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Rapport de recherche

DETERMINING THE ROLE OF MANUFACTURING IN CANADIAN ELECTRONICS FIRMS

By

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P.R. Richardson
A.J. Taylor

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The views and opinions expressed in this report are those of the authors and are not necessarily endorsed by the Department of Regional Industrial Expansion.

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Contents

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John R.M. Gordon

Peter R. Richardson

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Executive Summary

The Challenge

The performance of firms in the manufacturing sector of the economy is an important element in Canada's economic health. Within the sector, the electronics industry commands a special position both because of the success to date of many entrepreneurial Canadian electronics firms, and because of the industry's future growth potential.

Measuring the performance of manufacturing firms then, is of importance to executives in both industry and government. The Chief Executives of manufacturing firms need reliable measures that evaluate the ability of their plants and production executives to effectively meet company objectives over the long run. Governments need adequate measures of performance to be able to identify firms that have sound strategies and managements in order to be able to allocate financial incentives and support wisely.

Unfortunately, the measures of manufacturing performance that are commonly applied are not adequate. Current profitability is a poor indicator of future performance, and traditional factor productivity measures have been shown to be inappropriate in industries such as micro-electronics, where technology change is the driving force.

The Study

Recent developments in the field of manufacturing strategy do, however, offer the promise of more relevant measures. In this study, we have characterized manufacturing strategies implemented by Canadian electronics firms, and then determined a set of relevant criteria on which the success of these strategies can be evaluated.

In particular, we were interested in determining whether chief executives in the Canadian electronics industry had well focussed concepts of corporate mission and the role of manufacturing within this mission. We carried out this task by querying chief executives about their perceptions of these two key competitive success factors, and if the two were congruent. We then attempted to relate them to the overall financial performance of each firm for the last five years.

The Findings of the Study

Six differing types of corporate mission were identified through the field research, as shown in Exhibit i. Three of these stressed product innovation, while cost minimization was a key element in the remaining three. Companies participating in the study generally fitted clearly into one of the six categories, as shown by the measures of closeness of fit we use in the study.

In addition, four categories of manufacturing task are characterized in the study, and related to the corporate missions. We were able to identify the manufacturing task of

Exhibit i

Six Different Corporate Missions and Their Characteristics

TIMING: TO MARKET

Unit Volumes	FIRST	SECOND	LATE
HIGH	TECHNOLOGICAL FRONTIERSMEN . Outstanding product research, development and design . High product quality . Ability to introduce new products continuously	TECHNOLOGICAL EXPLOITERS . Rapid price reduction from high volume production . Substantial skills in product development and design . Ability to introduce new products . High product quality . Cost minimization skills	COST MINIMIZERS . Low price . High volume, low-cost production . Rapid delivery
LOW	TECHNOLOGICAL SERVICEMEN . Excellence in product design . High product quality and quality assurance . Flexibility to customer specification changes	CUSTOMIZER . Product quality and quality assurance . Flexibility to specification and volume changes	COST MINIMIZING CUSTOMIZER . Low price . Cost minimization (often without the benefit of high volume production) . Delivery on schedule . Flexibility to volume and specification changes

each respondent, although some chief executives had such broad definitions of this task that their operations could have fitted into more than one category.

A positive relationship was established between corporate success and the following measures:

1. The 'focus ' of the corporate mission; that is how clearly the chief executive recognizes and emphasizes the relatively small number of elements which are key factors in the overall success of the business.

2. The 'congruence' of corporate mission and manufacturing task; that is how well the chief executive's requirements from his manufacturing operation mesh with his expressed corporate mission.

3. The degree to which the strategy stressed innovation rather than cost minimization.

Firms which scored highly on the focus and congruency measures performed better, whereas those with a strong cost minimization element performed less well than others.

Returns were superior in those strategies based on innovation. Over the five-year period examined in the study, firms on the leading edge of technology exhibited the highest returns and those competing on the basis of costs had the lowest.

Successful, smaller Canadian owned firms tended to compete

primarily on the basis of product innovation, employing a corporate mission we termed technological frontiersmanship. These firms appeared to be heavily export oriented and needed to reinvest in high levels of research and development to remain competitive.

In contrast, another large group of firms implemented a mission which we called 'technological exploitation', requiring joint emphasis on product innovation and cost reduction. This broad mission is clearly difficult to implement effectively, and successful firms in this category tended to be larger subsidiaries of multi-national corporations implementing a product-mandated global production system.

Within the different categories of mission and task, executives were in general agreement about the importance of the different criteria for evaluating performance. Overall financial performance tended to be higher in firms where executives had a clearer sense of focus and a high degree of congruence between corporate mission and manufacturing task, giving support to the concept of the "focussed factory".

For executives in industry our study suggests that more attention should be paid to the selection of focussed corporate missions, and the attendant manufacturing task. Our study indicates that some strategies are inherently more attractive, such as the technological frontiersman and that others, such as the technology exploiter are extremely hard to implement well.

While many executives in the study had clear ideas about how the corporation competed, their view of manufacturing's role was

broad and lacked discrimination. Of particular concern to us was the number of firms where the chief executive was clear that the firm competed on innovation, but where he continued to evaluate manufacturing on the basis of cost minimization and productivity.

Governments should find our work useful in evaluating the impact of alternative public policy choices on the manufacturing sector. In particular, options which assist the technological frontiersmen to maintain their level of research, development and new product introduction would appear to be especially desirable. In addition, our research supports the view that product mandating is a viable and profitable strategy for Canadian subsidiaries of foreign multi-national corporations, and that the government should seek to make this an attractive option in Canada.

1. Introduction

A key task for senior executives in manufacturing firms is to select a mission for the business which will determine how the firm competes in the long run. Once a mission has been identified, goals and objectives can be established, priorities set, and strategies formulated for each functional area.

Manufacturing is one of the most important of these functional areas. Correct identification of critical trade-offs in this area can be a prime determinant of the firm's eventual success or failure. In industries where change is rapid, and manufacturing faces a stream of new products and specifications, these decisions are of overwhelming importance. The electronics industry is one such case.

