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TECHNOLOGY TRANSFER, INNOVATION, AND MARKETING IN SCIENCE-ORIENTED SPIN-OFF FIRMS

A CONCEPTUAL MODEL

by

Lawrence Michael Lamont

A dissertation submitted in partial fulfillment
of the requirements for the degree of
Doctor of Philosophy in
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Doctoral Committee:

Professor Charles N. Davisson, Co-Chairman
Professor Alfred W. Swinyard, Co-Chairman
Professor Joseph J. Martin
Professor Franklin G. Moore
Assistant Professor H. Paul Root

ABSTRACT

TECHNOLOGY TRANSFER, INNOVATION AND MARKETING
IN SCIENCE-ORIENTED SPIN-OFF FIRMS
A CONCEPTUAL MODEL

by
Lawrence Michael Lamont

Co-Chairman: Charles N. Davisson
Co-Chairman: Alfred W. Swinyard

Spin-offs are science-oriented businesses formed by the transfer of technology and entrepreneurial talent from industrial, governmental and educational organizations. Both technology transfer and innovation have been cited as important factors in the formation and development of spin-offs. Marketing ability has been suggested as one of the constraints to their development.

The entrepreneurs of most spin-off firms are aware of the need for technology and innovative ability, but they do not always recognize the importance of developing a marketing capability. The problem is complicated because during the early stages of development, spin-offs undergo dramatic changes in the scope of their business. A conceptual framework is needed to help management relate the role of marketing to the dynamic nature of the spin-off's development.

The objectives of this study are:

1. To evaluate the significance of technology transfer and innovation to the formation and development of spin-off enterprises.
2. To identify and analyze the critical variables in the marketing of technology-oriented products, services and capabilities.

3. To provide a conceptual model useful to management in specifying the role of marketing in the operation of their firm.

The research was limited to Michigan spin-offs formed during the period 1954-1968. Three data collection procedures were employed: (1) a mail survey, (2) interviews with spin-off entrepreneurs and manufacturers' representatives, and (3) a search of literature.

Michigan spin-offs were formed by employees of industry (including other spin-offs) and educational institutions (universities). The scope of their business activities covered a spectrum ranging from research and development to the production and provision of standard products and services.

All spin-offs are classified by source organization (industry or university) and major business activity. A relationship is established between the classification schemes and it becomes the framework for a conceptual model. The relative importance of technology transfer, innovation and marketing is examined within this framework.

The spin-offs at the research and development end of the spectrum were highly technically oriented. They transferred technology from the new fields of science but it was general scientific and engineering information. The opportunities for innovation were limited because nearly all the technical activities were performed on a contract or fee basis. When products or services were developed the firms faced a series of important adjustments in their marketing programs. The marketing efforts of these spin-offs were oriented to obtaining new contracts. Sales engineering performed by the principal founders was the major thrust of the marketing program.

By comparison, firms involved in a standard product or service activity transferred more business skills and market information. Transferred technology was less important, but the transfer was from well developed fields of technology and related to specific products or services. Opportunities for a directed program of innovation existed because the firms were usually able to finance some proprietary development.

As products or services were developed both the opportunity and the need for creative marketing increased. The marketing programs employed a broad range of sales promotion tools and an expanded level of sales effort. The need for broad market coverage required the use of market intermediaries and direct sales.

It is concluded that the importance of technology, business skills, marketing and market information is related to the spin-off's business activity. Innovation is a key factor in the development of all spin-offs. Those that are successful experience rapid growth in sales and employment. The role of marketing is influenced not only by the original nature of the business, but also by the changes that occur in the early stages of development. The firm faces a continuing need to evaluate and adjust the emphasis of the marketing effort. The conceptual model provides a framework for analysis and decision making.

PREFACE

The role of the science-oriented spin-off in transferring technology and introducing new innovations into the economy continues to be a subject of interest. The relative ease with which a certain level of business success can be achieved has encouraged increasing numbers of prospective entrepreneurs to test their innovative abilities in the marketplace. Since 1954, the rate of spin-off formations in Michigan has accelerated and in 1968, 126 firms were located in the state.

Despite their apparent success, only a few spin-offs achieve the level of operations envisioned by their principal founders at the time of formation. A few spin-offs fail, while the large majority are only moderately successful.

It has been suggested that a major constraint to the development of the science-oriented spin-off has been the failure or inability to acquire a marketing capability. The validity of this generalization is difficult to challenge. However, the question of interest to most entrepreneurs is, "What role should marketing play in my firm?" The need to find an answer to this question and relate it conceptually to technology transfer and innovation provided the motivation for this research.

This study of Michigan spin-off firms was started with the encouragement of Professor Alfred W. Swinyard, Associate Dean of the Graduate School of Business Administration at The University of

Michigan. Because the research focused on a group of small businesses vitally concerned with the development and diffusion of technology, the Institute of Science and Technology consented to finance the study. My gratitude extends far beyond the financial support provided for this research. During my doctoral program I was privileged to be associated with the Institute as a research associate.

Completion of this study would not have been possible without the cooperation of the spin-off entrepreneurs and manufacturers' representatives. They supplied invaluable data in the mail survey and during personal interviews. It is my hope that the results of this study will provide useful information to these individuals who gave so freely of their time.

The comments and recommendations of my doctoral committee were most helpful in the research and writing of this dissertation. My sincere appreciation for the considerable amount of time and effort devoted to my dissertation is extended to Professor Charles N. Davisson, co-chairman and Professor Alfred W. Swinyard, co-chairman; Professor Franklin G. Moore and Assistant Professor H. Paul Root, all of the Graduate School of Business Administration; and Professor Joseph J. Martin, Associate Director of the Institute of Science and Technology.

I would also like to acknowledge the assistance that I received while collecting the data and preparing the study from persons in the Industrial Development Division of the Institute of Science and Technology. Special

thanks also go to Mrs. Marilyn Meyers and Mrs. Gladys Smith for the many hours they devoted to typing the revisions and final copy of this dissertation.

Finally, a most sincere expression of appreciation is extended to my wife, Lynne. Her encouragement and consideration made the completion of this study a highly challenging and rewarding experience.

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CHAPTER I

Introduction

The Research Problem

Background

As a result of dramatic increases in the scale of research and development activities since World War II, there has been a significant increase in national concern over the role of technology transfer and innovation in economic development. This concern has resulted from a growing public recognition of the importance of advances in science and technology in the development of new products and services.

Beyond national recognition of the need to speed the development and spread of new technology, there is also growing interest at the regional level regarding the role of science and technology in state and local economic development.[1] In recent years, part of this interest has been stimulated by the emergence of a new type of small business enterprise oriented to the development and marketing of products, services and capabilities having a high technology content.

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[1]James F. Bednar, Bruce W. Macy, and Robert E. Roberts, Impact of Science and Technology on Regional Development, Report by the Midwest Research Institute to the U.S. Department of Commerce, December, 1967 (Washington, D.C.: Government Printing Office, 1967), p. 1.

Many of these small science-and-technology-oriented businesses have been referred to as spin-offs. They are formed by the spin-off or transfer of technology and entrepreneurial talent from educational, governmental, and industrial organizations and propelled by successful innovation. In many geographic regions of the country, the spin-offs have exerted substantial impact on the growth and structure of local economies. Through their frequent success in applying new technology, they have become an important vehicle in promoting technological change.

By definition, spin-offs are science-oriented firms formed by individuals who rely heavily on (1) knowledge about a particular technology gained from previous employment, and (2) their ability to transfer this knowledge from a previous employer and translate it into a marketable item.[2] The spin-off process is an informal mechanism of technology transfer which results in the formation of new scientifically oriented business firms. The term, spin-off, refers to the fact that the entrepreneurial talent and technology for the new firm spins out from some other existing organization.[3] Technological innovation describes the process through which

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[2]Dean C. Coddington and James F. Mahar, "The Scientific Complex--Proceed with Caution," Harvard Business Review, XLIII (January-February, 1965), 141-42.

[3]Edward B. Roberts, "Entrepreneurship and Technology," in Factors in the Transfer of Technology, ed. by William H. Gruber and Donald G. Marquis (Cambridge: The MIT Press, 1969), p. 220.

transferred technology is refined and applied by the spin-off firm. It is visualized as a sequence of activities extending from basic research to the manufacture of products or provision of new services.

In many respects, the characteristics of the spin-off firm are quite different from those of the typical small business. Because of the extensive innovation sequence involved in developing technology, spin-off firms are often engaged in a variety of different business activities. Some are formed with the objective of commercially exploiting a new product, service or process already developed, while others are formed on the expectation that new products, services, or processes would eventually be developed through further technical development.[4] The basic characteristic of this type of enterprise is that it is typically trying, through the development of technology, to do something that has not been successfully done before.[5] When the nature of the proposed technical development is not clearly defined, the spin-off firm is subject to not only a high degree of market uncertainty (typically present in small business) but also a high degree of technical uncertainty. If the uncertainty is substantial, initial financing through organized capital markets is almost impossible to secure because of the long development period required. As a

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[4]Albert H. Rubenstein, Problems of Financing and Managing New Research-Based Enterprises in New England, A Research Report to the Federal Reserve Bank of Boston, No. 3, 1958, p. 2.

[5]Ibid, p. 1.

result, many spin-off firms are initially undercapitalized and start business with a limited amount of working capital.

The heavy reliance of management on developing new technology means that they are marked by a strong technical orientation. Typically, the principal founders and most of the initial employees are technically trained. In many instances the need for formal business experience is considered of secondary importance to the technical capabilities of the firm.

The variety of possible business activities, the strong technological orientation of the business and the frequent absence of specific business skills in the organization creates some unique business problems. This research examines in depth one of the most challenging and difficult problems encountered by the spin-off firm; the successful marketing of a technically oriented product, service or capability.

Previous Research

Previous research and literature emphasizes a lack of knowledge of the role of marketing in technology-oriented spin-off firms. Further, detailed examination indicates that perhaps the problem has a dual nature. Not only does the literature confirm the existence of a problem in the spin-off firm, but it also illustrates the complex

nature of the problem and the need for a conceptual framework to build perspective.

One of the earliest research studies on the spin-off phenomenon was perhaps the most thorough and comprehensive. As early as 1958, Albert Rubenstein studied the emerging scientific complex in the New England area for the Federal Reserve Bank of Boston. His research was oriented to the problems of finance and management in new research-based enterprises, but he recognized the importance of marketing:

> NRBE's in New England are often staffed with men who have little or no experience with professional marketing, and who may also be inclined to dislike it, and underrate the necessity for it.[6]

A similar study, published in 1962, employed a mail questionnaire to examine a universe of 300 small spin-off electronic firms located in Southern California. Although the study examined all of the functional areas of business, one of the major conclusions was that there existed "an insufficient understanding of the importance of marketing in the overall operation."[7]

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[6]Rubenstein, Problems of Financing and Managing New Research-Based Enterprises in New England, p. 90.

[7]Bureau of Business and Economic Research, San Diego State College, A Study of the Problems of Small Electronics Manufacturing Companies in Southern California, A Report Prepared for the Small Business Administration, February, 1962 (San Diego: San Diego State College, 1962), p. 179.

