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THE EFFECT OF BUSINESS INTERDEPENDENCIES ON TECHNOLOGY-INTENSIVE BUSINESS PERFORMANCE: AN EMPIRICAL INVESTIGATION

by

Mel Horwitch and Raymond A. Thietart

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Revised July 2, 1985

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THE EFFECT OF BUSINESS INTERDEPENDENCIES ON TECHNOLOGY-INTENSIVE BUSINESS PERFORMANCE: AN EMPIRICAL INVESTIGATION

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Abstract

Technology is an increasingly important strategic issue for the modern corporation. One of the major decisions that firms face regarding technology is a structural one: establishing the appropriate level of internal strategic interdependency within and among technology-intensive business units. The highly visible current discussion over the efficiency of creating small, independent, and entrepreneurial venture units in multi-business corporations is really part of this larger structural concern. This study focuses on the overall matter of appropriate levels of internal strategic interdependencies in technology-intensive businesses. The PIMS data base is used. The businesses examined are technology-intensive as defined in terms of high product R&D expenditures. Seven different business configurations are identified. The industrial product business configurations are termed Established Suppliers, Fast Movers, High-Tech Job Shops, and Stalled Giants. The consumer product business configurations are termed Established Diversifiers, Dominant Specialists, and Laggers. Business performance is measured by ROI, which stresses short-term results, and market share, which focuses on long-term results. Three categories of interdependency were established: vertical integration, shared facilities, and shared marketing. The effect on both kinds of performance of all possible combinations of the three types of internal interdependency was assessed for each of the seven business configurations. The findings indicate that there is great diversity within the overly general category of technology-intensive business. Second, different levels of interdependency have different impacts on ROI or market share performance for different kinds of technology-intensive business configurations. Finally, the multi-business corporation that possesses a portfolio of technology-intensive businesses which represents several business configurations probably requires a more diverse set of interdependencies than just mainstream industrial R&D on the one hand and independent entrepreneurial units on the other hand. Effective competition for a firm with diverse technology-intensive businesses calls for a capability to support concurrently multiple levels of internal interdependencies and to reject, create, or modify this set of interdependencies as the situation warrants.

Introduction

One of the most remarkable trends in the management field during the first half of the 1980s has been the steadily increasing attention paid to the importance of technological innovation as a corporate-wide strategic matter of concern. Indeed, there has emerged in recent years a persistent and powerful chorus advocating the need to view technology as a high priority general management issue (Foster, 1982; Hayes and Abernathy, 1980; Lewis, 1982). However, the current attempt to transform technology into a strategic variable has resulted in a number of novel and important administrative issues.

Much of the literature before 1980 that did attempt to deal with the high-level selection of technological choices, emphasized the issues of the timing and positioning of a corporation's innovative efforts (Ansoff and Stewart, 1967; Freeman, 1982 edition); the types of technological innovation that exist (Burns and Stalker, 1961; Horwitch and Prahalad, 1976; Marquis, 1969); the need to fit a technological choice to the appropriate stage of a life cycle or an appropriate environment (Abernathy and Utterback, 1978; Hayes and Wheelwright, 1979; Lawrence and Lorsch, 1967). But these studies and concepts generally involve relatively straightforward tradeoffs and decisions, whereas today corporations are simultaneously engaged in technological activities that exhibit very different characteristics along key dimensions (Friar and Horwitch, 1984; Petrov, 1982). Such firms must concurrently make a set of strategic decisions regarding technology that may appear inconsistent and confusing when examined in light of the lessons from the older studies and concepts. One goal of this paper is to identify some aspects of administrative behavior that lead to positive results in the more complex current context and to offer a useful way of conceptualizing the strategic management of technology in this modern setting.

Part of the cause for the inability of much of the earlier management research to deal effectively with the current technology-strategy relationship is that traditionally the study of technology and the study of corporate strategy have traditionally been distinct (Kantrow, 1980). Technology has been studied in considerable depth as part of R&D management and the process of technological innovation. This process was portrayed as consisting of diverse parts, varied participants, complicated patterns of evolution and information feedback loops, and potentially lengthy time durations (Marquis, 1969; Project Sappho, n.d.; Rothwell, et.al, 1974; Utterback, 1971; Von Hippel, 1976). Technology has been examined and reexamined as a determinant of organizational structure (Hickson, et.al., 1969, Stanfield, 1976; Woodward, 1965); and it has been seen as being a critical factor in influencing the evolution of the international product life cycle (Wells, 1972). Finally, the key role of people, as champions, entrepreneurs, or technology-familiar managers, is increasingly accepted (Maidique and Hayes, 1983; Roberts, 1969, 1977; Schon, 1963, 1967).

But throughout the 1960s and most of the 1970s the corporate strategic literature has minimized the strategic role of technology. Instead, corporate strategy focused on such issues as leadership, various forms of strategic portfolios of product-market groups or business units, the applicability of industrial organization theory, and the influence of structure, process, and systems on strategy. Technology, if mentioned at all, was usually portrayed as a subsidiary force or component of other critical elements of corporate strategy (Andrews, 1980; Barnard, 1938; Buzzell, et.al., 1975; Galbraith and Nathanson, 1978; Henderson, 1972; Porter, 1980; Selznick, 1957).

The recent linkage of technology and corporate strategy has resulted in significant new administrative concerns. Perhaps of greatest importance is the explicit high priority for many corporations in a technology-intensive environment to remain innovative in diverse business settings. Competing in diverse businesses implies dealing with technologies that differ along key dimensions, such as life cycles, types of technologies, and the key competitive factors for success (Hambrick et al., 1983). A modern corporation having a portfolio of technologies must find ways to administer this technological diversity successfully (Petrov, 1982).

The methods available to modern technology strategy involves tradeoffs along at least three key dimensions, competition vs. cooperation; internal technology development vs. external technology development; and traditional corporate R&D activities vs. small-scale entrepreneurial units (Friar and Horwitch, 1984).

This paper focuses on the last dimension, a structural one. It is clear today that corporations are struggling with the simultaneous need to exploit their various economies of scale and scope while also capturing some of the spirit, commitment, and talent associated with high-technology small firms (Burgelman, 1983, 1984, Roberts, 1980). Another way of viewing this issue is to examine under different conditions the appropriate degree of linkages and integration among the various business units within a corporation that can be termed technology-intensive. This is a complex matter, as we will see, for technological diversity is at least as complex as business diversity and calls for an array of structural relationships depending on a number of important variables.

In this study, we analyze the performance of different intra- and inter-business linkages or business interdependencies for various types of technology-intensive businesses. The performance criteria are ROI and market share. Technology-intensive businesses are defined by the level of product R&D expenditures. The businesses are of several kinds: industrial (capital goods, raw and semi-finished materials, components, suppliers, and other consumables) and consumer (durable and non-durable). The results show that depending on the nature of the business and the goals that the business pursues, certain kinds of interdependency levels are more appropriate than others. In some instances, complete independence and flexibility lead to improved results. In other cases, a high degree of inter-business linkages and vertical integration are more efficient. And in still other situations, various intermediate levels of interdependency are associated with positive performance. The findings also highlight the frequent necessity for a multi-business firm with diverse types of technology-intensive businesses to possess enough overall flexibility to manage multiple levels of interdependency.

Methodology

Several phases of analysis are discussed in this section: 1) the choice of the sample and discussion of business configuration; 2) the choice of the dependent or performance variables; 3) the selection of the independent variables; and 4) the testing procedure.

1. The Sample Definition

A sample of 641 business units with high R&D expenditures (221 consumer products, 420 industrial goods) is drawn from the PIMS[1] data base. The unit of analysis is the business as defined in the data base (Schoeffler, 1977). The observation for a given business consists of four year moving averages.