In Canada, the electronics industry is an important component in the growth of the manufacturing sector and must be a cornerstone for any national strategy of industrial development based on high technology. A recent study of medium-sized firms in Canada which are on the threshold of becoming large entreprises reported that one fifth of these firms were in the electrical and electronics industries (Steed: 1982).

Unfortunately, many other nations have come to the same conclusion, and so future competition will be fierce. To survive in the inevitable scramble for markets, Canadian firms will have to develop manufacturing approaches that are distinctive and which can be viably sustained over extended periods. An

important requirement will be the development of suitable criteria which can be used to evaluate the performance of these strategies.

This report proposes a means by which executives in industry and government can characterize and evaluate strategic choices in manufacturing. While the study has examined the specific case of the Canadian electronics industry, we believe that the framework used has broader application in other manufacturing industries.

Using data gathered from field research, some tentative conclusions can be made about the relationship between the alternative manufacturing strategies available and company profitability. However, since this is the first time to our knowledge that a study of this type has been undertaken, we consider our methodology exploratory, and caution readers to treat our conclusions accordingly.

2. Manufacturing Performance

The performance of manufacturing is the critical determinant of success for many firms. Profitability can be considerably improved through the implementation of a manufacturing strategy appropriate to the firm's markets and products. During the last decade, Hewlett Packard and Texas Instruments have both been extremely successful while implementing different manufacturing strategies. However, it is important to note that each was appropriate to the firm's markets and products.

A vital task for chief executives is to identify and ensure high performance in the key elements of manufacturing strategy which are central to the corporate mission. In the language of strategic management, corporate mission provides an enduring statement of the business that the firm is in, its objectives, and how it will compete (this concept is also referred to as the firm's 'master strategy' in some works). Thre statement of mission identifies the image the firm attempts to project, and reflects the values and priorities of the firm's strategic decision makers (Pearce: 1982).

Subordinate to this overall mission are functional strategies (marketing, manufacturing, innovation) which should be defined by parameters which ensure that they fit the mission, and so enable the firm to achieve its long-run objectives (see, for example, Steiner and Miner: 1977, and Schendel and Hofer: 1979). These

relationships are shown schematically in Figure 1.

Traditionally, manufacturing choices have been described as tradeoffs between cost, quality, volume, delivery and design. The objective of production executives has been to maximize operating performance characterized by measures of efficiency in the transformation of inputs to outputs (see, for example Craig and Harris: 1973).

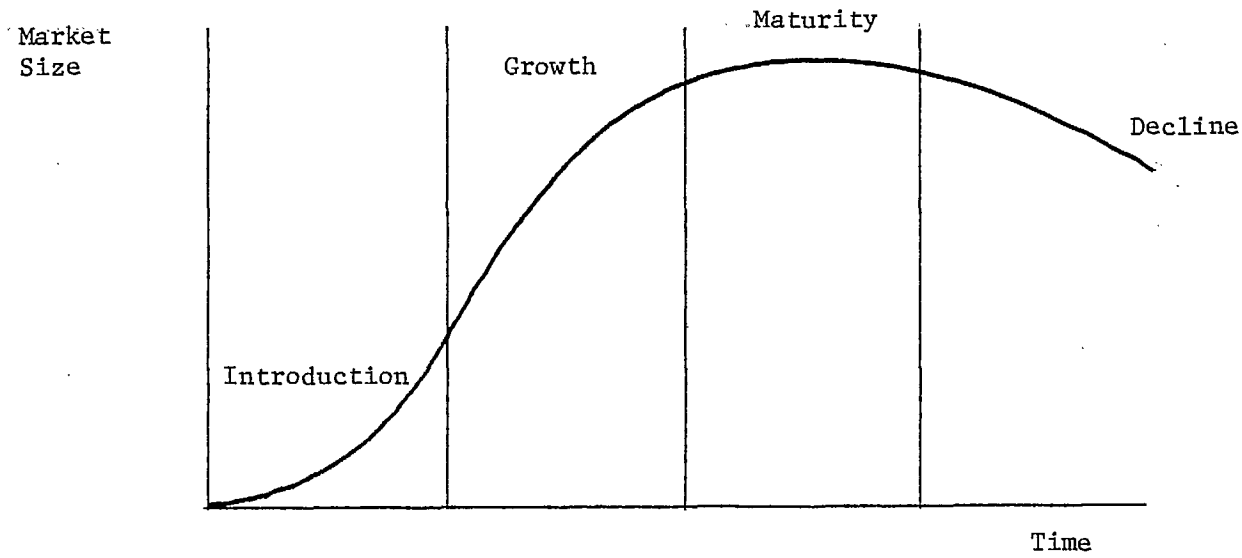
Recently, however, declining innovation has been highlighted as a major problem in mature manufacturing firms, and the deleterious effects of slavish adherence to the experience, or learning curve have been exposed (Abernathy and Utterback: 1978).

In response to these concerns, a broader view of manufacturing strategy has emerged in which other variables, such as product and process innovation are included. In this view, manufacturing performance is evaluated in terms of how well it meets the goals and objectives defined for it by the corporate mission. Effectiveness, rather than merely efficiency, then becomes an objective of the production function.

Manufacturing plants cannot excel in all aspects of performance (Skinner: 1974), and so hard choices have to be made about manufacturing which affect the firm's market and innovation strategies in ways that cannot easily be reversed. When these factors are included, decisions on manufacturing strategy become more complex, especially in market-driven, high technology firms where change is rapid. Under these circumstances is is difficult to provide manufacturing with an achievable production task.

Figure 1

Relationship Between the Product
Life Cycle and Functional Strategies



Functional Strategy	STRATEGIC FOCUS			
Marketing	Acceptance	Growth in Market Share	Maintain Market Share	Maintain Share at lowest cost
Production	Establish Manufacturing Capability	Increase Volume	Reduce Cost	Reduce Cost and Investment
Innovation	Product Performance	Achieve Dominant Design	Process Innovation Product Augmentation	Incremental Change

The introduction of new products is one such complicating factor. To re-vitalize the product portfolio in most firms, new products are periodically required, although the rate varies within different industries. Depending on the rate of product change, the ability to introduce new products may be more important in manufacturing than cost minimization.

