Manufacturing Strategy
The Research Agenda for the Next Decade


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which these combinations should be employed. This study supplies a beginning for developing quantitative measures for these future efforts.

REFERENCES


STRICT ENTRY INTO GLOBAL MANUFACTURING INDUSTRIES: EVIDENCE AND NEW THEORETICAL DIMENSIONS

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ABSTRACT

This paper develops a theory of strategic entry groups, entry-site strategic groups, and subsequent mobility across strategic groups within heterogeneous industries. We illustrate the concepts by discussing strategies followed by members of one strategic entry group in the medical diagnostic industry.

INTRODUCTION

Major American firms once met few challenges when they competed in international markets. As industry after industry has become progressively global, however, companies based in the United States have had to change their competitive strategies (Cohen, Teece, Tyson, and Zysman, 1984). Those that have not changed have failed.

In this paper, we will address this issue in two ways. The first part of the paper is empirical. We will describe the globalization of the medical diagnostic imaging industry during the last 30 years, with a focus on the strategies used by Japanese firms to compete with American and European manufacturers. We will then use the empirical case to motivate a theoretical framework for analysis of three specific competitive issues in global manufacturing industries. In the theoretical section we will discuss the origins of entry groups, their entry-site strategic groups, and their later movement across strategic groups.

GLOBALIZATION OF THE DIAGNOSTIC IMAGING INDUSTRY

In this section we describe one global high-technology manufacturing industry and entry strategies used by the entry group of Japanese firms that have competed in its American market.

Starting from minor positions in the United States during the 1950s, Japanese manufacturers have expanded to become strong players in the American segment of the international medical diagnostic imaging industry (Poole and Mitchell, 1989). The strategies they have used - how they entered and then how they expanded - underlie their current competitive strength. The description of the strategies will provide an example of the importance of the related theoretical issues.

Innovation and Competition in the Imaging Industry

Diagnostic imaging equipment is used to produce images of physiological structures within the body. Conventional x-ray and electrodiagnostic instruments have been available since early in the century. Since the 1930s, however, nuclear medical, ultrasonic, computed tomographic, magnetic resonance, and digital radiographic instruments have expanded the scope of the industry and challenged industry incumbents (Mitchell, 1988). We first describe imaging...
equipment development and commercialization trends and then identify competitive challenges
mourned by Japanese entrants to the U.S. market.

Each general type of imaging equipment emerged from academic research laboratories
throughout the world. Most commercial prototypes were introduced to medical markets by
 newcomers to the diagnostic imaging industry, often after contact with the academic researchers.

Once new types of devices achieved both technical and market success, the major diagnostic
 imaging industry manufacturers then incorporated the products into their lines.

In the late 1950s, international sales of conventional x-ray and electrodiagnostic
equipment totalled about $100 million, with almost half of the sales in the United States. With
sales growth of conventional instruments and successive introduction of new methods of producing
images, global shipments of imaging systems will exceed $9 billion by 1990, about one third in
the United States. Sales of auxiliary equipment and after-sales service will total several times that
figure. As shipments have grown, so has the globalization of the industry that produces the
devices. Once a series of national industries, the diagnostic imaging industry has now become truly
international.

In 1960 the American radiography industry consisted of about 45 firms selling equipment
into a $40 million market. The industry was dominated by three American firms, General Electric,
the Picker X-Ray Company, and the Westinghouse Electric Company, followed by two European
producers, Siemens AG and NV Philips. The five manufacturers shared 70% to 75% of the U.S.
market for x-ray equipment and a significant share of the smaller electrodiagnostic instrument
market.

In 1990, the radiography industry has become the diagnostic imaging industry, with about
150 firms annually selling $3 billion of x-ray, electrodiagnostic, nuclear, ultrasonic, computed
tomography, magnetic resonance, and digital radiographic equipment to American buyers. Among
the more than 500 manufacturers that have entered emerging subfields of the industry during the
past 30 years, several distinct entry groups can be identified. In addition to the traditional industry
leaders, the entry groups include startup firms, unrelated diversifiers, related diversifiers based
in Europe and the U.S., and established Japanese firms.