- Criterion for Selecting Businesses With High R&D Expenditures

The decision as to which businesses belong in the high R&D expenditure sample is based on product R&D expenditures as a percentage of sales. It excludes R&D aimed at new process development and emphasizes efforts made by businesses to develop new products or to modify existing ones.

This decision to use product R&D expenditures to define technology-intensive businesses is dictated by our desire to study a comprehensive range, though representative sample, of such businesses. We did not include process R&D expenditures because such an action might have biased our sample toward those businesses that competed in the latter stages of

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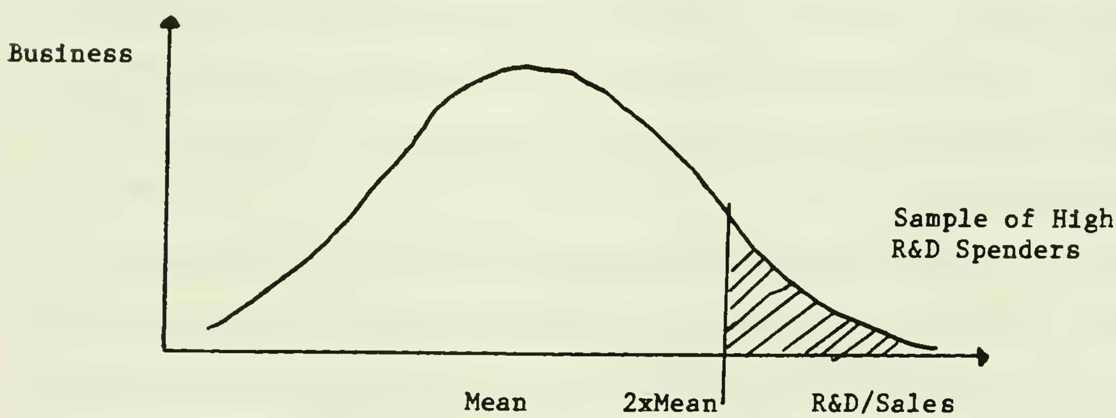
[1]Anderson and Paine (1978) provide a critical analysis of the PIMS data base. Although they voice some concern about the quality of the data, they think that the base is generally of high quality and reliability.

a product's life cycle and thereby possibly permitting too much attention on an unnecessarily narrow group of rather mature businesses, which might significantly distort our findings. (Abernathy and Utterback, 1978; Hayes and Wheelwright, 1979).

The selection of the 641 businesses in the sample is made as follows. For each type of business (consumer: durable and nondurable; industrial: capital goods, raw and semi-finished materials, components, supplies and other consumable), the mean of the product R&D expenditures as a percentage of sales is computed. Businesses are included in the sample when their five-year average for R&D expenditures as a percentage of sales is at least twice as large as the mean for their type of business (see Figure 1).[2]

Figure 1

Sample Selection Distribution of R&D/Sales[3]



[2]100 businesses out of 777 consumer durable products, 121 businesses out of 1014 consumer non-durable products, 81 businesses out of 1131 capital goods, 52 businesses out of 571 raw and semi-finished materials, 188 businesses out of 1591 components and 99 businesses out of 941 supplies and other consumables are selected.

[3]The distribution is computed for each type of business: industrial (capital goods, raw and semi-finished materials, components, supplies and other consumables) and consumer (durable, non-durable).

o A Strategic Configuration Perspective

Several recent studies (Dess and Davis, 1984; Hambrick, 1983; Harrigan, 1980; Hofer, 1975; McMillan, Hambrick and Day, 1982; Miles and Snow, 1978; Miller and Friesen, 1977, 1984; Miller and Mintzberg, 1983; Porter, 1980; Thietart and Vivas, 1984) show the influence of strategic, organizational and environmental characteristics in shaping the business competitive behavior. Consequently, due to the diversity of business behavior and of competitive conditions represented in our sample, the businesses should exhibit a great deal of heterogeneity.

For that reason, cluster analysis of the sample is necessary. Theil (1965), Bass, Cattin and Wittink (1977), Schendel and Patton (1978) stress that aggregation of observations, without accounting for the underlying models governing them, produces misleading results. At a highly aggregate level, the results may be completely different from the true phenomenon observed at a more disaggregated level.

Each business has its own characteristics, such as the age of the product, the nature of technological change, the type of customer, the production process, and so on. These characteristics permit grouping the businesses and allow us to infer, for each configuration, the existence of similar strategic behaviors. With this in mind, then, a search for configurations or groups of homogeneous businesses in terms of external and internal characteristics is undertaken. To do so, the businesses are divided into two main sets on the basis of the nature of the business (consumer and industrial). A cluster analysis (Schlaifer, 1978) is then made to identify the natural groups in each set.

To assess the stability of the groupings, three clustering methods are used. The first one is the "nearest-neighbor" method, which aims to maximize the minimum between - cluster distance. The second one is the "progressive-threshold" method (Wishart, 1969). The third method is the "unimodal" method (Gitman and Levine, 1970). To select the appropriate number of clusters, the program "Cluster" of the PIMS' AQD statistical package (Schlaifer, 1978) provides a "dendogram", which is a diagram describing the contents of the clusters existing at each stage of the merging process. The businesses in each cluster are listed in order of decreasing density. The inspection of the plot, which gives the number of clusters as a function of a density index, allows us to determine empirically the level at which the clustering should take place. The three different methods, in some cases, lead to slightly different business clustering. However, the natural groups that are identified are quite stable under the three procedures.

o <u>Variables of Configuration</u>

Thirty variables of configuration are used for the clustering. These variables deal with strategic, environmental, and business-related factors. They fall into three main groups:

1. Business strategic posture;
2. Product and corporate level specifics;
3. Industry competitive characteristics.

These different variables are discussed in the industrial economics and strategic management literature (Andrews, 1971; Bain, 1956; Caves and Porter, 1976; Harrigan, 1980; Porter, 1980; Scherer, 1980; Uyterhoeven, Ackerman and Rosenblum, 1973). They are shown to influence the competitive situation of the firm.

Table 1 gives a summary of the variables of configuration.

Table 1

Configuration Variables

Business Strategic Posture	Product and Corporate Level Specifics	Industry Competitive Characteristics
o Innovation	o Product	o Industry Specifics
- % New Product	- Patent	- Concentration
- Relative % New Product	- Age	- Life Cycle Stage
o Differentiation	- Development Time	- Real Market Growth
- Differentiation of Products and Services	- Market Share	o Barriers to Entry and Exit
o Marketing Mix	- Relative Market Share	- Capital Intensity
- Relative Price	o Corporate	- Competitors' Entry
- Marketing Expenditures	- Size	- Competitors' Exit
- Distribution Channels	- Diversity	o Suppliers' and Customers' Power
- Relative Product Quality	- Debt/Equity	- Number of Immediate Customers
- Relative Service Quality		- Relative Immediate Customer Fragmentation
o Manufacturing		- Immediate Customer Fragmentation
- Plant and Equipment Newness		- Importance of Auxiliary Services to End Users
- Production Process		- Supplier's Forward Integration
- Relative Direct Cost		