The importance of the role of marketing in the formation and operation of industry and university spin-off firms was further confirmed in recent research conducted by the Massachusetts Institute of Technology.[8] The MIT research studied 160 university spin-off companies founded by former full-time staff and faculty members of MIT's laboratories and engineering departments, nine secondary spin-off firms founded by the employees of the MITRE Corporation (an MIT spin-off) and a large number of industry spin-offs started by former employees of a large industrial electronic systems contractor. An important result of the research was the determination of a group of factors which were considered to have an important influence on the success of spin-off enterprises. Two of the factors listed as influencing success were the existence of a formal marketing organization and the extent of technology transfer to the new firm:

> Finally, one differentiating element we also note is the existence of a marketing department in the more successful new companies and the lack of formal marketing organizations in the less successful firms. This, in part, is related to one earlier finding pertaining to the general importance of recognizing the need for specific business functions in the corporation. More significant is the likelihood that this factor gives

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[8]Edward B. Roberts and Herbert A. Wainer, "Technology Transfer and Entrepreneurial Success," Proceedings of the 20th National Conference on the Administration of Research (Denver: Denver Research Institute, 1967), p. 83.

> testimony that advanced technology needs to be exploited, and that even brilliant ideas do not move by their own energies into the market place.[9]

The importance of technology transfer to the new firm is not surprising because it forms the initial base for further technical development. However, this related aspect of the MIT research draws its importance from the fact that it marked the first attempt to meaningfully classify spin-off firms by the extent of technology transfer, identify the factors that influence the extent of transfer, and assess the significance of transfer on the success of the firm.

Perhaps of most interest is the finding that high performing companies, determined by various measures of sales growth, were frequently those characterized by a high degree of technology transfer from the source organization to the new enterprise:

> Technology transfer from a research and development organization is, therefore, not just a nicety. It is instead directly correlated with and is a causal influence on the eventual degree of new company success.[10]

Several authors have used an alternative approach to confirm the existence of a lack of awareness of the role of marketing by examining its effects on the marketing efforts of spin-off firms. Egan, for

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[9]Roberts and Wainer, "Technology Transfer and Entrepreneurial Success," pp. 89-90.

[10]Ibid., p. 89.

example, in his dissertation on research and development in small defense firms noted that there was almost a complete absence of the marketing concept in the majority of these smaller concerns.[11] He further concluded that the heavy participation by technical people in the organization caused the value of products to be measured in terms of their intrinsic rather than their economic value.[12]

The absence of a marketing concept has been noted by other authors and appears to be a general conclusion applicable to some degree in all spin-off firms.[13] The cause seems to arise from the fact that the firms are often dominated by engineers, scientists, and other highly technical personnel. As a result, they are problem and product oriented and have failed or simply refused to recognize the significance of the marketing concept.

Rubenstein in his early research study of New England spin-off firms also discussed a number of difficulties encountered by these firms as a result of the lack of marketing experience and knowledge in their formation and operation:

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[11]Douglas M. Egan, "Research and Development in Small Defense Firms: A Study in Marketing to Government" (Unpublished Ph.D. dissertation, University of California, Berkeley, 1965), pp. 248-249.

[12]Ibid., p. 250.

[13]Harry Schrage, "The R&D Entrepreneur: Profile of Success," Harvard Business Review, XLIII (November-December, 1965), 56-69.

> One of the major competitive disadvantages of the NRBE is its frequent weakness in selling and in the general area of marketing which also includes market analysis, advertising, distribution, pricing and other activities in support of direct selling.[14]

He further mentions that products and services are frequently priced too low because of the failure of the firm to anticipate and include product development and promotion costs.[15] In reality, this understates the seriousness of the problem. It appears that many of the spin-off firms can neither estimate the cost or the value of their products and services to the customer.[16] The failure or inability to consider value frequently leads to an initial price lower than full costs and then to pressure to increase prices as the market for the product or service develops.

Product development efforts of spin-off firms are frequently characterized by a failure to design for market needs. The entrepreneur becomes so technically involved with a new product that serious design oversights result or the product is simply overdesigned for the market.[17] In part, this appears to be the result of inadequate market information.[18]

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[14]Rubenstein, Problems of Financing and Managing New Research-Based Enterprises in New England, p. 90.

[15]Ibid, p. 102.

[16]Personal interview with Mr. Henry R. Greenley, Vice President of Research and Development, Buhr Machine Tool Company, Ann Arbor, Michigan, October 15, 1968.

[17]Kenneth C. Germeshausen, "A Product Line for a Government-Oriented R&D Company," IEEE Transactions on Engineering Management, Vol. EM-15 (June, 1968), p. 85.

[18]Ibid.

Webster's study of science-oriented firms selling advanced electronic components to the military market describes another aspect of the problem. Although his research was not specifically directed to the spin-off firm, he concluded that the technology-oriented businesses included in his study did very little planning in the process of product development and were inclined to operate in response to immediate technical problems and needs.[19] While it might be argued that the dynamic changes in technology and the subsequent uncertainty of demand make a more organized approach to product planning unfeasible, the absence of even a crude planning effort has had serious consequences. Products frequently have a high rate of technological obsolescence because of a failure to adopt and adapt to changing technology. Further, products and services are too often addressed to small, poorly defined markets.

The study of Southern California spin-offs found that the function of sales forecasting in spin-off firms was both infrequently and poorly performed.[20] When it was attempted, the basic sources of information used in developing the forecast were (1) past sales,

[19]Frederick E. Webster, Jr., "Marketing Management for Defense Procurement: Selling Advanced Electronic Components to the Military Market," (Unpublished Ph.D. dissertation, Stanford University, 1964), p. 185.

[20]Bureau of Business and Economic Research, San Diego State College, A Study of the Problems of Small Electronics Manufacturing Companies in Southern California, p. 207.

(2) past experience, and (3) personal opinion.[21] This occurred in spite of the fact that ample information was available in various technical and trade publications.

While the literature supports the proposition that a problem of inadequate knowledge and understanding of the role of marketing does exist in spin-off firms, the structure of the problem cannot be analyzed because of the generalized nature of the literature and the absence of a conceptual framework to put the problem into perspective.

This suggests two conclusions which are relevant to university and industry spin-off firms. First, the ability of spin-off firms to analyze the role of marketing is being restricted because of the failure to relate it to a frame of reference. Second, while the specific nature of the marketing problem may vary in the individual firm, there are certain development patterns common to all spin-off firms which if understood would simplify the specification of the role of marketing in the formation and operation of the firm.

A Conceptual Scheme

It is helpful to view the formation and development of the spin-off firm as two distinct but related phases. Initially, the firm consists of a unique combination of transferred technology, entrepreneurial

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[21] Ibid.

talent, and financial resources. The formation process consists of bringing these three resources together in a blend which is consistent with the business objectives of the firm's principal founders. Depending on the extent of the financial resources, and the nature of the transferred technology and entrepreneurial talent, the newly formed firm can be visualized as falling somewhere along a broad spectrum of business activity. This spectrum is occupied by research and development firms at one extreme and firms engaged in the manufacture or provision of highly standard products and services at the other.

The growth pattern of the spin-off frequently involves a change in the nature of the firm's business activity. This occurs over a period of time and is characterized by a movement along the business activity spectrum. The direction and rate of change depend on the desire and ability of the firm's founders to innovate. When this desire exists, it is implemented through a sequence of technical activities which comprise the innovation process. The technical process itself may be relatively short in duration, but the time required for commercialization and a notable impact on the firm's business is usually much longer. In firms initially having a research and development orientation, the change may be viewed as a gradual movement toward the development of a line of standard products or

services. In product-oriented firms it results in the development of new products and related services. However, not all spin-off firms elect to move along the activity spectrum. Many, as a result of corporate philosophy or the absence of it are content to maintain an existing business orientation indefinitely while continuing to develop the markets readily available to them. The case of Bio-Engineering Consultants, Inc., illustrates this point. This Parke-Davis spin-off does a nationwide business in designing and fabricating custom medical electronic instrumentation for researchers with highly specialized applications. Bio-Engineering views itself as the interface between the medical researchers and the manufacturer. According to Pat O'Brien, the firm's president:

> We are the problem solvers—the middlemen between the manufacturers and the doctor or other researcher.
>
> If we develop a marketable product we turn it over to some other firm for manufacture. We would rather work with a manufacturing firm than compete with them.[22]

Both the formation and development process have important implications for the role of marketing in the spin-off firm. Previous research has suggested that the opportunity to form a spin-off firm may be influenced by the entrepreneur's knowledge of a specific market need or knowledge related to a particular product or service

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[22]The Ann Arbor News, June 15, 1969, p. 21.

concept:

> The men starting spin-off firms must be in a position to see problems or needs which, in turn, suggest profitable opportunities for the individual or firm which can solve these problems.
>
> As a rule, opportunities to form a spin-off become apparent to an individual who through his work in an organization acquires two types of knowledge—market knowledge and product knowledge.[23]

Although it seems possible that information of this type may be a strong motivating force to initiate the spin-off process, its significance to the nature of the formation process is not entirely clear.

The rate and direction of the firm's development also has important implications for the role of marketing. While the initial business orientation of the spin-off firm clearly implies the need for certain marketing skills and capabilities, the requirements can change. Firms actively engaged in the innovative process may change the nature of their business and at the same time increase the marketing capabilities required for continued success. For example, a spin-off firm may enter the market by performing contract research and development in a new field of technology. The revenue generated may then be used to support an

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[23]Denver Research Institute, The University of Denver, The Scientific Complex-Challenge to Colorado, A Report Prepared for the Public Service Company of Colorado, June, 1964 (Denver: Denver Research Institute, 1964), p. 4.

innovative effort designed to develop and market a product line in the same field. The case of Transidyne General, Inc., a recent University of Michigan spin-off, provides an excellent illustration and suggests the marketing implications:

> Although Transidyne has not had a "hardware" product until this fall, the scientists have been trying to keep their financial heads above water with research and development contracts to such companies as RCA-Whirlpool Corp., Lear Siegler Corp., Electro-voice Corp., Burroughs Corp., Sunbeam Corp., Sparton Electronics and Bendix.[24]

Those spin-off firms aggressively moving along the "business activity" spectrum may successively enter several entirely different markets on a temporary or permanent basis. The nature of the selling effort may vary from firm to firm and according to the change in orientation, but one example of the adjustments required in the spin-off's marketing program is suggested in the case of E.G.&G., of Bedford, Massachusetts. This company is an MIT spin-off organized to perform government contract research and development on firing systems for nuclear weapons. Following defense cutbacks on military R&D expenditures, the firm became concerned about their total dependence on the government as a source of revenue. The comments of Kenneth G. Germeshausen, President of E.G.&G. describe the problems

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[24]The Ann Arbor News, September 13, 1968, p. 19.

encountered by his firm in their attempt to shift the company from a research and development orientation to a product orientation:

> The fundamental lesson in this and what companies like ours so seldom recognize is the importance of finding out what the customer really wants. You need market inputs, but companies like ours fail to comprehend the difficulty in reaching a somewhat dispersed market and customers with whom your engineers have no direct contact. They do not recognize the need for a sales organization that provides these inputs. They do not even recognize that there is such a thing as a sales organization although they themselves are often acting as sales people.[25]

The conceptual scheme developed in this study views the technology-oriented spin-off firm as passing through two distinct stages each having important implications for successful marketing. During the formation stage the firm acquires market information and marketing skills which become part of the resource base and provide direction for the development of the business. Initially, each technology-oriented spin-off begins operations somewhere along a broad spectrum of business activities ranging from the research and development at one extreme to the marketing of standard products and services at the other.

