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Building Supply Chain Excellence in Emerging Economies
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PREFACE

Hau L. Lee and Chung-Yee Lee

In the last decade, we have seen major progresses in the development of the theories and practice of supply chain management in many industries. The most notable advances started in the apparel industry, dubbed "Quick Response (QR)," and shortly after, followed by the grocery industry, dubbed "Efficient Consumer Response (ECR)." Both industry-led movements have awaken major companies in the US and Europe on the need to integrate their supply chains. Academic research has followed, and courses on supply chain management are also standard at many business and engineering schools.

These movements, however, have involved companies that are in developed countries. Many of the leading edge supply chain examples that one can find in the literature are about powerful companies such as Dell Computer, Cisco, Seven-Eleven Japan, Wal-Mart, and Zara, etc. But the bulk of the focus has been on their excellent processes and systems in developed economies.

Yet the forces of globalization have resulted in a significant part of the supply chain of almost every industry being located in emerging economies such as China and India. Increasingly, these emerging economies also form the end-markets of a lot of industrial and consumer products. Our knowledge and experience of operating and managing a supply chain that involves emerging economies, however, is still very limited.

Supply chains are definitely increasingly global, as a result of the unprecedented growth of global trade. In 2004, global trade has grown by more than 10%, constituting 10% of the world's GDP. In fact, between 1973 and 1999, global trade has grown annually at three times the rate of worldwide GDP growth. In 1970, global foreign exchange transactions occurred at a rate of $10 billion a day. Today, that exchange is occurring at a rate of $10 billion a second. A recent Accenture study[1] showed that, in 2005, major companies had 35% of their revenues generated outside their home market, and 31% sourced raw materials, semi-finished goods, or finished goods from outside their home

[1] Accenture Global Operations Survey, 2005.

market. Such figures were expected to grow to 42% and 38% respectively in 2008. Companies can no longer afford to ignore managing their supply chain outside of their home country effectively.

With the rapidly developing new economies such as China, India, Hungary, Vietnam, Costa Rica, Mexico, Brazil, etc., emerging economies are at the crossroads of almost all major supply chains. The BRIC countries (Brazil, Russia, India and China) constitute 15% of the economic size of today's G6, but they are expected to grow to surpass today's G6 in less than 40 years' time. The special cultural and organizational barriers, infrastructure development, technological advances, logistics challenges, and public/private collaborations, all play central roles in the evolution of supply chains in these parts of the world. Increasingly, these parts of the world are playing the roles of suppliers, design centers, final assembly, and markets. Both forward and reverse logistics are critical for successful supply chain management.

Given the physical, social and cultural characteristics of the emerging economies, managing supply chains there could be even more challenging than in developed economies. How can we manage supply chains well in emerging economies, coordinate information flows with multiple partners, tackle challenges such as unexpected disruptions, diversify the risks and increase flexibilities, be efficient but at the same time contribute to the social and environmental developments of these economies, and use supply chain concepts and practices to improve the economic welfare of these countries, such as basic infrastructure developments and disaster relief, are topics of heightened interest.

This book seeks to provide some insights on the answers to the above questions. It is our hope that the collection of articles will enable practitioners to gain insights on the developments, challenges and opportunities when operating supply chains in emerging economies; and learn about some innovative approaches and experiences by some progressive companies and thought leaders. We also hope that this collection will stimulate researchers to gain deeper understanding and develop methods in operating supply chains in emerging economies.

We have organized the book in three key sections. The first section develops the overall framework in managing global supply chains and developing strategies. The second section describes the challenges and opportunities in supply chain management of emerging economies – the infrastructure constraints, the logistics inefficiencies, and limitations in service operations; and discusses how to create opportunities in such adverse conditions. The third section is devoted to a number of industrial cases that showcase innovative approaches to gain excellence, and share insights and lessons from such experiences.

Global Supply Chain: General Strategies and Framework

There are five chapters on the general strategies and framework. In "On the Globalization of Operations and Supply Chain Strategies – A Conceptual Framework and its Applications," Panos Kouvelis and Julie Niederhoff describe the forces that shape globalization and a framework to develop strategies. The authors illustrate how the framework can be used with the case of Acrilan, an acrylic fiber manufacturer.

