Technology Management: Strategies & Applications, Vol. 4, pp. 187–193
Reprints available directly from the publisher
Photocopying permitted by license only

Applied Research

Market Strategy in Emerging High-Technology Industries: Case of U.S. Robotics Firms in the 1980s

SUNG J. SHIM*

Silberman College of Business Administration, Fairleigh Dickinson University, 285 Madison Avenue, M104C, Madison, NJ 07940, USA

(Received in final form 9 June 1998)

Using a sample of U.S. robotics firms that were active in the 1980s, we examined the relationship between market strategy and survival of firms. We studied two dimensions of market strategy: (1) application focus (defined as the number of application areas per robot model) and (2) product-line breadth (defined as the number of robot models in each application area). While diversified robotics firms had broader product lines than specialized robotics firms, breadth of product line had no observable association with a firm's survival. Robotics firms that focused on a few application areas per model were more likely to survive than those that targeted more diverse application areas. Given the limited studies on robotics firms and their strategy, the results should be of interest to those who formulate market strategy for robotics products.

Keywords: Market, product-line, robot, robotics, strategy, the United States

INTRODUCTION

Since robotics technology was first commercialized in the early 1960s, over 100 firms have been involved at one time or another in producing and marketing robots in the United States. Many of them entered the robotics industry during the first half of the 1980s while it was growing rapidly. But by the second half of the 1980s many firms had left the industry. During the 1980s some new entrants gained substantial market share at the expense of incumbents who disappeared or were acquired by larger firms. Like other emerging high-technology industries, firms in the U.S. robotics industry struggled to build a sustainable market base. A firm's market strategy can influence its performance and chance of survival in emerging high-technology sectors where market needs are not well defined.

* Tel.: (973) 443-8843. Fax: (973) 443-8804. E-mail: sshim@alpha.fdu.edu.

To date, several studies, e.g., [1,2], have examined the robotics industry at the national as well as international levels, focusing primarily on the adoption and diffusion of robots. Few studies have examined the product and market strategies of robotics firms. This study attempted to examine the market strategy of robotics firms and investigate whether it is related to market survival. The results of the study are based on an analysis of data compiled from several secondary sources for a sample of U.S. robotics firms that were active in the 1980s. Given the limited studies on strategic aspects of robotics firms to date, the results of this exploratory study should interest those involved in the robotics field, particularly those who formulate market strategy for robotics products.

DEVELOPMENT OF THE U.S. ROBOTICS INDUSTRY

The 1960s and 1970s was a gestation period for the U.S. robotics industry, with both production and demand growing slowly. During the early 1960s robots were developed primarily for U.S. automotive manufacturers. Initially, less than twenty firms were involved in producing and marketing robots in the U.S. These early entrants were either specialized firms exclusively manufacturing robotics products (e.g., Unimation, Automatix) or small and medium-sized diversified firms with their origin in machine tools and other manufacturing technologies (e.g., Cincinnati Milacron, Prab). It was not until the early 1980s that large corporations such as GE, GM, IBM, and Westinghouse entered the robotics market. With a growing number of firms involved, production grew significantly in the first half of the 1980s. The high growth during the period was fueled by large investments in manufacturing sectors, particularly in the automotive industry. Both incumbents and new entrants shared in the vigorous market expansion. Market shares were unstable, with new entrants often gaining a substantial share of the market at the expense of incumbents.

After the high growth in the first half of the 1980s, the industry went into a major slump during the second half of the decade, due in large part to cutbacks in capital investment in the automotive industry. The decline in investment led to a shakeout in the industry. Figure 1 shows the patterns of entry and exit of firms in the U.S. robotics industry during the 1980s. Many small and medium-sized firms went bankrupt or were acquired by larger firms. Even such large diversified firms as GE, GM, IBM, and Westinghouse abandoned or sharply curtailed their robotics businesses. The few survivors halted their domestic production, preferring to source products from foreign firms as a way of bolstering their sagging sales.

