Technological Innovation Studies Program

Research Report

THE COSTS AND OBSTACLES OF COMMERCIALIZING NEW INDUSTRIAL PRODUCTS: A PILOT STUDY

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ABSTRACT

This report presents the findings of a pilot research study into the costs and obstacles of commercializing new industrial products in Canada. The results are based on a sample of 18 successful new product introductions. The amount and nature of the resources required in each of eight activities which constitute the commercialization phase are reported. A set of relationships which describe these costs in terms of the nature of the product project and the company are developed. Finally, the nature and frequences of obstacles which plague various commercialization activities are outlined. This pilot research provides important insights and recommendations for the design of a major study into product innovation.

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THE COSTS AND OBSTACLES OF COMMERCIALIZING NEW INDUSTRIAL PRODUCTS: A PILOT STUDY

"The beginning of wisdom in talking about the process of technological innovation is recognizing that it is one of the least understood management processes in business."[1]

INTRODUCTION

Product development as a business endeavor is not an end in itself. Rather development is an essential step in the process by which new and improved products are made available to the firm's customers. But it is only when the new product has been successfully commercialized that the entire process can be considered complete. Thus a critical phase in the new product process are those activities which move the new product from laboratory to marketplace....the commercialization phase.

This pilot research focusses on those new product activities which constitute the commercialization phase of the innovation process. In particular, the research attempts to identify the main costs, resource requirements, problems, obstacles and barriers of the commercialization activities.

The research itself is exploratory in nature. It was designed as a pilot study, principally to investigate the feasibility of conducting a major study into the determinants and resource needs of commercially successful new products. Thus, many of the conclusions of this pilot study are simply recommendations and observations - both positive and

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1. Donald R. Schoen, "Managing Technological Innovation", Harvard Business Review (May-June, 1969), pg. 157.

negative - pertaining to future research. Additionally, much of this report is devoted to the development of models, frameworks and definitions essential to the undertaking of further research. At the same time, this preliminary investigation involved empirical or field data collection from a small sample of firms. As a result, a number of the conclusions describe our findings about the costs, resource needs and problems of commercializing new products.

THE RESEARCH IN PERSPECTIVE

The overall purpose of the current research study was to provide useful inputs to the question:

> "Given a company X faced with new product opportunity Y, should the company proceed with the commercialization of the product?

The research question posed is both a common and clearly a very general one. A great deal of theoretical literature attempts to provide solutions,[1] and to a lesser extent some empirical research has also focussed on this topic.[2] The general question is of particular interest to DITC, who is faced with this problem in the process of allocating funds to the many corporations requesting new product financial assistance.

The resource allocation problem....whether or not to commit resources to a particular product project....can be reduced to two essential elements:

1. "Do-ability"
2. Profitability

The schematic in Figure 1 helps to set these issues and the pilot research into perspective. Each new product opportunity will entail a set of costs, will require a unique set of resources and will encounter its fair share of peculiar problems and obstacles. The "do-ability" issue then becomes: given these likely costs, resource requirements and obstacles, is the company

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1. See for example: J.T. O'Meara Jr., "Selecting Profitable Products," Harvard Business Review (January-February, 1961), p. 83.

2. See for example: Centre For The Study of Industrial Innovation, Success and Failure in Industrial Innovation: Report on Project Sappho (February, 1972); See also: A.H. Rubenstein, A.K. Chakrabarti and R.D. O'Keefe, "Field Studies of the Technological Innovation Process", Progress in Assessing Technological Innovation 1974, ed. H.R. Clauser, N.S.F. (Westport Conn: Technome Publ. Inc., 1975).

capable of undertaking the project? The criterion is one of resource compatability....whether the available corporate resources, skills, know-how and experiences are compatible in nature and exceed in quantity the resources likely to be required to develop and commercialize the product. The second element in the resource allocation problem is the criterion of profitability ....whether or not the product meets corporate profitability objectives, given that the company can indeed undertake the project.

Our research was much more narrow in scope than the broad problem of resource allocation outlined above:

1. The research focussed only on the commercialization phase.
2. The research dealt strictly with the "do-ability" question....the set of costs, resource requirements and barriers encountered in commercialization activities.

(The dotted box in Figure 1 helps to explain where our research fits into the more general resource allocation problem).

The commercialization phase was selected as the topic of investigation for several reasons. The commercialization phase of the innovation process.... those activities whose purpose is to move a product from laboratory to market-place....has long been recognized as a pivotal but often troublesome stage. The new product development process may be viewed as a sequence of steps, beginning with idea generation and culminating in market introduction. The high attribution rate of product ventures as they proceed from stage to stage has been well documented[1]: but it is in the commercialization activities where the highest attribution occurs. This is particularly disturbing in that by this stage, the firm is heavily committed to the venture. Moreover a large part of the venture's costs may already have been incurred.

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1. Booz, Allen and Hamilton, Management of New Products (New York: 1965)

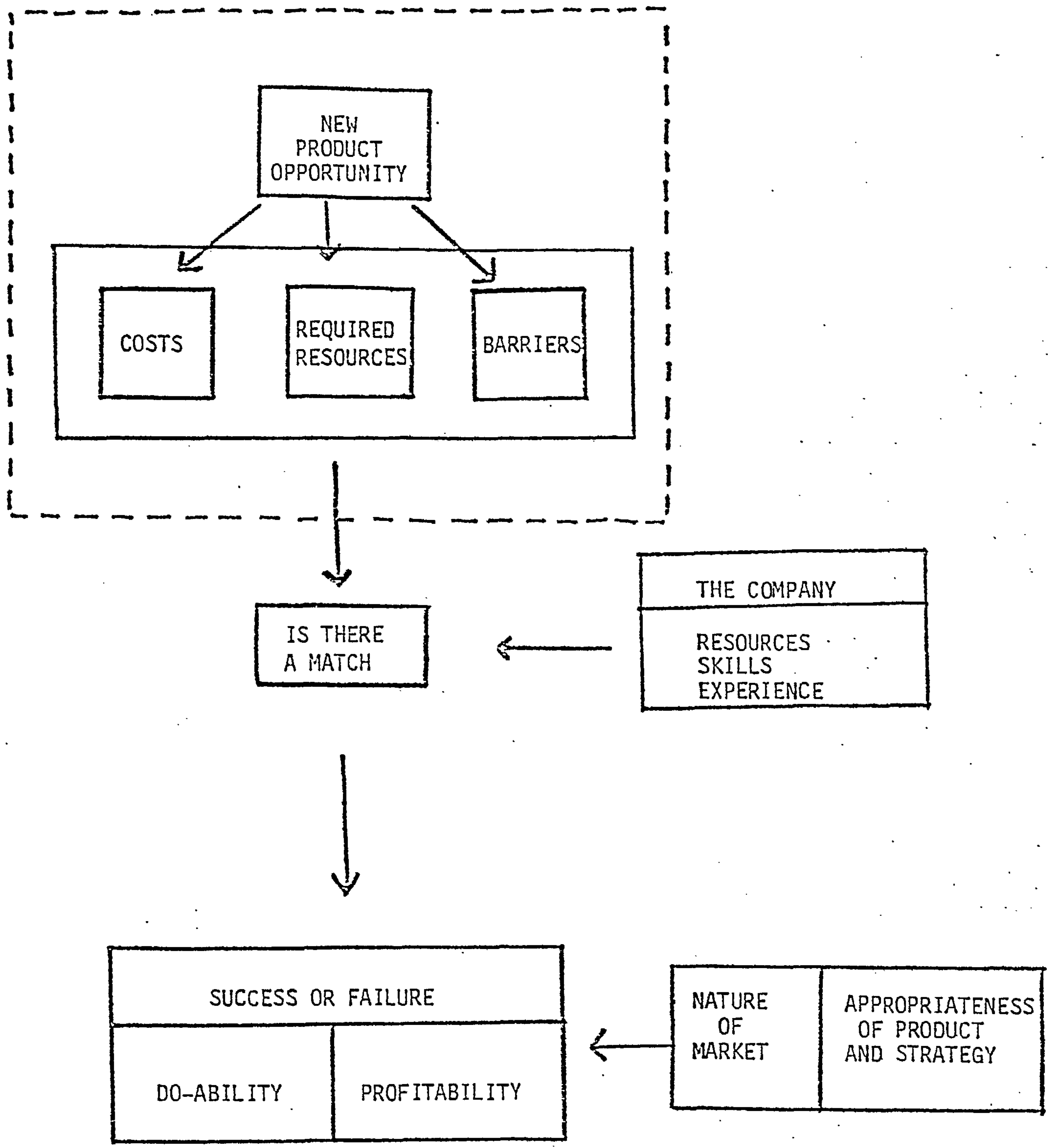

FIGURE 1: The research question in perspective. That part of the diagram enclosed by the dotted line denotes the focus of the current research.

Our focus on the "do-ability" question was premised on two key assumptions:

1. That a knowledge of commercialization costs, required resources and barriers would indeed be a useful input into the decision to commercialize or not.

2. That in fact, patterns of costs, resources and barriers could be identified, and were related to the characteristics of the product situation in a consistent fashion.

The first assumption appears logical, indeed almost truistic. The second assumption became the basis for the research questions which the investigation sought to answer. These research questions were:

1. What are the nature and amounts of the costs involved in successfully commercializing a new product?

2. What are the resources required to commercialize a new product?

3. What problems and obstacles must be overcome in commercializing new products?

4. How do the answers to question 1 to 3 depend on the nature of the product situation and environment?

These and other research questions were reformulated in terms of Research Objectives, which are outlined next.

RESEARCH OBJECTIVES

The specific objectives of the research outlined were:

1. To identify and quantify the various costs of commercializing a new product.

2. To identify the barriers and problems firms face during the commercialization phase.

3. To identify and quantify the key resources, skills, and strengths necessary to overcome these costs and barriers of product commercialization.

No two new product situations are identical. Implied in these research objectives is the desire to investigate different scenarios of new product ventures. Therefore, a necessary additional objective in the course of the research was:

4. To identify the relevant product, market and corporate dimensions which appear to affect the nature and magnitudes of launch costs and barriers.

A two phase research program, consisting of a pilot study followed by a full scale research investigation, was originally proposed.[1] Only the pilot study has been completed; consequently this report presents results and conclusions which only partially fulfill the stated objectives.

1: See: S.J. Shapiro, G. Leroy, & R. Cooper "Research Proposal: Cost of Launching New Products" (submitted to: DITC, Office of Science & Technology, July 10, 1975).

CONCEPTUALIZATION

An important facet of pilot or preliminary research is the development of tentative or speculative models, frameworks and concepts. A good deal of time and effort in this pilot study was devoted to reviewing current literature and to postulating frameworks to guide research in the major study. Unfortuantely much of the literature was not directly relevant to the study. Nevertheless, we outline an overview of some of the conceptualization undertaken, although some of it was not directly tested in the pilot study.

COMMERCIALIZATION ACTIVITIES DEFINED

The new product process can be thought to be a segmental stagewise and goal oriented process. It begins with an idea and ends with the market introduction of a new product. A number of normative-conceptual models have been proposed to describe the process.[1] But relatively little empirical work has dealt with the categorization and description of activities comprising the innovation process.

Booz, Allen and Hamilton identified eight stages of the new product process. Their definition of commercialization is a relatively narrow one, and includes only those activities involving in launching the product into full scale production and sale. Commercialization activities include[2]:

1. Completing final plans for production and marketing.
2. Initiating coordinated production and selling programs.
3. Control of the above.

