Relating the Firm's Global Production Network to Its Strategy

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Abstract This chapter provides a high-level review of the literature on global production networks and suggests that this area offers a fertile ground for future research. An important issue deserving attention is the relationship between the firm's strategy (particularly its manufacturing strategy) and the structure of its global production network. The chapter offers a model for this analysis. The model allows delayering the production network into clusters of plants based on the characteristics of the products they produce and the production processes they use to produce them, and gauges whether each cluster has the appropriate level of resources to carry out its strategic mission. The chapter also reviews the literature on transfer of know-how in global production networks. This is another area that deserves attention, particularly the choice of appropriate mechanism for this transfer under different conditions.

Keywords Global production networks · Transfer of production know-how · Global manufacturing strategy · Rooted and footloose production networks

Production networks in multinational companies are complex structures. It takes years to put them in place and it is difficult to change them quickly. Many variables, often outside the control of the firm, affect the configuration of these networks and make it a challenge to control their evolution. Therefore, if well managed, a firm's production network can be a formidable source of competitive advantage; if not, it can significantly limit the firm's strategic options. To borrow the famous analogy suggested by Skinner (1969), a firm's global production network can become a "millstone in corporate strategy."

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In spite of an abundance of literature on global production, there is a shortage of models on how multinational companies should assess, monitor, adjust, and generally manage their production sites around the globe. Scholars in diverse fields have studied how production networks are affected by a long list of factors, such as: changes in foreign exchange, new trade agreements, changes in tax rates and incentives for foreign direct investments, industrial policy at the national and regional levels, economic development, technology, sustainability, social responsibility of business, and other factors. They offer valuable insights, but there is still a gap between these broad and often policy-level perspectives and operational guidelines for how multinationals should ensure their global production network evolves in line with their business strategy. We need more research to fill this gap, particularly by scholars in our field of operations management. Studying how production should be organized and managed is at the core of what we do.

In the following pages, I discuss some of the inherent challenges in studying global production networks. These challenges can be daunting, especially to young scholars in our field, but as the contributions in this book demonstrate, this is fertile ground for research. I show this by providing a brief, high-level review of the literature on this topic and identify some of the gaps that need to be filled. Among the unexplored areas an important one is the relationship between the role of manufacturing in the firm's business strategy and the characteristics of its production network. As a step towards investigating this fundamental relationship, I propose a typology for categorizing the production networks based on the characteristics of the firm's products and production processes. This framework suggests how a firm's production network should change as its strategy for the mix of products it offers and the production processes it uses change. It identifies new propositions that need to be tested empirically.

Since several contributions in this book focus on the transfer of knowledge in global production networks, I also present a brief review of the literature on this important topic. This area, too, needs new research, especially on how to transfer production know-how in a firm's globally dispersed plants. Operations scholars should play a leading role in this investigation.

1 The Challenge

Studying global production networks is a challenge for at least three reasons. First, global production networks are particularly susceptible to *detail complexity*, with a very large number of factors directly affecting them. These range from changes in demand patterns (due to the emergence of new geographical markets, introduction of new products, discontinuing existing products, economic recessions or booms, and other reasons), changes in local laws and regulations (e.g., introduction of new tariffs, new intellectual property protection laws, new environmental rules, new labor laws or other legislation), to changes in the local competitive situation (e.g., entrance of new local or foreign competitors, changes in cost of energy, changes in national and regional logistics infrastructures, ports and customs, currency fluctuations, and changes in local wages, taxes, rate of local inflation, and availability of new subsidies). These are compounded by other factors, such as mergers and acquisitions, changes in technology (e.g., new process technologies, including 3-D printing or "additive manufacturing," and new Internet and communication technologies), and changes in political risks (e.g., unrest, regime changes, and security issues).

All this is compounded by the fact that a firm's production network is always embedded in a larger industrial network of suppliers, subcontractors, and often value-adding customers. Production networks of many of these suppliers and customers are also subject to similar levels of detail complexity, and as they change, they necessitate adjustments in the firm's production network, which creates additional complexity. This daunting list of variables can dissuade scholars who need quick publications to advance their careers to venture into this area. It is a lot safer to focus on more tractable areas.

The second reason studying production networks is a challenge is due to their inherent *hysteresis* (i.e., delayed response to stimuli). It may take months to adjust production allocations in a global network in response to changes in the value of local currencies; it takes even longer to close a factory or open a new one because of changes in demand for specific products or after a merger or acquisition. In the interim, other factors also continue to change and compound and confound the effects.