After the severe decline in the second half of the 1980s, growth resumed in the early 1990s due

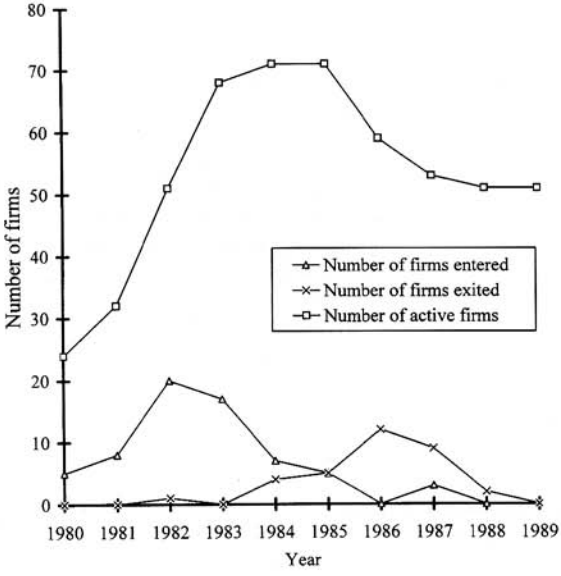

FIGURE 1 Entry and exit of firms in the U.S. robotics industry in the 1980s. We traced the entry and exit of firms in the U.S. robotics industry in the 1980s through an extensive search of archival sources such as business periodicals, trade magazines, industry reports, and so on. The numbers of firms in this figure appear to closely correspond to the actual numbers, since the total number of active robotics firms in each year during the period closely corresponds to that reported in other published sources such as the series of *Current Industrial Report: Industrial Robots* by the U.S. Bureau of the Census. The numbers of firms in this figure exclude foreign subsidiaries operating in the U.S.

largely to increased demand from automotive manufacturers. This expansion benefited Japanese firms. In the early 1990s, for example, more than eighty percent of U.S. imports of robotics products came directly from Japan or through Japanese affiliates in the U.S. [3]. Twenty of the forty-eight robotics firms operating in the U.S. were foreign-owned, and these twenty firms accounted for over eighty percent of total market revenues in the industry in 1994 [4]. Currently, only about thirty U.S. firms, mostly small and medium-sized, are engaged in producing and marketing robots. While U.S. firms are still claimed to lead in some advanced robotics technology such as machine vision and software, they are faced with finding ways to compete in domestic as well as world markets, especially with Japanese firms that have already expanded in the U.S. and world markets.

MARKET STRATEGY FOR ROBOTICS PRODUCTS

The initial task for a firm in formulating market strategy is to select the market segments that it wants to serve. The identification and selection of market segments is one of the most important strategic decisions facing firms, particularly in emerging industries where market needs are not well defined. Firms may segment markets in a number of ways with demographics being the common basis [5]. Although demographics have the advantage of being accessible, they often provide little insight about the way the product is used and generates value for the customers. Because value is regarded as the cornerstone of market strategy, it is suggested to segment the market place based upon the value of the product offering in a given application [6]. For this reason, many studies analyzing market segments, e.g., [7–9], suggest incorporating application areas as well as customer groups that the product supports.

Robotics firms vary in their selection of market segments and more importantly in the degree of market focus in terms of both the application areas and customer sectors that they serve. At one extreme, a focused market strategy would be represented by those who choose to serve one market segment, that is, one application area (e.g., welding or assembly) or one customer sector (e.g., automotive or electronics). At the other extreme, firms may choose to serve diverse application areas or customer sectors. Between these extremes lies the range of possible strategies with varying degrees of market focus.

Closely related to the selection of market segments is the breadth of product line. In this study, we define the breadth of a product line as the number of robot models in each application area or customer sector within a firm's product line. That is the number of robot models that a firm offers to customers in a certain application area or customer sector. Taken broadly, robotics firms may offer a single model in each application area or customer sector that they serve, or they may offer multiple models in each application area or customer sector, usually with varying technological configurations and capabilities. Between the extremes lies the range of possible strategies with varying degrees of product-line breadth.