As the emerging economies begin to mature, and the supply and demand points in a supply chain begin to shift, companies need to re-optimize the design of their global supply chain, so as to make the best use of their global resources. This is the subject of "Globalization and Emerging Markets: The Challenge of Continuous Global Network Optimization," by Peter Koudal and Douglas A. Engel.

Many emerging economies have lower direct labor costs, and are so attractive offshoring locations. But there could be many hidden costs. The decision to offshore has to be based on a sound comprehensive analysis of the total landed costs, the tradeoffs of associated risks, and the business strategies of the company. David Pyke provides us with the approach to tackle this decision, and share with us his personal experience in helping companies to make such decisions, in his chapter titled "Shanghai or Charlotte? The Decision to Outsource to China and Other Low Cost Countries."

It is not just commercial goods that would be of concern to operating supply chains in emerging economies. Such economies are also prone to natural disasters. In "Life-Saving Supply Chains: Challenges and the Path Forward," Anisya Thomas and Laura Kopczak show how humanitarian relief organizations could make use of information technologies and supply chain principles to improve the effectiveness of relief operations. The private sector can probably learn from humanitarian disaster relief operations, as supply chain disruptions in emerging economies are not uncommon and we have to be just as responsive and efficient.

Eric Johnson describes how Mattel developed its capacity expansion strategies in "Dual Sourcing Strategies: Operational Hedging and Outsourcing to Reducing Risk in Low-Cost Countries." The Mattel story can be used to develop better risk-hedging strategies, which is crucial given the often higher risk exposures in supply chains of emerging economies. Eric Johnson gives us a comprehensive treatment of all the risks in managing a supply chain.

Supply Chain Management in Emerging Economies: Challenges and Opportunities

There are six chapters in this section. India is one of the major emerging economies. Most of us think of India as a growing source of labor in software and computing technologies. But in fact, the supply chain of India encompasses many more products and services. In "Managing Supply Chain Operations in India – Pitfalls and Opportunities," Jayashankar Swaminathan gives a thorough overview of the state of supply chain management in India, as both a source and market, and outlines the necessary steps in order to gain control of the supply chain.

Another major emerging economy is China. Given the size of the country and the fact that the logistics infrastructure of most of the inland of China is still not well developed, order fulfillment is a major challenge. In "Integrated Fulfillment in Today's China," Jamie M. Bolton and Wenbo Liu discuss what these challenges are, and how these challenges are changing as a result of China entering WTO. They also give some lessons, based on their experience, on what companies need to do as they increasingly make use of China as a part of the supply chain. In "Logistics Management in China: Challenges, Opportunities and Strategies," Gengzhong Feng, Gang Yu, and Wei Jiang discuss in detail the transportation and logistics problems in China, but shows how the trends are changing and that opportunities can be created.

Hong Kong has long been a major logistics hub connecting the East and the West. But the economic growth of Southern China and its reliance on Hong Kong as a major outbound port has resulted in significant congestion and potential productivity degradation. In "Connectivity at Inter-Modal Hub Cities: the Case of Hong Kong," Raymond Cheung and Allen Lee describe such problems and discuss ways to improve logistics flow.

Besides the forward supply chain, the reverse supply chain is equally important as companies start to develop emerging economies as their markets. Part of the reverse supply chain is the provision of after-sales customer service. In "Service Parts Management in China," Steven Aschkenase and Keith Nash articulate the importance of managing service parts in China, and show that, by managing the service chain well, great values can be created.

Finally, supply chain flows in emerging economies are complicated by the existence of regulations, trade agreements, and other governance rules. In "DHL in China: The Role of Logistics Governance," Kevin Leung and Paul Forster use the DHL experience to discuss how companies need to be cognizant of logistics governance factors so that they could overcome barriers and gain control.

Building Supply Chain Excellence: Innovations and Success Cases

There are eight chapters in this section. The first one deals with the use of information technology to support supply chains of agri-business in India. Despite the poor infrastructure and the highly inefficient supply chain, smart use of information technology can help to transform supply chains and make a difference, leading to benefits to all parties in the supply chain. In "Supply Chain Reengineering in Agri-Business – A Case Study of ITC's e-Choupal," Ravi Anupindi and S. Sivakumar give us the case of e-Choupal, in which such transformation had been successfully implemented.