There are two possible patterns of business development. Those spin-offs willing to assume the risks of innovation can move along the spectrum and change the nature and orientation of their business. For

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[25]Germeshausen, "A Product Line for a Government-Oriented R & D Company," p. 85.

many spin-off firms this is almost a natural progression. However, for a variety of reasons many firms prefer to limit the risks of innovation and maintain their initial position. They develop by continuing to penetrate their original markets in greater depth. Firms following the first development pattern face a series of important adjustments in their marketing programs, while the latter group of spin-offs are confronted with the problem of improving the sophistication of an existing marketing capability to remain competitive.

The failure of previous studies to relate marketing problems and requirements to the formation and development stage of the spin-off firm makes the problem appear fragmented and complex. This is because there is no reference point for comparison. At the same time, the development process is complicated because innovative spin-off firms change their business orientation at widely different rates depending on the technology transferred and market conditions. Marketing problems current in one firm may be those experienced by other firms in the past, or encountered by others in the future. The capabilities required for their solution may also vary widely. These two factors account for much of the difficulty in understanding and specifying the role that marketing should have in the formation and development of a spin-off firm.

Research Hypotheses

From preliminary research, two major hypotheses were developed to further specify and evaluate the validity of the conceptual model suggested in the previous section. The first hypothesis explores the relationship between the spin-off firm and the entry point along the business activity spectrum and will be analyzed by testing three postulates. A second major hypothesis examines the role of marketing in the formation and development process of the spin-off firm. It also tests three related postulates.

1. Spin-off firms are initiated at all stages along the business activity spectrum.

    a) University spin-off firms enter into the business activities at the research and development end of the spectrum.

    b) Industry spin-off firms enter into the business activities at the standard product and service end of the spectrum.

    c) Second generation spin-offs enter into the business activities closer to the product and service end of the spectrum than the university or primary industry spin-offs.

2. Marketing plays a small role in the initial formation process, but assumes greater importance as the spin-off firm develops.

    a) Market information rather than knowledge of specific marketing functions or techniques plays the more important role during the formation process.

b) The marketing techniques and capabilities required by the standard product and service firms are more extensive than those required by the firms having a research and development or similar orientation.

c) Progression from a research and development or similar orientation to a standard product and service orientation requires major adjustments in the firms' marketing effort.

The Need for Research

A comprehensive analysis of the dimensions of the marketing problem has not been attempted. Although fragmentary knowledge exists, there is a basic need for research to integrate marketing with the formation and development process of recent university and industry spin-off firms.

There are other reasons that make the need for research of this type urgent. In recent years, the emphasis and concern over the burgeoning growth of science and technology activities has shifted from a focus on the process of creating new scientific and technological advances toward a greater emphasis on the effective utilization of discoveries and developments. Accordingly, attention has also been redirected to the role of the innovator, the individual who has acted to champion the translation of science and technology

from laboratory into use.[26] With this changing emphasis, marketing assumes an even more important role in the transformation of technology by the spin-off firm.

Further, because of the beneficial commercial and economic impact of the spin-off firms on several geographic regions of the United States, there exists a need for a greater understanding of the process to develop policies which will promote this unique form of technology transfer. The importance of this impact should not be underestimated. In the Boston area, for example, over 216 technology-oriented spin-offs have been formed by previous employees of several MIT labs and academic departments, a government laboratory, a non-profit corporation and a single industrial electronic systems contractor. A similar situation exists in Palo Alto, California where the spin-off firms and other technology-oriented business located in the 808 acre Stanford Industrial Park employ over 18,000 scientists, engineers, and supporting technical personnel.[27] It is estimated that more than 200 research-based companies doing about $1-billion in business are within a 50-mile radius of the Stanford University campus. By sampling techniques, the percentage of spin-off firms in this group was approximated at

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[26]Donald A. Schon, "Champions for Radical New Inventions," Harvard Business Review, XLI (March-April, 1963), 77-85.

[27]Victor J. Danilov, "The Spin-Off," Industrial Research, XI (May, 1969), 55.

50 percent or more.[28]

Finally, it is strongly believed that present and prospective entrepreneurs of spin-off firms need an operational framework which will be helpful in providing a realistic picture of the changing requirements for marketing expertise in their firms. It is hoped that the results of this research will fulfill this requirement and underscore the necessity for a careful consideration of marketing in the formation and operation of the firm.

Scope and Objectives of the Research

The scope of the research is limited to Michigan spin-off firms founded in the time period 1954 to 1968. This period includes a universe of 126 firms, concentrated in southeastern Michigan, but not limited to this geographic region. The spin-off firms under study are further defined as those independent corporations, partnerships and proprietorships employing technology developed in the physical, mathematical, and engineering sciences. The major areas of technology include electronics, materials, computer hardware and software, optics and electromechanical equipment. In general, the spin-off firms are engaged in one or more of the following business activities:

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[28]Ibid.

1. The provision of a technical capability to perform consulting, research and development, testing, design and engineering, prototype fabrication, and contract manufacture in specialized fields of technology.

2. The manufacture of products or provision of services developed by the firm for commercial, government and institutional markets.

The Michigan spin-off firms included in this study are in a broad range of industries and fields of technology, serving a variety of markets with their products, services and technical capabilities. It is difficult, therefore, to make highly specific statements about the significance of technology transfer and innovation that will be applicable to all firms. It is equally difficult to specifically define the marketing problems and adjustments which they all face. Nevertheless, there are certain technical and marketing requirements which are common to all spin-off firms. The focus and interest of this study then is to examine the formation and development processes to discover the common technical and marketing elements which are critical to success.

Given the above restrictions on the scope of the research, the objectives are established as follows:

1. To evaluate the significance of technology transfer and innovation to the formation and development of spin-off enterprises.

2. To identify and analyze the critical variables in the marketing of technology-oriented products, services and capabilities by spin-off enterprises.

3. To integrate the critical marketing variables into the formation and development process and provide a conceptual framework useful to management in specifying the role of marketing in the operation of their firms.

Research Design

The majority of the data reproted in this study and used as a basis for final analysis was generated through a mail survey of Michigan spin-off firms and personal field interviews with their principal founders. In addition, a detailed search of published and unpublished literature related to the spin-off phenomenon was started in the preliminary stages of research and continued throughout the study.

The Mail Survey

Purpose. The mail survey was designed to establish a technical and market profile of the spin-off firms in the State of Michigan and to examine the changes in these characteristics over the life of the firm. It also served the purpose of classification and as a source of firms to be surveyed in the field interview phase of the research. Spin-off firms were classified by type of source organization and by the major focus of their business activity. This information was used directly in examination and evaluation of the first major hypothesis and as a selection instrument for personal field interviews. The scope of the mail survey was confined to all spin-off firms meeting the geographic and time constraints previously discussed.

Sample design. Aside from the criteria mentioned, the sample was not limited in any other manner. Spin-off firms of all sizes in terms of sales and employment were included to provide diversity and contrast to the research. This diversity in size was essential because the research emphasis was on the examination of changes in the role of marketing in the spin-off firms. It was suspected that many of these changes occurred over time and were related in some manner to increasing firm size. The relative ease of gaining access to the population under study through use of the mail questionnaire and the economy of this method as opposed to other means of data collection led to the establishment of an initial sample that included all spin-off firms identified as being within the scope of the study.

Following definition of the universe, a list of spin-off firms was compiled. Traditional sources of business information, such as trade publications, Dun and Bradstreet statistics, the Michigan Directory of Manufacturers, Industrial Research Laboratories of the United States, newspapers, and knowledgeable university and industry personnel, were all used extensively. A list of 126 spin-off firms was constructed from these publications and information sources. They became the basis for the mail survey.

Methodology. A test mail questionnaire was initially directed to a random sample of eighteen of the identified spin-off firms in an effort

to estimate the response rate and determine the clarity of each question. A total of 14 firms sampled in this manner responded over a 4-week period, yielding a 78 percent response. The test questionnaire indicated that all questions were sufficiently understood to elicit a meaningful response. It also indicated that there was considerable motivation among respondents to reply to such a questionnaire.

A mail questionnaire identical in all respects to the original test questionnaire was directed to the remaining 108 firms located throughout the State of Michigan. An initial response was received from a total of 39 firms, representing 35.8 percent of the population not previously sampled. Approximately 21 days after the principal mailing, an additional follow-up mailing was addressed to all non-respondents. Completed questionnaires were obtained from another 20 firms, or 28.6 percent of the remaining portion of the universe. After tabulation of the responses had begun, 3 additional questionnaires were received, yielding a total response to the mail survey, including the test questionnaire of 76 firms, or 59.8 percent of the total population.

All of the mail questionnaires returned were found to be usable for the final analysis. However, 4 of the returned mail questionnaires were only partially utilized. These included responses from firms initially founded as spin-offs, but for a variety of reasons eventually became a part of another company through merger or acquisition.

Because the test questionnaire and the questionnaire used for the principal mailing were identical, the results of the test questionnaire were included in the tabulation of the survey responses.

The mail questionnaire. A copy of the mail questionnaire, the introductory letter that accompanied it in the mailing, and a detailed tabulation of the responses are included in Appendix A. In many respects the mail questionnaire contained some unique features. Not only was it useful in classifying each firm by source organization and major type of business activity, but it also accomplished the task of two successive surveys by measuring the change in the nature of the business over a period of time. The latter information was valuable because it allowed a direct comparison of the spin-off firm's progression along the business activity spectrum with the markets served and the type of market representation employed at each stage. Most of the questions were structured so that both major research hypotheses could be evaluated using data from the mail questionnaire.

Since the mail questionnaire requested information concerning the spin-off firm's first and latest complete year of business operations, it was directed to the principal executive officer. To

minimize the amount of time required by the respondent to complete the questionnaire, it was designed to use questions requiring only a check mark or short numerical answer. Questions that related to specific sales or profits of the spin-off firm were not included in the mail survey. This reflected the fact that many of the companies were privately owned by single individuals or a small group of investors. It was believed that they would be reluctant to respond to a survey containing such questions.

The questionnaire instructions requested answers based upon the respondent's immediate knowledge, rather than requiring a detailed search of company records. For questions where numerical answers were required, only estimates based upon information immediately available were requested. While these conditions might have imposed a limitation on the accuracy of data obtained from individual firms, the reliability of the total sample was probably increased because of the greater response to a questionnaire that could be completed in a minimum amount of time. A mail questionnaire designed to elicit a high response rate was also necessary because of the small number of firms in the population. It was previously mentioned that the firms for the field interview phase of the

research were selected from among those responding to the mail questionnaire. In order to provide a diverse representation of spin-off firms for this phase of the research, it was estimated that a substantial response to the mail questionnaire was essential.

Personal Interviews

Personal interviews were conducted with the principal executives of spin-off firms to further test the hypotheses advanced and provide general background information related to marketing. Of specific interest were the capabilities required for effective marketing of the firm's products, service or technical capability and the adjustments required as a result of the firm's development.

Simultaneously, a number of personal interviews were conducted with manufacturers' representatives. This was essential because the mail questionnaire responses indicated that these intermediary organizations played a key role in the marketing programs of many spin-off firms during some part of their existence.

All personal interviews were designed to maintain consistency of questioning and assure comparative evaluation of interview responses. Separate personal interview outlines were used for the

spin-off firms and manufacturers' representatives, but there was similarity in subject coverage. They contained both structured and unstructured questions and were uniformly administered with each group of respondents. Copies of the interview outlines are included in Appendix B.