Table 2

The 4 Configurations of Industrial Businesses With High R&D Expenditures

Configuration	1-I Established Suppliers	2-I Fast Movers	3-I High Tech Job Shops	4-I Stalled Giants
Sample Size	n=48	n=30	n=92	n=26
Nature of Businesses				
Capital Goods	8%	33%	26%	12%
Raw & Semi Finished Material	19%	30%	16%	50%
Components	27%	26%	29%	19%
Supplies & Other Component	46%	1%	29%	19%
Characteristics(1)	This group is composed of aging, low growth businesses in highly concentrated industries. They are part of large highly diversified firms. The products are patented, but are not very innovative. Their quality is high and are distributed, partly through dealers, to a highly concentrated group of customers. They have a dominant market share and are sold at a premium price. Costs of products are high. Equipment is aging. The manufacturing process is based on batch production.	This group is composed of young, high growth innovative businesses in highly concentrated industries. The businesses are part of highly diversified, medium-size firms. They are of high quality and are partly distributed through independent dealers. Development time for new products is short. The products have a dominant market share and are sold at a premium price. Costs of production are low. Equipment is new. Barriers to entry are high. There is some competitors' exit. Suppliers are integrated.	This group is composed of aging, but still growing and innovative businesses in fragmented industries. The businesses are part of small, specialized firms. Products are of high quality but are not patented. They are directly distributed to a fragmented group of customers. They have a dominant have a dominant market share and are sold at a premium price. Costs of of production are high. Equipment is new. Manufacturing is based on a capital intensive batch production process. Competitors are entering the industry. Exits are rare. Suppliers are not integrated.	This group is composed of aging, slow growth, and not very innovative businesses in highly concentrated industries. The businesses are part of very large highly levered and diversified firms. Products have a rather low relative quality but are patented. They are directly distributed and are patented. They are directly distributed and are supported by low marketing expenses. Customers are highly concentrated. The businesses have a dominant market share and are sold at a premium price. Equipment is aging. Manufacturing is based on an assembly production process. Exit from the industry is rare.

Business Strategic Posture	Business Strategic Posture	Business Strategic Posture	Business Strategic Posture	Business Strategic Posture
% New Product	8.38(2,3) (8.73) Low	21.83(1,4) (21.85) High	15.27(1) (19.08) Medium/High	11.2(2) (14.77) Medium/Low
Relative % New Product	.02(2) (5.11) Medium/Low	5.68(1,4) (12.72) High	2.06 (9.74) Medium/High	-2.74(2) (11.26) Low
Differentiation	.250 (.433) -	.367 (.482) -	.272 (.445) -	.192 (.394) -
Relative Price	105.65 (8.24) High	107.24 (8.13) High	106.36 (7.68) High	103.65 (8.30) High
Marketing Expenditures	10.89(4) (4.59) High	11.74(4) (5.44) High	11.53(4) (5.48) High	7.97(1,2,3) (5.86) Low
Distribution Channels	67.83(3,4) (34.39) Indirect	69.8 (34.06) Indirect	79.65(1) (32.73) Direct	84.3(1) (28.40) Direct
Relative Product Quality	28.27(4) (27.74) High	27.76(4) (18.93) High	28.83(4) (26.55) High	17.04(1,2,3) (16.98) Low
Relative Service Quality	3.51 (.84) Medium	3.73 (.76) Medium	3.43 (.92) Medium	3.8 (.88) Medium
Plant and Equipment Newness	45.82(2,3) (13.90) Relatively Old	59.40(1,4) (16.08) New	62.53(1,4) (14.38) New	50.75(2,3) (10.57) Relatively Old
Production Process	53.45(4) (38.45) Small Batches	38.03(3) (36.67) Mixed (Batch and Assembly)	56.14(2,4) (38.01) Small Batches	28.65(1,3) (41.68) Assembly
Relative Direct Cost	105.58(2) (9.87) High	101.84(1,3) (5.71) Low	104.98(2) (9.30) High	101.81 (8.41) -

Product and Corporate Level Specifics	Product and Corporate Level Specifics	Product and Corporate Level Specifics	Product and Corporate Level Specifics	Product and Corporate Level Specifics
Patents	$.417^{(3)}$ (.493) Patented	$.533^{(3)}$ (.499) Patented	$.239^{(1,2,4)}$ (.427) Not Patented	$.615^{(3)}$ (.487) Patented
Age	$2.77^{(2)}$ (2.02) Old	$3.80^{(1,3,4)}$ (1.81) Young	$2.72^{(2)}$ (1.71) Old	$2.38^{(2)}$ (1.71) Old
Development Time	$2.16^{(3,4)}$ (.74) Short	$2.13^{(3,4)}$ (.67) Short	$2.75^{(1,2,4)}$ (.78) Medium	$3.15^{(1,2,3)}$ (.66) Long
Size	$1435^{(2,3,4)}$ (0) Large	$638^{(1,3,4)}$ (0) Medium	$144^{(1,2,4)}$ (85) Small	$2152^{(1,2,3)}$ (0) Very Large
Diversity	$.963^{(3)}$ (.36) High	$1.243^{(3)}$ (.757) High	$.376^{(1,2,4)}$ (.486) Low	$.922^{(33)}$ (.558) High
Debt/Equity	$.404^{(4)}$ (.184) Low	$.365^{(4)}$ (.148) Low	.478 (.508) -	$.595^{(1,2)}$ (.310) High

Industry Competitive Characteristics	Industry Competitive Characteristics	Industry Competitive Characteristics	Industry Competitive Characteristics	Industry Competitive Characteristics
Concentration	$57.94^{(3)}$ (23.58) High	$64.43^{(3)}$ (18.23) High	$49.41^{(1,2,4)}$ (25.69) Low	$64.54^{(3)}$ (25.06) High
Life Cycle	2.70 (.45) Maturing	2.56 (.66) Growth	2.55 (.59) Growth	2.73 (.44) Maturing
Market Growth	$1.87^{(2,3)}$ (8.38) Low	$8.15^{(1,4)}$ (11.18) High	$6.75^{(1,4)}$ (12.87) High	$3.44^{(2,3)}$ (4.26) Low
Capital Intensity	$64.24^{(3)}$ (22.98) Low	$60.93^{(3)}$ (13.58) Low	$74.94^{(1,2)}$ (30.29) High	66.58 (16.42) -
Competitors' Entry	.333 (.471) -	$.267^{(3)}$ (.442) No	$.478^{(2)}$ (.500) Yes	.346 (.476) -
Competitors' Exit	$.104^{(4)}$ (.305) Some	$.267^{(3,4)}$ (.442) Some	$.065^{(2,4)}$ (.247) No	$0^{(1,2,3)}$ (0) No
Number of Immediate Customer	5.70 (1.32) -	5.66 (1.30) -	5.79 (1.30) -	5.96 (.94) -
Relative Immediate Customer Fragmentation	$2.06^{(4)}$ (.59) Same	1.9 (.65) -	$2.04^{(4)}$ (.73) Same	$1.69^{(1,3)}$ (.72) Less
Fragmented				
Immediate Customer Fragmentation	$12.04^{(3)}$ (.968) Concentrated	13.53 (11.95) -	$17.96^{(1,4)}$ (12.60) Fragmented	$8.88^{(3)}$ (7.72) Concentrated
Importance of Auxiliary Services	1.29 (.61) -	1.43 (.49) -	1.46 (.56) -	1.34 (.55) -
Suppliers' Forward Integration	.771 (.797) -	$1^{(3)}$ (.816) Yes	$.641^{(2)}$ (.76) No	.885 (.974) -

1. For each configuration, the means and standard deviations ( ) are given.

A pair-wise comparison between the different configurations for each characteristics has been performed. A two-tailed test on the differences between the means at a significance level of .05 has been made.

Configurations for which the characteristics are significantly different are indicated in the parentheses. For example, (2,3) next to the mean of configuration 1 means that the mean of configuration 1 is significantly different from the means of configurations 2 and 3.