As a result, more attention has recently been paid to the identification and measurement of other key competitive factors. Focussed manufacturing strategies have been hypothesized to be more successful than those with broad, and possibly conflicting requirements (Skinner, 1974). The importance of relating the manufacturing task to stages in the product/process life cycle has been pointed out (Hayes and Wheelwright, 1978). This approach has also demonstrated the need for long-run measures of performance instead of traditional short-run approaches (Banks and Wheelwright, 1979). In short, there has been a growing concern for the effectiveness of the manufacturing function rather than its efficiency.

However, there remains a lack of relevant measures of manufacturing performance, as noted in recent articles (Kaplan: 1982, Richardson and Gordon: 1980). Practitioner-oriented texts have typically provided long, unranked lists of variables which are relevant to manufacturing performance, but which provide little help to executives in specific operations. One recent article identified four important performance criteria: efficiency, dependability, quality, and flexibility, but failed to provide a statement of how these can be applied practically

(Wheelwright, 1978). Other researchers have attempted to develop measures of intangible factors, such as innovativeness (Bigoness and Perreault: 1974).

Unfortunately, these approaches tend to be too general for practitioners and researchers to operationalize, for the following reasons:

First, there has been a lack of good manufacturing strategy profiles, together with some measure of their degree of focus.

Second, there has been no attempt to see how congruent these strategies are to key elements of corporate mission.

Third, specific measures of manufacturing performance have been lacking, apart from input-output measures of factor efficiency.

This report extends the work of an earlier study in which data gathered from fifteen manufacturing firms were used to rank the importance of specific measures for different manufacturing strategies (Gordon and Richardson, 1980). This report defines these concepts more precisely, and extends them to a larger sample of companies in the Canadian electronics industry.

3. Evaluating Manufacturing Performance

3.1 The Corporate Context

An important determinant of the firm's manufacturing strategy is the definition by management (as personified in the chief executive) of the appropriate corporate mission and the consequent demands placed on manufacturing. Our first task is to identify different forms that this corporate mission can take.

In this study, we have chosen to examine the way in which a firm competes in its markets as a key element in determining its corporate mission. The importance of this factor in determining manufacturing strategy, together with the diversity of options, is clearly illustrated by considering as examples Hewlett-Packard and Texas Instruments.

Hewlett- Packard (H-P) has chosen to compete by focusing on a relatively small segment of the calculator/ instrument market which is concerned with performance and advanced features. Market share is not a dominant concern for H-P (Business Week: June 9, 1975). H-P's customers are relatively price insensitive, but demand computing power and reliability. Consequently, H-P aims to be first to market with the most advanced products. By the time other firms have copied its products, and price competition emerges, H-P aims to have a more sophisticated replacement available. Thus H-P does not have to compete in the mature stage of the product life-cycle, as shown in Figure 1.

Texas Instruments (T-I)competes in the large volume market where price is a major purchase factor and consequently market share is a driving force. Once a large volume market is seen to be emerging for a particular product, T-I's objective is to gear up for high volume production rapidly and price according to the experience curve in order to maximise volume and market share (Business Week: September 18, 1978). As a result, T-I can be competitive throughout the product life-cycle, surviving the inevitable shake-out, and remaining a dominant producer, as shown in Figure 1.

H-P's approach to the market has meant that manufacturing has had to emphasize new product introduction, quality and flexibility. Outstanding research and development productivity has resulted in a stream of new products that manufacturing has had to absorb. As a result, efficiency and cost reduction are not the prime objectives of manufacturing managers.

T-I's strategy has provided manufacturing with a much more challenging task. In addition to responding to the stream of new products which T-I has to introduce, volume has to be maximized and costs continuously reduced. As a result, a much more complex and formal structure has emerged at T-I, the whole focus of which, according to senior executives is productivity. Moreover, to assure a continuing supply of high-volume semiconductor chips, T-I has backward-integrated into chip manufacture.

So far, both companies have been highly successful, although with completely different manufacturing strategies. Nevertheless, questions about the long-run viability of each

approach persist. For H-P, the challenge is to continue to innovate successfully in a maturing market, and so stay away from price competition. T-I has already experienced problems with a loss of focus due to the business split between components and equipment (Fortune: March 23, 1981). In addition, it remains to be seen whether T-I can successfully combine the innovations and productivities needed to maintain its low cost position in the long term.

As illustrated by these examples there are a variety of possible corporate missions and corresponding manufacturing strategies. Previous attempts have been made to characterize the options that exist. For example, Porter identified three Generic competitive strategies: overall cost leadership; differentiation and focus (Porter: 1980). However, along with others, this approach did not provide sufficient discriminatory power for this study.

In this study we identified alternative forms of corporate mission in the following manner. First, using literature reviews and discussions with industry executives, we created a list of relevant dimensions in the firm's competitive market stance. These include market, production, service, and technology factors as listed in the first column of Table 1 below.

Six different corporate missions were then identified,

Table 1

Factors	Corporate Mission Profiles*					
	Technology Frontiersman	Technology Exploiter	Technological Serviceman	Job Customizer	Cost Minimizing Customizer	Cost Minimizer
Product Research	1	3	3	4	4	5
Product Development	1	1	2	4	4	4
Product Design	1	1	1	2	3	4
After Sales Service	3	-	2	2	-	-
Price	3	1	3	3	1	1
Product Quality	1	1	1	1	1	2
Delivery on Schedule	2	2	2	3	1	1
Rapid Delivery	-	2	-	-	2	2
Cost Minimization	4	1	4	3	1	1
Quality Assurance	2	2	1	1	1	2
Flexibility to Volume Changes	4	4	2	2	3	4
Flexibility to Customer Specification Changes	3	3	1	1	1	4
Ability to Produce New Products	1	1	2	2	3	4

* Notes: (1) Numeric values indicate relative importance of each factor in each profile.