Research design--spin-off firms. The field interviews were limited to those firms responding to the mail survey. From this designated group, a sample of thirty-two spin-off firms was selected for personal field interviews. Each firm was selected on the basis of sales volume, the type of market representation used and the nature of the business activity.

Eight major classifications of sales volume were established for the mail questionnaire, with a certain proportion of responding firms falling in each classification. Where possible, a similar proportion was used to select the number of firms from each sales classification to be included in the field interviews. However, exceptions were necessary to assure diversity and adequate balance of the other selection criteria in the sample. Firms falling in the larger sales classifications were intentionally overrepresented in the field interview sample. This was because many of the important changes in the approach to marketing occurred at this stage of the firm's development.

The interviews required a total completion time of two hours. In cases where the respondent was facing a time limitation, the interview was only partially completed and another appointment was scheduled to complete the interview. With one exception, all personal interviews were successfully completed.

Research design--manufacturers' representatives. A total of six manufacturers' representatives were included in the field interview phase of the research. Each firm selected represented one or more spin-off firms who manufactured technology-oriented products.

The sample size was not predetermined since its selection evolved in most cases from referrals by the executives of spin-off firms. This method of interviewing was continued until, in the opinion of the researcher, a feeling was developed for the role of the manufacturers' representative in the marketing of technology-oriented products.

The interview outline utilized in this segment of the field interview research was designed to provide another viewpoint on problem areas discovered during interviews with spin-off firms. About one hour was required for completion but in most instances respondents voluntarily indicated a desire to extend the discussion and the interview time.

Data Analysis

As the mail survey and field interview phases of the research were completed, the data collected were tabulated for use in analysis. When the number of data points in each cell was sufficient, the data were cross tabulated to evaluate the relationships between selected characteristics. The results of the analysis are expressed in the remainder of the report. They are given specific attention as they contribute to the evaluation of the hypotheses.

CHAPTER II

A Profile of the Firms

Introduction

The spin-off firm plays an important economic and social role in the Michigan economy. In 1968, the state's 126 spin-off firms had combined sales revenues of over $150 million and a total employment of slightly less than 9,000 employees. However, the statistics (derived from secondary data) understate the significance of these firms.

During the formation process the spin-off is an important mechanism for transferring the technology which becomes part of the technical base for a new emerging scientific complex. In the development stage the firm becomes an important force in introducing new innovations into Michigan industries. Many of the recent developments in medical technology, space technology, pollution control, data processing and automated manufacturing have been pioneered and made possible by the spin-off firm.

In their social role, these same spin-off firms serve as an outlet for the creative energies and innovative abilities of many scientists and engineers, which in other circumstances might not be optimally utilized for the benefit of society.[1] By their very nature, technical entrepreneurs are independent individuals, dedicated to the future

[1]Rubenstein, Problems of Financing and Managing New Research-Based Enterprises in New England, p. 1.

and the opportunity to form and develop a new business. In establishing their own firm they are free to accept high business risk for the sake of financial reward and the satisfaction of making a unique contribution to society.

Yet, despite the importance of these firms to the state, very little is known about the spin-off phenomenon in Michigan and the characteristics of these businesses. A clear understanding of the spin-off process, the firms, and the technology is required as a basis for the analysis of technology transfer, innovation and marketing.

The Spin-off Process

The spin-off process was first used to describe the transfer of military and space technology from federal research and development programs to the private sector of the economy.[2] The term spin-off referred to the tangible and intangible applications of the transferred technology. These "spin-offs" were new commercially available products, services, processes and techniques.

More recently, the spin-off process has been used to describe an informal mechanism of technology transfer which leads to the creation of new technically-oriented business enterprises. These

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[2]John G. Welles and Robert H. Waterman, Jr., "Space Technology: Pay-off from Spin-off," Harvard Business Review, XLII (July-August, 1964), 106-108.

science-and-technology-oriented businesses, also referred to as "spin-offs" are, of course, the focus of this study. In this spin-off process, entrepreneurial skill and innovative ability are the crucial factors. When these resources are combined with the financial means to launch the company, spin-off firms are initiated in a multitude of ways and exhibit a variety of formation patterns.

The Source Organization

Previous research has shown that industry (including other spin-off firms), university and government facilities can serve as source organizations to spawn spin-off firms.[3] During the 15-year time period (1954-1968) covered by this research all were identified individually and collectively as sources of technical entrepreneurs and spin-off firms.

The questionnaire sample. A total of 76 completed mail questionnaires indicated that Michigan industry was the most important source of science-oriented spin-offs. A variety of Michigan industrial firms accounted for 48 business enterprises. Of this total, 34 were identified as primary or first generation spin-offs from

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[3]Mahar and Coddington, "The Scientific Complex-Proceed with Caution," 141-142.

large industrial corporations. The remaining 14 were found to be "second generation" spin-offs in the sense that they were formed by an entrepreneur who had spun out from a primary industry spin-off or university spin-off by transferring technology directly to a new firm.[4] Michigan universities accounted for an additional 13 firms and 1 firm was identified as a spin-off from a U. S. Public Health Service laboratory.

The balance of the responding firms consisted of 14 spin-offs which might have been classified as hybrid organizations. The principal founders of 1 of the 14 firms were identified with all 3 source organizations, while the other 13 spin-offs were university-industry combinations with principal founders of the firms coming from both source organizations. By identifying the source of the firm's technology and the technical entrepreneur, each firm was classified as a university or industry spin-off. Of the 14 hybrids, 7 were classified as university spin-offs and 7 as primary industry spin-offs. For purposes of data analysis, the single government spin-off was put into the university category. This was justified on the basis that the firm's characteristics most closely resembled those of a university spin-off

[4]Hereafter, these second generation firms will be referred to either as secondary spin-offs or secondary industry spin-offs with both terms used interchangeably. To avoid confusion, the reader should recognize that both university and primary industry spin-offs can serve as source organizations for these firms. They are classified as secondary industry spin-offs because both source organizations are part of the industrial sector when the process occurs.

and the source organizations were highly similar. When the classification was completed, the questionnaire sample was comprised of 21 university spin-offs, 41 primary industry spin-offs, and 14 secondary industry spin-offs.

The Michigan universe. During the construction of the mailing list for the mail questionnaire a significant amount of secondary data was obtained for the universe of Michigan spin-off firms. Using this data, the balance of the 126 Michigan spin-off firms that had not responded to the mail questionnaire (50 firms) were also classified by source organization and their year of formation. These data were used to assess the overall significance of the spin-off phenomenon in Michigan.

The Bendix Corporation and Lear Jet Corporation were identified as the two most important industrial sources for Michigan spin-offs. During the research, 8 spin-offs were identified as directly or indirectly employing technology transferred from the various divisions of the Bendix Corporation. Three of these firms were primary spin-offs and 5 were secondary spin-offs. A total of 9 primary and secondary spin-offs were traced back to the Lear Jet Stereo Division, while 5 were identified as spin-offs from the Lear Siegler Corporation.[5] The

[5]Completed questionnaires were not returned by all these spin-offs. The conclusions are based on spin-offs contained in the universe and identified through secondary data.

University of Michigan was the source for 25 of the 28 university spin-offs in the universe and, in addition, contributed entrepreneurial talent to several industry spin-offs located in the Ann Arbor area.[6] Three spin-offs were founded by former faculty members of Wayne State University.

Table 1 classifies the universe of Michigan spin-off firms by source organization over the 15-year period covered in the survey. From the table it can be noted that the spin-off phenomenon in Michigan is relatively recent with most of the firms being founded in the 10-year period, 1959-1968. The trends in the data would suggest that the secondary industry spin-offs are increasing at a relatively faster rate.

When the geographic scope of the analysis was narrowed down to include only the emerging scientific complex in Ann Arbor and the nearby surrounding area, the validity of the observation is strengthened. In this region (see Appendix Table C-1) the university spin-offs appear to have started the complex growing by attracting industry spin-offs to the area. These university and primary industry spin-offs have in turn seeded the scientific complex by serving as source organizations

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[6]The history of The University of Michigan as a source of technology and entrepreneurial talent for spin-off firms dates back to July, 1919 when Horace W. King, a professor of civil engineering, and Halstead H. Seeley, a manufacturing executive, formed the King-Seeley Corporation. King utilized fluid mechanics technology to develop a hydrostatic gauge, while Seeley applied the development to manufacture a dashboard mounted hydrostatic gasoline gauge.

TABLE 1

Time Period of Formation by Type of Spin-off Firm for Michigan Spin-off Firms
(Percent of Different Types of Spin-offs Formed During Each Time Period)

	Type of Spin-off Firm			
Time Period of Formation	University	Primary Industry	Secondary Industry	Total
1954-1958	21.4	22.2	19.2	13.5
1959-1963	35.7	34.7	7.7	29.4
1964-1968	42.9	43.1	73.1	57.1
Total	100.0	100.0	100.0	100.0
No. of formations	28	72	26	126

Firms classified by date of incorporation or registration of business style.

for the secondary spin-offs which are now beginning to show a similar growth cycle.

Formation Patterns

The field interview phase of the research identified three different formation patterns for spin-off firms. The most common was the direct spin-off from the source organization leading to the formation of a new firm. Other less frequently observed patterns included the firms intentionally spun off by the source organization and a pattern which might best be described as evolutionary.

Direct spin-off. These businesses were found to be motivated by the desire to capitalize on a unique business opportunity, the outright failure of the source organization (often a spin-off itself) or employee dissatisfaction with his job.

The existence of an unusual business opportunity frequently motivated the formation of industry spin-offs. Prospective entrepreneurs often recognized the possibility of making major innovations or improvements in the products or processes of the source organization which would enable new applications or markets to be developed. The motivation for the spin-off occurred because the source organization was usually "locked in" to an existing product design or set of manufacturing equipment. This made adoption of the improvement or innovation

expensive and resulted in resistance or reluctance to change. The potential entrepreneur, having no investment in the past, easily recognized the opportunity and took advantage of it.

Secondary spin-offs were often found to occur for this reason. Rapidly changing technology quickly made the primary spin-off firm's products or processes obsolete and provided ready access by the secondary spin-off to undeveloped markets.

University spin-offs were also created because of unique business opportunities. Academic researchers working to solve technical problems generated a demand for specialized research equipment which they frequently designed and developed for their own use. The eventual solution of the problem and the widespread dissemination of the research results automatically created a demand for the equipment and related hardware. Perceptive researchers at The University of Michigan's Institute of Science and Technology have been taking advantage of opportunities such as these for a number of years.[7]

[7]It should be noted that one of the first major transfers of technology from The University of Michigan resulted in the formation of the Aerospace Systems Division of the Bendix Corporation in 1956. A number of researchers from the Willow Run Laboratories left the University during 1955-1958 to provide the management and technical base for the new division. This development is often referred to as a University of Michigan spin-off. According to the criteria established for this study, it was considered to be a corporate division and not a spin-off. However, the Aerospace Systems Division has been an important source of technology and entrepreneurs for a number of spin-off firms in the Ann Arbor area. At least six spin-offs have been founded by former employees of this division.

In addition to the desire to manage their own businesses, a variety of other circumstances surrounded the entrepreneurs' dissatisfaction with their previous job. They include changes in management brought about by a merger or acquisition of the source organization (frequently a spin-off), periods of corporate crisis resulting from general business conditions, the loss of important government contracts, the absence of financial incentive plans allowing the employees to share in the source organization's growth, and extreme cash flow problems resulting from poor financial management and explosive growth. One or more of these factors were almost always mentioned by entrepreneurs as reasons for leaving their jobs to accept the risks of forming and operating a new business. Alone, they were usually not sufficient to motivate the spin-off process. However, when coupled with the knowledge of a business opportunity, they contributed to and often justified the decision to spin-off.