The most successful of the entry groups has been the traditional leaders. The industry is
still dominated by General Electric, Picker (now part of GEC PLC of Britain), Siemens, and
Philips. Together, the four firms control about 70% of the American market. Of the 1980s
leaders, only Westinghouse, which left the industry in 1971, has dropped.

Firms in most other entry groups have had little success in the industry. Almost all
startups have failed, because of weak financial and organizational capabilities. Most unrelated
diversifiers have left the industry after learning that there are few profit for participants lacking
technical and sales backgrounds suited to the imaging market. Even the group containing
experienced American and European medical and electronic equipment manufacturers that made large
investments in imaging research, development, manufacturing, and distribution systems has been
signally unsuccessful. Several aerospace and military electronics companies, for example, have
manufactured diagnostic imaging equipment, believing that their technical expertise would allow
them to succeed; all have failed to become general imaging equipment manufacturers. Half a dozen
major drug companies have entered, expecting their medical technical and market expertise to give
them an edge in the imaging industry; none is now an imaging market leader and most have left the
industry.

Of all the entry groups to the U.S. industry, only the group consisting of experienced
Japanese manufacturers has produced broadly-based imaging equipment manufacturers that are likely
to enjoy increasing success in the industry. The Toshiba Corporation, Hitachi Ltd., and the
Shimadzu Corporation are beginning to approach the status of the historical market leaders and each
has the potential to expand from its existing base. Only the interaction between nationalinity of firm
ownership and technical and financial capability can explain the continued success. The Japanese
entry group had a successful combination of firm and national-level capabilities.

Five Japanese Entry and Mobility Strategies

Most Japanese entrants to the global imaging industry have been large, diversified firms,
often part of networks of companies possessing broad bases of financial, technical, manufacturing,
R&D, and distribution strength. Thus, they have had the resources needed to build long-term
positions in the industry. The firms have used those resources to enter and expand within the U.S.
market through a sequential series of five strategies. The strategies, which include the firms' entry-
site strategic groups and then movement across strategic groups, are listed in Table 1.

Table 1

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<th>Key aspects of Japanese firm entry-site and expansion strategies</th>
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<td>Key aspects of strategy</td>
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<td>1. Sell components to American and European manufacturers</td>
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<td>2. Sell systems to American and European manufacturers</td>
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<td>3. Sell Japanese-branded systems</td>
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<td>a. Indirect distribution</td>
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<td>b. Direct distribution</td>
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<td>4. Japan-based manufacturing joint ventures with American and European manufacturers</td>
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<td>5. U.S.-based assembly plants; most value-added in Japan</td>
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* Each strategy continues, but supplemented by later strategies.

The first strategy is the supply of components that are incorporated into imaging systems
manufactured by European and American firms. Japanese manufacturers have acted in this role
since the 1950s. The practice is found in all technical subfields of the industry, from the oldest
conventional x-ray products to the newest positron emission tomographic nuclear medical scanners.

The second strategy is the supply of systems that are sold with American and European firms' labels.
Japanese manufacturers have played this role since the 1960s. The activity is most common in
the older subfields such as x-ray, electrodiagnostic, nuclear, ultrasound, and computed
tomography. It is also common in niches within those subfields. In x-ray mammography, for
example, Acoma X-ray Industry Co. Ltd. supplies about 25% of the systems sold in the U.S.
Japanese manufacturers are also moving from the established subfields into the newer product areas,
as Japanese firms now supply magnetic resonance and digital radiography systems sold by
American and European firms.

The third Japanese manufacturing mobility strategy is the sale of Japanese-branded
products through indirect and direct distribution networks. Indirect distribution through sales
representatives was the norm until the mid-1970s. Even now, many Japanese firms sell products
through distributor networks in the U.S.; in 1988, for example, Acoma began to contract with
American dealers to sell its mammography units. Indirect distribution is not an effective way of
selling complex equipment, however, and the market share of Japanese-firm branded products often
has been small. In the less-complex electrodiagnostic instrument area, though, products
manufactured by Japanese firms such as the Nihon Kohden Corporation and NEC-San El
Instruments Ltd. dominate the market.