Table 3

The Three Configurations of Consumer Businesses With High R&D Expenditures

Configuration	1-C Established Diversifiers	2-C Dominant Specialists	3-C Laggers
Sample Size	n=62	n=52	n=81
Nature of Businesses			
Durable	69%	27%	44%
Non-Durable	31%	73%	56%
Characteristics(1)	This group is composed of maturing, standardized businesses in highly concentrated industries. They are part of large diversified firms. The quality of the products and of the service is high. Service is an important marketing factor. They are distributed through independent channels to a relatively concentrated group of customers. They have a dominant market share and charge a price premium. Direct cost and marketing expenses are kept low. Capital intensity is high, but equipment is aging. Suppliers are integrated.	This group is composed of younger but rapidly maturing businesses in higly concentrated industries. They are part of medium size, specialized firms. The quality of the products is high. Service is not an important market determinant. They are distributed through independent channels to a large number of fragmented customers. They have a dominant market share and charge a price preium. Marketing expenses are high. Equipment is quite new. The production process is assembly. Competitors are still entering the industry.	This group is composed of mature mature businesses in highly concentrated industries. They are part of small-size firms. The quality of the products and the service are poor. They are distributed through independent channels to a concentrated group of customers. They have a small market share and charge relative low price. Marketing expenses are kept low. However, direct cost is high. Equipment is aging. Parent company is highly levered. Suppliers are integrated.

Business Strategic Posture	Business Strategic Posture	Business Strategic Posture	Business Strategic Posture
% New Product	12.71 (16.85) -	12.51 (14.68) -	10.54 (18.47) -
Relative % New Product	3.11 (8.08) -	3.29 (11.09) -	2.93 (11.25) -
Differentiation	0[3] (0) Low	.038 (.192) -	.123[1] (.329) Higher
Relative Price	108.37[3] (9 .17) High	108.55[3] (9.47) High	102.04[1,2] (9.30) Low
Marketing Expenditures	13.43[2] (6.84) Low	25.12[1,3] (11.87) High	14.42[2] (9.12) Low
Distribution Channels	8.64 (22.60) Indirect	4.26 (19.19) Indirect	6.74 (17.26) Indirect
Relative Product Quality	30.43[3] (29.62) High	36.36[3] (25.49) High	4.55[1,2] (22.28) Low
Relative Service Quality	3.738[2,3] (1.100) High	3.216[1,3] (.614) Medium	3.012[1,2] (.487) Low
Plant and Equipment Newness	51.84[4] (9.78) Old	62.84[1,3] (14.00) New	50.01[2] (12.42) Old
Production Process	14.48[2] (25.59) Assembly and Batches	5.48[1] (17.49) Assembly	10.51 (22.05) -
Relative Direct Cost	101.51[3] (4.99) Low	102.74 (10.49) -	104.70[1] (7.96) High

Product and Corporate Level Specifics	Product and Corporate Level Specifics	Product and Corporate Level Specifics	Product and Corporate Level Specifics
Patents	$.210^{(2)}$ (.407) Patented	$.077^{(1,3)}$ (.266) Not Patented	$.222^{(2)}$ (.416) Patented
Age	$1.435^{(2)}$ (1.855) Old	$2.077^{(1)}$ (1.284) Younger	1.741 (1.676) -
Development Time	2.871 (1.039) -	$2.558^{(3)}$ (.77) Short	$2.877^{(2)}$ (.935) Long
Size	$1{,}435^{(2,3)}$ (0) Large	$956^{(1,3)}$ (0) Medium	$270^{(1,2)}$ (223) Small
Diversity	$.998^{(2,3)}$ (.562) High	$.298^{(1,3)}$ (.579) Low	$.684^{(1,2)}$ (.911) Medium
Debt/Equity	$.425^{(2,3)}$ (.258) Medium	$.218^{(1,3)}$ (.179) Low	$.809^{(1,2)}$ (.896) High

Industry Competitive Characteristics	Industry Competitive Characteristics	Industry Competitive Characteristics	Industry Competitive Characteristics
Concentration	64.24 (25.26) -	66.10 (22.98) -	65.21 (22.25) -
Life Cycle	2.855(3) (.352) Maturing	2.904(3) (.354) Maturing	3.074(1,2) (.466) Mature
Market Growth	2.14 (8.81) -	2.51 (6.48) -	2.96 (6.62) -
Capital Intensity	64.80(3) (12.47) High	59.80 (19.88) -	58.12(1) (19.49) Low
Competitors' Entry	.274 (.446) -	.423(3) (.494) Some	.198(2) (.378) No
Competitors' Exit	.210 (.407) -	.154 (.361) -	.111 (.314) -
Number of Immediate Customers	6.565(2,3) (.978) Medium	7.154(1,3) (1.406) High	5.494(1,2) (2.050) Low
Relative Immediate Customer Fragmentation	2.258(2,3) (.694) More Fragmented	1.885(1,3) (.543) Same	1.63(1,2) (.532) Less Fragmented
Immediate Customer Fragmentation	23.27(2,3) (16.11) Fragmented	11.86(1) (11.37) Concentrated	10.77(1) (10.37) Concentrated
Importance of Auxiliary Services	1.21(2,3) (.572) High	.250(1,3) (.616) Low	.802(1,2 (.792) Medium
Suppliers' Forward Integration	.742(2) (.694) Yes	.212(1,3) (.453) No	.593(2) (.782) Yes

1. For each configuration, the means and standard deviations ( ) are given.

A pair-wise comparison between the different configurations for each characteristics has been performed. A two-tailed test on the differences between the means at a significance level of .05 has been made.

Configurations for which the characteristics are significantly different are indicated in the parentheses. For example, (2,3) next to the mean of configuration 1 means that the mean of configuration 1 is significantly different from the means of configurations 2 and 3.

Four clusters of homogeneous industrial businesses and three clusters of homogeneous consumer businesses are obtained, each representing groups of businesses that are homogeneous in term of strategic, environmental, and business-related characteristics.[4] The composition and the characteristics of the groups are shown in Tables 2 and 3.

A statistical analysis comparing the characteristics of the configurations is performed.[5] The seven configurations have been named after their general distinctive characteristics: Configuration 1 (Industrial) - "Established Suppliers"; Configuration 2 (Industrial) - "Fast Movers"; Configuration 3 (Industrial) - "Hi Tech Job Shops"; Configuration 4 (Industrial) - "Stalled Giants"; Configuration 1 (Consumer) - "Established Diversifiers"; Configuration 2 (Consumer) - "Dominant Specialists"; Configuration 3 (Consumer) - "Laggers".

2. The Variables

o Dependent Variables

Two dependent variables measuring performance have been selected. These two variables are chosen because they appear frequently in the literature as performance measures (Bass, 1969; Buzzell and Wiersema, 1981; Montgomery and Silk, 1972; Hambrick and Schecter, 1984; Hofer, 1980).

One dependent variable measures the firm's performance in its market. The other measures profitability.

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[4]16 Small clusters with less than 20 observations have been eliminated.

[5]A pairwise comparison between the configurations for each characteristic is performed. A two tailed test on the differences between the means at a significance level of .05 has been made.

The dependent variables are:

- Market Share

- ROI (corrected for inflation)

The appropriateness of either a market or a profitability criterion as the business objective may depend on the orientation of the firm. On the one hand, building market share is usually motivated by a long-term strategic orientation. On the other hand, a high ROI objective is often motivated by short-term financial considerations (Boston Consulting Group, 1975; Hayes and Abernathy, 1980).

The use of these dependent variables provides insight into which organizational interdependencies fit best the different business configurations depending on the decision horizon selected.

o <u>Independent Variables</u>

Three independent variables are selected. They represent different intra- and inter-business interdependencies: vertical integration, marketing inter-relationships, and production interdependencies.

The variables are:

V: Vertical Integration

M: Shared Marketing (or Marketing Interrelationships)

F: Shared Facilities (or Production Interdependencies)

These three variables are chosen for the following reasons: they represent different forms of organizational interdependence; they have a low correlation with one another;[6] and show a strong correlation with other variables having the same conceptual meaning (see Table 4).

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[6]A correlation of .36 has been tolerated between variable M (shared marketing) and variable F (shared facilities) because they bear different conceptual meanings.