The importance of the preceding group of business related factors in explaining the occurrence of spin-offs assumes even greater importance when the formation pattern of the universe of Michigan spin-off firms is examined as a time series. The aggregate time series (see Appendix Table C-2), in particular, is cyclical with 1957, 1963 and 1967 being peak years in the 3 cycles. It was noted that the cyclical

turning points of the formation pattern lagged those of a similar time series of corporate mergers by 2 years.

Spin-off by the source organization. This second formation pattern describes those firms intentionally spun off by the source organization. In most cases the principal founders or their investor groups purchased the assets of a subsidiary, department or laboratory group of a much larger industrial corporation. The facilities, technology and personnel often remained the same, but the direction and objectives of the new firms were frequently changed following the spin-off process. One instance was observed where the spin-off was motivated by the opportunity to supply an improved electronic device to the source organization that was formerly purchased from an outside vendor. This spin-off operated as a subsidiary for a short period of time, but eventually became an independent corporation.

The source corporation usually supplied most of the motivation for the formation of the intentional type of spin-off. They occurred after the corporation had acquired a science-oriented firm or organized a subsidiary to develop a new field of technology which it believed offered an opportunity for future business. The conditions for the spin-off were established when the corporation discovered that the investment

in time and money required to put the operation on a profitable basis was substantially greater than originally anticipated. Rather than continue to subsidize an unprofitable and uncertain business venture, the operation was eventually spun off--often to existing employees who continued to try and develop the business.[8]

The evolutionary pattern. A third formation pattern might best be described as evolutionary. The spin-off firm was an outgrowth of a previous consulting activity by one or more entrepreneurs on a part-time basis. The business grew and developed to the point where the volume was sufficient to support a full-time endeavor. Frequently, these spin-offs began as partnerships and proprietorships and evolved into the corporate form as the organization liability changed.

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[8]Although the circumstances may be slightly different, the Lear Siegler Corporation provides an illustration of this pattern. In 1962, Lear acquired Trion Instruments, a University of Michigan spin-off formed in Ann Arbor in 1959 to exploit electro-optics technology developed at the Institute of Science and Technology. Trion became the Laser Systems Center and was operated by Lear until 1968 when the corporation spun off the commercial part of the business to existing employees. A new industry spin-off, Laser Systems Inc., was formed by this group using essentially the same technology, but having a new corporate direction.

With some exceptions, spin-offs from university academic departments exhibited a tendency to evolve as a result of prior consulting activities. Their early history was frequently marked by a long transition period in which the technical entrepreneurs were employed on a part-time basis by the university. In some instances, the relationship was never completely severed and they continued to split their effort between the academic department and the spin-off firm. By contrast, the spin-offs from university research facilities such as the Institute of Science and Technology were characterized by entrepreneurs who left directly to develop a new technology in which they had expertise. Some part-time employment might have been involved, but it was usually of much shorter duration.

Industry spin-offs were found to conform to all of the formation patterns identified during the research. However, an interesting relationship was observed between the number of principal founders and the firm's formation pattern. The firms reporting several founders were often formed as a direct spin-off from the source organization or by a purchase of assets, while those reporting one or a very few principal founders usually evolved from a consulting activity. In this instance it might be reasoned that in addition to providing financial resources by bridging the employment gap between resignation from

the source organization and the founding of a new enterprise, the consulting activity served as an alternative method of reducing the perceived risk in the business venture.

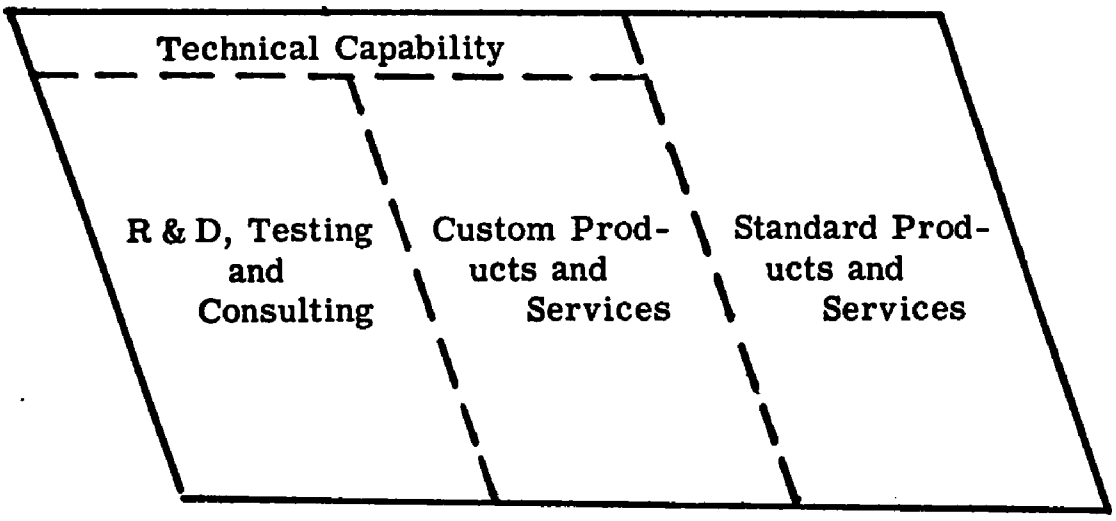
Initial Business Activities

Preliminary research indicated that the possible business activities to which spin-off firms might be attracted covered a broad spectrum. One of the objectives of the research was to identify and define some of the different positions on the spectrum so that a descriptive dichotomy could be developed which would prove useful for the construction of a conceptual model. It was found that three descriptive classifications adequately described the nature of these initial business activities. The first two classifications included the business activities commonly described by the term technical capability. These activities were (1) research and development, testing and consulting, and (2) custom products and services. The third classification (3) included the manufacture and provision of standard products and services. These business activities are conceptually illustrated in Figure 1, where each occupies a relative position on the spectrum.

The capability-oriented spin-offs. The largest percentage of the firms studied could be broadly classified as businesses initiated to provide

Figure 1

Conceptual Illustration of the Spectrum of Possible Business Activities



a technical capability. Part of the capability-oriented business firms occupied one extreme end of the spectrum. They included the spin-offs exclusively engaged in providing an engineering consulting service, testing or research and development on a contract or fee basis. Another group consisted of custom-product-and-service-oriented firms falling at the middle of the business activity spectrum. Conceptually, they occupy an initial position between the research and development firms at one extreme and the standard-product-and-service-oriented firms at the other. The business activities of these spin-offs were more directly related to solving short-range engineering problems. They included scientific computer programming and software development, engineering design and systems analysis, prototype design and fabrication, and contract manufacture to customer specifications.

The balance of the capability-oriented spin-offs fell somewhere on the spectrum between the research and development spin-offs, for example, and the custom product and service firms. These businesses were involved in both areas of activity and generated sales revenue from the performance of technical activities common to each group. For purposes of data analysis, they were initially classified in the capability area which provided the largest proportion of their first year's sales revenue.[9]

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[9]The reader should note that all firms were initially classified on the basis of their first year sales. In succeeding years the classification of many firms changed as the composition of their sales volume shifted. In Chapter IV, all firms are reclassified on the basis of 1968 sales.

The results of the technical efforts of all the capability-oriented firms took the form of non-proprietary software and hardware. In the case of research and development it was software in the form of a contractor's report, while in the custom engineering design and build activity the customer received a complete working design for a piece of hardware, one or more fabricated prototypes, or a number of items built on a custom basis to his design requirements. The most distinguishing characteristic of this type of business activity is that the results of the technical effort belong entirely to the customer. Only the new knowledge generated remains with the spin-off firm.

Most of the activities of the capability-oriented spin-offs were, of necessity, performed on a custom basis with the firm's technical ability tailored to individual customer needs rather than the needs of a mass market. Although a generalized mass market for the technical capability could be perceived, it was highly fragmented because each job was sufficiently different from the previous one to prohibit excessive standardization of methods or needs.

The standard product and service spin-offs. A small group of spin-off firms responding to the mail questionnaire were found to be initially engaged in the development and marketing of a standard product or service either for a specific customer or a larger group

of potential customers. Compared to the capability-oriented firms, the results of the technical efforts of these product-oriented spin-offs were retained in their control. They financed the research, development, design and engineering effort involved in bringing the product to the commercialization stage. The products, if successful, promised large orders and volume production runs of similar items.

Many firms initially falling in the standard product and service category planned to market on a national scale. The entrepreneurs perceived a mass end use market with defined market segments and common requirements. While some modification of products and services in this category was required to meet market needs (particularly in systems sales), the basic product or service was characterized by a high degree of standardization. Product variation, when necessary to meet varying performance requirements, was most often achieved by offering different models having minor design changes or by the addition of accessories.

Multiple activity spin-offs. Not all of the spin-off firms could be conveniently classified as being either capability oriented or product and service oriented. Some occupied more than one position on the business activity spectrum by initially providing a technical capability for custom markets on a regional or national basis and developing or

marketing a proprietary product or service for a larger mass market. In many instances, the activity involving the technical capability was pursued only as a sideline to the more important task of marketing standard products and services. It was justified on the basis that it provided needed cash flow for the proprietary development effort, had potential for product or service spin-off and enabled the firm to develop a manufacturing capability.

Under certain circumstances, the last advantage assumed major importance. Frequently, the projects involving research and development or custom design and fabrication would lead to follow-on production contracts in which the spin-off supplied a component, subassembly or part of a larger system to a prime contractor or an OEM.

It should be noted, however, that some instances were observed where spin-off firms were engaged in a product activity to support a technical capability. This frequently occurred in an area of technology which had not developed sufficiently to permit the large-scale manufacture of low-cost standard products for volume applications.

Laser Systems, an Ann Arbor spin-off, illustrates this situation. The firm's primary area of interest is in the design of laser machine tools which will weld or drill practically all ferrous and nonferrous alloys and metals as well as non-metallics such as plastics and rubber. Because the use of a laser as a power source is newer and presently

more expensive than conventional machining techniques most of the laser machinery has been custom designed and produced for specialized applications in which the cost/performance advantages are clearly superior. To finance the long technical and market development period required, the firm has developed some standard products to provide a source of additional revenue:

> But the firm's latest product, a new type of burglar alarm which soon will be produced by the thousands, does not involve the laser. Operating with a light emitting diode, it has no resemblance whatsoever to the traditional burglar alarm.[10]

According to Edwin Bruening of the firm's staff, "alarms and such things are our bread and butter items while the machine tools come along."[11]

These multiple activity firms were classified in the business activity category which accounted for the largest percentage of their first year sales revenue. For example, a spin-off reporting 10 percent of its first year sales revenue from consulting contracts, 80 percent from custom design and manufacturing and 10 percent from the sale of standardized products was classified as capability oriented to produce custom products. In the few cases where the proportions were evenly divided between business activity categories,

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[10]The Ann Arbor News, May 4, 1969, p. 2.

[11]Ibid.

the firm was classified by examining the composition of its 1968 sales revenue to determine the direction of progression.