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1. See for example: Mark E. Stern, Marketing Planning: A Systems Approach, (New York: McGraw Hill, 1965, p. 50; and Robert G. Cooper & Blair Little, "Reducing The Risk of Industrial New Product Development, "Canadian Marketer (Fall, 1974), pp. 7-12; and Handbook for Product Development (Manitoba Design Institute, 1976).

2. Booz Allen and Hamilton, Management of New Products (New York: 1967)

Thus according to the B.A.H. scheme, the commencement of commercialization presupposes the existance of a fully developed product. But this narrow definition is not universally accepted; for example, it is conceivable that a product is only partially developed or only "on paper" when commercialization activities begin in earnest.

Mansfield and Rapoport describe yet another set of activities comprising the innovation process.[1] Their six stages are arbitrarily split into development versus commercialization activities: in short, all non-developmental activities are necessarily commercialization activities. The researchers were successful in developing an empirical model explaining the split in costs between development and commercialization. Commercialization activity costs, as a percent of total costs, were smaller for:

- products with large expected revenues
- smaller firms
- products technologically unrelated to the firm's experience
- smaller (total cost) projects
- products requiring a pilot plant

A model of the development process is essential prior to undertaking any major investigation of commercialization costs and barriers. The model developed is based in part on the work of previous researchers, and in part on our own experiences during the pilot study. The model is presented in Exhibit I, with particular emphasis on commercialization activities. The logic

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1. Edwin Mansfield & John Rapoport, "The Cost of Industrial Product Innovations", Management Science (August, 1975), pp. 1380-1386.

EXHIBIT I

THE STAGES OF PRODUCT DEVELOPMENT
(Not Necessarily In Chronological Order)

I. DEVELOPMENT ACTIVITIES:

1. IDEA GENERATION
2. INITIAL SCREENING
3. TECHNICAL FEASIBILITY
4. PRELIMINARY MARKET INVESTIGATIONS
5. MARKETING RESEARCH
6. PRODUCT RESEARCH
7. PROTOTYPE CONSTRUCTION

II. COMMERCIALIZATION ACTIVITIES:

1. PRODUCT DESIGN CONSOLIDATION
2. PRODUCTION PLANNING
3. TRIAL PRODUCTION
4. ACQUISITION OF PRODUCTION FACILITIES
5. PRODUCTION START-UP
6. MARKETING PLANNING
7. TEST MARKETING
8. MARKET LAUNCH

is outlined below:

1. Developing a list of activities and stages proved no major problem. Indeed, a modified form of the B.A.H. model was deemed satisfactory.

2. The issue of what activities are part of commercialization proved more troublesome. Like Mansfield and Rapoport, we split the process into two steps:

   - development: the front end of the process
   - commercialization: the back end

3. The point at which development ends and commercialization begins was conceptually defined as:

   " the point at which management's objectives turn away from merely developing a product, and turn towards the market introduction of the product"

4. Operationally, our definition includes those activities which coincide with B.A.H.'s, Testing and Commercialization activities.

5. Eight specific activities were identified as being part of the Commercialization phase. (Exhibit I).

It is important to note that our definition of commercialization focuses on activities done rather than on organizational location. For example, in a large firm, commercialization may be defined as the point at which a product project is transfered from a staff department (eg. R&D) to an operating division. But this point of transfer will vary between companies, and indeed is not likely to occur at all in a small firm.

RESOURCES AND COSTS DEFINED

Costs are defined as resources used. A great many and variety of resources may be required for each of the activities which constitute the commercialization phase. Thus we define the cost of commercialization as the sum of these required resources:

$$C_c = \Sigma R_{ij} \quad (1)$$

C_c = commercialization cost

R_{ij} = resource type i required for activity j in commercialization

The term resources is used in the broadest sense, and may include resources which are not conveniently measured in monetary terms. For example, resources include:

People: both the manpower (quantity) and the skills and expertise of this manpower (nature or quality).

Facilities: both quality and quantity, i.e., nature and amount.

Money: A unidimensional measure, i.e., quantity

Thus the total monetary cost of commercialization (Equation 1) will equal:

out-of-pocket expenses (anything purchased)

plus

manpower cost

plus

facilities cost

Both manpower and facilities may already be available within the firm. Therefore, a method for imputing a "rental charge" to the project is needed. Manpower costs can be determined readily, certainly at the conceptual level....these costs are simply the salaries or wages paid to the employees during the period they spent full time on the project. The question of reducing the use of existing facilities to a dollar value is conceptually and operationally a complex chore (and in fact was never resolved in the pilot research). An imputed charge for facilities could be expressed in several ways:

1. The depreciation costs incurred during the time they are employed for a particular project.
2. The initial (or current) book value times a cost of capital charge.
3. The replacement value times a cost of capital charge.
4. The opportunity cost of use.

Regardless of the method, each is fraught with conceptual and operational difficulties. (Indeed, in the pilot research, a facilities cost was never imputed; the nature and size of facilities was merely recorded as an added piece of information).

The issue of allocation of overhead was avoided altogether in the pilot study. Overhead charges will vary with the nature of the accounting practices of each firm. Thus only direct costs are considered. Costs or resource demands can be expressed in a number of ways. Costs can be described in absolute terms or relative to other costs. Additionally they may represent different types of resources, such as manpower, facilities, or out-of-pocket expenses. Finally actual costs can be compared to the costs that a firm expected to incur during commercialization: actual versus expected. There also exists, possible trade-offs of resources required to commercialize a product. For example, astute management (high value, high cost) may reduce other commercialization costs.

OBSTACLES AND BARRIERS DEFINED

A number of barriers and/or obstacles may arise which prevent or jeopardize the introduction of a product to the marketplace. A barrier is something that bars or prevents a project from completing the commercialization phase. An obstacle, on the other hand, is anything that hinders the progression of the product in commercialization. The key distinction between these two terms revolves around the nature and availability of resources. An obstacle can be overcome if the firm prossesses sufficient resources of the type required, and is prepared to commit them to the project. If these resources are not avialable, or if the firm is unwilling to commit them, then the obstacle becomes a barrier. (To the extent the pilot research investigated only successful products, then only obstacles, not barriers, were encountered).

Obstacles are defined as occurrences which threaten or retard, but do not prevent, the commercialization of the product. Thus an obstacle is a point at which the resource demands of a project closely approach and threaten to exceed the resources available.

This definition of an obstacle can be expanded in order to develop a means of identifying, quantifying and categorizing obstacles to commercialization. The commercialization costs, C_C of a new product are comprised of two types of costs:

1. Expected costs, C_E
2. Unforseen costs, C_U

Expected costs are the sum total of resources which a firm anticipates spending on the various expected activities of the commercialization phase if, in fact, the decision is made to commercialize. The term "expected" implies "as expected, when considered prior to the commercialization phase". Unforseen costs are those resources which must be spent on commercialization activities, but were not anticipated prior to commercialization.

The reasons for unforseen costs might include:

1. Certain activities were undertaken which were never anticipated.
2. Activities were anticipated, but more of the activity was required than expected.
3. Activities proved more difficult than originnlly expected, hence resulting in a higher expenditure of resources.

The main premise is that a product will move through the commercialization phase provided that the costs of commercialization are less than the available resources for the project. That is, a necessary and sufficient condition for movement through commercialization is:

$$C_C < R_A \qquad (2)$$

where R_A = resources available for the project.

The relationship $C_C < R_A$ is the desired state. If for any reason, this relationship does not hold true, then a problem exists. Here, a problem is defined as the differences between a desired state and an actual state. If the problem remains unresolved, then a barrier to commercialization exists.

Various conditions ideally must be met in order for C_C to be less than R_A. First, the relationship (Equation 2) is expanded:

$$C_C < R_A \qquad (2)$$

$$C_E + C_U < R_A \qquad (3)$$

The following relationships, derived from Equation (3), should hold true in order for the project to move freely through commercialization:

1. $C_E << R_A$ (4)

Expected commercialization cost must be far less than available resources. Most managers expect to encounter unforseen costs, and hence desire a reasonable cushion between expected costs and available resources.

Thus the firm must be physically capable of finding resources, R_A, such that $R_A >> C_E$. Secondly the firm must be willing to commit the resources so that $R_A >> C_E$. If either condition is not met, the project faces and immediate problem or barrier.

2. $C_U \rightarrow 0$ (5)

Unforeseen costs are ideally zero. Practically speaking, unforseen costs must be sufficiently minor so as not to change the relationship in Equation (3).

However, unforseen events may require unexpected activities, hence resource expenditures during commercialization. Such a situation -- heavy unforeseen costs -- becomes a serious problem and potential barrier, particularly if the total costs approach or exceed the available resources, R_A.

3. R_A remains constant, or at least sufficient to cover C_C.

There are many reasons why R_A may decrease during the commercialization phase period:

- the product champion loses his power position.
- new events foretell a much lower profitability for the product.
- the company's financial position changes... resources become scarce.
- policy changes re product development expenditures.
- other, more promising, ventures capture more of the scarce resources, etc.

Thus, R_A, the resources the firm can and is willing to commit to the venture must remain great enough throughout the commercialization period to cover C_C. Any reduction in resources available could spell problems for the venture.

If any of the above three conditions are not met, an obstacle or potential barrier is said to exist. The above framework serves to identify, quantify and describe the nature of commercialization obstacles.

TYPES OF PROJECTS

The new product projects one might include in a study of resource needs and obstacles can be classified into one of three categories:

1. Births
2. Miscarriages
3. Abortions

Births are those products that weathered the commercialization phase. These are the products which are actually introduced to the marketplace. The question of financial success or failure in the marketplace is another matter.

Miscarriages are those projects that entered the commercialization phase but encountered obstacles that the firm was either unable or unwilling to overcome. As a result, the project died, voluntarily or involuntarily, during the latter part (commercialization) of the innovation process.

Abortions are those projects which were never allowed to enter the commercialization phase. These projects were conceived and allowed to grow through development, but were terminated prior to commercialization. Again, there exist the categories of voluntary versus involuntary abortions: projects where the firm was unwilling to continue versus those where projects where the firm simply lacked the ability to continue.

In order to gain a complete view of resource requirements for commercialization, projects which moved through the entire process must form the sample; that is, births. Conversely, if barrier identification during commercialization is the objective, truncated projects, namely miscarriages should constitute the sample. On the other hand, truncated projects only provide a picture of barriers and obstacles up to the point of truncation. This dilemma was resolved in the pilot study by focussing on successfully introduced products, in order to gain a complete view of resource needs, and a partial view of potential barriers. Additional research into barriers should consider matched samples of projects from both categories.

METHODOLOGY - DATA COLLECTION

The pilot research relied on three separate routes to data collection.

1. Informal Interviews: A number of unstructured, informal interviews were held with managers involved in the product development process. It was during these interviews that a number of the problems associated with the research began to arise:

   - difficulty in developing a common framework describing new product activities.
   - different notions of what commercialization was.
   - the hint that commercialization is not really the problem area at all.

   On the basis of these informal interviews, we were able to develop and refine much of the conceptualization material outlined above.

2. Formal Interviews: A purposeful sample of fourteen firms known to be active in product development was selected. Three dimensions were used to select firms:

   - Size of firm (sales).
   - Technology Level of Firm's Industry
   - Scope of Firm (foreign subsidiary; Canadian domestic; Canadian multinational)

Exhibit II provides a breakdown of the sample by firm type.

