manufacturing accounted for 35 percent of Gross Domestic Product

(GDP), employed 8.7 million workers (Select Committee on Trade and Industry, 2002) and was at the center of the country's post-war economic boom. Manufacturing industries are in a continual state of change as new technologies, products, processes and forms of competition emerge (Christopherson and Clark, 2009). In this sense, manufacturing sectors emerge, grow, restructure and decline in different ways and at different times. During the early years of the 20th century there was a debate regarding the decline of the British gun industry. According to two anonymous Birmingham gun manufacturers:

The evidence of decline comprises a lessening output at the British centre of the industry [Birmingham]; increased outputs at foreign centres of production; British exports of fire-arms are decreasing in number and value; British imports are increasing; the number of fire-arms manufacturers or manufactories is less than it was twenty-five years ago, but the number of retailers and merchants has increased; certain branches of the trade have disappeared; the industry is less prominent than it was; it is not so profitable as it used to be. (Artifex and Opifex, 1907: 31)

This account of British manufacturing identifies many different ways of measuring the decline of manufacturing – from a decrease in exports to a decline in profitability. This analysis was concerned with the increase in imports and a decline in exports, but also with the erosion of Birmingham's gun cluster and a decline in skills. The decline in the gun cluster was measured by an increase in demand for parts made in other countries and it was noted that “[n]ot many years ago everything requisite to the production of a small arm of any known type could be found or made in Birmingham; now, so many parts of various guns are imported from Belgium, or elsewhere” (Artifex and Opifex, 1907: 25).

This decline in the Birmingham gun cluster reflects a particular period in the economic history of Britain's fire-arms industry; this period of decline was followed by growth related to the onset of World War I. This account of the fire-arms industry highlights the need for detailed studies of industrial sectors and company case studies (Christopherson and Clark, 2009).

Since the 1970s the focus of academic and political debate has shifted towards charting the decline of manufacturing in developed market economies (Bazen and Thirlwall, 1991) and the rise of service employment (Bryson *et al.*, 2004; Gallouj, 2010). From 1970 manufacturing in developed market economies experienced a series of recessions and also the onset of competition from emerging economies. This is a complex history that includes the rise of Japan and then Taiwan, followed by Indonesia and China as important centers for labor-intensive manufacturing (Midler, 2011). The production of products has been switched between locations as the cost base of older “emerging economies” was undermined by newly emerging economies. The design and fabrication of the Barbie doll is a classic example of the changing economic geography of American manufacturing (Bryson and Rusten, 2011: 117–122). Barbie is designed and managed from the USA by Mattel, but has never been manufactured there. She would be too expensive to produce in the USA. Initially she was manufactured in Japan, but then production shifted to Taiwan in 1967 and Indonesia and China in 1987. The opening of the Taiwanese factory was an important innovation in global outsourcing. It is production decisions like this that led to the transformation of eastern Asia into the new “workshop of the world.” Barbie's design team has always been located in America and has always been separated from production. This represents an early application of an international

division of labor. Taiwan's economy developed from 1967 and this led to better working conditions and higher salaries as Taiwanese manufacturing shifted from producing low-value products to high-value electronics – laptops, personal organizers and MP3 players. As wages rose, Mattel shifted the manufacture of Barbie to mainland China. It is interesting to note that the “daughters of Taiwan's first Mattel employees are [employed in making] computers and [in] public relations” (Spencer, 2005: 15). Barbie's Taiwanese legacy is a Barbie museum that was opened in Taishan and on display are bridal Barbies, combat Barbies and Barbies in Chinese dresses.

Since the 1970s, manufacturing has been transformed. Manufacturing companies that design, market but outsource fabrication to anonymous contract manufacturers have become more like service firms. There are still many companies that design and manufacture but also provide products with embedded services. The dividing boundaries between manufacturing and service activities have become increasingly blurred (Bryson, 1997; Bryson, 2009; Bryson 2010; Bryson and Daniels, 2010; Daniels and Bryson, 2002). Manufacturing firms have been transformed into creative companies in which workers from across the supply chain work together to develop products and services. This transformation reflects new forms of financialization (Dore, 2008; Epstein, 2005), geographies of production, employment, logistics and consumption. However, academic understanding of manufacturing has not kept pace with these transformations. Much of the academic debate and literature has revolved around understanding the new knowledge-based economy and the service sector in general, and there has been a much more limited focus on manufacturing (Bryson *et al.*, 2004). In developed market economies there have been difficulties with the public perception of the manufacturing sector. The manufacturing stigma is not easily obliterated from the minds of those who consider manufacturing employment as low waged, labor intensive, repetitive, outdated and temporary; making it less attractive to young workers and entrepreneurs than service employment.