All 76 firms responding to the mail questionnaire and included in this survey were then classified as either capability oriented or standard product and service oriented. For purposes of analysis, an additional refinement was made by further dividing the capability-oriented firms into two separate groups. One group consisted of firms engaged in research and development, testing and consulting, while the second group comprised the firms involved in the provision of custom designed products and services. The third group, of course, included all of the spin-offs initially deriving the majority of their sales revenue from the development and marketing of standard products and services.

Evaluation of First Research Hypothesis

Classification of spin-off firms by type of source organization and primary initial business activity is necessary to investigate the first major research hypotheses and related postulates. Previously it was reasoned that since spin-off firms can originate from two separate source organizations some relationship might exist between the initial business orientation and the different types of spin-offs. The hypothesis stated that spin-off firms were initiated at all

stages along the business activity spectrum.

The research findings already reported in this chapter have supported the hypothesis. They are summarized in Table 2, which brings together the two classification schemes for the 76 firms being studied.

It was postulated that university spin-offs tend to enter into the business activities at the research and development end of the spectrum. From the table it can be noted that 42.8 percent of these spin-offs were initiated at the R & D, testing and consulting end of the spectrum compared to 26.8 percent of the primary industry spin-offs and 21.4 percent of the secondary industry spin-offs. This technical orientation is a reflection of the academic training and research background of the technical entrepreneurs of most of these spin-offs.

The second related postulate suggested that industry spin-offs tend to enter into the business activities at the standard product and service end of the spectrum. If the industry spin-offs are taken as a combined group (primary and secondary industry spin-offs) and compared to the university spin-offs, the postulate is rejected because the difference between the two groups is not significant when they are classified in this manner. For this reason a third postulate stated that second generation spin-offs enter into the business activities closer to the standard product and service end of the spectrum than the university and primary industry spin-offs. Here obvious differences are present in the distribution with 50 percent of the secondary

TABLE 2

Initial Business Orientation by Type of Spin-off Firm
(Percent of Firms Having Each Business Orientation)

Initial Business Orientation	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
R&D, testing and consulting	42.8	26.8	21.4
Custom products and services	38.1	58.5	28.6
Standard products and services	19.1	14.7	50.0
Total	100.0	100.0	100.0
Number of firms	21	41	14

industry spin-offs initiating business at this end of the spectrum compared to 19.1 percent of the university spin-offs and 14.7 percent of the primary industry spin-offs. Almost all of the variation in the distribution is a result of the extreme orientation of the secondary spin-offs. As will be seen in later chapters, these firms are different in many ways from the university and primary industry spin-offs which serve as their source organizations.

Finally, it should be noted that 58.5 percent of the primary industry spin-off firms were initially classified in the custom products and services category compared to 28.6 percent of the secondary industry spin-offs and 38.1 percent of the university spin-offs. This difference completes an interesting trend which can be observed in Table 2.

The largest percentage of the university spin-offs tend to cluster at the R & D, testing and consulting end of the spectrum. Moving diagonally across the table, it can be noted that in a similar manner the majority of primary industry spin-offs are found to be in the mid-range of the spectrum, while the largest percentage of the secondary spin-offs are found to initially start at the standard product and service extreme of the spectrum. This trend lends support to the major hypothesis that spin-off firms are initiated at all stages along the range.

The Areas of Technology

As a group, the Michigan spin-off firms responding to the mail questionnaire were found to be involved in several different broad areas of technology. In total, about 10 separate areas were identified ranging from acoustics to vibrational testing. Individually, however, most of the spin-off firms restricted the scope of their technical activity to the development of one major area. The technical background and prior employment experience of the founders usually determined the initial area of emphasis and the degree of technical sophistication, but this was often tempered by the financial resources available to the firm.

Table 3 presents a distribution of the 76 firms included in the study by the principal area of technology employed in their business. Each firm was classified by the use of product literature, personal interviews and secondary data sources. In the few instances where one firm overlapped two areas, classification was made on the basis of the firm's primary area of interest.

The largest area of technical activity contained all of the firms primarily involved in the application of electronics technology to the design and manufacture of instrumentation, devices, controls and components. A total of 43.4 percent of the firms fell in this area with most of them involved in instruments and controls. Both primary and secondary industry spin-offs showed a tendency to

TABLE 3

Primary Areas of Technology by Type of Spin-off Firm
(Percent of Firms in Each Area of Technology)

Area of Technology	Type of Spin-off Firm			
	University	Primary Industry	Secondary Industry	Total
Electronic instrumentation, devices, controls and components	28.6	43.9	64.2	43.4
Materials research and development, testing, fabrication, and synthesis	14.3	21.9	. . .	15.8
Optical and electro-optical instruments, devices and components	23.8	4.9	. . .	9.2
Electromechanical equipment design, development and fabrication	. . .	7.3	28.6	9.2
Electronic computer hardware and software	14.3	2.5	7.2	6.6
Consulting and miscellaneous	19.0	19.5	. . .	15.8
Total	100.0	100.0	100.0	100.0
Number of firms	21	41	14	76

concentrate in electronics with the largest percentage of each type of spin-off falling in this area. Among the 18 primary industry spin-offs engaged in some aspect of electronics, 13 were involved in the design and manufacture of custom products. The secondary industry spin-offs were clearly oriented to the production of standard items. Of the 9 firms in this technology area, 6 were classified as engaged in the manufacture of standard electronic products. The university spin-offs active in electronics were primarily research and development and custom product firms.

The materials area, accounting for 15.8 percent of the reporting firms covered a variety of technical activities and two major fields of technology. These included applied research, process development, testing, fabrication and synthesis in the fields of physical metallurgy, and inorganic and organic chemistry. As the table shows, both primary industry and university spin-offs were well represented in this area. Most of the firms were doing business in the technical capability segment with 9 of the 12 firms involved in research and development, physical testing and a custom product or service activity.

All of the 7 firms employing optics and electro-optics technology in their business were initially using laser, holography, and related optics technology transferred from The University of Michigan.[12]

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[12]A total of 11 spin-offs using optics and electro-optics technology transferred from The University of Michigan were identified in the universe of firms. Seven of these spin-offs responded to the mail questionnaire.

Five of the firms were university spin-offs from the Institute of Science and Technology, while 2 were spin-offs from a large Michigan electronic systems contractor. The firms, located in the Ann Arbor scientific complex, spanned the complete spectrum of business activities with the technical capability-oriented firms accounting for all but 1 of the 7. Because of The University of Michigan's technical depth in optics, the university spin-offs dominate this field of technology. Among the respondents to the mail questionnaire they accounted for 23.8 percent of the total university spin-off firms.

The electromechanical equipment category includes firms engaged in the design, development or fabrication of hardware primarily mechanical in nature, but controlled electronically. Of all the technology-oriented firms investigated in this study, the spin-offs falling in this area probably had the lowest technology content in their businesses. The 7 firms included in this category represented 9.2 percent of the respondents to the mail questionnaire. Of this total, 3 of the firms were primary industry spin-offs involved in custom product and service work. Secondary spin-offs comprised the balance, with 3 of the firms supplying custom products and design services and 1 engaged in the provision of standard equipment for a broad range of industrial applications.

The 5 firms developing computer technology comprised 6.6 percent of the mail questionnaire respondents. They were found to be engaged in the development of both software and hardware for data processing applications. All but 1 of the 5 spin-offs were located in the Ann Arbor and Detroit metropolitan areas where large potential markets existed. Three of the firms were University of Michigan spin-offs initially engaged in the custom development of computer hardware and software, while the remaining 2 firms consisted of a primary and secondary industry spin-off each doing research and development on standard computer software packages.[13]

The last classification, consulting and miscellaneous, contained primarily engineering consulting and research and development firms employing several technologies or a single technology which did not fit the major areas described in Table 3. With the exception of one firm providing a standard research service, the remaining 11 firms were initially capability oriented and concentrated in consulting and research and development activities.

Many technologies were represented by this group, including acoustics, bio-medical engineering, propulsion, systems engineering, heat transfer and nuclear reactors. Of the firms in this classification, 8 were from industry sources, while 4 were spin-offs from The University of Michigan.

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[13]In the universe of 126 Michigan spin-off firms, 15 were engaged in developing some aspect of computer technology. Six of these firms were spin-offs from The University of Michigan.

Research evidence was also obtained which suggested that new technologies tend to diffuse from university spin-offs to primary and secondary industry spin-offs as they are developed. These diffusion patterns are shown in Table 4, where the different types of spin-off firms are classified by their primary area of technology (percentages running horizontally).

It can be observed from the table that the better developed technologies such as electronics and electromechanical equipment are well diffused among the primary and secondary industry spin-offs. The majority of the electronics firms are primary industry spin-offs and 57.1 percent of the firms involved in some aspect of electromechanical equipment are secondary industry spin-offs. By comparison, optics and electro-optics, a newer area of technology is still concentrated primarily in the university spin-offs. A similar situation appears to exist in computer technology.

This diffusion trend supports the theory that large research-oriented universities are essential elements in the development of a major scientific complex. The trend also confirms the previous comment about the importance of university spin-offs in seeding the complex.

TABLE 4

Type of Spin-off Firm by Primary Area of Technology
(Percent of Total Firms in Each Technology Classification)

Area of Technology	Type of Spin-off Firm				
	University	Primary Industry	Secondary Industry	Total	No. of Firms
Electronic instrumentation, devices, controls and components	18.2	54.5	27.3	100.0	33
Materials research and development, testing, fabrication and synthesis	25.0	75.0	. . .	100.0	12
Optical and electro-optical instruments, devices and components	71.4	28.6	. . .	100.0	7
Electromechanical equipment design, development and fabrication	. . .	42.9	57.1	100.0	7
Electronic computer hardware and software	60.0	20.0	20.0	100.0	5
Consulting and miscellaneous	25.0	75.0	. . .	100.0	12

The Products, Services and Technical Capabilities

The technical capability, high technology product, or service offered for sale by the typical new spin-off firm might best be described as containing a strong element of the unknown. Not only is it the result of highly creative individuals working in an environment with an uncertain future, but it frequently employs new and sophisticated technology. To the spin-off entrepreneur these elements comprise the opportunity to work on challenging problems often not solvable by conventional methods or products. To the prospective customer, these same elements often mean that the firm's initial product, service or capability is difficult to understand and evaluate and perhaps something he may not know he needs.

The Technical Capability

For the recently established spin-off firm, the technical capability is as intangible as it is broad in scope. It ranges from the ability to create advanced technology for industrial applications through research and development to electronic competence in solid state and logic circuitry to perform advanced prototype design and fabrication on a custom basis. As such it can be used to broadly describe the tangible and intangible applications of technology made by the firms performing research and development, testing and

consulting and providing custom products and services.

To give it both form and meaning for potential customers, the technical capability must of necessity be composed of many different elements. Perhaps of most importance is the spin-off firm's personnel, their reputations and fields of technological cognizance. Difficult technical problems often require unique and innovative solutions. Firms offering personnel with in-depth technical and management experience in one or more applicable disciplines are frequently in the best position to solve these problems. The firm's facilities and their approach to solving problems complete the capability package. They are always of importance, but assume added significance for firms planning to develop business with the government.

If the spin-off firm's technical capability is employed in the design and development of a sophisticated piece of hardware or software for a specialized application, it assumes an added dimension of importance. Frequently neither the customer nor the spin-off firm can adequately describe the product before it is actually tested in the intended environment. Here, the firm's capability must be compatible with a high degree of customer participation in the product planning and development process.