Going against the trend of outsourcing, Esquel, an apparel manufacturer, developed a vertically integrated supply chain going all the way from cotton farms in Xinjiang, China, to fabric weaving and dyeing, garment manufacturing, and even retailing. In "Esquel Group: Going Beyond the Traditional Approach in the Apparel Industry," Barchi Peleg-Gillai describes how Esquel can run such a vertically integrated supply chain with efficiency, social responsibility, environmental sensitivity, and sound business results.

Most global companies would develop supply chain processes using developed economies as the test-bed, and then localize the processes in emerging economies. CEMEX, a major cement manufacturer, did it the other way round. It used Mexico, a country with very difficult physical logistics infrastructure, diverse customer needs, and very demanding customers service requirement, as its test-bed for innovative approaches and methods; and then extend such processes to the rest of the world. In "End-To-End Transformation in the CEMEX Supply Chain," David Hoyt and Hau L. Lee describe how CEMEX was able to use such an approach to become the world's leader in cement manufacturing.

As the emerging economies grow and mature, the increasing middle class enables such economies to become major markets for consumer goods as well. Distributing in these economies is not easy. But IDS, a Li and Fung company (which has often been dubbed as *the Supply Chain Architect of Apparel and Consumer Goods*), created an innovative approach to distribution. It first unbundled the multiple distribution services, and then re-integrate them to give the greatest values to customers. This is recorded in "The IDS Story – Reinventing Distribution," by Ben Chang and Joseph Phi.

As companies source materials from emerging economies that are in underdeveloped countries, the risk of supply disruptions is increased. Starbucks Corporation has recognized that sustainability of the supply bases is an important objective of a supply chain. In "Building a Sustainable Supply Chain – Starbucks' Coffee and Farm Equity Program," Hau L. Lee, Stacy Duda, LaShawn

James, Zeryn Mackwani, Raul Munoz, and David Volk describe the Starbucks initiative to help farmers in Africa, East Asia and Central America. A sustainable supply chain is also a socially-responsible supply chain.

Since emerging economies are just beginning to be growing markets for industrial and consumer goods, multi-national giants have not penetrated in many such economies. This provided a window of opportunity for smaller players to build its business. The value proposition can be based on sound customer service. In "Building a Distribution System in Eastern Europe: Organic Growth in the Czech Republic," Eric Johnson describes how this can be done, and draw learning lessons from this successful case.

Emerging economies often made use of highly focused industrial and logistics parks as a way to attract foreign investments to develop its manufacturing sector. In "A Path to Low Cost Manufacturing for Integrated Global Supply Chain Solutions." Wesley Chen describes the experience of Solectron in making use of the Suzhou Industrial and Logistics Park to create its manufacturing center of excellence. It requires a lot of collaborative work with the local government, but the payoffs are huge.

Finally, in "Transforming an India Manufacturing Company: the Rane Brake Lining Case," Ananth Iyer and Sridhar Seshadri describe the journey of Rane Brake Lining, an Indian manufacturing company. Emerging economies are often not known for high quality standards, but Rane Brake Lining ran against the conventional wisdom. Its persistent pursuit of quality management is a lesson for others in emerging economies.

Acknowledgment

Some of the chapters of this book were based on a conference in Shanghai in 2004, co-sponsored by Hong Kong University of Science and Technology, Stanford University, Eindhoven University and the China-Europe International Business School, with financial support by the World Bank. The theme of the conference was "China at the Crossroad of the Global Supply Chain." We are grateful to our collaborators of the event, which gave rise to the idea of developing the current book. We are also grateful to many of our colleagues, who encouraged us to expand our focus from China to many other emerging economies. Some of these colleagues also contributed chapters to this book.

Part I

GLOBAL SUPPLY CHAIN: GENERAL STRATEGIES AND FRAMEWORK

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Chapter 1

ON THE GLOBALIZATION OF OPERATIONS AND SUPPLY CHAIN STRATEGIES

A Conceptual Framework and Its Application

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Abstract: In a global market, companies do not compete solely as individuals but as part of an entire supply chain, and strategic managers must consider the whole supply chain and fully understand global forces and relevant trends when making operational decisions. We present a conceptual framework through which managers can evaluate the many forces affecting global operating strategies. This framework is composed of four types of forces: global market forces, technology forces, global cost forces, and political or macroeconomical forces. Global market forces, in general, motivate a company to seek a larger market for its goods or services. Technological forces generally ease barriers to globalization or require global operations strategies in order to access cutting edge technology. Global cost forces seek reduced or shared costs through high quality, lower total cost global production sites. Finally, political or macroeconomical forces cause a firm to seek competitive advantages through the careful utilization of exchange rates, regional trade agreements, or nontariff barriers. By using the global forces framework presented here, managers can clearly analyze the various important factors that shape global operations decisions and understand the implications of recent global events and trends on their supply chain strategies. We clearly illustrate the application of our framework in shaping supply chain strategy via a real case study from our consulting practice.