Table 4

Correlation Matrix of the Independent Variables and Their Correlates

Variables	Purchases /Revenue 1	Adjusted Vertical Integration 2	Vertical Integration Average 3	Vertical Integration Beg. Av. 4	Vertical Integration End. Av. 5	Shared Facilities 6	Shared Customer 7	Shared Marketing 8
1	1	-.9799	-.9917	-.9749	-.9822	.0017	.0001	.0010
2		1	.9878	.9703	.9791	-.0018	.0001	.0011
3			1	.9829	.9905	-.0017	.0001	.0011
4				1	.9502	-.0016	.0001	.0010
5					1	-.0018	.0001	.0011
6						1	.2355	.3638
7							1	.5046
8								1

Marketing interrelationships describe the extent to which products are handled by the same sales force and/or are promoted through the same advertising and sales-promotion programs as those of other components of the corporation. Production interdependencies indicate the extent to which the business shares its plant, equipment, and production personnel with other components of the firm. Marketing interrelationships and production interdependencies are an indication of the reciprocal interdependence that may be found between different business units. Vertical integration is defined as the ratio of value added (sales of the business - purchases of the business) and the net sales (Revenue). It is an indication of the sequential interdependence that may exist between the various components of the firm.

Horizontal interdependencies between businesses in marketing or production have received a great deal of attention from economists and organizational scientists. Baumol, Panzar, and Willig (1982), and Teece (1980) have proposed that multiproduct firms are able to develop economies of scope. These economies help individual businesses to improve their competitive position. For example, joint production may be less costly than the combined costs of manufacturing of two independent units (Willig, 1979). Also, sale of different products as a package may increase total revenue compared to selling the products separately (Adams and Yellen, 1976). However, these economies are limited. Sharing equipment or marketing resources may involve different costs: cost of coordination, cost of compromise, and cost of flexibility (Porter, 1985). The need for coordination may lead to longer reaction times or larger personnel requirements. Inflexibility may impede adaptation to a changing competitive environment. Consequently, these "transaction" costs may be higher than the economies that are derived from jointly using some of the firm's resources. A balance must be found between economies and de-economies of scope, between synergetic benefits and transaction costs.

Organizational scientists have also contributed to the issue of horizontal interdependency. For instance, in the early 1950s, the Tavistock studies (Trist and Bamforth, 1951) show that coordination is enhanced in a single, face to face group. In the same vein, Chapple and Sayles (1961) give an example of tasks that are put together according to the natural work flow. These studies stress the importance of a global vision in coordinating various tasks and, therefore, they challenge functional specialization as a basic organizational structure. On one hand, separate production and marketing functions associated with a given business facilitate the achievement of a global vision and coordination. On the other hand, functional specialization cutting across various businesses may lead to cost reduction via scale effects and to learning through interaction of specialists.

Sharing equipment or marketing resources is made at the expense of a better coordination of the work flow (Khandwalla, 1977). Functional specialization as an organizational design tends to be more bureaucratic and mechanistic than self-contained units that are more flexible and adaptable (Lawrence and Lorsch, 1967; Walker and Lorsch, 1970). However, the self-contained units, as an organizational arrangement, are less efficient than a functional structure (Galbraith, 1971).

Other evidence dealing with related issues: degree of decentralization (Shaw, 1964; Vroom, 1969); coupling between units (Weick, 1976); and nature of interdependencies (Thompson, 1967) show that centralized structures, strong coupling between units, and sequential interdependence are frequently associated with stable, cost conscious, and efficient organizations. Decentralized structures, loose coupling, and reciprocal interdependence tend to be associated with more adaptable and flexible organizations.

The independent variables of shared marketing M and shared facilities F are proxy variables for the various inter-business relationships which have been discussed above. Depending on their value they indicate the existence of a particular type of interdependency. For example, when shared marketing and shared facilities take on low values, they represent a situation of little interdependency between business units.

The other dimension of interdependency explored in this study is vertical interdependency. Vertical interdependency develops when the firm attempts to extend production upstream and/or downstream through vertical integration in order to extend control over supply and/or demand (Worthy, 1959). Vertically integrated firms have been explained in terms of market failures (Williamson, 1975). The higher the cost for negotiating contracts with outside parties, the greater is the incentive to integrate their function within the organization.

Whatever the benefits of vertical integration, it does entail some costs. The cost of coordination and lack of flexibility may offset the advantages of a closed and efficient system. The sequential interdependence associated with vertical integration requires the implementation of plans, programs, and schedules (Thompson, 1967) and, consequently, reduces the firm's flexibility and adaptability.

The vertical integration variable V represents the vertical interdependency that may develop between the various components of a firm.

Depending on its value, the degree of vertical relatedness is different. This may, in turn, be related to differences in efficiency and flexibility between units.

3. The Testing Procedure

To evaluate the effects of the different types of interdependencies on the variables representing business performance —market share and ROI - a multi-way analysis of variance is performed for each of the seven configurations.

The "vertical integration" variable has been transformed to assume one of two values: high or low. This is done by assigning the value "high" to any observation for which the original vertical integration value exceeds the overall mean of the varible. This mean differs depending on the configuration.

The independent variables of Shared Marketing (M) and Shared Facilities (F) assume one of three levels: low, medium, or high. However, to simplify the analysis and to obtain sharper contrasts between observations only the extreme values --low and high-- are investigated and discussed.

A low level of the shared marketing variable indicates that less than 10% of the products are handled by the same sales force and/or promoted through the same advertising and sales-promotion programs as those of other components of the corporation. A high level of the shared marketing variable indicates that more than 80% of the products are handled by the same sales force and/or promoted through the same means. A medium level indicates that "shared marketing" lies in the 10%-80% range.

A low level of the shared facilities variable indicates that less than 10% of the products share their plant and equipment and production personnel with other components of the corporation. A high level of the shared facilities variable indicates that more than 80% of the products share their equipment and personnel with other components of the firm. A medium level indicates that shared facilities lies in the 10%-80% range.

The joint effects on performance of the three independent variables M, F and V when they assume different levels are computed. Tests are performed at .001, .01, .05 and .10 levels of significance. F statistics and their P-levels are calculated.

Discussion of the Results

Our findings can be classified in at least two ways. First, we have discovered that there are indeed quite different types of technology-intensive businesses. For the businesses producing industrial products we have indentifed four distinct configurations: 1. Establish Suppliers; 2. Fast Movers; 3. High-Tech Job Shops, and 4. Stalled Giants. As seen in Tables 5 and 6, each configuration has broadly speaking very different sets of distinguishing characteristics. Similarly, for businesses dealing with consumer products in a technology-intensive context, three distinctive configurations emerge: 1. Established Diversifiers; 2. Dominant Specialists; and 3. Laggers.

The identification of distinctive sets of technology-intensive businesses is significant itself in terms of technology strategy. It implies that within the relatively bounded grouping of a technology-intensive businesses, a wide variety exists and that large corporations in all likelihood must be aware of this variety and must devise an appropriate mix of strategies and structures to deal with this complex situation.

The findings, however, go further in providing help for designing structures to enhance corporate performance in diverse technology-intensive contexts. As seen in Tables 5 and 6, it is clear that certain business configurations are associated with better performance, in terms of ROI or market share, with certain degrees of interdependencies and with poor performance with certain other levels of interdependencies. Moreover, the different business configurations have quite different profiles of corporate performance associated with various interdependencies.

