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Abstract

In recent decade, the world economy has been strongly driven by worldwide foreign direct investment (FDI) of transnational corporations (TNCs). Business globalisation is leading to widespread re-structuring of international manufacturing systems in TNCs. However, little systematic research in manufacturing engineering or production/operations management (P/O M) has focused on these new manufacturing systems, and little communication is organised between different academic disciplines such as manufacturing, management studies, economics, geography, international development studies and so on. Many critical issues are poorly understood and are not covered by current research agendas. In industry, the lack of global vision and appropriate strategies during internationalisation have become major barrier to the effective management of international operations. In academia, the limited multi-discipline exchanges have inhibited developments not only in each area but also knowledge contribution to industry which could arise from discipline integration. This paper introduces a recent research work on global manufacturing networks. Based on detailed case observations, it highlights some key industrial issues in manufacturing internationalisation and suggests a modified research framework to tackle international manufacturing.

Key words: manufacturing globalisation, international manufacturing networks, global manufacturing strategy

INTERODUCTION

Business globalisation is changing the pattern of world economic relations. But, its real impacts on manufacturing systems, especially its strategy process, are still not crystallised. For many people in the field, as the manufacturing strategy (Skinner, 1969) bridges manufacturing system design and market demands and competitive priorities, manufacturing globalisation is actually to implement the strategy process worldwide. In another word, people doubt, except some new geographically related varieties, in term of strategy and its process, if there is really serious difference between the classical manufacturing strategy and a global manufacturing strategy. This paper argues that, as manufacturing crosses the borders and becomes global operations, its managers not only face new environments and challenges, but also need new strategy thinking, decision processes, perception, and theory about manufacturing systems.

In conducting the research on which this paper is based, twenty transnational corporations (TNCs) are studied in order to understand if there is any new demand for manufacturing strategy in its globalisation. Following the introduction of three short cases, the paper summarises typically challenges in global manufacturing, and suggests a new strategy framework to tackle the issues for both practitioners and academia.
INDUSTRIAL CASE STUDIES

**Case A Company** is one of the largest industrial and municipal boiler manufacturers in the world. Up to the 1980s, it adopted an export policy and licensed its technology worldwide based on its Northern America manufacturing base.

During the early 1980s, the company started to feel the impact of intensive international competition. It gradually changed its policy to take off-shore manufacturing strategy as a double edged sword cutting product costs for re-gaining domestic market and at the same time discovering new opportunities in emerging areas. The company set up a series of joint ventures (JVs) in developing countries. Widely dispersed manufacturing and strong autonomy JVs transformed the company into a multinational corporation.

In 1990s, however, the company faced serious duplication problem. Each succeeded JV asked more support for expansion. From corporate point of view, it had to answer some tough questions, such as relation between strategic markets and manufacturing centres, and better way to compete worldwide. In 1995, it started adapting global manufacturing strategy. The JVs in its vertically integrated network have a more specialised component focus according to JV existing competencies, as well as undertaking routine manufacturing operations to optimise the manufacturing and transportation costs.

In sum, the Case A Company has experienced two main transformations towards global coordinated network during past fifteen years. As its manufacturing systems were re-configured, the whole company’s strategic capabilities were transformed from market accessibility towards increased thriftiness, efficiency and resource integration focus.

**Case B Company**, a leading pharmaceutical company, had 47 manufacturing sites in 32 countries and 17,000 staff worldwide in the middle of 1990s. ZTK was the company’s the most successful and important medicine, taking more than 40% of its total sales.

Before ZTK’s success, the company was a UK based pharmaceutical manufacturer ranked number 25 in the world. Great market opportunities from ZTK pushed it into a “global reach” company in 1980s. After experiencing fast geographic expansion, it rationalised its world wide manufacturing from a loose linked sites into more integrated and better coordinated networks, especially, along the value-adding chains. The new international manufacturing strategy embodied the following principles:

- highly centralised strategic sites for bulk of medicine and new product introduction;
- specialised and regionally dispersed sites for its complex formulations;
- more widely dispersed and market driven local packaging and labelling sites for closer relation with national or local markets.

Such balanced and optimised global integrated manufacturing networks have clear advantages in higher efficiency, a high level of quality and supply control security, exploitation of both manufacturing sites and local market opportunities, and higher responsiveness to various kinds of changes. But on the other hand, some weaknesses is also obvious, such as fragmented supply chains, diffused control, and little immediate contribution to the competitive advantage from highly complex network operations.

**Case C Company** is one of the world's largest computer companies, especially, in world-wide PC markets. In its 15-year history, the company, from a standards-based portable computer, has become a major supplier of PC related various types of products.

There are many factors that lead to the company’s success. Among them, however, the following two factors play the most important roles. The first is the manufacturing and marketing of the industry standard computer. The global product development with compatibility and quality, but different market positioning strategy from other competitors, have made the company achieve world-wide top PC market share.
The second factor is the compatible manufacturing systems dispersed in strategic markets. Taking service industry experience in internationalisation very seriously, the company structured its manufacturing system more like the McDonald's hamburger restaurant with focused market strategy, standardised product manuals, and globally identical operation systems. "Some random communications between our factories, such as quality assurance, operational innovation, and quick response manufacturing service to the markets, pushed us to re-think further coordination between our factories, not only from the aspect of operational standards and procedure protocol but also internal learning, benchmarking, knowledge sharing, and especially the national capability tapping perspectives," its manufacturing director introduced.