With the exception of government contract business, marketing is initially done on a local or regional basis to a quite well-defined customer group. Often they are large, technically sophisticated corporations interested in utilizing the spin-off's technical capability to improve their products or processes or supplement an existing in-house capability.

Technical performance and customer satisfaction are highly important because past successful efforts and a list of satisfied customers and clients define the spin-off's capability image to potential customers and bring repeat business. Economic performance is also important, but it depends on the nature and complexity of the problem. Some of the less competitive projects are those which (1) involve one-of-a-kind problems and result in a single piece of hardware or software, or (2) those requiring the development of complex systems which are difficult to define until the work progresses into the later stages of development. However, technical problems having the potential for large follow-on business in the form of production contracts are usually competitive from both a technical and economic performance standpoint.

Some competition exists on most of the jobs, and a firm's competitors vary as much as the problems requiring solution. Firms possessing unique technical capabilities or working in new areas

of technology are often able to isolate themselves from competition unless other technological approaches to solving the problems are possible.

Capability-oriented spin-off firms in Michigan were represented in all the major areas of technology. A partial list of the activities and applications include research and development on high temperature metals and alloys, drug intermediates, and plastics; physical testing of materials and fabrications; special materials fabrication; chemical synthesis and process development; systems engineering; custom designed analog and digital computers and related hardware; scientific computer programming and data processing; automatic controls; instrumentation for testing and measurement; printed circuits; electronic assembly; custom laser crystals and laser machinery; and holographic equipment and displays.

High Technology Products and Services

In contrast to the technical capability which is frequently applied to solve problems for customers with diverse technical requirements, high technology products and services are usually developed by the spin-off firm for a set of common needs expressed by a few potential customers in a market which is limited or must be developed. Technical accomplishment and customer satisfaction still assume major

importance and in most cases products and services compete on the basis of uniqueness and quality rather than on the basis of price. However, economic performance assumes importance in competitive situations where two or more products have similar performance characteristics or a high degree of standardization exists.

The Michigan spin-off firms that decided to market standard products as their initial business activity usually developed items that were small, relatively inexpensive and specialized in their application. The most successful products were not unique because of their high technology content or complexity, but because they offered an innovative approach to an unsolved problem or a technical improvement over an existing product. The technological content of most initial products was intentionally reduced to a minimum level whenever possible. This reflected the need to reduce the costs of product development, production and commercialization and obtain a quicker financial return on a limited investment.

The actual products and services marketed by Michigan spin-offs during their first year of business fell in every area of technology and were extremely diverse. They included a wide range of electronic instruments for non-destructive testing and related quality control applications; amplifiers; microwave components;

photocells; industrial controls for equipment and processes; medical electronic instruments, devices and electromechanical equipment for medical applications; computer memory discs; magnetic tape cartridges; computer time sharing, proprietary computer software and data processing services; statistical analysis of survey data and related research services; holographic components and optical data processing equipment; scientific and industrial lasers and laser components; and supporting services related to the sale of products.

Because the initial application for the spin-off firm's product was often in highly specialized market segments (scientific laboratory supplies, for example), production quantities were usually small and required relatively little investment in sophisticated assembly equipment. Many of the parts were machined or fabricated by outside suppliers so that only assembly and testing were performed by the spin-off firm. Mass production techniques were usually not feasible or justified in the initial scale of operations. The first products, by their nature, had a high labor content and the availability of technically trained technicians was frequently the key to continued success.

Summary

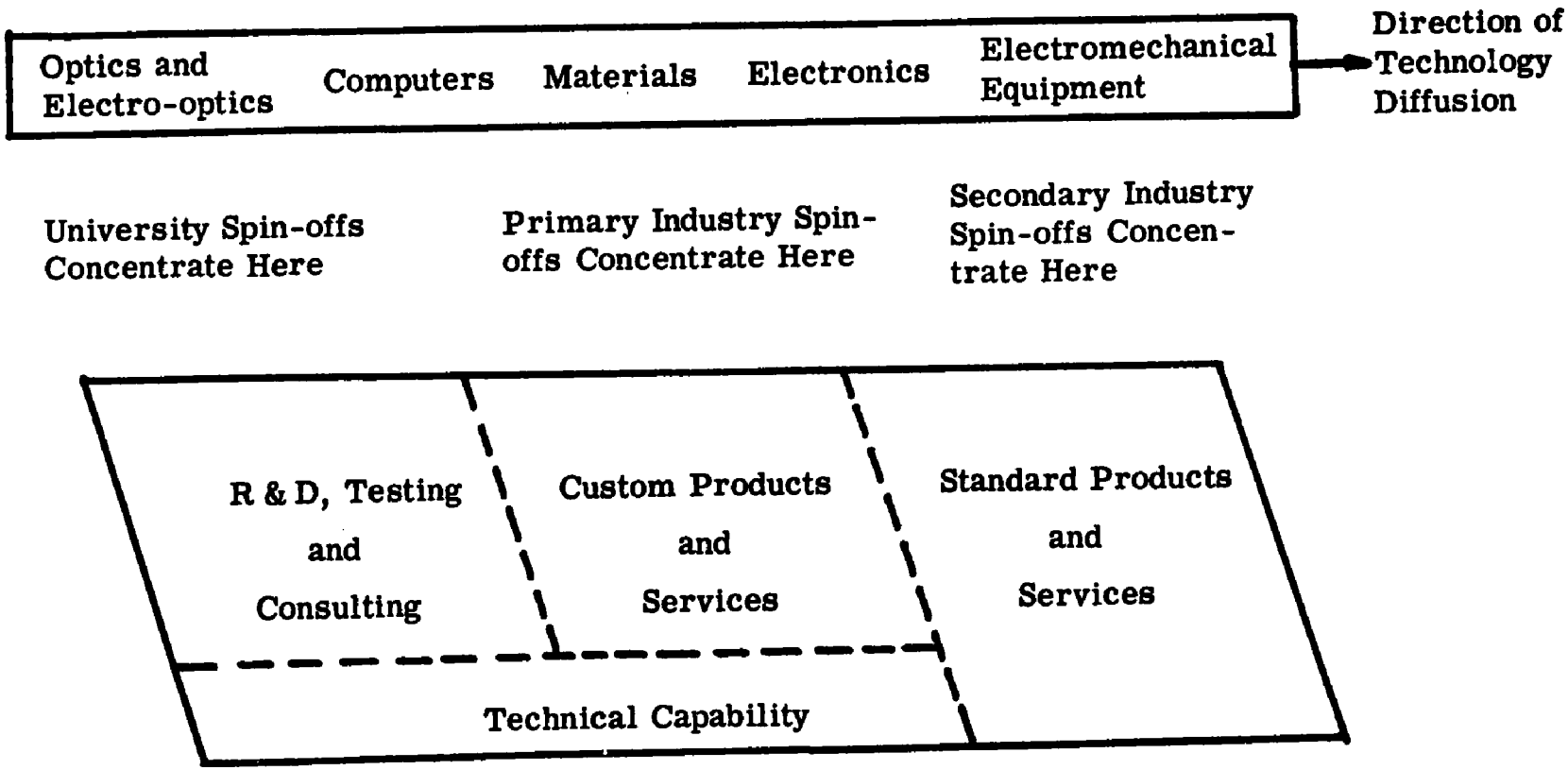
This chapter begins the development of the conceptual model previously suggested. The analysis has established (1) two major

classification schemes for the spin-off firms studied, and (2) a relationship between the source organization, the type of spin-off and the firm's initial position along the spectrum of possible business activities. As shown in Figure 2, university spin-offs exhibited a tendency to begin operations in research and development, testing, and consulting and the majority of primary industry spin-offs as suppliers of custom products and services. Most of the secondary industry spin-offs started as standard-product-and-service-oriented businesses and tended to occupy the extreme end of the business activity spectrum. These findings support the first major research hypothesis.

A number of different technologies were identified among the spin-offs studied, but most of the firms were working in one of five major areas. These were electronics, computers, optics, materials and electromechanical equipment. In certain areas of technology (such as optics and computers) and in well defined scientific complexes (such as Ann Arbor and the surrounding area), there was also research evidence to indicate that the university spin-offs started the complex growing by transferring technical knowledge from the new, emerging fields of science and technology. Primary industry spin-offs resulted from the large industrial source organizations attracted to the area by the promise of applications for the new technology. They transferred technology from the same fields,

Figure 2

Relationship Between the Type of Spin-off Firm, the Area of Technology and the Initial Business Activities



but usually after a period of technical development which resulted in more promise of market application.

Both the university spin-offs and the primary industry spin-offs eventually became the source organizations for the secondary industry spin-offs. These firms, the latest group in a sequential series, transferred technology from similar areas, but it was now at an advanced stage of technical development which facilitated its application to standard products and services. The pattern described suggests that technology may be diffused along the business activity spectrum by the spin-off process. It begins at one extreme as scientific information (often in a university research and development spin-off) and is successively transferred and developed until it emerges at the other extreme of the spectrum embodied in the form of a standard product or service.

Beyond the geographic constraints, empirical evidence indicated that regardless of the area of technology, university spin-offs tended to transfer technology from the new scientific fields while secondary spin-offs transferred technology from the fields already quite well defined and developed.

CHAPTER III

The Resource Base

An Overview

In the conceptual model being developed, the formation process of the technically oriented spin-off consists of bringing together three essential ingredients—entrepreneurial talent, technology and financial resources. All three are of crucial importance. Together they influence the spin-off's business objectives, the initial business activity and the rate and direction of the firm's development.

The technical entrepreneur and the other principal founders play a key role in the formation and development of the business enterprise. It is usually their combination of technological knowledge and innovative ability that form the technical foundation for the new firm. However, many of these same founders provide the initial financial resources to launch the company and bring the business skills which are so necessary to provide continuity in the day-to-day operations of the firm.

Yet, the mere existence of technology, entrepreneurial skill and financial resources does not seem sufficient to motivate the spin-off process in a well conceived business venture. It has been suggested that an awareness of unsolved problems and knowledge of market needs provide the motivation to form a spin-off firm.[1] Apparently,

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[1]Denver Research Institute, The Scientific Complex—Challenge to Colorado, p. 4.

technical entrepreneurs starting spin-off firms have in addition to technological knowledge some awareness or concept of a potential product, service or capability for which a market need either exists or can be created. This information, along with the transferred technology, often becomes the basis for the firm's initial market orientation.

When it comes to translating advanced technology from the concept stage into useful hardware and software, more is required than a technical background and an awareness of an unfilled market need. Marketing is needed to overcome resistance to complex products, services and capabilities employing advanced technologies. The spin-off firm must have trained marketing people with the necessary skills to successfully interact with the customer not only on technical matters but on marketing questions as well.

This suggests that in addition to the technology, entrepreneurial talent, and financial resources, which are transferred to the new firm, knowledge of market needs and marketing techniques may also be related to the firm's formation and direction of development. The purpose of this chapter is to explore the transfer of entrepreneurial skill, technology, and financial resources and evaluate the significance of market and marketing knowledge in the overall formation process.

Entrepreneurial Talent and Business Skills

Technical skills are usually not enough to assure the long-run success of the spin-off enterprise. Many entrepreneurs having only a technical background realize the need for help in management, production and the other functional areas of business. They attempt to obtain these skills in one way or another early in the formation and development of the enterprise. This is one reason why most of the spin-off firms begin business with more than one principal founder.