(2) " - " means no clear prediction for the corresponding factor and mission combination was indicated.

differentiated on the basis of three principle characteristics:

product volume
product variety (focus)
degree of innovativeness

The missions were postulated to vary from those based primarily on innovation skills (such as the technological frontiersman), to those based almost entirely on low cost production (such as the cost minimizer). The profiles of the types of mission are characterized as follows:

Technological Frontiersmen: These firms are research and development driven. They remain on the leading edge of product technology by constantly innovating. Thus the ability to introduce new products is a key success factor. Markets are abandoned when they become price-competitive and margins fall. Price and promotion are not significant attributes because product performance is the major selling feature. A well known example of this type of company is Hewlett-Packard.

Key factors for successful implementation of this mission are:

* Outstanding product research, development and design

* High product quality

* Ability to introduce new products continuously

Technological Servicemen: These firms are also on the leading edge of product technology, but provide custom service on complex systems for low volume customers and markets. In this sense extreme flexibility and adaptability are demanded of the firm in order to respond to customer needs. The Canadian division of Litton Industries exhibits these types of characteristics.

Key factors for successful implementation of this mission are:

* Excellence in product design

* High product quality and quality assurance

* Flexibility to customer specification changes.

Technology Exploiters: These firms attempt to introduce new products, but follow through the complete life-cycle by manufacturing even when the product becomes price competitive. This strategy is complex since innovation and cost minimization are both required from the manufacturing organization. Texas Instruments is an outstanding example of a company implementing this strategy.

As a result, there are a broad, and potentially conflicting range of key success factors for this mission:

* Rapid price reduction from high volume production

* Substantial skills in product development and design

* Ability to introduce new products

* High product quality

* Cost minimization skills

Customizers: These firms are true job-shop manufacturers. While they do little innovation themselves, they can take product designs from customers and produce competitively on a low-volume basis. Since a wide variety of work may be accepted, the organization must have considerable volume and specification flexibility.

Key factors for the successful implementation of this mission include:

* Product quality and quality assurance

* Flexibility to specification and volume changes

Cost-minimizing Customizers: These firms manufacture low volume mature products to customer requirements. The organization's principle skills lie in design and process

engineering. Price is an important factor in the marketing process.

This mission requires both job shop and cost-minimization skills for successful implementation. Key success factors are:

* Low Prices

* Cost minimization (often without the benefit of high volume production)

* Delivery on schedule

* Flexibility to volume and specification changes

Cost-minimizers: These firms are high-volume producers whose skills lie in low-cost production of mature products. Accordingly, productivity and return on assets will be important measures of their performance.

The narrow set of key success factors for this mission are:

* Low price

* High volume, low-cost production

* Rapid delivery

The importance of the different factors in each mission were then predicted. By discussing each model with industry representatives and our colleagues, we sought to characterize how an executive would rank the relative importance of each factor for the mission profile relevant to his own firm. The rankings ranged from very important (1) to not important (5), as shown in Table 1.

Given this set of relative importance assessments on the firm characteristics, we may categorize firms in the sample as being 'most like' one of our six categories by comparison with the above profiles. A procedure to make this association is discussed below in the section on Data Analysis.

As previously discussed, another important determinant of manufacturing strategy is the degree of focus in management's perception of the corporate mission (Skinner: 1974). To operationalize focus for this study we have defined it as the extent to which a consistent set of parameters in the firm's mission is both selected and given importance relative to other parameters. Thus, for example, a firm which attaches equal importance to every parameter we would call unfocussed. On the other hand, a firm which, viewing itself as being on the frontier of technology, rates product R&D, design, and quality as being very important but other factors like price, promotion and cost as being relatively unimportant we would call highly, and consistently focussed. Later we use the profiles in Table 1 to form a measure of

focus of firm strategy.

3.2 Manufacturing Task

Having characterized the perceived corporate mission and focus, we now examine the manufacturing task of the firm. A literature search and in-depth interviews with industry executives identified a set of variables which describe the important factors in specifying this task. These are listed in the first column of Table 2. We have identified four different types of manufacturing task as perceived by management. These are:

New-product centred: In this type of plant, emphasis is on innovation through the ability to adapt to varying product specifications while maintaining quality. Cost and productivity are of low importance given the innovativeness of the product. Typical products of this type of plant include electronic office equipment, and micro-computers.

Custom-innovator: In this type of plant, the introduction of new products is important, but the fact that each job is in some way unique adds to the complexity of the task. Increased flexibility, especially to specification and volume changes, is thus especially important. Typical products include electronic connectors and commercial sonars.

Cost-minimizing job-shop: In these plants, productivity and cost minimization are important, but since customers demand custom production, volume and specification flexibility will also be required. Products include military electronics and video display terminals.

Cost-minimizer: These plants are classical cost minimizing plants in which long runs, productivity, and return on assets are the key parameters of manufacturing performance. New products are rarely introduced, and so flexibility is relatively unimportant. Products include consumer electronics and electronic components.

In Table 2, as in Table 1 we related each of these tasks to the identified variables by specifying the relative importance we would anticipate a manager placing on each variable given the mission (where 1 corresponds to "most applicable" and 5 to "not applicable"). The resulting manufacturing profiles are presented in Table 2.

Given a response from a manager for his perceived importance ratings on the variables, we can describe his perceptions as being 'most like' one of the above profiles. In addition, we developed an equivalent measure of focus of manufacturing task as for the corporate mission. That is, we can call tasks which concentrate on a consistent set of the variables more focussed than others which attach strong importance to either a broad or

Table 2

Manufacuring Mission Profiles*

Factors	New-product-centered	Custom Innovator	Cost Minimizing Job Shop	Cost Minimizer
Volume of output	3	3	3	2
Cost per unit	4	4	1	1
Quality	1	1	1	2
Delivery on schedule	3	2	1	2
Labour productivity	4	3	2	1
Ability to introduce new products	1	2	4	4
Flexibility to product specification changes	2	1	1	4
Flexibility to volume changes	3	1	1	3

* Numeric values are relative importance weight of each factor in each profile.