**CHANGED ENVIRONMENT AND MANUFACTURING SYSTEMS**

International manufacturing environments have fundamentally changed in at least three aspects. The first is market changes, including new global demand/market emergence, some major developing nations involving international economy, and trade liberalisation and regionalisation. They provide fresh opportunities for expansions and radical re-structuring. The second is intensive global competitions. Not only the numbers of competitors but rules of competition have been rewritten. Traditional trade-offs principle is challenged and global competitive power needs globalised resources to build on. The third is new technology development from information, communication, web-site and cyber-space, to new manufacturing and strategy techniques. They enable global manufacturing operations and integration in global supply chains from physical to virtual worlds. All of the changes challenge manufacturing systems with new requirements including market presence, dynamic response, global competitiveness, resource access, system potential exploitation, and capability development. The left column of Figure 1 details the external driving forces of manufacturing system. Obviously, the classical manufacturing systems have some difficulties to cope the challenges.

<table>
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<th>New Requirements to Manufacturing Systems</th>
<th>Key Driving Forces from Internal Determinants</th>
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<td>• Emerging markets in developing countries</td>
<td>• Strategic Market Presence</td>
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<td>• Regionalisation and liberalisation from different strategic regions</td>
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<td>• Better service &amp; customer confidence</td>
<td>• Global Competitiveness</td>
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<td>• Manufacturing Resource Access</td>
<td>• New level of coordination between international factories</td>
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<td>• Market requirements identification</td>
<td></td>
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<td>• Market fragmentation</td>
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<td>• New competition rule asking for more learning process, capability development, and pro-active strategies</td>
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<td>• To gain strategic benefits through manufacturing system re-structuring</td>
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<td>• Efficiency orientation: continuous improvement and perfection process</td>
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<td>• Global competition: the best products, optimised systems, and to tap all existing potential for the long term strategy</td>
<td>• Capability Development</td>
<td>• Strategic capability identification and development from operations</td>
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<tr>
<td>• New competition rule asking for more learning process, capability development, and pro-active strategies</td>
<td></td>
<td>• Coordination and learning in systems</td>
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Figure 1. New Requirement Analysis and Strategic Capabilities of New Manufacturing Systems
The responses to the changes from manufacturing systems are quite diversified and may be divided into three levels. Most suggestions focus on factory level to improve the performance through lean production, world class manufacturing, ISO9000, AMT, and the classical manufacturing strategy process. Some people radically switch to virtual manufacturing networks and seek manufacturing agility through strategic alliance along the business supply chain (Goldman, et al 1995). A few researches (Flaherty, 1986; Ferdows, 1989) emphasise between them by tackling intra firm international manufacturing networks. Although collaborative manufacturing becomes more and more important between alliances on the supply chains as manufacturers are leaner and focused on core competences, it is still a precondition for companies to fully tap their owned resources by leveraging the worldwide manufacturing nodes into a co-ordinated network. The internal rationalisation of manufacturing system, presented in the right column of Figure 1, also provides pushing forces and new mechanisms for changes.

Illustrated in the middle column of the Figure 1, the new challenge and requirement provide a bird eye view on the complex network systems and the future system functionality. It also implies that a research framework to tackle global manufacturing strategy process is urgently needed. The industrial cases demonstrate that some leading TNCs have started to explore the new potentials of networks. But both industrialist and academia need more systematic research observation and theory development.

NEW FRAMEWORK FOR INTERNATIONAL MANUFACTURING

The diagram in the Figure 2 is a modified framework to define international manufacturing as a strategy process from environment analysis to different levels strategy formulation, network design, operational actions and leaning, supported by understanding of network capabilities and national characteristics (Gregory, et al 1996).

![Diagram](image_url)

*Figure 2. The “Arrow Diagram” represents a research framework covering critical issues and their linkages in International Manufacturing*
Figure 2 mainly include three different dimensions, as the Figure 3 demonstrates. The first dimension represents international expansion of networks including geographic location, dispersion and disposition. The second one deals with manufacturing value-adding chain and supply chain along which company can position, integrate, rational, and optimise its spans of business. The third one leverages relationship with other companies, which is a spectrum of strategic alliances. As the Figure 3 shows, the most important and difficult part may not be the individual dimensions but their integration or even synthesis process. On international and intra-firm coordination platform, configurations are identified to explore the cohesion and consistence of the building blocks (Shi and Gregory, 1998). It is clear that it becomes much more complicated when the strategic collaborative relationship involves into the networks.

In summary, the framework highlights some critical issues in international manufacturing, such as strategy formulation process and network design, operations and learning, networks and embedded capabilities, and different national cultures, characteristics and impacts on manufacturing system. But the framework does not detail the “how to” questions instead of the arrow linkages. These leave wide spaces for further harder research work in an emerging area.

REFERENCES
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