Since the early 1970s, British industrial policy has not had a specific manufacturing focus (Livesey, 2012). Successive governments have focused on the deregulation of financial services, privatization, attracting foreign direct investment, encouraging the growth of clusters, promoting research and development, and entrepreneurship (Beath, 2002; BDO, 2010; Livesey, 2012). British policy emphasized the importance of financial and knowledge-intensive services, and manufacturing was often considered to be an activity that was best undertaken in countries with low labor costs. The credit crisis of 2008–2009 that was centered around failures in the financial system led to a new political debate that called for a rebalancing of the British economy towards manufacturing and away from financial services (HM Treasury/Department of Business, Innovation and Skills, 2010). In March 2011 the Chancellor of the Exchequer concluded the Budget statement by arguing manufacturing would play a central role in the UK's economic recovery and that: “We want the words: ‘Made in Britain’, ‘Created in Britain’, ‘Designed in Britain’ and ‘Invented in Britain’ to drive our nation forward – a Britain carried aloft by the march of the makers. That is how we will create jobs and support families” (House of Commons, 2011). This concern with rebalancing can be traced back to 2008 with the publication of a new industrial strategy that argued the “UK's future lies in a mixed and balanced economy, where manufacturing activities complement services to deliver the widest possible range of economic benefits across all regions, and create skilled jobs that

span the entire value chain, from research through to fabrication, branding and sales” (Department for Business, Enterprise and Regulatory Reform (BERR), 2008:5).

This edited book brings together scholars working on manufacturing from many different countries and academic disciplines. The aim is to develop a state-of-the-art account of manufacturing research by exploring theory, method, empirical research and policy. Our intention has been to create an inter-disciplinary collection that includes academics from across the social sciences and also engineering.

STRUCTURE OF THE BOOK

In both an international and multi-disciplinary context, this *Handbook* aims to provide a critical review of current manufacturing processes, practices and policies to broaden understanding of the dynamics of manufacturing, both theoretically and empirically. It aims to engage with and reflect upon the current state of manufacturing as well as the politics and policy of how we think about and practice manufacturing policy (Clark, 2013). The chapters in this handbook seek to enhance understanding of the ongoing debates about related aspects of manufacturing which include production processes, labor, supply chains, logistics, financialization, design and innovation; regional strategies and policies; manufacturing and management; and manufacturing and labor relations. Furthermore, they include insights into advanced manufacturing, energy costs (Mulhall and Bryson, 2013, 2014), raw materials, and industry and firm case studies of manufacturing from around the world.

This handbook is organized into five parts. Part I is the Introduction. Part II comprises 11 chapters serving as building blocks in understanding factor inputs and product organization. Part III comprises 12 chapters that provide theoretically grounded empirical analysis of manufacturing sectors and firms. Part IV explores the policy context that supports manufacturing and includes seven chapters, followed by Part V, Conclusion.

Following the Introduction, the first chapter begins by exploring the emergence of manufacturing management theory and practice. The main principles and developments underlying the management of the manufacturing function within business are examined. The first chapter has taken a historical perspective through the contributions of practitioners and academics alike to arrive at models and frameworks for manufacturing strategy formulation as practiced today. It demonstrates how a rich heritage of factory studies, often adopting socio-ethnography as the investigative style, enabled these discussions to evolve, right through to studies of Japanization. The development of lean, agile and mass customization principles, or what has been termed as Japanization, has influenced what is deemed as best practice manufacturing today. The chapter concludes by reviewing some of the frameworks that are employed to assist in the analysis and development of manufacturing strategies today.

Labor as one of the key factors of production is discussed in Chapter 2 and elsewhere throughout the book. In Chapter 2, the focus is on the internal organization of manufacturing work and the evolution of the labor process within manufacturing firms. The relationships between firms’ internal forms of organization and the external labor markets from which they draw their labor supply; the impact of globalization on the distribution of manufacturing employment; and the changes that have emerged in the organization of

manufacturing work as firms reorganize their operations in internationalized production networks are also discussed. In the conclusion, some key challenges facing manufacturing workers are identified.