Table 3

Congruency Scoring Matrix

Plant Task \ Corporate Mission	Technological Frontiersman	Technology Exploiter	Technological Serviceman	Customizer	Cost Minimizing Customizer	Cost Minimizer
New Product Centred	High	Low	Low	Low	Low	Low
Custom Innovator	Low	Low	High	High	Low	Low
Cost Minimizing Job Shop	Low	Low	Low	High	High	Low
Cost Minimizer	Low	Medium	Low	Low	Low	High

inconsistent set (such as simultaneously emphasizing cost per unit and the ability to introduce new products).

3.3 Congruence Between Corporate Mission and Manufacturing Task

An important factor in corporate success is the degree to which the perceived corporate mission matches up with the measures of performance of the manufacturing function. We predict that firms with a congruent corporate mission and manufacturing task will out-perform those in which these are mis-matched. For example, if a firm considers itself to be on the technological frontier, with heavy emphasis on flexibility and R&D, and yet its manufacturing requirements call call for cost minimizing behaviour, we would say the congruence is low, and would expect poor corporate performance.

To operationalize a measure of congruence between corporate mission and manufacturing task, we rated each pair as either highly congruent, of medium congruence, or of low congruence. These ratings are summarized in Table 3.

Finally, we require a measure of the degree of focus in the corporate missions and the plant tasks. Recall that by focus we mean the prioritization of the most important variables. We have defined our measure as the sum of the squared differences between the respondent's expressed importance rankings and the closest fitting mission or task profile: the higher the sum of squared errors (SSE), the lower the apparent focus in the mission or task.

4. Data Acquisition and Quantitative Analysis

From the Federal Department of Industry, Trade and Commerce industrial listing of Canadian firms in the electronics industry, we selected for our sample all firms with annual sales of more than five million dollars, and a random sample of 50% of the remaining firms. A total of 176 questionnaires were mailed and 64 useful responses were received. The questionnaire is reproduced in Appendix A.

We established the 'best fit' of each response to our corporate and plant mission profiles, choosing as the best fit that profile which yielded the minimum sum of squared deviations. In making these comparisons, each response was manually checked to ensure that missing or apparently spurious data points were not unduly influencing these assessments. The sums of squared errors are reproduced in Appendix B, which also contains some additional firm-specific data which will be of interest later. Each observation of a corporate-plant mission pair was assigned a numeric value, explained below, and these results are summarized in Table 4.

In order to measure the apparent impact of increased corporate focus and mission congruence, we require a measure of corporate performance. Although, as the literature suggests, there were a great number of dimensions of corporate performance (ROI, market share, growth and market penetration, etc.), we

Table 4

Mission Incidence Matrix*

Plant Task \ Corporate Mission	Technological Frontiersman	Technology Exploiter	Technological Serviceman	Customizer	Cost Minimizing Customizer	Cost Minimizer	Mean
New Product Centred	47 29 17 40 6 20	21	12 7				22.1
Custom Innovator	22	18 10 20 17	18 23 25 32 20 15 15 21 12	15	15		18.6
Cost-Minimizing Job Shop	28	17 7 11 9 5 23 19 20 7 15 8 20	21 21 20 25		5 11 25 9 17		15.6
Cost Minimizer	11 5 15	26 6 24 9	14 16 14		13 3 3	11 0 6 9	10.9
Mean	21.8	14.0	18.4	15.0	11.2	6.5	

* Numeric values are after tax profit and R & D as a percentage of sales for each firm corresponding to the indicated mission pair.

selected a profitability measure as the most usual measure of corporate success. The specific measure chosen is profit plus research and development expenses (after tax) as a percentage of sales. This measure has been adopted by other studies of strategy and performance (see for example, Horovitz and Thietart:1982). The numeric entries in Table 4 are these values.

(A natural alternate measure of corporate success might have been profitability as a percent of assets. We found, however, that there is no common definition of a suitable asset base, given the wide variety of activities of the firms in our sample. Such a measure tended to unduly handicap companies engaged in component production, with relatively large fixed assets, versus assembly-type operations, with a relatively low fixed asset base.)

To summarize, then, we expect to find that increased corporate and plant focus, and increased congruence between corporate and plant missions, should be correlated with improved corporate performance. We will also examine whether a more fundamental division of corporate missions into 'technologically-oriented' missions versus 'cost-oriented' missions holds any explanatory power. (Given our definition of corporate success, we would expect that the former group should outperform the latter, as cost competition shaves the competitive margin). Also of interest is the impact of corporate size on profitbility. We would expect to find that smaller firms would tend to have a higher profitability ratio due to the more highly specialized nature of their products.

4.1 Variable Definition

We identify the following variables:

PROFIT: corporate profit as a percent of sales,

CFOCUS: measure of corporate focus, sum of squared errors from least fit profile,

PFOCUS: similar focus measure for plants,

CHIGH: dummy variable = 1 if congruency score is "High" (see Table 3), otherwise 0

COST: dummy variable = 1 if corporate mission is less cost orientation (missions C, CME, and CM); otherwise 0

SIZE: an index with values: (1: less than $1 million sales), (2: 1-5 $M), (3: 5-15 $M), (4: 15-25 $M), (5: 25-50 $M), (6: 50-100 $M), (7: 100-500 $M).

4.2 Analysis

The variable correlation matrix for this set is shown in Table 5.

Table 5

Variable Correlation Matrix

	PROFIT	CFOCUS	PFOCUS	CHIGH	COST
CFOCUS	-.254				
PFOCUS	.041	.098			
CHIGH	.209	-.013	-.316		
COST	-.310	.128	-.107	.205	
SIZE	.010	.151	.015	-.142	-.058

We observe from Table 5 that the variables corresponding to plant focus and size appear to have little relationship with our success measure. The remaining variables, however, do have some apparent correlation, and the direction of the relationship is as anticipated. That is, given the variable definitions, higher values of the variable CFOCUS correspond to a lower degree of focus and are associated with lower profit values; higher congruence corresponds with higher profits, and a cost orientation corresponds with lower profits.

Moreover, Table 5 shows a low multi-collinearity within this set of variables.