It would be desirable to consider both application areas and customer sectors in analyzing the market strategies of robotics firms. But we could not secure data on specific customer sectors served by each robot model. Consequently, we considered only application areas in this study. In classifying application areas, we followed the widely used classification scheme of the International Federation of Robotics. In an aggregated form, or at the first level of classification, the International Federation of Robotics classifies the applications of robots into fourteen different areas, each corresponding to a different manufacturing application. The fourteen application areas are: casting, forging, plastic molding, heat treatment, stamping, welding, painting, machining, cutting, assembly, palletizing/packaging, measuring/inspection/testing, material handling, and education and research [1].

DATA SOURCES AND VARIABLE MEASURES

The analysis of market strategy requires specific data on models within the product line over a period of time. Further, since changes in the product line are frequent, the time horizon has to be long enough to capture variations in the product line. An alternative is to exploit variances in the product line across firms. We employed the latter approach, since it was not feasible to secure detailed data on robot models for individual firms. In order to consider as many firms as possible in our analysis, we used data from several secondary sources including *Stock Drive Products Data Book* [10], *Industrial Robot: Productivity Equipment Series* [11], and advertisements of robot models in trade magazines such as *Industrial Robots* and *Robotics World.* In addition, we searched business periodicals, trade magazines, and industry reports for information on business activities of individual robotics firms in the 1980s. From these sources, we constructed a data table for thirty U.S. robotics firms that were active in the 1980s.

The degree of application focus was measured in three steps. First, the number of application areas for every model in each firm's product line was counted. Second, these numbers were summed for the entire product line of the firm. Third, this sum was divided by the number of models considered. This normalized the data for different numbers of models among firms and produced the application focus index (AFI) for each firm. The lower the AFI, the smaller the average number of application areas per model and the more focused the firm's application areas. To measure breadth of product line, we first counted the number of models for every application area in each firm's product line. Second, these numbers were summed for the entire application areas that the firm serves. Third, this sum was divided by the number of application areas considered in order to normalize the data for different numbers of application areas among firms. This produced the product-line breadth index (PBI for each firm. The higher the PBI, the larger the average number of models in each application area and the broader the firm's product line.

RESULTS AND IMPLICATIONS

Figure 2 shows the distribution of AFI and PBI for the thirty firms. AFI ranges from 1.00 to 9.40 with a mean of 3.89. The firms varied widely in the degree of application focus as measured by the average number of application areas targeted by each model in the product line. Most the firms (77 percent) show AFI between 2.00 and 6.00, suggesting that each of their models targeted two to six application areas on average. Only 10 percent of the firms show AFI lower than 2.00, whereas 13 percent of the firms show AFI higher than 6.00. PBI also ranges from 1.00 to 10.00 with a mean of 2.12. Most the firms (83 percent) show PBI lower than 3.00, that is, the average number of robot models available in each application area was less than three. Further, 40 percent of the

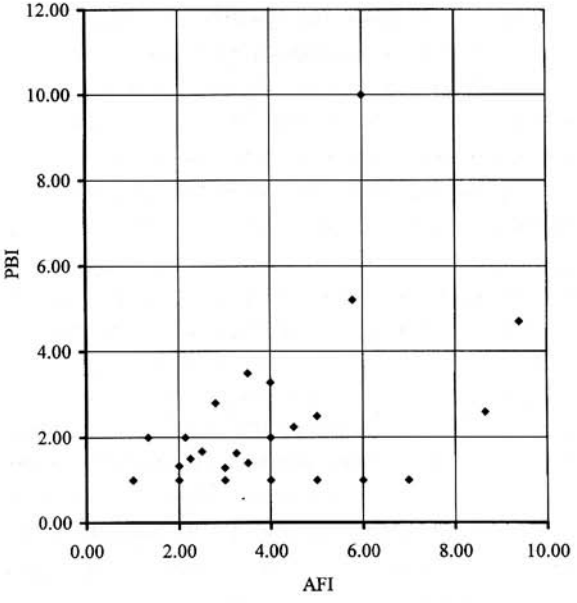

FIGURE 2 Distribution of AFI and PBI. Two firms at (1.00, 1.00), three firms at (2.00, 1.00), two firms at (3.00, 1.00), and two firms at (7.00, 1.00).