Table 5

Industrial Goods
Joint Effects of Interdependencies Between Business Units on Performance

	Performance Criteria[1]							
	ROI				Market Share			
	Configurations (2)				Configurations (2)			
Interdependencies[3]	C_I^1	C_I^2	C_I^3	C_I^4	C_I^1	C_I^2	C_I^3	C_I^4
Low Vertical Integration No Shared Facilities No Shared Marketing	** -6.49 (3.47)	* -10.19 (7.61)	**** -18.18 (5.46)	**** 15.03 (2.80)	-3.68 (2.97)	**** 33.56 (6.89)	*** -10.19 (4.26)	** -19.81 (10.87)
Low Vertical Integration No Shared Facilities Shared Marketing		* -14.51 (9.49)		-.49 (.94)		*** -17.61 (8.59)		3.12 (3.67)
Low Vertical Integration Shared Facilities No Shared Marketing			4.26 (9.18)				*** -18.85 (7.15)	
Low Vertical Integration Shared Facilities Shared Marketing		** 14.14 (6.46)	-.84 (9.18)			*** -11.98 (5.85)	**** 33.71 (7.15)	
High Vertical Integration No Shared Facilities No Shared Marketing	*** 14.76 (5.39)	**** -23.88 (5.07)	-6.91 (5.46)	.31 (2.23)	**** 18.28 (4.61)	5.47 (4.59)	-4.77 (4.26)	-10.44 (8.69)
High Vertical Integration No Shared Facilities Shared Marketing	*** 43.20 (15.26)			** -7.07 (2.80)	7.84 (13.05)			10.04 (10.87)
High Vertical Integration Shared Facilities No Shared Marketing			3.53 (11.31)				-8.25 (8.81)	
High Vertical Integration Shared Facilities Shared Marketing	4.63 (5.89)	*** 15.46 (5.67)	**** -20.44 (5.87)		* -6.83 (5.04)	5.95 (5.85)	-2.35 (4.58)	
F	3.77	10.2	4.53	16.9	3.07	5.10	6.12	1.06
df	(8,39)	(7,22)	(15,76)	(8,17)	(8,39)	(7,22)	(15,76)	(8,17)
P	.002	.000	.000	.000	.009	.001	.000	.432

(1) Joint effects of the predictors on the performance criteria, with their statistical significance, are given in each column. Standard errors are also given between parentheses. The levels of significance are: p < .10*, p < .05**, p < .01***, p < .001****

(2) Configurations are the following: Established Suppliers (C_1^1), Fast Movers (C_1^2) Hi-Tech Job Shops (C_1^3) and Stalled Giants (C_1^4).

(3) Some combinations do not have any observation. Consequently, no data are available in the table.

Table 6

Consumer Goods
Joint Effects of Interdependencies Between Business Units on Performance

	Performance Criteria[1]					
	ROI			Market Share		
	Configurations (2)			Configurations (2)		
Interdependencies[3]	C_C^1	C_C^2	C_C^3	C_C^1	C_C^2	C_C^3
Low Vertical Integration No Shared Facilities No Shared Marketing	 -5.38 (5.51)	** -6.26 (3.52)	*** 16.94 (6.20)	** -13.39 (6.89)	*** -11.62 (4.71)	* 6.80 (4.51)
Low Vertical Integration No Shared Facilities Shared Marketing	** 9.21 (4.24)			 4.85 (5.30)		
Low Vertical Integration Shared Facilities No Shared Marketing		 -3.55 (7.50)			** -18.44 (10.05)	
Low Vertical Integration Shared Facilities Shared Marketing	 2.79 (8.93)		*** -24.10 (8.36)	 -6.85 (11.17)		*** -16.14 (6.09)
High Vertical Integration No Shared Facilities No Shared Marketing	*** 6.16 (2.55)	**** 26.70 (7.50)	 -4.83 (17.05)	**** 13.61 (3.19)	*** 23.06 (10.05)	 -.19 (12.42)
High Vertical Integration No Shared Facilities Shared Marketing	 -7.69 (6.21)		 1.19 (7.43)	 -5.82 (7.77)		 .95 (5.41)
High Vertical Integration Shared Facilities No Shared Marketing		 -3.55 (4.15)			**** 19.23 (5.56)	
High Vertical Integration Shared Facilities Shared Marketing	** -27.34 (12.74)		 -1.09 (7.43)	*** 44.85 (15.93)		 .29 (5.41)
F	2.32	6.46	3.63	3.45	6.86	2.20
df	(11,50)	(9,42)	(12,68)	(11,50)	(9,42)	(16,68)
P	.021	.000	.000	.001	.000	.021

1. Joint effects of the predictors on the performance criteria, with their statistical significance, are given in each column. Standard errors are also given between parentheses. The levels of significance are $p < .10$*, $p < .05$**, $p < .01$***, $p < .001$****.

2. Configurations are the following: Established Diversifiers (C_C^1), Dominant Specialists (C_C^2), Laggers (C_C^3).

3. Some combinations do not have any observation. Consequently, no data are available in the table.

What does this complex set of relationships signify for scholars and administrators? We will deal with this question in two ways. First, we will discuss the results for each configuration and will interpret the specific results. Second, we will discuss the corporate-wide strategic significance of these findings, especially in terms of the current discussions regarding the increasing co-existence and varying relationships between large-scale, integrated corporate R&D and small-scale, entrepreneurial units within the large corporation.

The results of configuration 1-I in the industrial products group, termed Established Suppliers, indicate that the absence of all kinds of interdependencies is negatively associated with ROI performance. However, the high vertical integration alone or high vertical integration plus high shared marketing are positively associated with ROI performance. Obviously, there may be several explanations for these findings. For Established Suppliers, we know that there is a small concentrated set of users. They probably buy a great many components from the same vendor. Therefore, there may be significant synergies in sharing marketing activities. Moreover, cost is a key competitive factor and, therefore, vertical integration can be significant. On the other hand, the components themselves may be very different and, hence, require little sharing of facilities.

The market-share performance results for this configuration, however, exhibit rather different set of relationships. While high interdependency in solely vertical integration is associated positively with market share performance, a high level of interdependency in all three interdependency categories is negatively associated with market share performance. It may be that capturing market share for this businesses configuration requires internal flexibility and rapid adaptation to market conditions. Extreme interdependency puts an enormous burden on administrative behavior and makes coordination an extremely complex and, in this case, unproductive task.

For the second configuration in the industrial products area, 2-I, termed Fast Movers, our results show that little or no interdependency is negatively associated with ROI performance as is high vertical integration alone. But high interdependency in simultaneously all three categories is positively associated with ROI performance, as is high shared facilities plus high shared marketing. But in terms of market-share performance, the total absence of interdependency is positively associated with market share performance, while high shared marketing alone and high shared marketing plus high shared facilities are negatively associated with market share performance.

These contrasting interdependency-performance relationships according to ROI and market share criteria call attention to the very difficult strategic tradeoff that young high technology businesses face: to capture market share early in a product's evolutionary cycle or immediately to seek high profitability. If long-term industry dominance, in terms of volume, is a major objective, then, according to our findings, these businesses should strive to keep simultaneously all three forms of interdependencies low, since this profile is associated positively with market share. One explanation for this result is that any kind of appreciable amount of any type of interdependency may tend to undermine the ability of a young high-tech business to maintain a set of focused commitments for each of its products.

But such a profile of interdependencies is maintained at the likely expense of a positive ROI performance, according to our findings. A high level of interdependencies along all three dimensions or high levels of interdependencies in terms of shared facilities plus shared marketing are positively associated with ROI performance. On the other hand, the interdependency of high vertical integration alone is negatively associated with ROI performance.

The beneficial results of flexibility seem to be one of the important lessons of those findings that are related to Fast Movers. On the one hand, the absence of any kind of interdependency appears to allow these types of businesses to adapt quickly to changing external conditions and thereby achieve positive market share results.

However, the efficiency of the businesses may suffer. To achieve better profitability, a high level of coordination and exploitation of synergies appear quite useful. Therefore, clarity of strategic goals is crucial - a theme that seems to be important in the technology-intensive environment and one that we will stress throughout this paper. These young businesses must be careful in employing management control methods too enthusiastically and in implementing a wide array of tight linkages. Such a posture may lead to high profitability, but not market dominance. But extreme flexibility has its own dangers. Namely, inefficiency in the midst rapid market growth.