Hysteresis makes empirical research difficult. The researchers must collect sufficient longitudinal data to be able to observe the effects of any variable. Furthermore, they need to track evolution of a large number of metrics, such as changing production costs, quality, delivery, safety, automation level, as well as contextual variables, including national and organizational cultural traits, and macro-economic factors. All this takes time and energy.

An alternative to empirical research is to do analytical modeling. However, the detail complexity and hysteresis make many such analytical models often too confined or unrealistic. The third challenge, therefore, is that unlike many other areas in operations management (e.g., inventory management, quality management, scheduling, or stylized buyer-supplier transactions), we still do not know enough about the relationship between changes in global production networks and the variables that affect it to be able to do much credible modeling in this area.

As a result, while no one seems to dispute the importance of studying global production networks, only a few scholars in operations management have focused their research on this topic. These challenges—detail complexity, hysteresis, and limitations of non-empirical research—also explain why many operations scholars who have focused on global production networks have relied on case-based research (Eisenhardt 1989; Voss et al. 2002; Yin 2003).

2 Perspectives on Global Production Networks

Several overlapping streams of research provide the context for studying the broad topic of production networks. The first stream is the rich literature on multinational companies. In the last three decades, research on the structure and organization of multinationals has shifted from a focus on a hierarchical view of relationships between the company's headquarters and its subsidiaries towards a perspective of a web of diverse inter- and intra-firm relationships. Theories that have been used to examine these relationships include network theory (Ghoshal and Bartlett 1990; Gulati et al. 2000), evolutionary theory (Kogut and Zandar 1993), learning organization (Grant 2010; Nonaka 1994) and knowledge transfer (Grant 1996; Szulanski 1996). A common theme among these theories is that multinational organizations can benefit greatly from transferring resources and competencies developed in different locations within their company. These approaches provide useful contextual knowledge, but in general, stay at a high strategic level and seldom delve deep into how factories should be organized, managed, and work together.

The second stream is the literature on industrial networks. The focus here is on the external, mostly vertical, networks in which the firms—especially original equipment manufacturers (OEMs)—operate. Relationships with suppliers (Dyer and Nobeoka 2000), subcontractors, and contract manufacturers (Plambeck and Taylor 2005), in particular, have received considerable attention in recent years. There is a general consensus that increased data, information, and knowledge transfer in the "extended enterprise" can be beneficial to all parties. However, there are also warnings against excessive outsourcing and reliance on others for the production and design of the firm's core products (Arrunada and Vázquez 2006; Pisano and Shih 2009).

At a more abstract level, Håkansson (1990) views the industrial networks as interplay between *actors, resources,* and *activities* that reside in different firms that comprise the network (where actors have knowledge of activities and control resources, and activities change or exchange the resources). A key implication of this view, as Dekkers and Van Luttervelt (2007), Karlsson (2003), and Karlsson and Sköld (2007) also observe, is that manufacturing strategy is best defined in the *context* (i.e., industrial network) in which the firm operates. In other words, manufacturing strategy should extend its reach beyond the firm's boundaries and clarify the level of dependence on long-term suppliers, alliance partners, contractors, design labs, distributors, arms-length suppliers, and other key actors in the relevant industrial network. This is exactly what (Pisano and Shih 2009) mean by "industrial commons," and how their presence or absence can completely alter the options for locating global production sites.

The third stream of research has focused directly on the intra-firm production networks. An early article in this stream is Hayes and Schmenner's (1978) "How Should You Organize Manufacturing?" They suggested that a firm's production network can be organized along products, processes, or a combination of the two, and show under what conditions a product-oriented versus a process-oriented network would be more effective. There were also other perspectives for viewing production networks and, among them, I suggested that factories in a network have different strategic roles which define their relationships to headquarters and to each other, to other functions in the firm (especially research and development, procurement, and distribution), and to other entities outside the firm (Ferdows 1989, 1997). Vereecke et al. (2006) provided additional empirical support for different roles of factories in a network.

A subgroup of this stream of research uses the *network*—as opposed to factories within the network—as the unit of analysis (Colotla et al. 2003; De Meyer and Vereecke 2009; Ferdows 2008; Shi and Gregory 1998; Vereecke et al. 2006). An important premise here is that intra-firm manufacturing networks can develop capabilities that go beyond factory-level capabilities, and especially with the advent of new communications and transportation technologies, companies must pay more attention to the design and management of their production network as a whole. We need more research in this area and many contributions in this book extend this line of research.