1.1. Introduction

Over the past two decades, a new global business environment has evolved. If current trends continue, world exports of goods and services will reach $12

trillion dollars by 2006, or close to 30% of world gross domestic product, up from a mere 10% two years ago. The vast majority of businesses now have some form of global presence – through exports, strategic alliances, joint ventures, or as part of a committed strategy to sell in foreign markets or locate production plants or business process services abroad. American manufacturers have 8,000 units overseas employing almost 5 million workers, equal to nearly 25% of US manufacturing employment. Previously, large multinational corporations dominated the international marketplace, which domestic firms generally ignored. However, according to the 2001 census, 97 percent of manufacturers who exported were considered small- or medium-sized. In today's marketplace, most companies realize that it is essential to be aware of and participate in international markets. The main goal of this chapter is to examine the factors and forces that are driving the increasing globalization of operations activities and to organize them into a framework through which managers can analyze globalization decisions.

In a global market, companies do not compete solely as individuals, but as part of an entire supply chain, and strategic management must consider the whole supply chain and the global forces and trends shaping the new competitive environment when making operational decisions. Using the case of an acrylic fiber producer in the apparel supply chain, we illustrate how a viable company can lose its competitive edge when a less competitive member of the forward supply chain acts as a bottleneck to the market. In the global market, competition is at a supply chain level and this case, along with many other examples, illustrates many of the driving forces for globalization in the supply chain, analyzed through the "globalization forces" framework. Effective management in a global operations setting requires a sophisticated understanding of these global forces and the new manufacturing order of dispersed manufacturing with supply chain and logistics as core management capabilities.

1.1.1 Globalization is Increasing

Trends among U.S. businesses illustrate the growing size and importance of global operations:

- According to the U.S. Census, from 2003 to October 2005, the value of goods imported rose nearly 45 percent while the value of goods exported rose only 31.3 percent. Overall the trade deficit for goods rose 62 percent in that time.
- When other characteristics of companies are held constant, exporting firms perform much better than nonexporters. Worker productivity in exporting firms is 20 percent higher than that of non-exporting firms. Export jobs are better jobs: production workers in exporting firms earn 6.5

percent more. They are also more stable jobs: exporting firms are 9 percent less likely to go out of business than comparable nonexporting firms. (Bergsten, 2001)

- According to U.S. Census information from 2001 to 2002, nearly 20 percent of U.S. manufacturers participate in exporting, accounting for over 71 percent of the total known value for exports.
- Manufacturing assets held by multinational enterprises in foreign countries are substantial and rapidly increasing.
- Much of the US trade deficit represents what US corporations buy from their overseas units. In the late 1990's such foreign affiliates of US corporations generated close to $3 trillion dollars in sales, with 65% of that sold to local markets and the remaining 35% brought back to US.
- In 2004 about 8 percent of administrative office work had been outsourced, much of it to India. In IT services, 16 percent of all IT work is done by an outsourced party. Much like manufacturing in the 1980's and 1990's, Business Process Outsourcing (BPO) is a growing trend, estimated to grow from $3.6 billion in 2003 to $21-$24 billion by 2008.

Two factors underlie the dramatic rise in globalization. First, global reach is important to a firm's survival. Second, multinational firms are more profitable and grow faster. Among twenty major U.S. manufacturing industries, multinational firms grew faster than domestics in nineteen of the cases and were more profitable in seventeen cases (Bergsten, 2001).

Given this environment, the goal of this chapter is to understand the development of successful global operations strategies when competing at a supply chain level. These strategies achieve business objectives through a dynamic process of leveraging and managing manufacturing, logistics, and research and development (R & D) activities. Using the framework presented here (Figure 1.1), managers can organize the decision process for globalization strategy. The essence of our framework is that there are four major driving forces for globalization: global market forces, technological forces, global cost forces, and political and macroeconomical forces. The power of this chapter is the usefulness of this framework to aid managers in analyzing how these forces are impacting a specific industry or product and to illuminate potential advantages or pitfalls to various globalization options.