The results of configuration 3-I, High-Tech Job Shops, exhibit still another set of interdependency-performance relationships. The findings that are negatively associated with ROI performance highlight the hazards of either extreme, a complete absence of interdependency or complete interdependency, for this configuration. Moreover, the absence of any interdependency, as well as the profile of high shared facilities alone, are negatively associated with market share performance. On the other hand, the profile of high shared facilities plus high shared marketing is positively associated with market share performance.

The findings related to this configuration, High-Tech Job Shops, indicate that an effective strategy may very well be a middle-of-the-road one that is flexible and adaptive. Such a stance makes sense. These businesses serve a diverse set of customers. Cost is not the key competitive factor, but quality is. Therefore, some interdependency is probably useful, at least for families of products and for related segments of the market, especially for increasing market share. Probably the exact kind of beneficial interdependencies varies depending on the specific product and the market.

The results for configuration 4-I, termed Stalled Giants, are especially instructive since they do not support the commonly held belief that mature large businesses can effectively and probably should usually compete on the basis of economies of scale and scope (Porter, 1980). Indeed, the complete absence of interdependencies is positively associated with ROI performance, while a high interdependency level for vertical integration plus shared marketing is negatively associated with ROI performance. On the other hand, the complete absence of interdependencies is negatively associated with market share performance.

Again, in a very different context, a major strategic tradeoff looms as a key issue. It seems that in these businesses, which are rather mature, which experience long development times, and which serve concentrated customer groups, extreme loosely linked structure appears to be beneficial in terms of profitability. Perhaps such a decoupling prevents contamination from spreading from the poorly performing SBUs to the businesses with health or at least potential health. On the other hand, such a fragmentation will inhibit such firms from exploiting any possible synergies, and this situation will constrain market share performance. A significant lesson that possibly emerges from these findings is that mature firms in technology-intensive settings need to be able to focus their resources on the businesses that still possess the likelihood for success in the present or future. They should not become distracted by too much diversity.

Our findings with regard to consumer product businesses also exhibit a diverse array of interdependency-performance relationships. For the configuration 1-C, termed Established Diversifiers, our results offer an intriguing set of relationships between interdependency levels and ROI or market share performance. High shared marketing alone and high vertical integration alone are positively associated with ROI performance, while simultaneous high levels of all three kinds of interdependency are negatively associated with ROI performance. On the other hand, simultaneous high levels of all three types of interdependency, as well as vertical integration alone, are positively associated with market share performance, while a complete absence of interdependency is negatively associated with market share performance.

Again, maintaining clarity of objectives is an important lesson from this set of findings. Some flexibility is needed to compete effectively for this business group, where quality and service are key competitive factors. There is a significant amount of customer concentration, and, therefore, shared marketing can often enhance efficiency, as can vertical integration for businesses serving those clusters of customers for whom cost is important. Moreover, in the long run, maintaining control over costs and establishing a comprehensive set of synergies lead to high market shares. Established Diversifiers probably should not become overly enamored with the attraction of flexibility since their customers appear to be constantly seeking lower cost and demanding efficiencies, as long as quality and service measure up.

Configuration 2-C, termed Dominant Specialists, offers still another set of findings and lessons. Our results indicate that a complete absence of interdependencies are negatively associated with both ROI and market share performance, while high vertical integration alone is positively associated with both ROI and market share performance. High shared facilities alone is negatively associated with market share performance.

Economies of scale in manufacturing are clearly often beneficial for this configuration of businesses. There may not be a great deal of variety of products, though there is some variety in the customers base. But the customers generally, at least in the long run, appear to value low cost products and efficiency on the part of their vendors, the Dominant Specialists. Also, overall coordination and control appear to improve market share performance. Finally, the findings issue a clear warning to Dominant Specialists not to become too flexible, adaptive, and decentralized. Perhaps a hyper-isolation or decentralization of business units for this configuration inhibits the transfer of key synergies, which are required to remain strong for serving specialized markets.

The findings that relate to our final configuration, 3-C, termed Laggers, offer lessons for what are one of the least healthy of the types of businesses that we studied. The complete absence of interdependency is positively associated with both ROI and market share performance, while high shared facilities plus high shared marketing are negatively associated with ROI and market share performance. A clear implication of these results is the obvious attraction of high flexibility, structural decoupling, and decentralization for businesses in "sick", though perhaps technology-intensive, industries. Such a structure may reduce possible contamination from poorly performing businesses and at least may allow for a turnaround for a few growth areas through a targeted niche strategy. In this manner, the relevant existing strengths of a firm can be exploited selectively, new essential strengths can possibly be established, and distraction through counter-productive coordination can be avoided.

The most important significance of our findings, however, may not lie in the interpretation of and in discerning the lessons of each of the specific sets of interdependency-performance relationships for each of the business configurations indentified. Rather, the crucial meaning of our findings is that, in fact, the whole relationship between technology, structure, and strategy is a much more complex one than has previously been documented. There is clearly a diverse array of technology-intensive business configurations. The behavior of each of these configurations appears to follow quite different rules from the others.

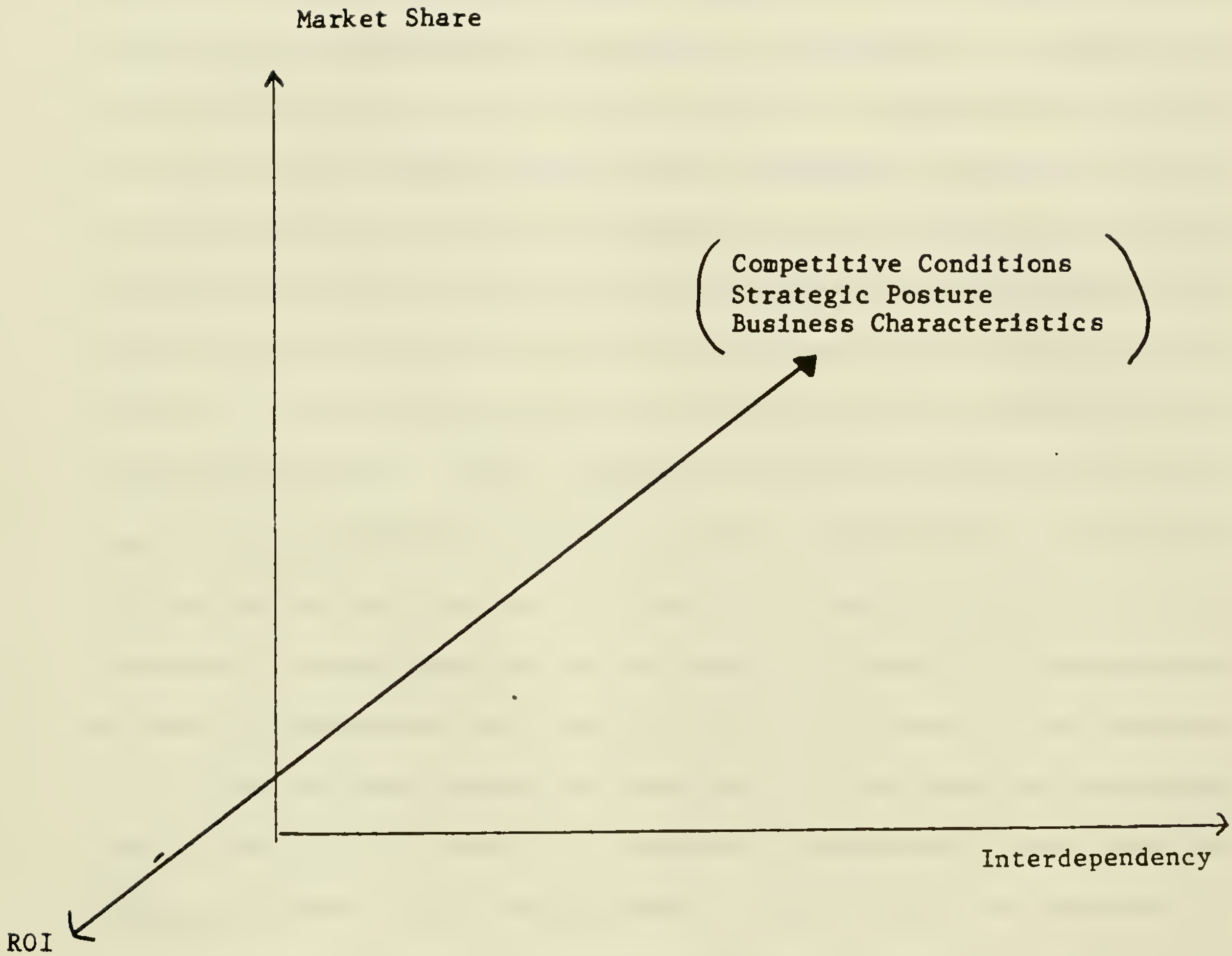
Successful business performance in a technology-intensive context is a multifaceted matter. Indeed, as an issue it is probably similar in nature to the related challenge of managing multi-business firms, which usually requires managing a portfolio of business units that have different types of objectives and characteristics (Haspeslagh, 1982).