Combined, these streams of research provide valuable insights into how to spread the firm's production network globally and assess and chart a strategic course for individual factories in the network. However, they do not seem to link their findings directly to the rich literature on the role of manufacturing in corporate strategy (Hayes et al. 1996; Pisano and Shih 2009; Skinner 1969; Wheelwright and Hayes 1985, among others).

This is an important relationship that has not been sufficiently investigated. Perhaps a reasonable way to proceed is to use the well-known Wheelwright and Hayes (1985) "four stages" for the roles of manufacturing in a firm's strategy (ranging from stage one, "internally neutral," where manufacturing does not contribute to the firm's competitive strategy, to stage four, "externally supportive," where manufacturing is a prime source of competitive advantage in the firm's strategy). It is not clear how these stages affect the shape of the firm's global production network. Furthermore, given the possibility of a production network becoming a "millstone in corporate strategy," distinguishing between the cause and effect is not always clear (i.e., does the stage determine the network or vice versa?). Most likely, the process is an iterative interplay between the role of manufacturing in the firm's strategy and the shape of its production network. We do not know with certainty yet.

In short, despite an abundance of literature on international production, there are still many gaps in our knowledge of how to plan and operate global production networks. Given the growing complexity of these networks, it helps to focus on the basic questions in managing them.

3 Basic Operational Questions

When a company produces its products in more than one production site, its managers face three new basic questions:

1. Are we producing (and sourcing) our products in the right places?
2. Does each production site have the required resources to do what is expected of it?
3. How do we transfer know-how among production sites and improve their operations?

These are deceptively simple questions but are difficult to answer. The most difficult one is the first, which also largely determines the answers to the second and third questions. The main reason for this difficulty is that, because of *detail complexity,* too many variables affect the optimal allocation of products to production sites.

Even a well-configured production network must be reexamined constantly to adjust for the adoption of new process technologies, the introduction of new products and changes in the product mix, changes in local wages, tariffs, and regulations, fluctuations in foreign exchange rates, changes in logistics costs, arrivals or departures of important suppliers, new concerns for sustainability and ethical supply chains, acquisitions, and many other factors.

The problem is exacerbated by the fact that the answer to the second question can also affect the answer to the first question. If a company does not allocate sufficient resources to a production site, after a while it can justify reducing its production volume and allocating less complicated products to it. This can lead to a subtle but vicious cycle of continuing decline in a plant's capabilities and effectiveness.

How a firm allocates resources in its global production network is, therefore, a critical decision, which is both affected by and affects the role of manufacturing in its strategy. In other words, firms that do not consider manufacturing to be a source of their competitive advantage often rely on others to produce their products and are not likely to allocate many resources to develop their own global plant networks; conversely, firms that invest heavily in their own plants depend on superior manufacturing capabilities as a source of their competitive advantage.

In an earlier paper, (Ferdows 2008) I suggested that the former is likely to have a "footloose" and the latter a "rooted" production network:

> There are two seemingly irreconcilable models for building production networks. One advocates staying footloose—that is, continuing searching the world for a better factory inside or outside the company and moving production there as soon the firm finds one; the other advocates developing deep roots—making long term commitments to each production site and giving it the resources to reach its full potential.
>
> Both models have their own logic. Those in search of more agility in an increasingly uncertain and volatile world usually argue for more footloose networks; and those who want more stability to develop unique production capabilities, ironically to cope with the same uncertain and volatile world, argue for more rooted networks. The first group wants to leverage the capabilities of others and conserve its own resources for other functions like design and marketing; the second group wants to use its own production capabilities as a competitive weapon. (Ferdows 2008, p. 150)

I suggested that production networks are being constantly pulled in different directions, particularly in one of these two directions. Sometimes, this pull is abrupt and visible—like a decision to close a factory and outsource production of a product; other times, it may be gradual and subtle—like continuing to reduce (or increase) new capital investments in factories. The cumulative effect of these movements can cause the production network to evolve in an unintended direction. It is logical to hypothesize that the higher the role of manufacturing in the firm's strategy (e.g., closer to stage four of Wheelwright and Hayes 1985), the more likely that firm would move towards the rooted network. We need new research to see if, indeed, higher roles of manufacturing in a firm's strategy lead to more stable global production networks.