In each firm, a manager who was most familiar with his company's product development effects from a commercial viewpoint, was personally interviewed. He was asked to select one (two if possible) products which had been recently and successfully introduced to the market by his firm in Canada. In total, data on 18 projects were sufficiently complete to permit meaningful analysis.

The discussion of each product venture was based on a lengthly questionnaire.

EXHIBIT II

DISTRIBUTION OF THE SAMPLE OF NEW PRODUCT PROJECTS STUDIES

OWNERSHIP \ SIZE AND TECHNOLOGY LEVEL	FIRM SIZE: SALES ($ MILLIONS)					
	SMALL 0-10		MEDIUM 10-100		LARGE 100+	
	TECHNOLOGY					
	HIGH	MEDIUM	HIGH	MEDIUM	HIGH	MEDIUM
FOREIGN OWNED	Bailey Meter (1) Cegelec (1)		Allis Chalmers (2) CAE (1)	Crane (2)	CIL (1) Dominion Engineering (1)	
DOMESTIC OWNED	Pylon Electronics (2)			Canadian Technology Tape (1) JWI (1)	Northern Telcom (1)	Domtar Constr. Materials (1)
DOMESTIC-OWNED MULTI-NATIONAL					Polysar (1)	Alcan (2)

Note: Although firms were purposely preselected to be evenly distributed in terms of the three criteria (i.e., one firm from each category during the interview, it was often necessary to re-categorize a firm. Hence the presence of empty categories in the table above. Numbers in parenthesis indicate number of projects obtained with complete data (18 in total).

The questionnaire sought information on the following topics:

(a) a brief case history of the venture

(b) a more detailed discussion of each commercialization activity

(c) quantification and description of resources used in each commercialization activity

(d) an indication and description of obstacles faced

(e) a quantification of expected versus actual costs

The interviewer employed had been extensively involved in the development and pretesting of the questionnaire. Moreover she was particularly knowledgeable on the topic of new products, having just completed a masters thesis on the subject.

3. Management Workshop: Upon completion of the interview program, the interviewees were invited to participate in a one-day discussion on the topic of barriers and costs of commercializing new products. The workshop was held at McGill University, and DITC officials were invited. (The detailed transcripts of this session are available in a separate report).[1]

1. Workshop: Commercializing New Industrial Products, February 1977.

RESULTS AND DISCUSSION

The "Results" Section presents the findings of the research based on the sample of 18 new product projects studied. Initially we present data which focuses on the costs and resources involved in these projects. Next, relationships between these costs/resources and the nature of the project and its environment are investigated. Finally, the report turns to the nature, frequency and effect of obstacles encountered.

COSTS AND RESOURCE REQUIREMENTS

Activities Undertaken

The commercialization phase was subdivided into eight distinct and identifiable activities (Exhibit I). This scheme was based on the work of previous investigators as well on our preliminary and informal interviews. In spite of the apparent widespread acceptance of such "stagewise" models, it became increasingly clear that a great many managers interviewed had difficulty in breaking their own new product activities into analogous stages. Indeed such stagewise activity approaches appeared foreign and unfamiliar to many managers. One might speculate that a significant proportion of Canadian managers are uninformed about the most basic schemes for planning and controlling new product ventures.[1] Besides, portraying a somewhat bleak picture of the state of the art in Canada, this finding also made our interviewing considerably more difficult.[2]

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1. This finding was confirmed in our management workshop. See: Workshop: Commercializing New Industrial Products, February 1977.

2. In spite of this difficulty, the interviewer was able to explain the meaning of each stage, and carry on with the interview.

Not every firm undertook all of the activities commonly associated with product commercialization. Table 1 presents the frequencies with which the eight activities were performed. As might be expected, certain activities were done in almost every project. Market launch (100%), production start-up (89%) and consolidation of product design[1] (89%) were the three most popular activities. In the case of product design consolidation, a handful of firms were fortunate enough to move from development directly into full scale production with virtually no consolidation of design:

> A major pump manufacturer was able to design its third generation process pumps so completely in the development stage, that production of the product was the logical next step.

In contrast, most firms undertook some product design consolidation during the commercialization phase:

> A large plumbing equipment manufacturer actually launched a new line of bathroom plumbing fixtures, before realizing that major redesigns were necessary. The product was recalled; the line was redesigned and broadened considerably, and relaunched sometime later.

While this example represents somewhat of an extreme, indeed the majority of firms spent considerable time, money and effort refining and modifying the product design even after the development period was considered completed.

The fact that "production start-up" did not occur in every project can be explained by the nature of the product:

> "Our new product is custom-made, and costs millions of dollars per unit. We manufacture only one or two per year. It makes little sense to speak of production start-up".
>
> - A manufacturer of heavy capital equipment.

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[1] Usually involved modifications, revisions and finalization of design prior to production.

TABLE 1

FREQUENCY OF ACTIVITIES

I.	CONSOLIDATION OF PRODUCT DESIGN	89%	
II.	PLANNING OF PRODUCTION FACILITIES	50%	←
III.	TEST OR TRIAL PRODUCTION	72%	
IV.	ACQUISITION OF PRODUCTION FACILITIES	78%	
V.	PRODUCTION START-UP	89%	
VI.	MARKET PLANNING	56%	←
VII.	TEST/TRIAL MARKETING	50%	←
VIII.	MARKET LAUNCH	100%	

→ Low Frequency

At the other extreme, some products were so inexpensive and inconspicuous that production start-up was hardly noticable. In the case of an electronics equipment manufacturer, a few trial versions of the product were made; then a few more; and so on. The company virtually "crept" into production.

Several activities in Table 1 are noticable for their lack of frequency. Half of the projects studied showed evidence of no production planning and no test or trial marketing. Marketing planning activities took place in only a small majority of projects (56%).

That test marketing[1] was not attempted in half the projects is not surprising. Industrial products are often difficult or uneconomic to test market: the product itself is too expensive; expected sales are too small; the market is limited to only a handful of customers. But a quick review of those products where test marketing was not undertaken revealed that only half could be considered poor candidates for such an activity. Indeed, the remaining half could easily have been subjected to a test-marketing program::

Poor Test Market Candidates	Possible Test Market Candidates	Products When Test/ Trial Market Was Done
Specialty slurry pump	Cedar shingles	Explosive
High voltage transformer	Aluminium siding	Lavoratory
Paper machine	AC/DC converter	Tire rubber ingredient
Process control system	Specialty rubber	Flight simulator
		Process sprayer
		Communications switcher
		Process pump
		Electrical cable
		Sealing tape
		Bathroom fixtures

1. Test marketing was generally defined to include any activities involving an attempt to sell or market the product prior to full scale market launch.

Closer scrutiny of the nature of these "test marketings" reveals that in virtually no cases was the activity a rigorous test market. Indeed, such activities usually amounted to little more than an informal "trial sell". Certainly, there was no evidence of testing of the firm's marketing strategy in the sense that well-managed consumer goods firms often undertake a formal test market. Thus the generous definition of "test-market" together with the high proportion of products not subjected to such a test points to serious inadequacies in the new product process. One might speculate that industrial product firms are simply not up-to-date in the application of modern business and marketing practices.

Planning activities were also noticable for their absence in many of the projects. To the extent that new product development is an uncertain and high risk endeavor, one might expect that considerable planning effort would be an integral part of the process. Such was not the case in half the product cases.

The "Average" Project

A prime objective of this study was to determine the costs and/or resource requirements of product commercialization. For each activity undertaken during commercialization, complete data was obtained on costs, resources, and the nature of these. Costs or resource requirements were broken down into two categories, and quantified:

1. Out-of-pocket costs
2. People costs (based on salaries)

These two costs together were taken to be the TOTAL cost of an activity. In addition, data on the nature of "in-house" facilities employed was also gathered, but an imputed cost could not be determined.

An insight into the costs and resource requirements of new product development can be gained from the " average" product venture.[1] Tables 2 and 3 present data on the breakdown of costs over the eight activities for the average project.

The average project cost $1.243 million in terms of out-of-pocket expenses and people costs. The use of existing facilities, such as laboratory or production facilities, is not included in this figure. The bulk of this $1.2 million was spent on out-of-pocket items, with only $263,000 accounted for by people.

The great majority of out-of-pocket expenses are for the acquisition of production facilities (60.5%). Test production and consolidation of product design account for significant costs as well, 14.7% and 11.7% respectively. Marketing activities, including marketing planning, test marketing, and marketing start-up, together make up less than 7% of the out-of-pocket expenses in the average project.

In contrast, people costs are more evenly spread over the eight activities. Market launch is the single most expensive activity in terms of people, representing almost one-third of the people costs. Acquisition of production facilities and consoldiation of product design each account for approximately 18% of people expenses.

When one considers the TOTAL costs, both out-of-pocket and people, the acquisition of production facilities stands out as biggest resource user (51.3%). Consolidation of product design (13%), test or trial production (12.8%), and market launch (10.9%), in that order, also represent significant

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1. Mathematical average or <u>mean</u>.

TABLE 2

THE "AVERAGE" PROJECT: ACTUAL COSTS

ACTIVITY	Out of Pocket		People		Total	
	Mean ($000)	Standard Deviation	Mean ($000)	Standard Deviation	Mean ($000)	Standard Deviation
I. CONSOLIDATION OF PRODUCT DESIGN	115	187	47	81	162	222
II. PLANNING OR PRODUCTION FACILITIES	38	68	28	36	66	98
III. TEST OR TRIAL PRODUCTION	144	439	15	21	159	442
IV. ACQUISITION OF PRODUCTION FACILITIES	593	1085	46	107	638	1129
V. PRODUCTION START-UP	22	39	16	31	39	67
VI. MARKETING PLANNING	5	110	15	33	21	43
VII. TEST/TRIAL MARKETING	12	27	12	19	23	46
VIII. MARKET LAUNCH	51	98	84	225	135	311
ALL ACTIVITIES	980		263		1243	

TABLE 3

THE "AVERAGE" PROJECT: SPLIT OF COSTS

ACTIVITY		% OUT-OF-POCKET (Column %)	% PEOPLE (Column %)	% TOTAL (Column %)	% OUT-OF-POCKET (Row %)	% PEOPLE (Row %)
I.	CONSOLIDATION OF PRODUCT DESIGN	11.7	17.9	13.0	71.0	29.0
II.	PLANNING OF PRODUCTION FACILITIES	3.9	10.6	5.3	57.6	42.4
III.	TEST OR TRIAL PRODUCTION	14.7	5.7	12.8	90.6	9.4
IV.	ACQUISITION OF PRODUCTION FACILITIES	60.5	17.5	51.3	92.9	7.1
V.	PRODUCTION START-UP	2.2	6.1	3.1	57.9	42.1
VI.	MARKETING PLANNING	0.5	5.7	1.7	25.0	75.0
VII.	TEST/TRIAL MARKETING	1.2	4.6	1.7	50.0	50.0
VIII.	MARKET LAUNCH	5.2	31.9	10.9	37.8	62.2

costs. Notable for their almost neglible impact in terms of costs are the two planning activities and test marketing.

Whether an activity is people intensive or not is revealed in the last two columns of Table 3. Acquisition of production facilities and test product are largely out-of-pocket expenses, and on a relative basis, require proportionally little in the way of people resources. In contrast, the three marketing activities, marketing planning, test marketing and market launch, predominately represent people expenses. One might argue that a lack of financial resources will have a greater impact on the technical and production activities, while a lack of qualified people will be felt more in the marketing activities. To the extent that market problems have been cited as the prime cause of industrial new product failure, perhaps there is a message here....that the major resource deficiency is not money, but qualified people.