A regression analysis of this data yields the following results:

$$\text{PROFIT} = 19.6 - 0.35\ \text{CFOCUS} + 4.62\ \text{CHIGH} - 6.89\ \text{COST}$$
$$\qquad\qquad\qquad (-1.76) \qquad\quad (2.32) \qquad\quad (-2.83)$$

where the bracketed figures are the t-statistics for each coefficient. The regression yielded an R^2 value of 0.215.

Using a one-sided test, the CFOCUS variable is significant at a 5% level of confidence, and CHIGH and COST are significant at 2%.

In addition to the statistical analysis presented above, the data were analyzed for other relationships of interest. Two major findings of interest were noted.

Some relationship between performance, ownership and size was evident, although statistical validation could be not be obtained. As shown in Table 6, with only one exception the

Table 6

Performance, Ownership, and Size

(Profit and Tax Plus R and D Expenditure as a Percent of Sales)

Technological Frontiersman	Technological Exploiter	Technolgocial Serviceman	Customizer	Cost Minimizing Customizer	Cost Minimizer
		32-C2			
	26-F7	25-C1			
	24-F7	25-F3			
	23-F3	23-C1			
	21-C2	21-F5			
47-C2	20-C1	21-C1			
40-C2	20-C1	21-C1			
29-C2	20-F3	20-C2			
28-C2	19-F3	20-C2			
22-C2	18-F4	18-C3			
20-C2	17-C3	16-C2		25-F3	
17-C2	17-C3	15-C2		17-C2	
15-C1	15-C1	15-F3	15-C3	15-C3	
11-C1	11-C3	14-C4		13-C1	11-C2
6-C1	10-C2	14-F5		11-C3	9-C3
5-F6	9-C3	12-F3		9-C2	6-C3
	9-C1	12-F4		5-C1	0-F3
	8-F3	7-F5		3-F2	
	7-F3			3-C2	
	7-F1				
	6-C3				
	5-C1				

Legend: Ownership: F: Foreign, C: Canadian

Size: 1: under $1 million annual revenues, 2: $1 - 5 million, 3: $5 - 15 million, 4: $15 - 25 million, 5: $25 - 30 million, 6: $50 - 100 million, 7: $100 - 500 million.

Technological Frontiersmen were all Canadian owned firms. These firms tended to be smaller in size than the sample average, and some exhibited extremely high rates of return and growth. The two largest firms in the sample were both foreign owned and implemented a strategy of technology exploitation.

There was also evidence of a relationship between strategy export orientation, and performance, as shown in Table 7. Firms which competed on the basis of technology had much higher levels of exports than firms which competed primarily on the basis of cost. Moreover, within each strategy grouping, higher levels of exports appeared to be correlated with higher return on sales. Few firms with return on sales less than 15 percent had significant levels of exports.

Although there was no evidence overall of a relationship between ownership and export orientation, subsequent investigation revealed that four out of six high performing foreign owned firms in the technology exploiter category implemented some form of product mandating at the Canadian operation. By contrast, it appeared that few, if any, of the lower-performing foreign-owned firms in either this or the innovative customizer category were product mandated.

Table 7

Performance, Ownership, and Export Orientation

(Profit after Tax plus R and D Expenditure as a Percent of Sales)

Technological Frontiersman	Technological Exploiter	Technological Serviceman	Customizer	Cost Minimizing Customizer	Cost Minimizer
		32-CH			
	26-FL	25-CH			
	24-FM	25-FL			
	23-FM	23-CVL			
	21-CH	21-FL			
47-CM	20-CL	21-CVH			
40-CVH	20-CVL	21-CM			
29-CH	20-FVH	20-CH			
28-CH	19-FVL	20-CL			
22-CH	18-FH	18-CVH			
20-CVH	17-CH	16-CL		25-FVH	
17-CM	17-CL	15-CL		17-CVL	
15-CM	15-CH	15-FL	15-CM	15-FH	
11-CVL	11-CH	14-CH		13-CL	11-CM
6-CVL	10-CH	14-FL		11-CM	9-CL
5-FVL	9-CH	12-FVL		9-CVL	6-CVL
	9-CVL	12-FM		5-CVL	0-FM
	8-FVL	7-FVL		3-FVL	
	7-FL			3-CVL	
	7-FVL				
	6-CM				
	5-CVL				

Legend: Ownership: C: Canadian, F: Foreign

Export Orientation: VL: no revenues from exports. L: 59 percent of revenues from exports, M: 10 - 24 percent, H: 25 - 49 percent, VH: 50 percent or over.

5. Discussion

All firms in the study were categorized by corporate mission and manufacturing task. In the majority of cases there was one obvious choice of category for each firm and plant. In a few cases, however, the mission and task were defined in such broad terms that small variations in response would have moved the firm into a different category. Overall, we conclude that our profiles provide quite robust characterizations of the corporate missions and manufacturing tasks implemented by firms in the Canadian electronics industry.

Analysis of the corporate responses showed that most of the variables we measured were useful discriminators in identifying corporate mission and manufacturing task. A small subset of the variables, consisting of after sales service, promotion, delivery, and return on assets, bore no apparent relationship to specific strategies and tasks. Product quality as well proved to be a poor discriminator, since over 90 percent of the firms in the sample rated it as very important. Note that the Corporate Mission Profiles in Table 1 have correspondingly de-emphasized the importance of those variables.

Profitability varied by category of both corporate mission and manufacturing task. Innovative strategies demonstrated the highest returns on sales, which is not surprising as we expect a higher profit margin where cost competition is not an important

factor. Particularly noteworthy is the observation that the technology exploiter category was the poorest performing of the three missions with an innovative component. We feel that this is attributable in part to the conflicting demands of both innovation and cost minimization implicit with this strategy.

Custom missions and their associated manufacturing tasks proved to be inherently broader than other types of mission. Whereas technology frontiersmen and cost minimizers would rank four or five variables as very important, customizers typically ranked eight of the fifteen as very important. This intrinsic breadth of focus in customizing strategies may account for the lower performance of these types of firms.