We can begin to conceptualize the general outlines of the important factors for managing successfully a technology-intensive business. There are at least two key dimensions: performance goals, which in this study are ROI or market share, and strategic interdependencies, which can range from a complete absence of interdependency to total interdependency with various forms of intermediate interdependency levels inbetween. Conceptually, as seen in Figure 2, technology-intensive businesses have to consider the time horizon of their strategic goals, ahort term (related to ROI) or long term (related to market share). They also must consider the degree of strategic linkages that they should establish. Extreme decoupling and business unit independence can be associated with flexibility and entrepreneurial venture units, while extreme interdependency can be associated with the benefits of economies of scope and scale. Perhaps, most interesting is that there is clearly a variety of structural possibilities inbetween these two extremes and that these mid-range positions are at times also associated with positive (as well as negative) performance results.

A very important aspect of these findings relates to the strategic behavior of the large corporation that competes in several technology-intensive areas. In our opinion, the meaning for this institution is unambiguous and significant. Technological diversity requires a corporate-wide capability to manage simultaneously an appropriate, and possibly extremely diverse, set of internal strategic interdependencies and to be able to select from a range of strategic goals for the technology-intensive businesses in a portfolio.

Figure 2

Strategic Goals and Linkages



Conclusion

We would first like to point out some of the limitations of this study. To begin with, the analysis has been made on pooled cross-sectional data. Consequently, an identical business may be observed over a four-year time span. Because we expect each individual business to maintain a consistent behavior and similar characteristics over a four-year time period, this may have biased some of the results. Second, our choice of R&D expenditures as a proxy variable for technology-intensive businesses may not be totally accurate. On the one hand, consumer goods with high R&D expenditures may include businesses that have products which are modified frequently to respond to taste and fashion changes. Consequently, the technology content of these expenditures may be very low. On the other hand, our decision not to include process R&D expenditures tends to limit the notion of technological intensity. Although our decision to focus on product R&D may clarify the set of businesses examined, this decision also may unnecessarily narrow the set of "real" technology-intensive businesses. Third, the multi-way analysis of variance performed is on a limited data set. Several cases of interdependencies are not observed. Consequently, only the joint effects for which data is available are computed. In addition, the lack of observations for some of the cases of interdependencies prevent computing the main effects on performance of each specific interdependency and the interaction effects between interdependencies. Fourth, the notion of intra-organizational interdependency has not been fully explored. For example, interdependencies in terms of information networks, hierarchical relationships, and power structure have not been taken into account. An investigation of a broader spectrum of intra-organizational interdependencies and linkages should also be studied. Finally, our study only deals with internal interdependencies. High technology also involves interorganizational linkages (Ohmae, 1985). An important area of research still to be done would certainly combine a review of performance results associated with both internal and external interdependencies in technology-intensive contexts.

But in spite of the acknowledged constraints of this research, the analysis has resulted in some significant findings and implications for both further study and for management practice. First, it appears that there are several distinctive kinds of technology-intensive businesses. We identified seven configurations. Four are in the industrial products area: Established Suppliers, Fast Movers, High-Tech Job Shops, and Stalled Giants, and three are in the consumer products area: Established Diversifiers, Dominant Specialists, and Laggers. Clearly, technology-intensive business behavior is a quite diverse matter.

Second, we also identified a spectrum of strategic interdependency levels, ranging from total independence of the businesses to complete interdependence. We used three different types of interdependencies in our analysis, vertical integration, shared facilities, and shared marketing. We originally expected, and later found to some degree, that each kind of interdependency and each combination of interdependency might affect business performance differently for each of the different business configurations.

Conceptually, we believe that there are at least two important kinds of performance measures for technology-intensive businesses, short-term oriented ones and long-term oriented ones. We used ROI as a short-term measure and market share as a long-term measure. We found that often the kinds of interdependencies that are positively associated with ROI performance were not similarly associated with market share performance. Hence, clarity of strategic goals is critical in a technology-intensive business.

The research also produced a complex and diverse set of interdependency-performance associations for the seven configurations. Our discussion of the findings and implications for each of the specific configurations is presented above. At a more general level, however, terms such as "technology-intensive", "high technology", or "innovation-intensive" alone are not very useful for devising effective strategies in product-markets where R&D expenditures are high. The strategy-structure relationship in such a context is complex and varied. Technology is only a starting point in understanding structure and competitive behavior.

The implications are especially crucial at the corporate level, which usually has the responsibility for allocating resources for a portfolio of technology-intensive businesses that differ themselves along a number of critical dimensions. Again, we repeat: technological diversity is at least as complex as business diversity. Of course, a key concern at the corporate level is the selection of the proper portfolio of technology-intensive businesses, which, given the fact that we identified seven distinctive configurations of such businesses, is a more difficult task than the earlier relevant research would lead us to believe (Ansoff and Stewart, 1967; Freeman, 1982 edition).

Another crucial issue relates to effective structure for innovation. The current debate has focused on the costs and benefits of establishing various forms of venture, small-scale, and entrepreneurial units within the large corporation. However, as we have seen in our research, designing the most appropriate internal structure for effective technology-intensive competition involves much more than a simplistic tradeoff between the two extremes of total independence and complete interdependency of business units. Different technology-intensive business configurations require different levels and types of interdependency for different kinds of positive performance. A technologically intensive and diverse corporation in all likelihood contains more than one type of configuration. Consequently, such a corporation must be able to cope with and exploit several levels of inter-dependencies at the same time. The organization, in fact, must also possess the capability of continuously rejecting, creating, and modifying its set of strategic interdependencies as the situation warrants.

To conclude, for effective technology-intensive competition, what we are ultimately calling for is an organizational form that maintains an overall capability for mega-structural flexibility with regard to internal interdependencies. This institution should be able to support and use diverse sets of strategic interdependencies. The specific design of such a structure is obviously contingent on the selection of technology-intensive businesses in the overall portfolio of a firm. But the characteristics of the set of interdependencies are also clearly more complex than merely possessing on the one hand mainstream industrial R&D, with such units as research laboratories, engineering design departments, and pilot plants, and, on the other hand, independent entrepreneurial units that tend to mimic Silicon Valley within the large corporation. Clearly, modern enterprises are only now beginning to confront in a sophisticated fashion technology-intensive competition, which is emerging as both a crucial and surprisingly complex management challenge.

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