1.2. The Driving Forces of the Globalization Process

The conceptual framework that follows classifies the major factors and driving forces behind the globalization process. Each of these factors affects different industries, even different products, to varying degrees. The affects

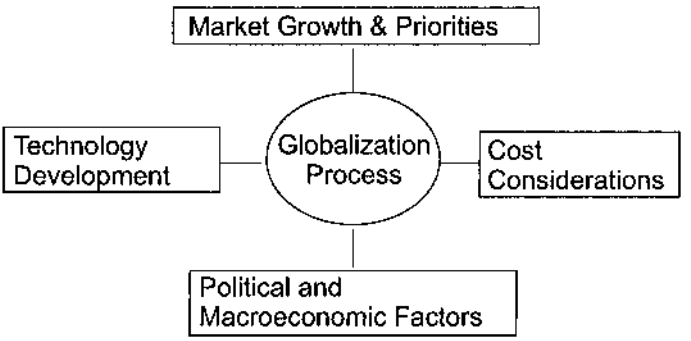

Figure 1.1. Four Forces Globalization Framework.

of each on the globalization efforts of Acrilan are detailed in Section 7. Even though generalizations are impossible and "recipes" undesirable in strategy development, the framework will allow an operations manager to structure his or her thinking process in understanding changes in the global environment, prioritizing the importance of various factors, and developing strategic alternatives.

The motivations for globalization of operations can be grouped into four categories, as shown in Figure 1.1. These forces, and specifically how they emerge in the Acrilan case, are detailed in the following sections.

1.2.1 Global Market Forces

Market forces for globalization include the need to establish a presence in foreign markets to capitalize on foreign demand and recoup domestic demand lost to foreign imports, as well as to build a global presence to minimize foreign threats into the domestic market through a competitive balance. As the existence of secondary markets for end-of-life products begins to fade, speed to market sometimes dictates a global production and distribution network. Finally, as state-of-the-art niche markets develop in specific countries, companies must consider establishing a presence in these markets to stay competitive and abreast of the latest technology developments and demands.

1.2.2 Technological Forces

Many companies seek a global market in order to achieve economies of scale as they simultaneously narrow the scope of their product to a niche market by differentiating themselves in a commodity market. This, in effect, is the mass customization of a good at a global-level.

As technological production skills develop globally, multinational firms need to tap into the technological knowledge of various countries and integrate the new technology into their own product as necessary to stay competitive. In order to stay current and access these new developments in real time, global companies may benefit by forming close relationships with dominant foreign suppliers instead of investing in an in-house capability. Additionally, by placing production facilities close to the state-of-the-art suppliers and competitors, costly delays due to breakdowns are minimized. Globally located firms can also engage in technology sharing and interfirm collaborations, and take advantage of state-of-the-art or lower priced R&D workers in countries such as Taiwan, China, and India.

1.2.3 Global Cost Forces

Perhaps the most commonly recognized force for globalization, experiences from previous global expansion projects, and some of their failures, indicates that costs to consider for offshore sourcing should go beyond just direct labor and definitely include quality, differential productivity, and design costs, and carefully account for added logistical and transportation costs. Often, direct labor is such a small component of total product cost that it is misleading to offshore based solely on reduced labor costs. In industries with capital-intense production facilities, globalization can be a natural result of multiple firms seeking a joint production facility or a single firm seeking economies-of-scale through high utilization of a private production facility.

1.2.4 Political or Macroeconomical Forces

Currency rate fluctuations can help or hurt global operations and require careful analysis and, preferably, a portfolio of options to balance unfavorable fluctuations. Regional trade agreements, such as NAFTA, also influence the decision to globalize operations. Finally, the imposition of trade protection mechanisms, such as tariffs, trigger price mechanisms, local content requirements, technical standards, health regulations, and procurement policies, influence where a company may choose to locate global operations in order to make the most of its supply chain.

1.3. Global Market Forces

Manufacturers cannot afford to ignore the tremendous growth potential of foreign markets. First they need to attack competitors abroad to develop a competitive balance and protect domestic market share. They also may need to acquire market knowledge in markets other than the home country, to respond

quickly to customer orders, and customize products for various local markets. For many products and industries, penetration of global markets depends on having global facilities and/or distribution and supply networks to respond to customer demand in all the relevant competitive dimensions of cost, quality, service, and flexibility.