Although we collected data on return on assets for the sampled firms, we were unable to discover any significant relationships between this and the other variables. We attribute this to three underlying factors: 1) sampled firms varied widely in the nature of their assets; 2) different firms had different methods of calculating return on assets; and 3) follow-up interviews with a small sub-sample of the managers indicated that many did not consider this an important indicator (a typical comment was "My important assets drive home at 5 o'clock each evening"). In addition, contrary to our expectations, we could establish no significant relationship between profitability and sales growth. This finding appears to contradict the notion that firms may choose to sacrifice profits for growth, and is a topic worth further study.

Increasing focus, as expected, is positively correlated with

company profitability. Low performers in the sample tended to have broad statements of mission and task. We concluded that a consistent, focussed statement of corporate mission provided the basis for the development of a focussed manufacturing task capable of producing high performance.

Our measure of focus, the sum of squared errors from the 'closest' template, proved to have a significant relationship with profits. This mechanistic measurement made no allowance for any weighting among elements of each corporate response. That is, for a given mission, variance in some variable may be more significant than in others. Our data was insufficient to estimate an appropriate weighting.

Congruence between corporate mission and manufacturing task was also significant, but less so than the focus measure. One reason for this might be the surprisingly low discrimination exhibited by chief executive officers in their definition of plant mission. In some cases all nine manufacturing task variables were ranked as being "very important". In such situations, the manufacturing manager is faced with a mission impossible. A later study will correlate responses from the plant managers themselves with the Chief Executive Officer's perceptions to examine the impact of congruence here.

6. Conclusions

The results go some way to substantiate concepts in manufacturing management that have so far lacked empirical validation. The data show that the strategies of manufacturing firms can be categorized and empirically studied. Moreover, we believe that our classification provides useful parameters for each form of strategy. However, we do not believe that our classification is exhaustive, nor do we think that all firms will fit neatly into the scheme. We do think that the classification provides a useful framework for managers in industry as well as government to view the strategies of manufacturing enterprises.

6.1 Implications for Managers

Our findings strongly suggest that chief executives should pay close attention to concise, focussed definitions of corporate mission and manufacturing task, as well as ensuring that the two are congruent. Performance was positively related to increasing focus, and although congruence between corporate mission and manufacturing task appeared less important, the relationship was still significant.

In particular, chief executives should pay close attention to the definition of the manufacturing task. Although most executives responding to our study were able to provide relatively consistent descriptions of corporate mission, a number exhibited very little ability to discriminate on the important factors in manufacturing task.

This inability to discriminate may have deleterious effects on long-run manufacturing performance if manufacturing managers are not able to determine what the chief executive's priorities are. The impact of this conflict can be seen most clearly in the performance of firms implementing the Technology Exploiter mission. The performance of these firms was lower than either of the other innovative categories, we argue, partially because of the inherent conflicting demands placed on manufacturing. Clearly, some firms can achieve high performance with this mission, but it is difficult to implement successfully for extended periods.

The leading edge strategy which we have designated the Technological Frontiersman, has evidently been adopted as a rapid growth strategy by the smaller, Canadian owned firms. This class of mission evidenced the highest levels of performance, which enabled these firms to spend considerably more on research and development on average than other firms in the sample.

The task for these firms will be to maintain the innovative drive that enables them to avoid price competition (as in our earlier example of Hewlett Packard). Manufacturing has to retain its focus on new product introduction and quality, rather than cost minimization. We recommend that chief executives in these firms develop performance and control measures for their manufacturing operations which stress innovation, quality and flexibility, rather than cost and efficiency.

6.2 Implications for Government Policy

We believe that the classification schemes we have developed here for corporate mission and manufacturing task, together with our findings have relevance for government efforts to evaluate potential policy options for manufacturing industry. The classifications offer a new way of characterizing the strategies of manufacturing firms relating to competition and overall effectiveness rather than static measures of production efficiency.

Our findings suggest that technology based strategies are the most viable. According to our criterion, return on sales, the highest performing Canadian firms over a reasonably extended period were those that chose to compete on the basis of a premium product. These firms were largely concentrated in the technological frontiersman and innovative customizer categories. Data from the technology exploiter category tentatively indicate that smaller Canadian firms cannot successfully exploit this strategy.

Technological frontiersmen and innovative customizers need to reinvest a high proportion of profits in research and development if they are to maintain the strategy successfully in the long-run. Hewlett-Packard, for example, re-invests just less than ten percent of annual revenues in research and development. Canadian firms, much smaller in size, must be able to maintain similar rates of expenditure if they are to keep up in fast-changing high technology industries.

In the absence of government support, temporary declines in profits and margins are likely to lead not only to reductions in

research and development expenditure, but also to a switch in the focus of manufacturing to efficiency and cost reduction at the expense of innovation which we have shown is not healthy for continued corporate success.

The government should continue to actively encourage large foreign manufacturers to adopt product mandating in Canada. Large, domestic subsidiaries can gain access to international markets through their parent's distribution system, from which they can exploit economies of scale which are key to the success of this strategy. Although our data to support this conclusion is sketchy, we believe that the evidence we do have points to a positive relationship between product mandating, export performance and company performance. Thus it can be argued that the approach is also in the interests of the foreign parent.

6.3 Future Research Directions

The study provides an initial attempt to attach quantitative measures to variables that have so far only been discussed qualitatively. We feel that two in particular are worthy of future consideration.

The first is the development of profiles which can be used to categorize corporate missions as well as manufacturing tasks. While managers evidently have trouble discriminating among several variables, such as quality, others prove to be extremely robust, with the result that different manufacturing options can be characterized and studied.

The second is the development of measures for manufacturing

focus and congruence. These are two of the most important factors in manufacturing strategy, and as noted earlier, have received considerable attention in the literature. The measures developed for the study both proved significant.

The study also provided support for the 'focussed factory' concept discussed earlier. The notion of focus being attention to a relatively narrow set of key performance variables appears valid, and the impact of conflicting demands on manufacturing (such as cost minimization and innovation) does appear detrimental. However, further research is necessary before conclusive statements can be made.

Finally, we recognize that our chosen measure of overall corporate performance is constrained, and that other criteria, such as return on equity might also be applied. We recommend that future studies adopt more robust measures to fully examine the relationship between manufacturing mission and financial performance.