The contextualization of capital, another key factor of production, is critical in understanding the evolution of manufacturing. Hence, the examination of “financialization” and its role in the manufacturing world is crucial. As manufacturing continues to matter not only because of the jobs it creates, but also because of its stimulus to innovation and its contribution to exports and the balance of trade, Chapter 3 engages the debate over the role of manufacturing in the US and UK by examining evidence for a new location calculus favoring the location of manufacturing in the two economies. It also examines how processes associated with the “financialization” of the US and UK economies affect investment in firms in areas critical to manufacturing product and process innovation, including human capital and research and development.

Product and place linkages enabled by a complex and modern transportation system are one of the greatest achievements of capitalism. With this, however, come challenges associated with logistics, particularly in identifying the most efficient and effective global production and management networks. Chapters 4, 5 and 6 deal specifically with these challenges and their implications by examining how new transport modes and routes, steps in the production process and the locations of manufacturing have changed in tandem with new communication technologies, the emergence of logistics as an industry and new forms of corporate organization; by shedding light on “reshoring” and historically contextualizing reshoring within broader global dynamics and discussing the term’s recent rise to fame; and by exploring the social dynamics inherent in the relocation of production from one location to another.

Chapters 7 to 11 delve into the complexity of a product from its inception to sales and marketing, including a discussion on required engineering and production techniques (Chapter 8) and market protection in the form of patents and intellectual property rights. We have witnessed technological and scientific developments since the early 18th century. The coupling of technical innovations, market need and efficient manufacturing methodology has resulted in new and improved products. It is this methodology, argued in Chapter 7, that has transformed manufacturing. For instance, in the automotive industry it was Henry Ford’s approach to mass manufacture that transformed car manufacture from a traditional cottage industry to a global business. In this chapter, the author elucidates the greatest improvement in manufacturing technology and methodology, which he terms “tool-less manufacture”, which is going to change the world. It is tool-less because a product can be directly manufactured from a computer file, without the need for any intermediate tooling. It is also known as 3D printing, rapid prototyping and additive manufacture. The author prefers the term tool-less manufacture, as this name captures the essence and novelty of the technology as a new manufacturing methodology. The characteristics of current and future visions of tool-less manufacture are explored in detail. Suitable business models and intellectual property right protection to support this methodology are also examined.

Chapter 8 proposes an engineering-oriented model aimed at increasing the domestic production of manufactured goods using the guiding principle: “Discover here – accelerate Translation – Build here” (DTB). In order to accomplish this goal, the authors propose a new Accelerated Readiness Level (xRL) model that accelerates the speed at

which new concepts become products. They argue that this xRL model increases profitability by mitigating the time it takes to move an innovation to market. It also emphasizes the role of design and customization in advanced and high-tech manufactured goods that requires higher skills and will likely lead to more high-tech jobs.

Chapter 9 provides a valuable background for examining the role of energy from two perspectives: 1) manufacturing in energy production; and 2) energy use in manufacturing. Energy is not only a necessary input in the manufacturing of goods and services, but is also an industry in its own right, beginning with resource extraction and including processing and conversion as well as the transport of energy commodities. As a result, this chapter discusses opportunities for cutting energy costs while exploring international policies in six countries. Two case studies – combined heat and power technology in the pulp and paper industry and solid-state technology in the lighting industry – are provided to illustrate the role of manufacturing in the creation of green energy innovations.

The new economic geographies of production reflect the complex transformations and interwoven relationships between manufacturing and service companies. Thus, Chapter 10 examines the relationship between design and manufacturing. Within the context of new economic geographies of production, it examines the global competitiveness of industrial design companies in the United States, Europe and China. While foreign export markets contribute to long-term growth and survival of companies in developed countries, increasing foreign competition, particularly from emerging markets, has affected the competitive advantage of companies in the design industry. Key determinants of firm success and long-term growth are discussed, which include service provision, human capital, market orientation and adaptability. In tandem with design as part of knowledge creation and diffusion, protecting intellectual property rights (IPRs) is crucial. IPRs are recognized as having established the conditions necessary for the development of a market system, in which the search for new knowledge of economic value is rewarded. Hence, the focus of Chapter 11 is patents, which are one form of IPRs widely used in highly innovative manufacturing industry sectors that offer insight into patterns of knowledge creation and diffusion.