The nature of global market forces, how they contribute to the globalization of operations activities, and the strategies manufacturers pursue in response to them, are characterized by five main themes.

- Intensified foreign competition in local markets
- Growth in foreign demand
- Global market presence as a competitive threat
- Changing competitive priorities in product markets
- Establishing a presence in state-of-the-art markets

1.3.1 Intensified Foreign Competition in Local Markets

Among U.S. manufacturers, penetration of foreign goods in the U.S. consumer goods markets doubled during the 1980s and the value of foreign goods imports more than tripled between 1990 and 2004. The numbers are even more exaggerated in capital goods markets, where foreign penetration rose from about 14 percent to over 40 percent in the 1980s and the value of capital goods imports in 2004 almost tripled that of 1990. Manufactured goods such as machines and transport equipment increased from a mere 4 percent of China's total exports in 1985 to nearly 35 percent in 2000, many of which are exported to the United States. Clearly, foreign competition has intensified in virtually every industry and affects all companies to some degree.

As a result, even small- or medium- sized firms that have never marketed or produced products abroad need to understand developments in the global environment. The openness of most international markets today allows foreign firms to compete directly with domestic firms in previously protected local markets. These competitors frequently are large multinationals with integrated global operations. They are adept practitioners of world-class manufacturing and logistics standards, which forces many small- and medium-sized firms to upgrade their operations, to keep abreast of product and process innovations, and to adopt the latest in just-in-time and total quality management techniques. In many cases, small- and medium-sized firms must even consider expanding into international operations – either through exporting, outsourcing some production, or entering into alliances and licensing agreements with foreign partners.

1.3.2 Growth in Foreign Demand

In recent years, the world market has grown disproportionately larger relative to the U.S. market, and most of the growth is coming from developing country markets. It therefore makes sense for operations executives to target those markets for future growth potential.

Growth in foreign-market demand necessitates the development of a global network of factories, as well as an expanded sales and distribution network. If *economies of scale* are important in an industry, the global network probably will consist of a few centralized production facilities in countries that offer comparative advantages in the critical production process inputs (i.e., labor, resources). The multinational firm then uses its global economies of scale to attack local markets.

If *customization and fast response* drive the industry, and economies of scale are less important, then the resulting global network will contain multiple facilities, each dedicated to serving a specific local or regional market.

Having the opportunity to operate in, and meet the demand of global markets complicates the production-planning task of the global operations manager. It requires attention to complicating factors such as currency movements and coordination of dispersed production facilities. On the other hand, operation on a global scale allows more efficient utilization of resources and a more stable production plan. Companies can take advantage of regionally different demand fluctuations to smooth production.

1.3.3 Global Market Presence as a Competitive Threat

Global presence can be used as a defensive tool to stop aggressive moves by foreign competitors toward penetrating a firm's home market. For example, in the ready-to-eat cereal market, the U.S.-based Kellogg company and its large European competitor Nestlé have large market share in their home markets, but limited presence in their competitor's home market. The two companies maintain a gentleman's agreement of nonaggressive penetration of each other's home markets following unsuccessful past efforts and heavy revenue bleeding from subsequent retaliations. In general, a company that is unable to retaliate against aggressive foreign competitors attempting to penetrate its home market is in a vulnerable competitive position.

1.3.4 Changing Competitive Priorities in Product Markets

For many years the dominant theory in international production was based on the concept of an *international product life cycle*. Under this theory, a company introduced a product in one or several developed-country markets. When

the product entered the decline stage of its life cycle in these markets, the company simply began shipping it to developing-country markets. The strategy regenerated or extended the product's total life cycle by sequentially cultivating markets that lagged behind in customer needs and knowledge on the latest product and process technology developments.

Unfortunately, few industries remain today in which this theory still applies. Product markets, particularly in technologically intensive industries, are changing rapidly. Product life cycles are shrinking as customers demand new products faster. In addition, the advances in communication and transportation technology give customers around the world immediate access to the latest in available products and technologies. Thus, manufacturers hoping to capture global demand must introduce their new products simultaneously to all major markets. Furthermore, the integration of product design and development of related manufacturing processes have become the key success factors in many high-technology industries, where fast product introduction and extensive customization determine market success. As a result, companies must maintain or source from production facilities, pilot production plants, engineering resources, and even R & D facilities all over the world. For example, in the 1980s, Apple Computer built a global manufacturing and engineering infrastructure with facilities in California, Ireland, and Singapore. This network allowed Apple to introduce new products simultaneously in the American, European, and Asian markets. With the improvements to logistics technology in the 1990s, they moved to entirely outsourced production based largely in Asia, while maintaining design in California.