The cost intensity of an activity is also a measure of the resources used in a project. Cost intensity is the cost per unit of time. Thus a highly intensive activity....one with a high peak....requires the existence of a resource in the firm at that peak level, even though the resources may not be required at that level over the entire project. In short, a highly intensive activity is likely to place greater demands on the resources of the firm. Table 4 presents the results for the average project for cost intensities. Not surprisingly, the out-of-pocket costs have a wide intensity range, from a low of $320/month for marketing planning to a high of $105,000/month for acquisition of production facilities. The people cost intensities are more evenly spread, possibly because they are not as easily varied over time as financial expenditures. People costs for all activities range from almost zero to $10,000 per month. Market

TABLE 4

THE "AVERAGE" PROJECT: TIMES AND INTENSITY OF ACTIVITIES

ACTIVITY		AVERAGE ACTIVITY TIME (Months)	INTENSITY		
			Out-of-Pocket Costs Per Month	People Costs Per Month	Total Costs Per Month
I.	CONSOLIDATION OF PRODUCT DESIGN	14.0	8.21	3.36	11.57
II.	PLANNING OF PRODUCTION FACILITIES	7.8	4.87	3.59	8.46
III.	TEST OR TRIAL PRODUCTION	4.8	30.00	3.13	33.13
IV.	ACQUISITION OF PRODUCTION FACILITIES	5.6	105.89	8.21	113.93
V.	PRODUCTION START-UP	3.8	5.79	4.21	10.26
VI.	MARKETING PLANNING	19.0	0.32	0.79	1.11
VII.	TEST/TRIAL MARKETING	2.8	4.29	4.29	8.21
VIII.	MARKET LAUNCH	8.3	6.14	10.12	16.27
	ALL COMMERCIALIZATION ACTIVITIES	26.0	27.69	10.11	47.81

ALL COSTS IN $000

launch is the most intensive in terms of people, while marketing planning is the least intensive.

A closer review of the marketing planning activity poses some interesting issues. On the one hand, it is the longest single activity, averaging 19 months....that is, occurring over much of the entire commercialization period.[1] In contrast, marketing planning accounts for a small proportion of the people and out-of-pocket costs of the projects. Its cost intensity is the lowest of all activities, by a considerable margin. One might speculate that marketing planning is not a very diliberate, conscious and formal activity in the entire new product process. Its long time span and low intensity suggests that this is one activity done on an ad hoc, casual and from time-to-time basis.

The data presented above have provided an insight into some costs and resource requirements of new products. But this data must be interpreted with care. In the first place, the findings are based on a sample of only 18 projects, which were not randomly selected. Thus the reader is cautioned about generalizing the results to other projects. Secondly, the data presented describe the average or mean project. Thus the results tend to be weighted towards the largest projects, and do not reflect the distribution of costs in all projects equally. (A more meaningful breakdown of costs is provided later in this section). Finally, we use the term the "average" project; but there is no such venture as the average one. Indeed the deviations of costs between activities and projects are very large (Table 2). Therefore, while the notion of an "average project" is conceptually useful in interpreting the results, it should be noted that the likelihood of actually encountering an "average project" is small indeed.

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1. The "average" project had a commercialization period lasting 26.0 months.

Relative Costs And Their Distribution

To gain a more comprehensive overview of project resource requirements, relative costs were determined. For each project, the percentage split of costs over each activity was calculated. By considering relative costs (percent splits), each project....large and small....gains an equal weighting in the analysis. Thus relative cost provides a more accurate view of resource needs than the "average project" concept. In addition, the distribution of these costs across various expense items was determined. Tables 5 through 10 present the means of these costs or resource distributions in terms of percentage splits.

Acquisition of production facilities represents the largest single resource demand of the out-of-pocket commercialization costs (Table 5). Overall, production facilities account for 36% of out-of-pocket costs, and in projects where production facilities had to be acquired; this proportion increases to 46.3% of costs. Consolidation of product design and market launch also constitute areas where major out-of-pocket expenses are incurred (18% each). Indeed, the three above-mentioned activities total to almost three-quarters of the entire out-of-pocket expenses. The least expensive activities, in terms of out-of-pocket costs, are : planning production facilities (0.5%); test marketing (2.4%); and marketing planning (2.5%) in that order.

People resources are more evenly distributed across activities (Table 6). Market launch (25.8%) closely followed by product design consolidation (22.2%) are the activities requiring major inputs of people resources. Once again, the two planning activities together with test marketing are relatively minor resource users.

TABLE 5

DISTRIBUTION OF OUT-OF-POCKET
COSTS OVER ACTIVITIES

AVERAGE	% SPLIT (Overall)	% SPLIT (If Done)	STANDARD DEVIATION
I. CONSOLIDATION OF PRODUCT DESIGN	18.4	20.7	24.8
II. PLANNING OF PRODUCTION FACILITIES	0.5	1.1	1.5
III. TEST OR TRIAL PRODUCTION	10.4	14.4	13.0
IV. ACQUISITION OF PRODUCTION FACILITIES	36.0	46.3	34.5
V. PRODUCT START-UP	11.4	12.8	19.5
VI. MARKETING PLANNING	2.5	4.5	7.9
VII. TEST/TRIAL MARKETING	2.3	4.7	6.2
VIII. MARKET LAUNCH	18.0	18.0	19.9
	100.0		

TABLE 6

DISTRIBUTION OF PEOPLE COSTS
OVER ACTIVITIES

ACTIVITY	% SPLIT (Overall)	% SPLIT (If Done)	STANDARD DEVIATION
I. CONSOLIDATION OF PRODUCT DESIGN	22.2	24.9	22.9
II. PLANNING OF PRODUCTION FACILITIES	4.0	8.0	5.4
III. TEST OR TRIAL PRODUCTION	14.0	19.4	17.9
IV. ACQUISITION OF PRODUCTION FACILITIES	13.8	17.8	21.6
V. PRODUCT START-UP	12.9	14.5	19.0
VI. MARKETING PLANNING	4.1	7.4	5.0
VII. TEST/TRIAL MARKETING	2.9	5.8	4.4
VIII. MARKET LAUNCH	25.8	25.8	27.2
	100.0		

TABLE 7

DISTRIBUTION OF COSTS OVER ACTIVITIES
TOTAL COSTS: SUM OF OUT OF POCKET AND PEOPLE

ACTIVITY		% SPLIT (Overall)	% SPLIT (If Done)	STANDARD DEVIATION
I.	CONSOLIDATION OF PRODUCT DESIGN	20.8	23.4	23.7
II.	PLANNING OF PRODUCTION FACILITIES	1.7	3.4	19.4
III.	TEST OR TRIAL PRODUCTION	10.8	14.9	13.6
IV.	ACQUISITION OF PRODUCTION FACILITIES	31.4	40.4	18.6
V.	PRODUCTION START-UP	11.3	12.8	12.6
VI.	MARKETING PLANNING	2.4	4.3	32.5
VII.	TEST/TRIAL MARKETING	2.4	4.8	10.6
VIII.	MARKET LAUNCH	18.9	18.9	34.9
		100.0		

A review of the TOTAL costs....both people and out-of-pocket.... reveals a similar picture (Table 7). Acquisition of production facilities accounts for almost one-third of the resource needs of a project. Consolidation of product design and market launch each represent approximately one-fifth of the costs. In contrast, test marketing, marketing planning and production planning each require less than 3% of the projects' resources.

Certain activities were found to be much more people intensive than others. Table 8 presents a summary. As might be expected, the most people intensive activities are the two planning functions: marketing planning (68.3%) and production planning (72.8%). Test marketing also involves a majority of people expenses (54.2%). In contrast, acquisition of production facilities is predominantly an out-of-pocket expense (76.2%). The remaining activities are more evenly divided between people and out-of-pocket costs. The split in resource requirements for the entire commercialization phase is 60% for out-of-pocket, 40% for people.

Again the reader is cautioned in the use of these results. The high deviations from mean values suggest that most projects varied considerably from the percentages splits reported.

Of prime interest in this pilot research was to discover how the various resources were actually spent. Out-of-pocket costs were arbitrarily divided into seven broad categories. These were:

Building:	Construction of new buildings; expansion of buildings.
Equipment:	Purchase of capital equipment, e.g., a lathe or a drill press.
Tooling:	Purchase of non-capital equipment, e.g., jigs and dies.

TABLE 8

DISTRIBUTION OF COSTS:
OUT OF POCKET VERSUS PEOPLE COSTS

ACTIVITY	TOTAL COSTS % SPLIT (column %)	% OF OUT OF POCKET (row %)	% PEOPLE (row %)
I. CONSOLIDATION OF PRODUCT DESIGN	20.8	50.2	49.7
II. PLANNING OR PRODUCTION FACILITIES	1.7	27.1	72.8
III. TEST OR TRIAL PRODUCTION	10.8	59.7	40.2
IV. ACQUISITION OF PRODUCTION FACILITIES	31.4	76.2	23.7
V. PRODUCTION START UP	11.3	62.0	37.9
VI. MARKETING PLANNING	2.4	31.6	68.3
VII. TEST/TRIAL MARKETING	2.4	45.7	54.2
VIII. MARKET LAUNCH	18.9	52.4	47.5
ALL ACTIVITIES	100.0	60.0	40.0

Consultants: The hiring of outside consultants, agencies, labs, etc.

Promotional Material: Purchase of materials for promotions, e.g., literature; booklets; displays, etc.

Material: Purchase of material and components used in the product itself, e.g., raw materials.

Travel: All out-of-pocket travel expenses.

People costs were divided into six categories:

Management: General management; no functional specialty

Sales: Salesmen and sales managers

Marketing: All non-sales marketing personnel

Scientific: Scientists and scientific technicians

Engineering: Engineers: design, development and production

Production: Production workers and management

A breakdown of out-of-pocket costs is provided in Table 9. Equipment and material are the greatest single out-of-pocket costs, representing 24.9% and 15.1% of all out-of-pocket expenses respectively. The construction of new buildings (or expansions of buildings) and the hiring of outside consultants represent the least costs (3.8% and 5.7% respectively). On an activity-by-activity basis, the pattern changes. In descending order of importance:

Acquisition of Production Facilities: Mostly equipment (48.7%), and tooling (38.0%).

Design Consolidation: Essentially material (39.6%); travel (27%) and consultants (21.3%).

Market Launch: Largely promotional materials (66.9%) and travel (30.8%).

Production Start-Up: Mostly material (39.9%); equipment (27.7%) and tooling (21.4%).

Trial Production: The majority in material (66.8%).

Marketing Planning: Almost all travel (85.7%).

TABLE 9

ALLOCATION OF OUT OF POCKET EXPENDITURES

(% SPLITS)

ACTIVITY	DISTRIBUTION ACROSS ACTIVITIES (column %)	DISTRIBUTION ACROSS ITEMS: ROW %						
		Buildings	Equip't	Tooling	Consultants	Promotion Material	Material	Travel
I. CONSOLIDATION OF PRODUCT DESIGN	18.4	0.0	9.1	2.7	21.3	0.0	39.6*	27.0
II. PLANNING OR PRODUCTION FACILITIES	0.5	0.0	20.0	0.0	40.0	0.0	20.0	20.0
III. TEST OR TRIAL PRODUCTION	10.4	0.7	17.5	5.5	7.6	0.0	66.8	1.7
IV. ACQUISITION OF PRODUCTION FACILITIES	36.0	9.3	48.7	38.0	0.0	0.0	2.8	0.9
V. PRODUCTION START UP	11.4	2.5	27.7	21.4	2.5	0.0	39.9	5.7
VI. MARKETING PLANNING	2.5	0.0	0.0	0.0	14.2	0.0	0.0	85.7
VII. TEST/TRIAL MARKETING	2.3	0.0	0.0	0.0	1.0	22.5	36.5	39.7
VIII. MARKET LAUNCH	18.0	0.0	0.7	0.0	0.8	66.9	0.4	30.8
ALL ACTIVITIES	100.0	3.8	24.9	17.6	5.7	12.9	20.1	15.1

* major cost is circled

<u>Test-Marketing:</u> Travel (39.7%); material (36.5%); and promotional materials (22.5%).