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APPENDIX A

Data Summary

The accompanying table summarizes the identification procedure for determining the corporate mission and plant task for each firm in the ample, and also includes corporate profit, research and development expense and size measures.

In the first column set, each corporate response was compared with each corporate profile as indicated in the text, and the sum of the squared deviations of the corporate response to each profile calculated. Abbreviations used are:

TF: Technological Frontiersman C: Customizer
TE: Technological Exploiter CMC: Cost Minimizing Customizer
TS: Technological Serviceman CM: Cost Minimizer

In the second set, a similar procedure was carried out for each plant in each firm. Abbreviations used are:

NPC: New Product Centred CMJS: Cost Minimizing Job Shop
CI: Custom Innovator CM: Cost Minimizer

Finally, reported corporate profit after tax, and research and development expenditures are summarized, and a size measure for each corporation indicated. The coding is as follows:

1: Under $1 million annual revenue 2: $1-5 million
3: $5-15 million 4: $15-25 million 5: $25-50 million
6: $50-100 million 7: $100-500 million

Data Summary

Appendix A

Co ID	Corporate Profile Squared Errors						Plant Profile Errors						
	TF	TE	TS	C	CMC	CM	NPCP	CI	CMJS	CMP	PROFIT	R&D	SIZE
1	8	12	16	30	29	36	18	20	13	4	9	2	1
2	3	17	21	35	50	57	8	12	17	16	25	22	2
3	21	22	17	31	33	66	14	4	17	30	10	8	3
4	15	25	17	17	38	49	8	18	17	24	5	12	2
5	38	16	24	18	7	14	21	15	14	11	10	3	1
							21	15	14	11			
6	12	9	14	20	18	33	14	12	11	22	10	7	3
7	14	12	18	32	35	52	17	19	10	7	20	6	7
							19	19	12	9			
8	11	7	25	42	36	45	31	19	18	25	5	0	1
9	59	37	40	38	20	32	37	19	10	19	5	0	1
11	13	10	9	19	27	50	14	6	15	26	22	1	2
12	31	36	9	9	23	44	16	6	11	20	10	5	3
14	36	18	24	24	23	40	20	20	13	24	5	2	1
16	8	28	14	26	47	68	6	10	19	26	2	4	1
17	20	17	12	14	30	45	15	15	14	9	4	10	4
18	17	12	27	37	41	50	21	19	14	13	18	5.5	7
							23	21	18	15			
19	14	11	8	15	22	38	11	11	18	21	15	7.5	1
21	15	22	9	25	35	66	10	8	13	26	10	10	2
22	6	16	12	26	37	48	8	8	15	28	15	14	2
25	32	17	12	18	18	47	19	13	10	23	18	3	1
26	36	30	26	30	25	46	37	19	10	19	20	5	3
27	25	9	17	23	23	31	13	23	16	25	15	6	2
							13	22	15	21			

Co ID	Corporate Profile Squared Errors						Plant Profile Errors						
	TF	TE	TS	C	CMC	CM	NPCP	CI	CMJS	CMP	PROFIT	R&D	SIZE
*28	26	21	30	38	24	47	31	23	4	13	7	0	3
29	34	20	34	32	19	18	27	19	26	15	6	5	2
30	16	21	14	21	27	31	16	12	11	14	10	10	2
31	37	19	25	25	8	15	15	14	1	12	15	2	2
34	24	11	38	50	30	55	31	35	18	25	9	14	3
36	16	3	18	25	15	24	25	13	6	13	20	0	1
37	47	43	29	17	26	29	8	6	15	16	15	0	3
38	16	11	18	28	28	57	28	20	15	22	13	2	1
39	27	14	21	31	29	58	25	17	8	11	4	6.6	3
40	17	20	5	9	23	38	5	9	16	21	8	4	3
41	38	23	16	14	4	23	32	20	7	14	8	3	3
*43	8	21	10	26	42	57	11	11	8	15	18	10	2
44	12	17	20	32	42	51	35	29	12	5	5	0	6
*45	26	14	14	18	25	42	13	15	20	19	5	1.9	5
46	14	11	16	26	30	51	15	7	12	15	10	8	4
47	20	14	14	22	23	34	16	6	11	20	15	6	5
48	20	18	6	8	19	30	12	10	13	12	22	2.5	3
49	5	11	19	31	42	45	7	17	22	19	24	16	2
50	25	8	19	29	23	46	31	19	18	25	19	0	3
51	24	7	36	42	32	31	14	12	17	18	20	0	1
52	9	18	5	15	29	46	13	9	10	11	10	5	1
53	64	46	62	60	37	18	43	41	12	5	6	0	3
*54	19	22	9	15	25	38	43	35	16	5	10	6	2
							5	7	12	21			
*55	35	18	25	29	15	30	19	15	2	17	5	3.5	2

Co ID	Corporate Profile Squared Errors						Plant Profile Errors						
	TF	TE	TS	C	CMC	CM	NPCP	CI	CMJS	CMP	PROFIT	R&D	SIZE
56	16	19	14	20	20	29	15	11	10	9	9	4.5	5
57	16	13	14	28	28	57	23	11	16	25	9	8	3
58	28	13	16	22	24	31	17	15	6	7	2	6	3
59	11	18	9	17	25	40	17	11	6	17	15	10	1
60	6	19	14	28	44	55	6	4	13	18	7	15	2
61	23	14	17	29	27	58	16	6	6	16	5	5	2
62	17	28	31	45	57	52	25	15	15	7	12	2.5	1
64	20	22	14	28	33	66	28	16	15	24	11	9.5	1
65	22	9	24	32	22	31	32	20	15	14	3	6	3
66	17	13	7	19	26	47	14	10	13	18	6	6	4
67	28	7	20	28	16	37	20	18	9	20	5	4	1
68	33	21	19	19	10	27	23	11	12	21	10	5	5
69	16	9	26	38	36	41	22	20	5	6	10	10	3
70	34	26	26	22	23	18	19	17	16	7	6	3	3
71	42	22	22	20	5	22	37	31	8	3	2	.5	2
72	14	38	24	34	63	68	7	15	24	21	10	10	1

n = 61 companies

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