1.3.5 Presence in State-of-the-Art Markets

In certain industries, particularly hypercompetitive high-technology segments, certain country markets demand state-of-the-art products to meet their consumer needs. For these industries and product markets, customer preferences drive the next generation of product and process innovations. Firms that intend to remain product/process leaders in these state-of-the-art markets must set up production, and in some cases, product development facilities there. Examples of state-of-the-art markets are:

- Japan: Semiconductor process equipment, consumer electronics and machine tools
- Germany: Machine tools
- United States: Aerospace, computers, software

Companies use the state-of-the-art markets as learning grounds for product development and effective production management, and then transfer this

knowledge to their other production facilities worldwide. This rationale explains why Mercedes-Benz decided to locate a huge manufacturing plant in Vance, Alabama. The company recognized that the United States is the state-of-the-art market for sport utility vehicles.

1.4. Technological Forces

In recent years, transportation and communication costs have fallen dramatically, and international operating activities have become much easier to organize. At the same time, the sources of creation and dissemination of knowledge have globalized. Competitive success depends more and more on how quickly and effectively a firm incorporates new product and process technology into the design and production of its products and services. This need for speed has prompted companies to locate more production, R & D, and business processes services abroad, closer to the suppliers of advanced technological knowledge in component production or of crucial process equipment or skill bases. Companies have formed joint ventures to share technological knowledge in exchange for market presence. They have located R & D facilities in countries with the most cost-effective technological resources and scientific infrastructure.

Technological forces have shaped the global operations strategies of multinationals in four ways.

- Technological advancements and effective mass customization in global markets
- Diffusion of technological knowledge and global location
- Technology sharing and interfirm collaborations
- Global location of R & D facilities

1.4.1 Technological Advancements and Effective Mass Customization in Global Markets

Another major trend in operations strategy is *fewness*. Fewness characterizes markets that have a limited number of producers. The concept is not new, but is a strategic quality firms should seek by segmenting existing markets or creating new product niches from scratch. This tradeoff reduces competition to just those within the niche market, but also reduces the market, leading to the necessary pursuit of a larger global market.

The average number of all competitors in specific industry segments dropped by 45 percent in the late 1980 and early 1990s, according to The Conference Board manufacturing database. The same trends intensified in the

90s and the new millennium. *Fewness* generally is associated with increasing profitability. A firm that achieves market leadership and has few competitors in its market segment is likely to be more profitable than one that typically has many competitors or small market share. Indeed, in this era of globalization, it is easier for companies to expand within a market segment across borders than to expand across diverse product lines within a country.

How are firms able to pursue fewness and simultaneous profitability in the global marketplace? The answer is fairly straightforward, and relies on exploiting a unique synergy of global market forces and recent technological advancements in manufacturing and logistics. Fewness is the result, in part, of two forces: diversity among products and uniformity across national markets. Product diversity has increased as products have grown more complex and differentiated and as product life cycles have shortened. At the same time, national markets have become increasingly similar, especially in the industrial countries, and particularly for intermediate goods. Companies have been able to expand their global market presence and simultaneously realize economies of scale, as a result of more flexible manufacturing and distribution methods and better communications and transportation technologies. Falling transportation costs are driven in part by dramatic improvements in containerization and supply chain management.

1.4.2 Diffusion of Technological Knowledge and Global Location

Advanced technological/production knowledge is no longer the preserve of large American or European multinationals. The U.S. only produces about 7 percent of the world's engineers, less than China, Japan, and Russia. The share of the U.S. market for high-technology goods supplied by imports from foreign-based companies rose from a negligible 5 percent to more than 20 percent in the early 1990s. Moreover, the sources of such imports expanded beyond Europe to include Japan and the newly industrialized countries of Hong Kong, Singapore, South Korea, Taiwan and more recently China. China's market share of the semiconductor market is expected to grow from 5 percent in 2000 to 15 percent in 2010 due to the influx of Taiwanese semiconductor technology into China and the tremendous growth in local demand. By 2010, China is expected to dominate the low-end design chips market. China's abundance of engineers makes it a popular destination for R & D facilities. Companies such as GM, Siemens, and Nokia have research centers in China.