<u>Production Planning:</u> No essential pattern (a very small out-of-pocket expense).

People costs tend to be much more concentrated. Indeed, over one-third of the people costs are attributable to engineers. Production personnel account for 24.9% and sales personnel 22.5% (Table 10).

In contrast, management, marketing and scientific personnel have relatively few inputs during commercialization. The lack of a scientific input can be readily explained: at the commercialization stage, the product has been largely developed; only a few "bugs" remain to be ironed out, and this is the realm of an engineer, not a physicist or chemist. But the meagre demands placed on general management and marketing personnel are indeed noteworthy. The evidence appears to support claims that the lack of a top management involvement and a lack of a market orientation plague all too many new product projects.

On an activity-by-activity basis, there are few surprises. In descending order of importance:

<u>Market & Launch:</u> Largely a sales force effort (66.2%) with minor engineering inputs (14.4%).

<u>Design Consolidation:</u> Overwhelmingly an engineering function (70.5%).

<u>Trial Production:</u> Mostly production personnel (57%) with engineering back-up (26.2%).

<u>Acquisition of Production Facilities:</u> Mostly an engineering function (54.5%) with production involvement (16.2%).

<u>Production Start-Up:</u> Strictly production personnel (81.7%).

<u>Marketing Planning:</u> Split between marketing (43.3%); sales (28.3%); and management (25%).

TABLE 10

ALLOCATION OF PEOPLE RESOURCES
(% SPLITS)

ACTIVITY	DISTRIBUTION ACROSS ACTIVITIES (column %)	DISTRIBUTION ACROSS PEOPLE: ROW %					
		Management	Marketing	Scientific	Production	Sales	Engineers
I. CONSOLIDATION OF PRODUCT DESIGN	22.2	7.6	2.8	4.1	12.1	2.8	70.5 *
II. PLANNING OR PRODUCTION FACILITIES	4.0	2.7	0.0	0.0	31.6	0.0	65.5
III. TEST OR TRIAL PRODUCTION	14.0	1.2	7.6	7.6	57.0	0.0	26.2
IV. ACQUISITION OF PRODUCTION FACILITIES	13.8	4.1	0.0	12.8	16.2	12.1	54.5
V. PRODUCTION START UP	12.9	9.3	0.0	0.0	81.7	1.1	7.8
VI. MARKETING PLANNING	4.1	25.0	43.3	0.0	0.0	28.3	3.3
VII. TEST/TRIAL MARKETING	2.9	11.2	2.7	11.6	0.0	63.6	10.8
VIII. MARKET LAUNCH	25.8	9.6	8.9	00.0	0.7	66.2	14.4
ALL ACTIVITIES	100.0	7.6	5.8	4.1	24.9	22.5	34.6

* Major input to each activity is circled.

Production Planning: Mostly engineering (63.5%) and some production (31.6%).

Test Marketing: Mostly a sales function (63.6%).

Of particluar interest is the fact that two key marketing functions.... market launch and test marketing....are handled largely by sales personnel, with few inputs from general management and marketing. This adds evidence to the suspicion that "test marketing" is really a trial sell and not a test market at all. General management has an input, albeit small, at every stage, the largest input at market launch. But overall, engineers and production and sales personnel dominate the entire process.

Facilities Requirements

In many of the projects, the commercialization activities made use of "in house" facilities which already existed in the company. For example, the use of existing buildings, production equipment, tooling and test facilities was a common occurance. The use of these existing resources was not considered part of out-of-pocket nor people costs. But such facilities clearly cannot be overlooked in any study of resource requirements. For example, one might argue that such facilities, if they were not available in house, would be purchased outright or rented by the company, thereby incurring an out-of-pocket cost.

As might be expected, the largest resource requirements in commercialization is for production facilties. But the majority of firms appeared to minimize their out-of-pocket costs by utilizing their existing production facilities for the new product. Indeed, of the four dimensions of newness measured (in order to characterize the product situation), namely:

- product newness (to the market);
- technological newness (to the company);

- market newness (to the company);
- manufacturing process newness (to the company);

"manufacturing newness" is the one on which the sample of projects scored the lowest. Of the 18 projects, 12 involved manufacturing processes which were "totally" or "fairly" familiar to the company. It appears that a dominant strategy to risk reduction, then, is to select new products which do not move the company "too far from home" in terms of manufacturing process. That is, a major screening criterion, explicit or implicit, is the ability to utilize existing production equipment, either as is, or in modified form.

In only three cases of the 18 was there any evidence of new plant acquisition (new buildings). And in only one of the cases did the new plant represent a significant portion of the out-of-pocket expenses:

> A large chemical company actually undertook a major plant expansion and modification in order to produce a line of new specialty rubbers.

In the other two cases where new plants were involved, these amounted to minor expenditures relative to the cost of the entire project....essentially extensions of existing plant.

In contrast, most firms were able to minimize expenditures on production facilities by utilization of existing resources:

> A producer of aluminium siding found spare capacity on one of its lines for a new product. By modifying the line at a cost of $500,000, a possible outlay of $10 million was avoided. The acquisition of a new line will continue to be postponed for 3 to 4 years, until the new product is proven.

But the nature of most products was such that even smaller expenditures were required to modify existing production facilities.

The prevailing tendency to rely on existing production facilities for new product has several important implications:

1. The downside losses are minimized, thereby reducing the risk of product development. Clearly the larger firms, with more diversified production facilities, had an advantage here.

2. The capital investment is minimzed. This can only enhance the projected profitability of the product. Thus, almost by default, projects utilizing existing production facilities are likely to pass the financial evaluation stages more readily.

3. In the case of smaller firms, with limited existing production facilities, the nature of the new products was such that production facilities were simply not a major resource requirement. Specialty electronic equipment is an appropriate example.

On the negative side, the desire to minimize outlays by utilizing existing facilities may be severely constraining companies' new product horizons. In seeking low risk new products which are compatable with existing production facilities, companies may be missing lucrative market opportunities which promise far greater sales and profits.

Other facilities which were typically available "in-house" included:

1. An existing salesforce or distribution network to market the new product;

2. Existing laboratory, design and testing equipment.

In summary, the use of existing facilities, notably production equipment and plant, plays a major role in commercializing new products. It was not possible to place a dollar value on these facilities. But during the interviews, it became apparent that for most projects, had "in house" facilities not been available, the total commercialization costs would have considerably higher, and in some cases many times higher. One cannot lightly dismiss the importance of resource compatability as a screening criterion....the fact that new products rely heavily on existing facilities, particularly production plant and equipment.

Timing And Sequencing

The timing and sequencing of activities also plays an important role in determining resource requirements. Figure 2 presents a schematic or flow chart, depiciting the timing relationships amongst the various commercialization activities. For all projects, timing of activities was reduced to a relative time on a 0 to 100 scale (where zero is the beginning of commercialization, and 100 the completion). The data presented on Figure 2 are the mean relative times for the 18 projects.

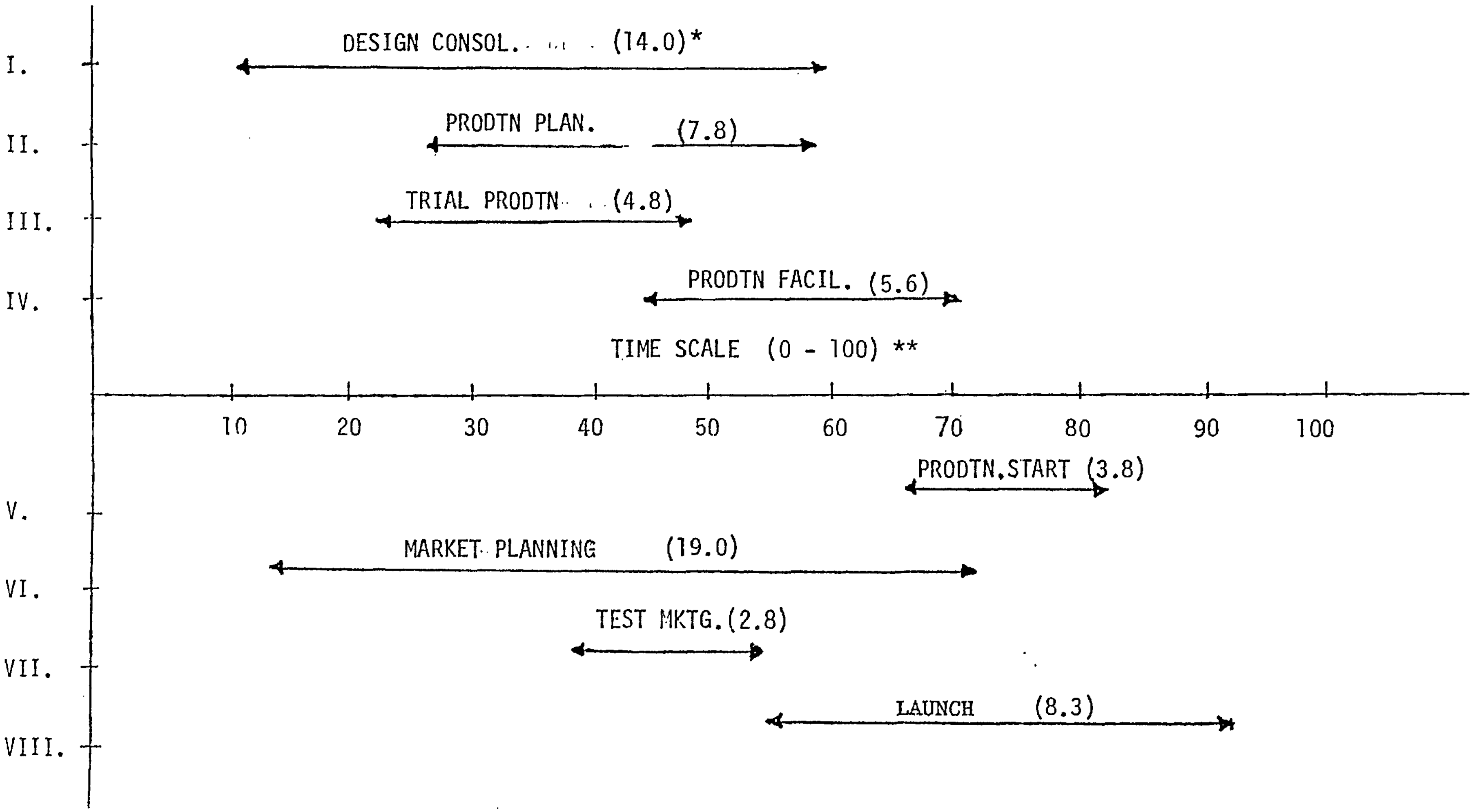
The sequencing of activities is as one might expect. Based on beginning points, the sequence is:

1. Design Consolidation
2. Marketing Planning
3. Trial Production
4. Production Planning
5. Test Marketing
6. Acquisition of Production Facilities
7. Market Launch
8. Production Start-Up

It is also seen from Figure 2 that virtually all activities overlap one another. The notion of a stagewise process, in which one stage begins as another ends, simply does not reflect reality. At most points in the process, several activities are underway concurrently. The need for critical path analysis and resource allocation planning is highlighted.