Since the late 1970s, starting with Toshiba in 1976, several Japanese medical equipment
manufacturers have established direct sales systems. This is the strategy of at least the three
strongest Japanese competitors, Toshiba, Hitachi and Shimadzu. Although the direct sales presence
of these firms is not yet large, market shares will increase as the sales and service systems become
better established.

The fourth Japanese manufacturing strategy is the establishment of joint ventures in Japan
between Japanese and American or European companies. Japanese firms enter into the joint
ventures in order to gain access to technical, market, and regulatory knowledge held by the
American and European firms. The Western manufacturers, in their part, enter the ventures to acquire
high quality production, technical advances, and lower cost manufacturing capability. Although
a few American medical equipment companies have long had manufacturing joint ventures in Japan,
the number of joint ventures recently has increased.
Most major European and American imaging manufacturers now participate in Japan-based joint ventures with Japanese firms. Yokogawa Medical Systems (YMS), a 1982 venture of General Electric and the Yokogawa Hoku-Shin Electric Corp., is the strongest of these. YMS sits with Toshiba and Hitachi atop the Japanese imaging market and, through GE, is becoming an important supplier to the U.S. market. YMS now manufactures most of GE’s ultrasound product line, much of its computed tomography line, and in the last three years has also begun to manufacture magnetic resonance imaging systems. Picker-Tory-Puji, a joint venture of Picker, Tory Industries, Inc., and the Fuji Electric Co., is now responsible for most of Picker’s ultrasound and nuclear production and is also developing magnetic resonance imaging systems. Siemens, too, has recently formed a joint venture with the Asahi Optical Co. Ltd.

And a fifth stage of the Japanese manufacturing strategy is the establishment of manufacturing plants in Europe and the United States. Toshiba, for example, has established a California assembly plant for some of the imaging instruments that it sells in the American market. Thus far, however, most of the advanced manufacturing and consequent value-added takes place in Japan.

If the Japanese firm had attempted to jump directly to the secular strategies, they probably would have failed. The firms would not have understood the U.S. market (Toshiba’s first ultrasonic scanner, for instance, were too small for many American patients) and potential users would not have understood the firm. But by taking the sequential road of entry and expansion across strategic groups, firms such as Toshiba and Hitachi gradually have moved into strong positions. At the same time, because the earlier strategic steps tend to be less expensive than the later stages, Japanese firms that have not been as broadly successful as Toshiba and Hitachi have limited their entry costs. The five stage sequence, therefore, has been both a ladder and a toe. For successful firms, it has provided a ladder to the top. And for less successful manufacturers, it has provided a low-cost way of testing the U.S. waters.

The previous discussion has focused on a key entry group in the diagnostic imaging industry, the entry group of established Japanese manufacturers that have expanded into American markets. Many of these firms have become important competitors in the industry. However, we do not have a systematic way of analyzing the strategies used by such companies to gain competitive advantage.

In the next section, we move from induction to deduction. We review important ideas from the economics and management theory literature. Three components of our empirical discussion - entry groups, entry site, and later movement - stem from the basis of new theoretical dimensions of entry strategy. Our perspective extends the existing literature, helping to identify entry and expansion strategies and understand why such strategies may be successful.

**GLOBAL MANUFACTURING**

Strategic groups. Empirical studies have found partial support for this theory (Newman, 1973; 1978; Oster, 1982; Cool and Schendel, 1987; 1988; Fiegenbaum and Thomas, forthcoming).

In this section, we have noted that entry strategies will be affected by characteristics of individual firms. We also have argued that post-entry behavior and performance will be influenced by mobility barriers between strategic groups. The next section will describe how the concepts of strategic groups and mobility barriers can be combined with entry analysis to understand aspects of the strategic entry and subsequent movement within heterogeneous industries.

**THEORY: STRATEGIC ENTRY AND SUBSEQUENT MOBILITY**

Origins of Entrants: Strategic Entry Groups

Where do new entrants come from? Are they arbitrarily selected from a pool of all possible firms? We argue, instead, that there are strategic profiles of entrant characteristics, which we call strategic entry groups. And just as membership in a strategic group of current competitors may explain performance outcomes, so may membership in a strategic group explain entry outcomes.