In the same paper (Ferdows 2008), I also suggested a simple framework which can be used to categorize different production networks (or sub-networks). A slightly modified version of this framework is shown in Fig. 1 (Ferdows et al. 2013).

According to this framework, networks (or sub-networks) can be categorized on the basis of *what kind of products* they produce and *how* they produce them. The

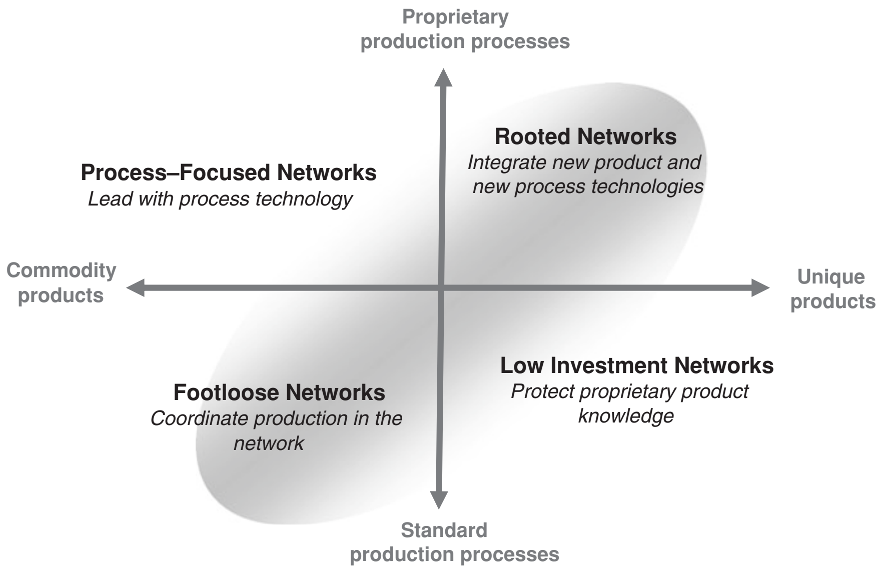

Fig. 1 A typology of production networks

scales, ranging from "commodity products" to "unique products" and "standard processes" to "proprietary processes," can be defined relative to the business unit, the firm, or the industry—depending on the level of granularity desired in the analysis.

If the scales are chosen relative to common industry practices and if we make an analysis from a pure manufacturing perspective, it is logical to expect the networks on the diagonal to be more stable than those that are far above or below it. Each quadrant poses a different managerial challenge. In the top right quadrant, you find production networks that produce fairly complicated products with proprietary processes. Production networks of companies like Intel or Steinway Piano are generally in this quadrant. These networks have distinct capabilities in most of their factories, supported by production know-how that is mostly in tacit form and not easy to transfer from one factory to another, especially one outside the firm. Therefore, these networks are usually rooted in the sense that most of their factories are likely to stay in place for long periods. They need the stability and continuity of having deep roots in order to build the requisite expertise and production capabilities.

The networks in the bottom-left quadrant produce fairly simple products with standard processes, such as those producing IKEA components or Dell personal computers. Relative to rooted networks, these are generally more footloose, in the sense that it is easier to shift production from one of their factories to another (belonging to the firm or its suppliers or subcontractors). The reason, of course, is that the requisite know-how to produce a standardized product is usually more codified and production processes are more widely available; hence, transferring production from one factory to another inside or even outside the company is not as difficult.

It follows that the position of the network on the diagonal also gives an indication of the aggregate level of competence in its factories. Factories in the rooted networks that are higher on the diagonal generally perform more skilled and value-adding functions than those in lower positions. They design, customize, or upgrade their machinery more often, do more process improvements, engage in more technical collaboration with their key suppliers, and generally participate more actively in product and process development activities. Networks on the lower positions on the diagonal become more footloose. The ultimate footloose network sources all its products from suppliers at arm's length. In the middle of the diagonal are the networks that produce or procure their products from a mix of sources: own factories with some product and process development activities, suppliers that engage in some product and process development activities, and suppliers that supply products at arm's length.