FIGURE 2

FLOW CHART: SEQUENCE AND
TIMING OF ACTIVITIES



* Numbers in parenthesis denote time of activity in months.

** Where 0 is beginning of commercialization; 100 9s end.

Certain activities appear to stretch out over much of the process, while others are quite short in duration. Marketing planning followed by design consolidation appear to be almost on-going activities, present throughout much of the process. In contrast, production start-up and test marketing are activities of short duration. Once again, the variances of these relative times are great, and hence these results should not be generalized.

PREDICABILITY OF RESOURCE REQUIREMENTS

The resources required to undertake the commercialization activities of a new product were tentatively hypothesized to be a function of the nature of the product situation itself. (The model in Figure 1 , which served as a guide to the pilot research, demonstrates this hypothesized relationship). A major concern of the pilot research was to determine the viability of using the product situation - a set of variables characterizing the product and its market - as a valid predictor of resource requirements or costs.

Resource requirements or costs were broken down by activity and into the two categories: people costs and out-of-pocket costs. Simple cross-tabulations between these costs and variables describing the product situation revealed few significant ($\alpha = .10$) and important relationships. Product situation variables measured and included in this analysis were[1]:

Market Newness: How new the product market was to the company.

Manufacturing Newness: How new the manufacturing method or process for the product was to the company.

Technological Newness: How new the technology used in the product was to the company.

Product Newness: How new the product was to the market.

Product Magnitude: The total cost of the project relative to other or typical new product projects done by the company.

Product Importance: The importance of the product to the success of the company over its competition.

1. These variables have been used in previous research as important dimensions by which to characterize new product projects. See for example: Robert G. Cooper & Blair Little's "Determinants Of Market Research Expenditures For New Industrial Products" Industrial Marketing Management (March-April, 1977).

Each of these six variables were measured on five point scales (where 1 = low and 5 = high). The few statistically significant relationships ($\alpha = .10$) were weak, certainly not powerful enough to be of interest in developing predictive functions.

The resulting weak relationships might be explained in part by the fact that costs depend on sets of variables acting together, rather than on any one situational variable acting alone. Therefore multiple regression analysis[1] was used to determine the existence of relationships of the form:

$$Y = a + b_1X_1 + b_2X_2 \; . \; . \; . \; . + b_nX_n$$

where Y = cost of an activity

$X_1, X_2 \; . \; . \; . \; . \; X_n$ = situational variables.

Once again, the relationships proved to be weak, and in all cases, failed to explain even half of the variance in costs of activites ($R^2 < 0.50$).

But the inclusion of company variables dramatically changed the analysis results. A combination of company variables - variables describing the company itself - and the product situation yielded multiple regression equations which explained a large part of the variances in costs for all but a few activities. Company variables included:

- Annual sales (in Canada)
- Annual R & D budget (in Canada)
- % of sales by new products (last 5 years)
- % of sales by Canadian developed products (last 5 years)
- Technology level of firm's industry (low; medium; high)

The results of these regression analyses are shown in Table 11.

1. Statistical Package for the Social Sciences (S.P.S.S.); stepwise multiple regression analysis.

TABLE 11

COMMERCIALIZATION COSTS AS A FUNCTION [1] OF

PRODUCT AND COMPANY PREDICTOR VARIABLES

ACTIVITY	PRODUCT VARIABLE COEFFICIENTS						COMPANY VARIABLE COEFFICIENTS							
	MARKET NEWNESS	MANUFACTURING NEWNESS	TECHNOLOGICAL NEWNESS	PRODUCT NEWNESS (TO MARKET)	MAGNITUDE OF VENTURE	IMPORTANCE OF VENTURE	SALES ($ MILLIONS)	R & D EXPENDITURES	% OF SALES BY NEW PRODUCTS	% OF SALES BY CANADIAN NEW PRODUCTS	TECHNOLOGY LEVEL OF COMPANY'S INDUSTRY	CONSTANT[2]	% VARIANCE[3] EXPLAINED R^2	F[4]
OUT-OF-POCKET COSTS														
I. CONSOLIDATION OF PRODUCT DESIGN	39.66[5]	(7.77)		29.72				7.19	-9.66	(7.99)	93.50	-358.86	88.91	14.78
II. PLANNING OF PRODUCTION FACILITIES	30.27	38.18				- 31.88			4.65	- 5.62	61.96	-151.61	77.78	8.00
III. TEST OR TRIAL PRODUCTION		- 25.82	(15.49)				- 0.217	28.35				- 8.03	98.83	268.20
VI. ACQUISITION OF PRODUCTION FACILITIES	535.49	1021.56				-624.77		- 27.11	96.49	-124.02	1411.41	- 34.29	76.46	6.43
V. PRODUCTION START-UP				- 8.38	(-4.82)	8.25	- 0.027	2.68				26.55	88.31	19.75
VI. MARKET PLANNING	3.77	6.57		2.31		- 4.97		- 0.29		- 0.26	9.61	- 25.29	69.63	4.76
VII. TEST/TRIAL MARKETING		- 2.22	1.21				- 0.013	1.48				1.86	98.59	221.46
VIII. MARKET LAUNCH	80.20		52.56		51.30	- 38.32		(0.18)		- 1.97	200.57	-449.40	83.24	9.44
PEOPLE COSTS														
I. CONSOLIDATION OF PRODUCT DESIGN				44.36	(24.09)				-13.03	11.48		-132.00	26.98	1.86
II. PLANNING OF PRODUCTION FACILITIES	8.72	24.59	- 10.73	(5.80)		(7.95)		0.63		- 0.74	29.04	- 77.67	73.79	4.97
III. TEST OR TRIAL PRODUCTION	- 7.44	6.42	- 5.31		9.15		- 0.013	0.64			- 23.54	58.47	45.90	2.23
IV. ACQUISITION OF PRODUCTION FACILITIES		129.94	-100.32	29.21	39.81		0.107	- 2.44		2.21	(48.80)	-255.35	80.38	6.90
V. PRODUCTIONS START-UP	- 2.19	4.49	- 2.94		1.86		- 0.017	1.97	1.47	- 1.52		0.627	98.81	124.90
VI. MARKET PLANNING	21.38	12.91	(8.89)		(-9.51)	- 16.13		- 1.13	(1.42)	- (2.11)	51.72	-113.89	75.38	4.71
VII. TEST/TRIAL MARKETING		- 2.60		(1.62)		(1.43)	-(0.001)	1.03				- 4.40	90.80	25.59
VIII. MARKET LAUNCH	205.71		134.94		-124.63	-115.59		7.71		- 5.56	487.82	-1024.70	66.97	4.30

1. The equations are linear, of the form: $Y = a + b_1X_1 + b_2X_2 \ldots.$, where Y is the cost,($000) (noted in left column) and X's are the product and company variables, or predictors.
2. Constant is the value of "a" in the linear equation.
3. % Variance explained is the percent of the variability in the cost which is explained by each equation. Adjusted for degrees of freedom (small sample).
4. F is the F-test value.
5. Coefficients shown are the "b" values in the equations. Statistically insignificant variables (α = 0.10) are shown in parenthesis. Only coefficients of important variables....those which improve the adjusted R^2....are shown.

The regression equations for both people and out-of-pocket costs[1] are shown across the rows in Table 11. The numbers under the headings "Product Variable" and "Company Variable" are the regression coefficients, the values of b_i in the equation (previous page). The R^2 figure gives the percent of the variance in costs which the equation can account for. Values of R^2 shown are adjusted downwards to account for the limited degrees of freedom due to the small sample size. The equation selected in each case was the one in the step-wise routine with the maximum adjusted R^2. Coefficients shown indicate that the predictor variable is statistically significant ($\alpha = 0.10$, two tail t-test), unless the coefficient is in parenthesis.[2] The F-value indicates the level of significance of the equation as a whole (for example, with 5 predictor variables, F - values of 2.8 and 4.0 indicate levels of significance at the 0.05 and 0.01 levels respectively).

The general conclusions drawn from the regression analyses are:

1. For the most part, the costs of undertaking various commercialization activities are quite predicable. Indeed, only in the case of people costs for three activities was the percent variance explained less than 70%. For the other 13 costs, the equations explained at least 70% of the variances, and over 80% in half the instances.

2. The inclusion of company variables describing the company itself appears to have a major impact on the predicability of the relationship. A quick review of Table 11 reveals that for all activities, at least several company variables had a significant and important impact on the costs of the activity.

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1. "Costs" are in thousands of dollars.

2. It is possible for a predictor variable to have an important effect on the predicability (R^2) of a regression equation, yet itself be statistically not significant.

The resources expended on each activity are dependent on a number of variables. The interpretations of the relationships in Table 11 are provided below.[1]

Out-Of-Pocket Costs

Design consolidation costs are higher for unique new products, entering new markets, and involving new technologies. Firms with larger R & D budgets and operating in higher technology industries spend more on design consolidation. Firms which rely more on new products, particularly new products developed in Canada, spend more on design consolidation.

Production planning is a small cost, but tends to be greater in the case of product involving new manufacturing processes, moving into new markets, but not considered to be competively important products to the firm. Firms relying more on new products, particularly on non-Canadian new products, spend less. Production planning also costs more for firms in high technology industries.

The resources spent on trial production are actually less for products involving new manufacturing processes[2], but more for new technology products. (We interpret this to mean that new technology products, which often involve new manufacturing processes, have more spent on trial production . But existing technology products involving new manufacturing processes have less spent.) Larger companies tend to spend more on trial production, particularly larger firms with a very large R & D budget.

Acquisition of production facilities is a major out-of-pocket cost.

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1. Simple correlating and partial correlations (not shown) also aided in this interpretation.

2. Although, on a simple correlation basis, the effect of manufacturing newness was positive.

Products involving new manufacturing processes and seeking new markets are costly in terms of production facilities. However, these products are typically unimportant to the firm's competitive success. Firms relying on new products to generate sales, but not so much on Canadian products, and firms with smaller R & D budgets, spend more on production facilities. Firms in high technology industries also spend more. We interpret this to mean that large firms spend more on production facilities overall; but that those large firms in high technology industries tend to spend much more on R & D, rely more on new products and spend less on production facilities for new product commercialization.[1] In short, the technology-oriented company, large and small, can usually get by with smaller expenditures on production facilities.

Production start-up require more resources in the case of competively important products, and fewer resources for products unique to the market. Large firms, particularly those with heavy R & D budgets, also spend more on production start-up.

Marketing planning represents a small out-of-pocket cost. Unique products involving new manufacturing processes, and aimed at new markets required greater marketing planning efforts. But competitively unimportant products also required more marketing planning resources. Firms spending less on R & D, relying less on Canadian new products, but operating in high technology industries spend more on marketing planning.

Test marketing out-of-pocket costs rely much more on company characteristics than the product profile. Large firms, particularly those spending more on R & D spend much more on test marketing. Products involving new technologies, but familiar manufacturing processes, also required more test marketing resources.

Launch costs are greater for new technology products entering new markets. Ironically, the direct effect of relative magnitude and importance

1. Based on path analysis.

of the venture is negative (although project magnitude is positively correlated with launch costs). Firms in high technology industries, but relying less on Canadian new products, spend more on out-of-pocket launch costs.