From an empirical perspective, Chapters 12 to 23 provide insights into industries ranging from traditional textiles, farm machinery and furniture to consumer electronics, aerospace and non-traditional industries such as the surfboard industry. They also uncover the intricacy of supply chains, global production networks and competitiveness. Real-life case studies are also included to provide in-depth understanding of the sophistication of various types of manufacturing and its factor inputs.

Textile manufacturing, a traditional industry, has experienced great transformations – economically and geographically. It has seen a major decline in employment in developed countries, such as the United States and United Kingdom, and a significant rise in less developed countries such as Bangladesh, Sri Lanka, Vietnam and China. Chapter 12 explores the survival and evolution of UK textile manufacturers in this context of understanding the changing geographies of manufacturing in a global marketplace. The evolution of the UK textile industry, presented in the chapter, is based upon individual manufacturing firms' decision-making and the competitive strategies of innovation implemented, which have created a highly advanced and niche industry involved in the production of technical textiles. This industry is identified as an example of Susan

Christopherson's concept of a "Phoenix Industry". Thus, these manufacturers play an integral role in developed market economies.

In a similar vein, Chapter 13 examines the US furniture industry. This industry has experienced economic downturn with the movement of furniture manufacturing to Asia, and particularly China, since the final decade of the 20th century. The revitalizing strategies for this industry are very similar to those developed in the British textile industry and include process innovations, targeting niche markets and localization of companies in centers of regional production. As lower-cost manufacturers shift production to Southeast Asian sites, increases in transportation costs and wage rates in China, and demands for rapid delivery times provide opportunities for stabilizing the US furniture industry. Proceeding on a more technologically sophisticated industry, Chapter 14 provides a critical analysis of the new geographies of advanced manufacturing in the case of the machine tool industry. It examines changes in the global machine tool industry since 2000. Machine tools are of interest as they are critical to many manufacturing processes. Therefore, as argued in this chapter, expertise in this industry can serve as a gauge of a country's overall manufacturing activities. China was found to have garnered a large share of worldwide production and consumption, while the machine tool sectors of Germany and Japan have maintained their longtime leadership positions, plus, more importantly, in terms of exporting. A number of other international changes in this strategic industry are also discussed.

The next chapter explores a relatively unknown industry – farm machinery as part of manufacturing industry. Contrary to its limited public reputation, this industry is crucial as it provides the ability for nations to feed themselves. This chapter examines the major players in this industry and the challenges they face, with a focus on the US farm machinery industry. Another industry that is of interest is the optics and photonics industry. This industry sits at the crossroads between science policy and economic development, falling along the spectrum from high-tech to an established manufacturing sector. As a consequence, as argued in Chapter 16, photonics often fails to garner the state and federal investment directed at seemingly newer and more fashionable enabling technologies like nanotechnology and biotechnology. It also falls beneath the radar of policy-makers focused on new materials like lightweight composites or additive manufacturing. Thus, this chapter focuses on the regional clustering characteristics of the optics and photonics industry by providing an important example of the dynamics that underscore working regions in two key examples: Rochester, New York and Quebec, Canada.

Steel, an important contributing factor to both global production and consumption, warrants in-depth understanding. As such, Chapters 17 and 18 examine the restructuring of global steel supply chains in both traditional and emerging regions of the world; and the role of intermediate metal processing manufacturers in the West Midlands region of the United Kingdom. The steel industry has experienced significant transformation similar to other industries discussed in this handbook as a result of technological change and globalization. The ways in which the twin forces of technological change and global market expansion have contributed to the de-verticalization of the steel industry, the rise of emerging market players and the transformation of the role of traditional steel-making regions are discussed in Chapter 17. Chapter 18 offers insights into the intermediate metal processing industry, which comprises two principal activities: forging and

casting of metal. This industry too has undergone a continued transition to higher-value-added products and services to remain competitive.