firms show PBI of 1.00, that is, they had only one model in each application area. Taken together, these results on AFI and PBI suggest that the firms as a whole targeted somewhat diverse application areas but with a relatively small number of models in each application area.

In addition, we tried to investigate any association of AFI and PBI with the type of firms. For this, we classified the firms into two groups: specialized and diversified. As described above, the U.S. robotics industry in the 1980s was a heterogeneous mix of firms ranging from small venture-capital funded firms to large diversified firms. Specialized robotics firms were mostly venture-capital funded and derived most of their revenue from the sale of robots and related products. Diversified robotics firms had their origin in other product lines prior to going into robotics and they were usually larger in size. In our sample, twenty-two were identified as specialized robotics firms, whereas eight were identified as diversified robotics firms. In testing any difference in AFI and PBI between the two groups, we used the Levene's test of homogeneity of variance, which is less dependent on the assumption of normality than most tests.

Table I shows the results of the Levene's test on AFI and PBI between specialized and diversified robotics firms. No significant difference was found in AFI between the two groups. But a significant difference was found in PBI between the two groups. We found that diversified firms were likely to make more models in each application area than specialized firms. The decision on product-line breadth could be made, to some extent, on the firm's judgement and knowledge of market potential and model complementary. But it would be constrained and influenced by resource and technology that the firm possesses. Large diversified firms that were generally in a better position could broaden their product lines as they had greater access to resource and technology.

Finally, we considered investigating any association of AFI and PBI with the firm's performance in the market. In studying the firm's performance, it is desirable to utilize financial performance measures such as sales growth and profitability. But securing such financial performance measures for individual robotics firms was hampered by the consolidated financial results of diversified firms and the presence of privately held firms. Alternatively, we chose to use the firm's survival in the market as a proxy. Because the U.S. robotics industry in the 1980s was so turbulent with many entries and exits, the ability of a firm to stay in the business appears to be a good indicator of performance in the market. We classified the firms into two groups: survivors and non-survivors. In our sample, nine firms were identified as survivors and twenty-one firms as non-survivors.

Table II shows the results of the Levene's test on AFI and PBI between survivors and non-survivors. A significant difference was observed in AFI between survivors and non-survivors, although the absolute mean difference between the two groups was small. This result suggests that firms targeting limited, focused application areas per model were more likely to survive as compared to firms targeting diverse application areas per model. There might be various explanations for this. At first glance, the focused application

TABLE I Analysis of AFI and PBI by the type of firm

Variable	Type of firm	Number of cases	Mean	Standard deviation	Levene's test	
					F	*p*
AFI	Specialized	22	3.697	2.114	0.032	0.860
	Diversified	8	4.411	2.408		
PBI	Specialized	22	1.753	1.114	6.908	0.014
	Diversified	8	3.138	2.995		

TABLE II Analysis of AFI and PBI by the survival of firm

Variable	Survival of firm	Number of cases	Mean	Standard deviation	Levene's test	
					F	*p*
AFI	Survivors	9	3.722	1.195	5.945	0.021
	Non-survivors	21	3.958	2.506		
PBI	Survivors	9	2.809	2.770	1.894	0.180
	Non-survivors	21	1.828	1.278		

strategy seemed less risky, as firms could accumulate knowledge and expertise in the few application areas over time and take few chances in exploring new ones. Also, firms could achieve a certain degree of economic success by virtue of their resource concentration and expertise. By contrast, the diverse application strategy might cause firms to try to achieve too much with few resources, as it would require substantial re-tooling and re-programming knowledge and experience.