People Costs:

The manpower requirements of design consolidation were explained poorly by the regression equation ($R^2 = 26.98\%$). Unique products and larger magnitude projects required more design manpower. Firms relying more on new products to generate sales, and to a lesser extent firms relying on Canadian new products, spend less on design consolidation.

Production planning costs are greater for unique products involving new manufacturing processes and entering new markets. Costs are less for new technology products, and for competitively important products. Firms spending more on R & D and in higher technology industries also spend more on production planning.

Trial production involves more manpower for products involving new manufacturing processes, and for relatively larger projects. But products entering new markets and requiring new technologies had less trial production costs. Large firms spend more on trial production, particularly those firms with large R & D budgets. Firms in high technology industries spend less.

Acquisition of production facilities is greater for products involving new manufacturing processes, and for unique products in the market. Manpower requirements are also higher in the case of relatively larger projects and for products not requiring new technologies. Firms which are large, but spend less on R & D, were found to require more manpower in the acquisition of facilities. Finally, firms in high technology industries spend more on acquisition.

Production start-up is more costly in the case of larger magnitude ventures and products requiring new manufacturing processes. But new technology products moving into new markets required less production start-up manpower. Firms which are larger, particularly those spending more on R & D, employ more production start-up personnel. Finally firms relying on new products, particularly non-Canadian new products, spend more.

Marketing planning, which is largely a people cost, is more expensive in the case of products entering new markets and involving new manufacturing processes and new technologies. Marketing planning is less costly for competitively important products and large magnitude projects. Less manpower is required in the case of heavy R & D firms, and firms relying more on new Canadian products to generate sales. But companies in high technology industries spend more on marketing planning.

Most of the manpower resources required for test marketing is explained by the R & D budget of the firm. That is, large firms, particularly those heavy on R & D, spend much more on test-marketing. Products with new manufacturing processes require less test-marketing.

The launch phase is one of the most demanding activities in terms of people. Products entering new markets and involving new technologies are most costly. But competively important and relatively larger projects required less launch manpower (although "magnitude" was positively correlated with costs). Large firms, spending more on R & D, and in higher technology industries also spend more on the launch. But these large firms also rely less on new products to generate sales.

The important role of company variable as a resource determinant is evident. Just how important company variables are is revealed in Table 12 Here the variance explained by each regression equation is divided between product variables versus company variables. A review of Table 12 shows that:

1. Of the eight out-of-pocket costs, in five cases, the company variables account for more than half of the explained variance. That is, company variables are more important.

2. Of the eight people costs, in four cases the company variables account for most of the explained variance.

3. Of the 16 cost relationships, eight appear to be particularly "good fits" ($R^2 > .80$). In seven of the eight "good fit" cases, company variables dominate in the regression equations.

4. The activities which are dominated by each type of variable are:

Mostly Product Situation	Mostly Company Characteristics	Equally Depend On Both
Production Planning (out-of-pocket costs only)	Design Consolidation	Trial Production (people cost only)
Acquisition Of Production Facilities	Production Planning (people costs only)	
Marketing Planning	Trial Production (out-of-pocket costs only)	
Market Launch (people cost only)	Productions Start-Up	
	Test Marketing	
	Market Launch (out-of-pocket costs only)	

TABLE 12

PROPORTIONS OF EXPLAINED VARIANCE DUE TO COMPANY VERSUS PRODUCT VARIABLES

ACTIVITY	Out-Of-Pockets Costs			People Costs		
	R^2 [1]	Product[2]	Company	R^2	Product	Company
I. CONSOLIDATION OF PRODUCT DESIGN	88.9[illegible]%	7.0%	93.0%	27.0 %	48.7%	51.3%
II. PLANNING OF PRODUCTION FACILITIES	77.8[illegible]%	75.2%	24.8%	73.8[illegible]%	34.5%	65.5%
III. TEST OR TRIAL PRODUCTION	98.8[illegible]%	2.8%	97.2%	45.9 %	50.2%	49.8%
IV. ACQUISITION OF PRODUCTION FACILITIES	76.5[illegible]%	57.9%	42.1%	80.4[illegible]%	56.1%	43.9%
V. PRODUCTION START-UP	88.3[illegible]%	5.2%	94.8%	98.81%	1.3%	98.7%
VI. MARKET PLANNING	69.6[illegible]%	56.5%	43.5%	75.4 %	57.4%	42.6%
VII. TEST/TRIAL MARKETING	98.6[illegible]%	0.8%	99.2%	90.8[illegible]%	3.4%	96.3%
VIII. MARKET LAUNCH	83.24%	47.3%	54.7%	67.0[illegible]%	82.5%	17.5%

1. R^2 is percent variance explained by both sets of predicotr variables.

2. Reads: "Of the R^2 value, ____% is explained by product variables.".

The ability of the regression equations to explain a good part of the variability in resource requirements for various commercialization activities was a positive result of the pilot research. But the almost dominant role of company variables at the expense of product situation characteristics was a surprise. Indeed, this latter finding points to a rethinking of our hypothesized model, and the entire focus of the Phase II research:

1. It is the company situation, and not so much the nature of the new product, which determines how much commercialization activities will cost.

2. Our ability to predict commercialization costs from a knowledge of only the product situation is limited.

3. The model of Figure 1, where resources requirements were hypothesized to be a function of the product project, appears invalid.

Two explanations are offered to account for the important role of company variables. These explanations are:

1. A Pre-Screening Phenomenon.

2. The Influence of Corporate Practice, Policies and Resources.

1. Pre-Screeing Phenomenon

The logic of this argument is that companies tend to select new product projects which are closely matched to their own capabilities. For example, large companies will pick large projects; low technology firms will opt for low technology projects; and so on. Therefore, the nature of projects will depend to a large extent on the nature of the company. Consequently, the activities undertaken in projects will also be closely related to the nature of the company. The sequence of relationships are best described in Figure 3 . Thus, the ability of firms to prescreen or bias their project selection

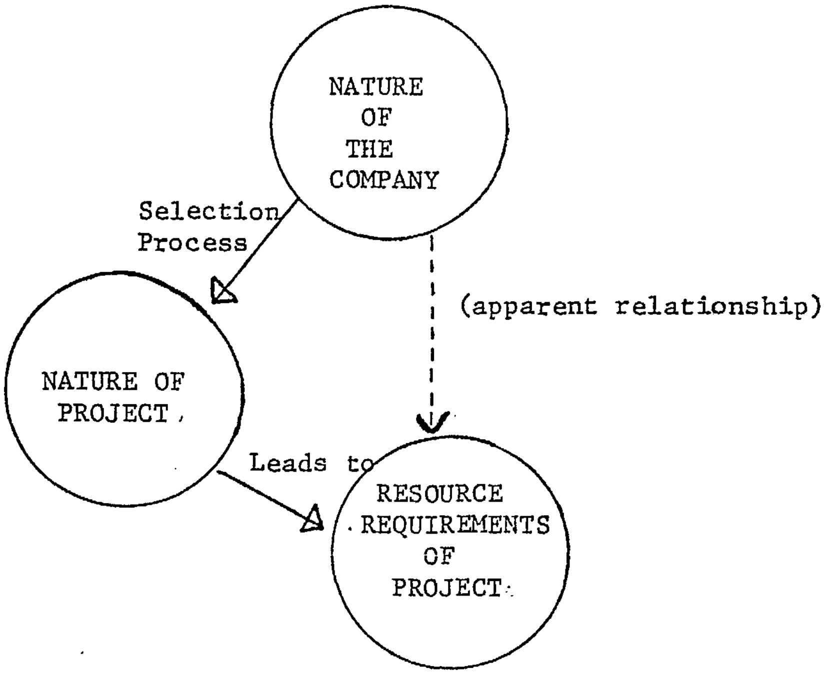

Figure 3: A Prescreening Phenomenom may occur. The fact the companies pick projects means that the resource requirements of projects appear closely related to the nature of the companies. (dotted line)

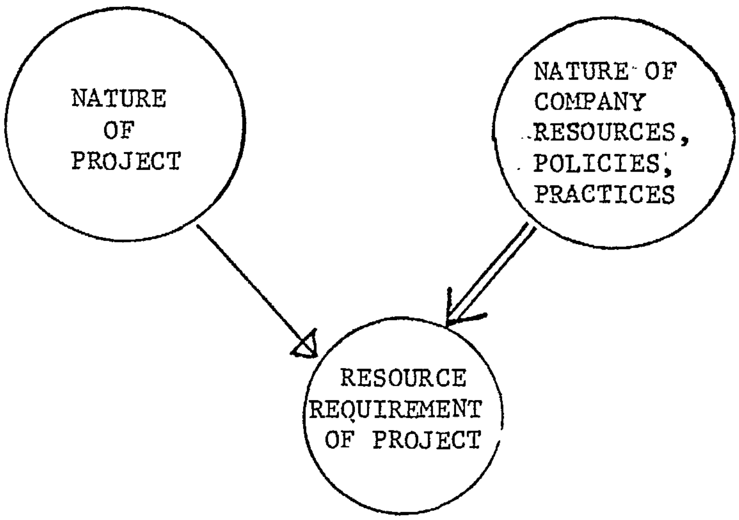

Figure 4: Corporate practice, policies and resources may simply override the unique needs of each project.

means that costs are likely to be very closely related to the nature of the firm itself, and not so much the project.

2. Corporate Practice, Policies and Resources

The argument here is that what is done in a new product venture depends not so much on the needs of the venture, but on the practice, policies and resources of the firm. For example, if the firm has a marketing research department, has a policy of test markets, and has found test marketing to be a useful tool in the past, then chances are on any new project, test marketing will be done....regardless of whether the project really needs a test market! In contrast, the firm which lacks key resources, or has certain operating practices, may simply "cut corners" on some activities, thereby reducing costs on these activities. The tendency for corporate practice, policies and resources to override the unique requirements of each project is shown schematically in Figure 4 .

With the limited data available, it was not possible to determine which of the two explanations offered is most appropriate. One might speculate that probably both phenomena occur simultaneously. It matters little which explanation is the more correct. The point is that the development of a simple set of equations to predict commercialization resource requirements as a function of the nature of the new product project does not appear to be feasible.

OBSTACLES

Three methods were used to identify and quantify obstacles encountered during the new product project:

1. Unaided: The manager was asked, for each activity, what obstacles he faced. He then indicated the "seriousness" of each obstacle on a 1 to 5 scale.

2. Aided: The manager was asked to identify situations where resource requirements began to seriously approach resources available (the three scenarios or categories developed in the Conceptualization Section of this report provided a guide).

3. Directed: Managers were asked to indicate serious cost overruns, i.e., actual versus expected costs for each activity.

Out intentions to measure obstacles to commercialization were well founded; the results were disappointing. Indeed, this is one facet of the pilot research which proved inoperative and extremely frustrating.

The reasons for our failure to measure obstacles are numerous. To list a few:

1. Successful Products Encounter Few Obstacles

To the extent our limited sample was comprised only of successful launches, very few serious obstacles were actually encountered. Had a large number of obstacles been encountered in a project, its chances of success would have been greatly diminished. Thus our sampling procedure, by definition, tended to screen out obstacle - ridden projects.

The rationale underlying our sampling procedure has already been discussed. To summarize, if resource measurement is the aim, successful launches must comprise the sample. Truncated projects (mis-carriages) provide a view of resource requirements and obstacles only up to the point of truncation. Thus measurement of obstacles poses a serious sampling dilemma.