Cost pressure represents a common challenge across sectors and technological levels. As examined in Chapter 19, aircraft and space vehicle manufacturing, an industry at the top of the manufacturing echelon in both technology and cost, has also been transformed. This industry has a unique set of requirements, centering on public safety of the product as, though accidents are rare, each has high visibility so that the consequences of error are high for manufacturers. Cost pressures and environmental demands have led to costly products that must be operated for decades to recoup the purchase price. These have caused the industry to evolve into aircraft design and assembly companies supplied with many specialist components such as engines or landing gear. Current challenges of design and manufacturing outsourcing, logistics, materials and finance are considered in Chapter 19.

Before proceeding to explore specific case studies of companies in different parts of the world, Chapter 20 offers a unique case study of the surfboard industry. It is a recurring theme in this handbook to offer insights into a broad array of industries, including those that are relatively unknown yet are relevant and critical in providing a comprehensive analysis and understanding of manufacturing industry and its evolution. This chapter explores the trajectories of commercial surfboard manufacturing, which has transitioned from a craft-based activity to a large-scale industry paralleling surfing's own expanding popularity. However, the difficulties and dangers of up-scaling craft-based production are highlighted. Consolidation of surfboard manufacturing has occurred with a refocusing on customization for local surfers and breaks. The key to maintaining profitability, argued in this chapter, is to combine a diverse range of skills and rely on enduring demand for customized boards.

From a specific case study perspective, Chapters 21 to 23 examine the history, characteristics, competition, challenges and successful business strategies of an ethnic bakery business in the UK; Škoda, a Czech-based automobile manufacturer owned by the German company Volkswagen (VW); and Samsung Electronics (SEC). In the first case presented, a Polish bakery, Chapter 21 considers the significance of translocal exchanges and global value chains in the establishment and evolution of Polish manufacturing enterprises in the UK. In the case of Škoda, the coupling of its assets and capabilities with the strategic needs of VW and the successful integration of Škoda into global production and distribution networks are credited for its success as a Tier-Two lead firm. The government's decision to privatize Škoda and its privatization policy, including the conditions of privatization and the selection of VW as its original joint venture partner, are also explored. Nevertheless, foreign ownership is not unproblematic and does not automatically lead to success in the automotive industry. In the case of SEC, presented in Chapter 23, the company has been transformed from a subcontract manufacturer of products to an innovation flagship for producing world-first new products. Design innovation, brand marketing and networking are considered to be important for a firm's competitiveness, reflecting the need for complex processes and strategies. The SEC case study identifies the importance of the processes of path dependence, restructuring and new path creation.

Part IV follows with a policy emphasis, tracing manufacturing employment in the US since the 1980s; exploring and examining manufacturing redevelopment policies

in different urban areas and in a global city such as New York city; and examining the role of innovation and technology industries in restructuring manufacturing; as well as addressing the gap in the labor market by accentuating the meaning and interpretation of “skills”. As stated at the start of this Introduction, manufacturing employment has significantly shrunk in the developed world since the mid 20th century. In particular, in the US manufacturing industry shed more than 12 percent of its total workforce between 1979 and 1983 (see Chapter 24). This chapter argues that while contemporary scholarship on manufacturing has generated significant new ideas about innovation systems and global–local dynamics, it has yet to be reconciled with a systematic characterization of the shifting geography of the US manufacturing sector from deindustrialization. Thus, this chapter traces the industrial, occupational and spatial development of US manufacturing over the course of the 1980s, 1990s and 2000s business cycles. The findings are discussed; particularly the regional occupational endowments with manufacturing that have remained stable over time.

Recently, the term “advanced manufacturing” has been promoted by policy-makers and scholars to illustrate and emphasize a renewed interest and advancement in the manufacturing sector. The evolution of the term “advanced manufacturing” is explored in Chapter 25. This chapter then explores the re-emergence of manufacturing policy in the United Kingdom and the United States in relation to advanced manufacturing. The author argues that it is difficult to define the term “advanced manufacturing” in absolute terms. The meaning depends entirely on the motivations or objectives that influence the person or institution attempting to develop or apply a definition of advanced manufacturing. A number of terms have been used not as synonyms but in some fashion interchangeably by researchers, policy-makers and commentators over the past 10 to 20 years.