Networks can also be off the diagonal. The position can reflect a deliberate strategic choice. For example, the production network of a company like Lego, which produces rather simple products (Lego bricks and other plastic pieces) with advanced and proprietary processes, or Nucor, which produces simple steel products with rather sophisticated production processes, fall above the diagonal, in the top-left quadrant. Mastery of process technology and large economy of scale can in such cases be important sources of competitive advantage. However, it is also possible for a network to find itself in this quadrant because of strategic negligence—by continuing to produce products that have turned into commodities that can be produced with simpler processes. In general, a position far above the diagonal makes the network unstable.

Alternatively, a network can be below the diagonal. If a network of factories is producing a relatively complicated and proprietary product using production processes that are standard in the industry (e.g., factories producing high-fashion apparel or cell phones), it is operating in this region, in the bottom-right quadrant. Many factories in the networks in this quadrant often belong to contract manufacturers, subcontractors and suppliers. A network in this quadrant, again, can reflect a deliberate strategic choice or possible underestimation of the strategic role of production in the business strategy of the company. These networks, like the ones above the diagonal, are also unstable, especially if they are far from the diagonal.

This typology offers an organized approach for future research into the fit between the firm's products and processes and the architecture of its production network. Such research would help in answering the first and second basic questions mentioned earlier; that is, are we producing our products in the right plants and do these plants have adequate resources to do what is expected of them? However, answering the third basic question—how to transfer production know-how among plants and improve their operations—needs a different line of research.

4 Improving Operations in Global Production Networks

One would expect that transferring production know-how between plants, especially two that belong to the same company and produce rather similar products, should not be difficult. Yet, it often is. There is rich literature about the transfer of knowledge that provides a long list of reasons. The reasons range from the difficulty of transferring tacit know-how (Gupta and Govindarajan 2000; Leonard and Swap 2004; Polyani 1967;

Szulanski and Winter 2002; Zandar and Kogut 1995), to insufficient *absorption capacity* at the receiving plant (Allen 1977; Bjorkman et al. 2004; Cohen and Levinthal 1990; Gupta and Govindarajan 2000; Tsai 2001), and resistance to change and organizational inertia (Kotter 1996) and reluctance to share knowledge at the source plant (Minbaeva et al. 2002; Leonard and Swap 2004). Still other reasons stem from a poor choice of transfer mechanisms (Ferdows 2006) and, more generally, inadequate attention to the role of knowledge management in the firm's strategy (Grant 1996).

It is important to differentiate between the different types of knowledge that need to be transferred. With today's communication technology, it has become relatively easy to collect up-to-date data about operations of each plant and make it widely available to managers both at the headquarters and in the plants. It has simplified the transfer of information about best practices and benchmarks in the network, as well as assessing the gaps in individual plants. The literature usually refers to this type of knowledge as *declarative knowledge* (Kogut and Zandar 1993). It is different from production know-how, often referred to as *procedural knowledge* or, more broadly, "organizational practices" (Jensen and Szulanski 2004). Procedural knowledge is a recipe for action, arguably the most valuable type of knowledge for a plant. Knowledge about *how* to produce is different from information about things or situations (i.e., *declarative knowledge*) or scientific knowledge about how one variable affects another, usually referred to as *causal knowledge* (Dhanaraj et al. 2004; Leonard-Barton 1995). These three types of knowledge are, of course, complementary, and sometimes packaging them together helps their transfer (Lapré and Van Wassenhove 2003; Szulanski 1996), but, in general, transferring one does not necessarily transfer the others (Nonaka and Takeuchi 1995).

A notable trend in recent years is the emergence of corporate lean programs in large multinational manufacturing companies (Netland 2013). Almost all of these programs are based on the famed Toyota Production System with the goal of inculcating good production practices in every plant in the company's network. This requires a massive transfer of knowledge from the headquarters to the plants, and from the plants to other plants (sometimes including those belonging to the firm's major suppliers and customers).

As several chapters in this book show, transferring production know-how in a globally dispersed network is a challenge. The issues range from the micro level of how to transfer appropriate knowledge from one plant (or the headquarters) to another plant efficiently and quickly, to the macro level of how to transfer know-how to multiple plants or an entire production network simultaneously. The chapters in this book address some of these issues, but there are still many more for future research.

5 Final Word

With the increasing fragmentation of global production and supply chains, the need for research into the design and management of global production networks can only escalate in the foreseeable future. With many unexplored areas, it offers a fertile ground for future research. There is a unique opportunity to make significant contributions to expand our knowledge in this critical area. We, in operations management, should be at the forefront of this research. We need more books like this one.

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