2. Commercialization Activities Are Not Prone To Obstacles

The most serious obstacle new product managers appeared to face was an internal one....getting top management approval of the project.[1] Once approval is given, it appears that the implementation of the commercialization activities is a routine matter. As one manager put it:

> "Commercialization is not a serious problem. Once we get the green light, it's a simple matter of turning the crank".

3. The "Obstacle Model" Which Balances Resource Needs And Availability Proved To Be Unrealistic

The model outlined in the Conceptualization Section suggested that as long as resources available to the project far exceeded resources required, then the project would continue in an unthreatened fashion. This model assumes a certain degree of normative decision-making and sequential evaluations throughout the commercialization phase.

This model proved unworkable. Indeed, in most cases, the commercialization decision appeared to be an irrevocable one. Once the decision was made to commercialize, then there was no turning back. If obstacles were encountered, they would, in fact, must be overcome. The inevitability of commercialization was assumed. In one manager's words:

> "It was never a matter of 'if'. The product was a necessity, and we were going to launch it at any cost".

One assumes the manager meant "at any cost within reason". But the point is, how can one speak of "obstacles "or" resource demands which seriously threaten a project" in the face of this degree of commitment?

4. Cost Overruns Could Not Be Measured

Actual costs are difficult enough to measure, due to the complexity of projects, the lack of adequate records, and the intricacies of accounting systems. But the task of measuring actual versus expected costs proved formidible. In a number of firms, the lack of planning meant that cost estimation was simply not done, or done in an informal fashion and never recorded. In other instances, frequent cost forecasts were made, each forecast coming closer to the actual cost. The

1. This view was also supported by the workshop discussions.

> question of which forecast to use as the "estimated cost" became an issue. Finally, in some cases, the question of actual verus expected costs was irrelevant. The phenominom of "a launch at any cost" is an appropriate example.

In the face of these problems, it becomes clear that our approach in the measurement of obstacles was simply inadequate. Whatever data we were able to collect was obtained largely from the "unaided" questions. The "aided" and "directed" questions proved fruitless.

Those obstacles which were measured are presented in Table 13. Design consolidation followed by production start-up appear to be plagued most often by obstacles. The most serious obstacles are encountered in the test market and design consolidation. An overall rating was obtained by multiplying frequency by seriousness. On the basis of the data, one might conclude that design consolidation, followed by production start-up and production planning are the most troubled activities. On the other hand, the fact that the sample is prescreened to include market successes obviously biases the results to obstacles of a technical nature. If a sample of market failures or truncated projects were included, the results might be quite the reverse.

Attempts to relate frequency and seriousness of the obstacles to variables describing the product and its environment met with no success. In our sample, the occurance of obstacles appeared to be a random phenomenom.

This "freak occurrence" hypothesis tends to be supported when one reviews the nature of the obstacles encountered. Exhibit III presents a sampling of unaided comments for the three most troubled activities. The projects appeared to be beset by a number of difficulties, no two of which were the same. Identifying a pattern or developing a classification scheme proved impractical.

TABLE 13

OBSTACLES TO COMMERCIALIZATION

ACTIVITY		FREQUENCY	SERIOUSNESS (1-5)	RATING
I.	CONSOLIDATION OF PRODUCT DESIGN	10	3.1*	31*
II.	PLANNING OF PRODUCTION FACILITIES	4	2.5	10*
III.	TEST OR TRIAL PRODUCTION	4	2.0	8
IV.	ACQUISITION OF PRODUCTION FACILITIES	2	1.5	3
V.	PRODUCTION START-UP	77*	2.1	15*
VI.	MARKET PLANNING	1	1.0	1
VII.	TEST/TRIAL MARKETING	2	3.5*	7
VIII.	MARKET LAUNCH	0	-	0

* indicates largest values.

EXHIBIT III

A SAMPLE OF UNAIDED DESCRIPTIONS OF OBSTACLES

I. DESIGN CONSOLIDATION OBSTACLES/PROBLEMS

Installers' objections to design lead to redesign of product.

Had to redesign product to reduce costs.

Modification of product to meet customer requests.

External technological advances lead to product redesign.

Product redesigned three times.

Lack of understanding of product technology lead to rethinking of product design.

Product recalled due to improper choice of materials.

Design difficulties.

Acquiring external skills for product

Lack of understanding of customer needs.

Technical defects in product.

II. PRODUCTION PLANNING OBSTACLES/PROBLEMS

Technical difficulites and required modifications resulted in delays and replanning.

A strong desire to sell technology lead to delays in production planning.

Hard feelings between designers and production engineers.

Chief engineer quit!

V. PRODUCTION START-UP OBSTACLES/PROBLEMS

Inventory shortages.

Rising capital costs.

Costs overruns in manufacturing.

Material procurement problems.

Did not have anticipated production capacity.

Plant went out on strike!

Components were not received on time.

Cost overruns.

SUMMARY AND CONCLUSIONS

EMPIRICAL FINDINGS: A SUMMARY

Costs And Resources Required:

1. Eight distinct activities were identified as comprising the commercialization phase of product innovation. Certain activities, notably marketing and production planning, and test marketing, are undertaken with much less frequency than others.
2. Resource requirements were measured for all eight activities and subdivided into two categories: out-of-pocket costs and people costs. Out-of-pockets costs typically account for 60% of commercialization costs overall.
3. Acquisition of production facilities, design consolidation and market launch require the lion's share of out-of-pocket expenditures, accounting for almost three-quarters of all out-of-pocket costs.
4. People costs are more evenly distributed across activities. Market launch and design consolidation require the most manpower, together accounting for almost half the people cost in commercialization.
5. Certain activities are particularly people intensive. Marketing planning, production planning and test marketing represent mostly manpower costs.
6. Both out-of-pocket and people costs were further subdivided into individual expenditure items for each activity.

Equipment and material are the greatest out-of-pocket costs. Engineers, production and sales personnel dominate the manpower requirements. Senior management and marketing personnel are minimal resource inputs.

7. The use of "in house" facilities has an important impact on most projects. But these costs could not be easily inputed. The use of existing production facilities is a common theme in most ventures.

8. The timing, sequencing and intensities of the eight commercialization activities were also measured.

Cost Predicability:

9. The predicability of the people and out-of-pocket costs for each activity is surprisingly high. Multiple regression equations were able to explain 70% of the variability of costs for all but a few activities.

10. But these costs could not be well predicted on the basis of product situational variables alone. Variables describing the company itself play an important role, and indeed dominate the costs in more than half the instances. Two explanations were offered to account for this phenomenom, but were not tested.

11. The variables - both company and product situation - which appear to influence the out-of-pocket and people costs for each activity were described.

12. The results do not support the hypothesized model. The fact that resource requirements are not overwhelmingly determined by the nature of the product situation itself suggests that the model proposed for the research was naive. The development of an empirical model to predict resources expended from a knowledge of the product situation itself does not appear to be feasible.

Obstacles:

13. The measurement of obstacles to commercialization proved to be more difficult than originally anticipated. Several reasons were offered:

    i) the sample included successful launches only.

    ii) the commercialization phase is simply not that troublesome.

    iii) our resource balancing model proved to be unworkable.

    iv) measurement difficulties were encountered.

14. Most obstacles were found in design consolidation followed by production start-up. The most serious obstacles occur in test marketing and design consolidation. Overall, the most troubled areas are: design consolidation; production start-up; and production planning. However these results might be strongly biased by the nature of the sample.

15. A sampling of obstacles revealed relatively little pattern at all. The occurrence of obstacles appears to be a random phenomenon...a "freak occurrence".

IMPLICATIONS FOR PHASE TWO OF THE RESEARCH

1. The research problem has been set in clearer perspective. The central issue remains one of resource commitment to new product ventures. And this central issue has two important facets:

   1. Do-ability: Does the firm possess the needed resources?
   2. Profitability: Will the product be a commercial success?

   The pilot research strongly suggests that these two elements cannot be separated. A project may be "do-able", but in a very minimal way. Indeed the project may be completed (hence by definition is "do-able"),but is undertaken so poorly and/or with such limited resources that the prospect of commercial success is small. For example, in our sample, a number of important activities....marketing planning, production planning, and test marketing....were omitted or marginally performed; in hindsight, it was a matter of luck that some of these projects succeeded at all!

   Future research must therefore consider not only the minimum resource requirements of projects, but must also focus on the commercial success of the project focus on the commercial success of the project. Commercial success is the ultimate criterion; mere "do-ability"is a necessary but not sufficient condition for success.

   The need to consider commercial success, and the obvious problems we encountered in sample selection, point to the inclusion of both commercial successes and commercial failures in the sample in future research.

2. The prospect of developing an empirical model to predict the resource requirements of a product project does not appear promising. Company variables rather than product variables play the more important role. The fact that companies preselect "good fit" projects, and that company policies, practices and resources available may dominate the resource commitment decision suggest that basing a resource predicting model on current practice is invalid. The "ideal resource commitment" may be quite different from what was "actually committed" in a project.
   Future research therefore should not focus on measuring actual costs or resources used in projects, since these actual costs may differ greatly from the true needs of a project.
   Rather the emphasis should be placed on determining the key dimensions of resource compatibility. (By "dimensions of resource compatibility", we mean the degree of fit between company resources and project needs in various resource areas). Certain areas of compatibility are likely to be more important than others; and it is the identification and quantification these key dimensions, and how they depend on the nature of the project, which is critical. In short, future research must look at the product project <u>in relationship to the company</u>.
3. The research must be broadened to include not only the commercialization phase, but the entire product

development process....from idea generation to launch. This pilot study revealed[1] that the commercialization phase was not the most troublesome aspect of product innovation. The main obstacles appeared to be internal ones....getting the "green light" from senior management. Commercialization itself was viewed by many as a rather routine set of activities. Moreover, many of the obstacles encountered in commercialization had their roots in earlier phases of the development process. Thus, future research must deal with all activities of the innovation process, not just the commercialization phase, in order to paint a complete picture.

4. To summarize, Phase II of the research must:

   1. Consider commercial success as well as project do-ability.

   2. Include failures and successes in the sample.

   3. Avoid measuring "resources used" as a proxy for "resource requirements".

   4. Consider the project in relationship to the company and focus on dimensions of resource compatability.

   5. Consider the entire product innovation process, not just the commercialization phase.

The research proposal for Phase II[2] incorporates the above recommendations in the new research design.

This pilot research certainly cannot be considered as an unqualified success. But it was by no means a wasted effort. The empirical findings presented

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1. The workshop discussions confirmed this finding..

2. Submitted under separate cover.

certainly are of interest to researchers, policy-makers and managers in the field of technological innovation. Perhaps the greatest contribution of this pilot study....and indeed this was its objective....was to provide for the design of a major study (Phase II) into product innovation.

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TECHNOLOGICAL INNOVATION STUDIES PROGRAM

PROGRAMME DES ÉTUDES SUR LES INNOVATIONS TECHNIQUES

REPORTS/RAPPORTS

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITÉ	REPORT TITLE/TITRE DE L'OUVRAGE
1.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Canadian Entrepreneurship: A Study of Small Newly Established Firms. (October 1971)
2.	Harold Crookell	School of Business Administration, University of Western Ontario.	The Transmission of Technology Across National Boundaries. (February 1973)
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7.	J.W.C. Tomlinson	Faculty of Commerce and Business Administration, University of British Colombia.	Foreign Trade and Investment Decisions of Canadian Companies. (March 1973)
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