The abundance of engineers and MBAs in India has made it the most common choice for business process offshoring. Adding to India's appeal are the 2.5 million graduates each year who have the necessary skills to do BPO work,

such as accounting, telesales, technical support, and insurance. Along with their technical knowledge and language skills, technical infrastructure, such as telecommunications, has enabled immediate service at minimal cost to companies seeking to offshore business processes in India.

In response to this diffusion of technological capability, multinational firms need to improve their ability to tap multiple sources of technology located in various countries. They also must be able to absorb quickly, and commercialize effectively, new technologies that, in many cases, were invented outside the firm – thus overcoming the destructive and pervasive "not-invented-here" attitude and resulting inertia.

The need to have access to critical technological components for their products forces firms to develop close relationships with dominant foreign suppliers in certain product/technology areas. Supplier involvement in new product design efforts becomes critically important, thereby causing some companies to locate production facilities close to their suppliers. Two examples of dominant suppliers are Canon and Fanuc, many of whose industrial customers have located close to their plants. Canon is the leader in global production of motors for fax machines and laser printers, with more than 80 percent of the world market. Fanuc controls more than 70 percent of the world market for machine-tool controllers.

The alternative to dependence on dominant foreign suppliers is a *deep-pocket* investment strategy of developing component production capabilities in-house. This strategy is not only expensive but also risky, especially if the required know-how lies outside the firm's core capabilities. However, some firms pursue it, with IBM's manufacturing of engines for its own laser printers being one such example.

Another clear trend is for companies to locate production facilities close to foreign suppliers of critical process equipment because of the sophisticated nature of this equipment, the devastating effect of prolonged breakdowns or production slowdowns, and the need for process technology know-how in the accelerated cycle of new product-manufacturing process development. In a high-technology environment, for instance, buying process equipment long distance is not usually a viable solution. For example, both IBM and Xerox chose to produce video displays in Japan, which has the best process capability of this technology. A large U.S. paper company has built operations in Europe, not only to penetrate the European market, but also to gain fast and easy access to process development emerging from the major European equipment suppliers, as well as from smaller European competitors. These smaller paper firms are open to licensing agreements for their process innovations, an attractive alternative for U.S. firms.

In services, technology has reduced the need for proximity between markets and service providers. Dramatically lower telecommunication costs, significant increases in telecommunication capacity, and radical improvements in digitization of services have redefined the range of services that may be provided remotely. Fast food orders at some McDonald's restaurants in Missouri are routed through call centers a few states away, and there is no reason why that can not be a continent away.

1.4.3 Technology Sharing and Interfirm Collaborations

In many cases, the main motivation behind interfirm collaborative agreements such as joint ventures, participation in international consortia, or technology licensing, for example, and a variety of other alternatives, is the need to gain access to technological development. In the partnership between Texas Instruments (TI) and Hitachi, two of the world's top-ten chip-makers, the firms began collaborating in 1988 with the intent of sharing basic technologies. As the joint venture succeeded, however, TI and Hitachi decided to capitalize on their success by expanding the agreement to include manufacturing as well. The two partners have now built a joint facility in Richardson, Texas, in order to create the next generation of Dynamic Random Access Memory (DRAM) chips.

The main motivation of joint ventures in the steel industry between U.S. and Japanese firms (for example, LTV and Sumitomo, Inland Steel and Nippon Steel, National Steel and Marubeni) was the desire of the U.S. firms to gain access to advanced process technology, combined with the need for financial backing from Japanese producers. In return, the Japanese obtained broader access to the U.S. market and a production base to supply the American plants of Japanese automakers.

The well-known joint ventures in the auto industry between U.S. and Japanese firms (GM-Toyota, Chrysler-Mitsubishi, Ford-Mazda) followed a similar pattern. U.S. firms needed to obtain first-hand knowledge of Japanese production methods and accelerated product development cycles, while the Japanese producers were seeking ways to overcome U.S. trade barriers and gain access to the vast American auto market.

1.4.4 Global Location of R & D Facilities

As competitive priorities in global products markets shift more toward product customization and fast new product development, firms are realizing the importance of co-location of manufacturing and product design facilities abroad. In certain product categories, such as Application Specific Integrated Circuits (ASICs), this was the main motivation for establishing design centers