Porter (1980) noted that potential entrants are an important industrial force. His five forces model, however, does not help to identify strategic entry groups. But if we rearrange the five forces model into our cross-currents model of industrial fortune, shown in Figure 1, it now becomes possible to classify potential entrants.

The cross-currents model is derived from Schumpeter’s (1934) observation that technological change may occur through innovation in components, production processes, products, uses, or organization. Like Porter’s (1980) five forces model, we argue that industries are affected by upstream, midstream and downstream forces, that is, by supplier, existing producer, and customer strategies, and we also identify a product cross-stream, which includes producers of substitute products but also manufacturers of complementary goods and firms with experience in foreign markets. Moreover, we add a social cross-stream category, which includes the effect of laws, customs, and social norms on industrial health. The model encompasses the five forces framework, therefore, but augments it with key aspects of industrial fortune.

Unlike the five forces model, we do not treat potential entrants as a distinct category of industry-level analysis. Instead, we recognize that entrants usually emerge from the other key categories of industrial definition. New entrants sometimes are suppliers or customers for existing products or components; they may be producers of items that will substitute for or complement existing goods; and they sometimes emerge from the social cross-stream when, for example, a government nationalizes an existing member of an industry or forms a new competitor. We expect, therefore, that by analyzing the cross-currents that are pummelling an industry, we will be able to identify many of the potential entrants to it.

In addition to determining where an entrant comes from, by classifying entrants into strategic entry groups, it is important to examine where an entrant will first land in an industry and where it will later move. In the next section, we outline the concepts of entry-site strategic groups and sequential mobility into subsequent strategic groups.

**Entry Site Strategic Groups and Sequential Mobility**

Although the concept of strategic groups and mobility barriers was first used to explain intra-industry performance differences, Caves and Porter (1977) suggested that they also can be used to understand competitive dynamics. A strategy of entry and sequential movement may lower the total cost of overcoming mobility barriers into the strategic group that is the ultimate target of the potential entrant. Costs can be lowered by accumulating knowledge and brand identification in the industry through entry into the initial group. Managerial talent can be developed in a more measured way in this fashion. In addition, the reaction of existing firms to entry may be tempered by such a sequential strategy.
A sequential strategy often lowers the risks of entry because the firm can better control it. If it fails in its initial entry, for example, the firm is spared the cost of going further. In addition, a firm can choose to take its first step into a strategic group in which overcoming mobility barriers requires relatively reversible investments.

Although a firm may benefit by following a sequential strategy, several organizational and economic theories suggest that firm movement within an industry will not be common. Oligopoly theory (reviewed in Sherer, 1980 and Waterman, 1984) argues that oligopolistic firms will behave so as to jointly maximize profits; thus, they may tend to remain within traditional strategic groups rather than expand into new groups. Firms also may remain in the same strategic group over time because of the existence of strategic barriers to change, such as cost (Caves and Porter, 1977) and difficulty of imitation (Rumelt, 1981). Bureaucratic and structural inertia (Crozier, 1964; Hannan and Freeman, 1977) also may inhibit adaptation and create resistance to change.

Thus, there are two broad competing theories about the best entry and movement strategy within an industry. On one hand, some analysts (e.g. Caves and Porter, 1977) have argued that firms should alter their position within the industry by entering different strategic groups over time. On the other hand, oligopoly, mobility barrier, and organizational theorists argue that there are market and firm-specific impediments to movement.

In order to reconcile these competing theories, we argue that it is necessary to examine strategic entry groups and the capabilities of the firm within them. Some groups will be able to overcome the mobility barriers of the industry. Other combinations of cross-currents characteristics, however, will not allow a firm to move from an inferior strategic group to a superior one.

CONCLUSION

Firms now competing in global industries face strong challenges from new entrants and expanding competitors, challenges that will only become stronger in the future. We have shown, through empirical evidence from the medical diagnostic imaging industry, how the competitive challenge from Japanese manufacturers has evolved. We argue that the theoretical concepts of entry group, entry-site strategic group, and mobility across strategic groups help us understand the entry strategies followed by Japanese companies.

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