No significant difference was observed in PBI between survivors and non-survivors, although the absolute mean difference between the two groups was rather large. This suggests that the breadth of product line was not likely to have any association with the firm's survival. However, this result could explain, in part, why large diversified firms had difficulty in selling robots and eventually withdrew from the market. We noticed in Table I that large diversified firms were likely to have broader product lines than small, specialized firms. But they extended their product lines, mostly through acquisition of smaller firms and network of licensing agreements with foreign firms [1,12]. This strategy of extending product lines through acquisitions and licensing agreements, however, did not appear to help improve their performance. Most of these diversified firms went out of the robotics business. Rather, as suggested by the association of AFI with market survival, the extensive knowledge and experience in a few focused application areas appeared to be more vital in staying alive in a turbulent market.

The main result of this study is that there were some differences in market strategy among U.S. robotics firms in the 1980s, as manifest in the application focus and the product-line breadth. Large diversified robotics firms served more application areas per model than small, specialized robotics firms did. But the breadth of product line had no observable association with the firm's survival. Instead, robotics firms that focused on a few application areas per model were more likely to outperform those that did not. The focused market strategy appeared to enable firms to avoid the high degree of market diversity that would have necessarily accompanied significant levels of marketing, technological, and financial resources. The issues of market strategy for robotics products that we examined are well worth trying to understand for more viable market strategy in the field. We hope that the results of this study will prove helpful to those formulating market strategy for firms in emerging high-technology industries.

There are several limitations to this study. First, the variables of market strategy that we examined are not exhaustive, although they are believed to be important. In this regard, we may incorporate customer sectors in addition to application areas. We may also pair the dimensions of market strategy with those of technology strategy, given the important role of technology for such high-technology products. Second, in measuring the variables, we relied on data from secondary sources. The data from these sources might be biased or not objective, although we tried to incorporate and crosscheck them as much as possible. We may replicate or collect more recent data, preferably from primary sources, and examine changes in the product line over time. Finally, we used a sample of thirty U.S. robotics firms for our analysis. While we tried to secure data for as many firms as possible, the sample may not be large enough to represent the total population during the period. These limitations are not certainly exhaustive but rather important ones. Obviously, these limitations suggest several possibilities for future research.

References

[1] Karlsson, J.M. (1991) *A Decade of Robotics*, Mekanförbundets Förlag, Stockholm, Sweden.
[2] Mansfield, E. (1989) The diffusion of industrial robots in Japan and the United States, *Research Policy*, **18**(3): 183–192.
[3] International Trade Administration (1992) *U.S. Industrial Outlook*, U.S. Government Printing Office, Washington DC.
[4] Frost and Sullivan (1995) *U.S. Robotics Markets: Diversification and Integration Lead to Market Expansion*, Frost and Sullivan, Mountain View, California.
[5] Shapiro, B.P. and Bonoma, T.V. (1984) How to segment industrial markets, *Harvard Business Review*, **62**(3): 104–110.

[6] Anderson, J.C. and Narus, J.A. (1991) Partnering as a focused market strategy, *California Management Review*, Spring, pp. 95–113.
[7] Abel, D.F. (1980) *Defining the Business: The Starting Point of Strategic Planning*, Prentice-Hall, Englewood Cliffs, New Jersey.
[8] Cooper, R.G. (1987) Defining the new product strategy, *IEEE Transactions on Engineering Management*, **34**(3): 184–193.
[9] Crawford, C.M. (1980) Defining the charter for product innovation, *Sloan Management Review*, Fall, pp. 3–12.
[10] Educational Products (1983) *Stock Drive Products Data Book*, Educational Products, Mineola, New York.
[11] Society of Manufacturing Engineers (1985) *Industrial Robot: Productivity Equipment Series*, Society of Manufacturing Engineers, Dearborn, Michigan.
[12] International Trade Administration (1987) *A Competitive Assessment of the U.S. Robotics Industry*, U.S. Government Printing Office, Washington DC.