In Chapter 26, a new national manufacturing agenda in the United States is discussed as it has sparked hope of strengthening production networks in ways that draw on the specific assets of cities and their metropolitan regions. This chapter argues that the gap between scales of action – that is, the lack of powerful policy-implementing institutions at the regional level in US policy-making – makes the project of manufacturing redevelopment in cities problematic. To illustrate this argument, a local urban area, Newark, New Jersey in the US is explored, and policy recommendations are offered. In the case of a nearby city also known as a global city, New York, Chapter 27 explores the extent to which the decline in manufacturing has been inevitable, given the shift in the United States to a services economy, or consciously achieved to sustain the City’s position as a premier global city. It discusses the city’s efforts to upzone and redevelop industrial land and explores the apparel and furniture manufacturing sectors to understand how the City’s bifurcated policies have affected them.

Emphases on the role industries play in the knowledge economy continue to be at the forefront of academic and policy debate. In the global competitive arena, the knowledge economy is where acquisition, creation and utilization of knowledge are the key factors in explaining the competitive advantage of firms. This type of competitive advantage is considered to have contributed to sustained economic growth for firms located in high-rather than low-wage economies. Because different industries exist in the knowledge economy, it is imperative to highlight both ends of the spectrum via low- and high-technology industries. Chapter 28 introduces this taxonomy. It then examines the role

low-tech manufacturing industries play in the knowledge economy. It is argued that low-tech industries continue to be of large economic importance in high-wage countries, as they actively pursue strategies to maintain competitiveness and increase the value added of products and processes. This chapter questions the current focus of policy-makers on R&D investments and high-tech industries as a strong synthetic knowledge base while investments in machinery and human capital allow low-tech industries to resist the increasing global price competition.

From a regional perspective, Chapter 29 revives the discussion of mature regions by providing an exploratory case study of one key mature regional economy in the United States – the cities of Pittsburgh, Cleveland, Akron and Youngstown, which have banded together to define themselves as the “Tech Belt” – a continuous geographic region with similar industrial structure and the need to secure its economic future. As older industrial cities struggle to redefine themselves, this chapter considers the process of regional restructuring for this Tech Belt. Rather than evaluate a specific public program, this chapter considers how innovative firms draw upon the array of local and federal programs. The findings stress the need to coordinate efforts, as government policy interventions do not reinforce one another to form a cohesive policy infrastructure but instead appear to operate in silos.

Part IV concludes with Chapter 30, which underscores a key factor of production and a critical component of the manufacturing economy as well as of the entire economy – human capital. In response to policy initiatives to generate job growth, it is imperative to explore skills and manufacturing by first identifying what skills are, how to obtain them and who will utilize them and how. Chapter 30 explores what is at stake if the skills needs of industry are narrowly presented as an educational policy problem. It reframes a recurring industrial debate by presenting skill as an ambiguous and fluid concept, and therefore subject to interpretation. In response, labor market intermediaries do not just supply skilled workers to the industry, but they engage employers in a negotiated process over what is meant by skill, who is presumed to possess that skill and what structures are needed to develop and defend skill by using strategies of skill reinterpretation.

Part V concludes this handbook by re-emphasizing the main arguments developed in this collection: manufacturing matters, and continues to matter. Manufacturing has been evolving and these transformations merit further research from social scientists, engineers and policy-makers.

It is possible to argue that within developed market economies there has been a manufacturing renaissance. Unfortunately, academics and policy-makers have not kept up with all these alterations and it is also possible to argue that many policy-makers no longer understand manufacturing. Nevertheless, the 2008 recession altered the political landscape and led to a call for developed market economies to rebalance their economies and to take manufacturing seriously. The second decade of the 21st century has seen major policy interventions intended to encourage growth in manufacturing exports and in manufacturing more generally. Thus, today manufacturing, in political terms, has become a hot topic and one that requires further sustained academic research. This handbook has identified many of the avenues that require further research, but perhaps the most important areas for research include a new focus on factor inputs, including energy and skills, and on understanding the local and global aspects of complex commodity chains. Other important topics include understanding the adaptation and

survival strategies developed by manufacturing companies located in high-cost locations and also the ongoing blurring of services and manufacturing.

It is becoming increasingly important that a research dialogue occurs between the social sciences and engineering. This is an under-developed area for inter-disciplinary research, but it is an important area as engineering departments are involved in developing new process and production technologies and techniques that have the potential to revolutionize manufacturing. These innovations will lead to new economic geographies and sociologies and will have important implications for social policy.

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