The Technical Entrepreneur

Typically in a new business, one individual is responsible for the idea that conceives the firm and provides the leadership for the firm's development. To a degree, this is also true of the spin-off enterprise where the innovative ability of one individual is primarily responsible for applying technology to the development of a marketable product, service, or capability. During personal interviews with the technical entrepreneurs of 32 different spin-off firms, additional information about these individuals was obtained by examining their educational background and previous employment history.

Educational background. As a group, spin-off entrepreneurs were well educated. All but one of the 32 entrepreneurs interviewed reported

some formal college training prior to founding their firms. A total of 5 Ph.D's and 7 masters degrees were reported and overall 26 or 81.2 percent of the entrepreneurs reported a bachelors degree or better, usually in science or engineering. The actual level of educational attainment was found to be related to the type of spin-off firm.[2] Most of the Ph.D. entrepreneurs were the founders of university spin-off firms, while the entrepreneurs having a bachelors degree or less were typically involved in the formation of secondary industry spin-offs.

Table 5 summarizes the relationship between educational achievement and the type of spin-off firm for the 32 entrepreneurs contacted during the field research. As can be noted from the table, the trends are quite dramatic. In 8 of the 9 university spin-offs, the technical entrepreneurs held a masters degree or better, while in 12 of the 15 primary industry spin-offs the entrepreneurs had at least a bachelors or masters degree. Somewhat surprisingly, the lowest educational level was reported by the technical entrepreneurs of secondary spin-offs. As shown by the table only one of the entrepreneurs reported the

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[2]For an interesting viewpoint on the influence of the entrepreneur's education on the success or failure of the firm, the reader is referred to: William H. Hoad and Peter Rosko, Management Factors Contributing to the Success or Failure of New Small Manufacturers, Michigan Business Reports, Number 44 (Ann Arbor, Mich.: Bureau of Business Research, Graduate School of Business Administration, University of Michigan, 1964), pp. 96-99.

TABLE 5

Educational Background by Type of Spin-off Firm for 32 Technical Entrepreneurs Interviewed During Field Research
(Number of Entrepreneurs Having Each Educational Background)

	Type of Spin-off Firm		
Education of Entrepreneur	University	Primary Industry	Secondary Industry
Ph.D.	3	1	1
Master's	5	2	. .
Bachelor's	1	9	4
0 to 3 years college	. .	3	3
Number of entrepreneurs	9	15	8

educational equivalent of a masters degree or better.

Employment experience. Whatever the secondary spin-off entrepreneur missed in formal educational training, he quickly compensated for it through practical business experience. The entrepreneurs of these firms reported holding an average of 2.8 jobs prior to starting their firms compared to 2.5 for the entrepreneurs of primary industry spin-offs and 1.4 for the university spin-off entrepreneurs. This is a trend that should logically be expected in view of the educational data.

Since it was previously shown that each type of spin-off firm tended to cluster at certain points along the spectrum of possible business activities, a similar relationship might also be expected to exist between the entrepreneur's educational level and the initial business orientation of his firm. Only one noticeable trend (see Appendix Table C-3) was found in the data. All six of the technical entrepreneurs reporting an educational level less than a bachelors degree were found to be initially engaged in the manufacture of custom products and services. The differences in the average number of jobs held by the entrepreneurs of the spin-off firms having each business orientation were negligible.

As a general observation, most of the entrepreneurs interviewed were highly determined and confident of success. Prior to starting their firms, many had always planned to have their own business and

they worked in industry or a university laboratory for a few years only to gain some practical experience and seasoning. When the right opportunity came along or the "time was right" they usually recognized it and began putting their business enterprise together.

Other Principal Founders

In spite of the key role of the technical entrepreneur, he usually did not assume complete responsibility for the success or failure of most spin-off firms. Only 29 percent of the firms responding to the mail questionnaire reported that their firm had only one principal founder, while over 40 percent of the spin-off firms reported between two and four principal founders. In general, the firms having a research and development or similar orientation had fewer principal founders than the spin-offs having a standard product and service orientation.

It appears that part of the need for additional founders is explained by the difficulty encountered by new firms in obtaining venture capital. Firms planning to develop and market their own products and services often incur high costs for technical development and commercialization. One way of securing funds to cover this expense is to add additional principals who are willing to contribute financially for some equity in the venture. This reason is

particularly important in university and primary industry spin-off firms because of their lack of previous business experience in obtaining funds from organized capital markets. Another related factor may be the market uncertainty inherrent in the different types of business activity. It has already been suggested that spin-off firms having a standard product and service orientation may be required to employ more sophisticated marketing strategy and programs. The greater number of principal founders in these spin-offs may be a reflection of the need for additional business skills such as marketing and production in the organization to reduce the uncertainty in the venture.

Field research indicated that the need for business and management skills in the firm was an important reason for multiple founders. Many times the technical entrepreneur was an engineer or scientist who had little skill or interest in running the routine business affairs of the company. He was often willing to have a person with some business experience to handle the non-technical aspects of the operation.

Despite the obvious advantages of multiple founders in the spin-off firm, the relationships were not always very durable. Numerous examples were found where the technical-business alliance was destroyed because of differences of opinion, unclear authority relationships and countermanded decisions. Rubenstein observed this

same problem and he summarized it as follows:

> It is a delicate partnership situation and one that seldom runs smoothly. It is related to the belief among many technical people that any smart person can understand business matters—because they are just common sense, while the technical matters are too difficult and too mysterious for a layman to have anything to say about them.[3]

Regardless of the point of view, the interpersonal relationships among the principal founders are a critical aspect in the development of the business enterprise. Among the spin-off firms contacted during the personal interview phase of the research, over 30 percent went through this crisis during the first few years of their existence.

Technical and Business Skills

Professionally, most of the principal founders interviewed classified their backgrounds as technical as opposed to business, but many brought valuable business experience and training to the new firm. The majority of the entrepreneurs having only a technical background realized the need for help in management, production, and the other functional areas of business. When it was not possible to have these skills in the business initially because of financial or other constraints, the entrepreneurs carefully selected their employees to complement the existing technical and business skills present in the firm. Many of

[3]Rubenstein, Problems of Financing and Managing New Research-Based Enterprises in New England, p. 3.

the founders took great pride in the fact that their firm's operation was sound from both a business and technical standpoint. Sometimes this pride was not justified.

Type of spin-off firm. The technical orientation of the spin-off firm was confirmed by the response to the mail questionnaire. Respondents were requested to indicate the types of major employment experience represented in their firm by the principal founders and other employees when it was originally founded. Table 6 presents the combined response to this question for all initial personnel (founders and other employees) of university, primary industry and secondary industry spin-offs.

All spin-off firms reported that either a principal founder or employee had research, development or engineering experience at the time of founding. This was to be expected because the technical experience of the personnel is the primary basis for the firm's creation. However, important differences begin to appear when the presence of various business skills is considered. As a group, the industry spin-offs clearly had an advantage over their university counterparts. They were more inclined to have production, general management and the other functional business skills such as accounting, finance and marketing initially present in their organization.

TABLE 6

Employment Experience Present at Time of Founding by Type of Spin-off Firm
(Percent of Firms Mentioning Each Type of Employment Experience)

Type of Employment Experience	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
Research, development or engineering	100.0	100.0	100.0
Production	9.5	41.5	71.4
General management	23.8	56.1	78.5
Accounting or finance	19.1	41.5	35.7
Marketing or sales	28.6	48.8	50.0
Number of firms	21	41	14

Also to be noted is the trend and difference in the percentages of each type of spin-off firm reporting production and general management experience. This is a direct reflection of the fact that the university, primary industry and secondary industry spin-off firms have a tendency to occupy different positions along the business activity spectrum. It is reasonable to expect that the percentage of firms reporting production and general management experience would increase in moving across the table from university to secondary industry spin-offs. This is almost analogous to moving along the business activity spectrum from research and development, testing and consulting to a standard product and service orientation.

When the employment experience of the principal founders and initial employees is examined as two individual groups (see Appendix Table C-4), somewhat similar trends can be observed. With the exception of the technical skills and marketing or sales experience, the secondary industry spin-offs reported a broader range of business experience among the principal founders than university and primary industry spin-offs. Without exception they also showed a greater tendency to supplement and balance this experience with other employees. The trend in the percentage of the different types of spin-off firms reporting business skills among the principal founders is also consistent with the data previously reported on the number of

jobs held by the technical entrepreneur. The technical entrepreneurs of primary and secondary industry spin-off firms reported a greater amount of prior employment experience before starting their firms. It is only natural to see this reflected by the existence of a broader range of business skills in the spin-off firm.

Initial business orientation. Further insight can be obtained into the distribution of business skills in spin-off firms by cross tabulating the data with a different explanatory variable. Table 7 shows the combined employment experience of principal founders and other employees present in spin-off firms at the time of founding by initial business orientation. Again some interesting overall trends can be observed in the data. In moving along the business activity spectrum from a research and development, testing and consulting orientation to a standard product and service orientation, the percentage of firms reporting the presence of the different business skills (with the exception of accounting or finance) in the organization at the time of founding increases. As might be expected, the trend is quite dramatic for the presence of production experience, but a similar trend is also noted for general management and marketing or sales experience. Perhaps the most important conclusion to be drawn from the

TABLE 7

Employment Experience Present at Time of Founding by Initial Business Orientation
(Percent of Firms Mentioning Each Type of Employment Experience)

	Initial Business Orientation		
Type of Employment Experience	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Research, development or engineering	100.0	100.0	100.0
Production	13.1	41.7	64.7
General management	39.1	52.8	64.7
Accounting or finance	30.4	38.9	23.5
Marketing or sales	39.1	41.7	52.9
Number of firms	23	36	17

table is that these different types of business activities may require entirely different business skills for their successful performance by the firm.

The Financial Resources

The conceptual model being developed indicated that in addition to entrepreneurial talent and transferred technology, the financial resources transferred to the new firm were an important aspect of the formation process. Although the original research was not explicitly designed to provide an extensive survey of initial financing or sources of venture capital for spin-off firms, some limited secondary data were available to help focus this aspect of the study.

The capital required to initially finance a new science-oriented enterprise is a combination of various needs.[4] In the case of a spin-off firm planning to manufacture a standard product or a group of related products in large quantities, the required capital is determined by the need for a physical plant, equipment, labor and the materials necessary for production. In a research and development firm the requirements are reflected in the need for physical facilities and equipment to investigate and hopefully apply a new scientific

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[4]Clark E. Chastain and Marvin G. DeVries, Financing in Michigan (Ann Arbor, Mich: Institute of Science and Technology, University of Michigan, 1966), p. 4.

principle.

The sources of capital available to the new spin-off firm to finance business operations consist of current liabilities in the form of short-term credit, long-term borrowing and stockholders equity.[5] However, all three sources were not utilized by spin-off firms because they generally weren't available. The sources used depended on the nature and scope of the firm's business activity. The capability-oriented firms such as those engaged in research and development, consulting and custom products and services, typically relied on stockholders equity or loans from non-institutional investors to initially finance the firm. Financing was usually difficult to secure because of the risk involved in the venture and the absence of an asset base. The product-oriented spin-offs planning to conduct a manufacturing operation were able to tap all three sources of capital to some extent because of the lower risk involved and the prospect of a quicker financial return. However, even in the majority of these firms, equity capital appeared to be the most important source of initial financing.

Only data pertaining to the use of equity financing were obtained during this research. The findings, based on 21 firms

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[5]Ibid.

studied, tend to suggest that both the availability and requirements for equity financing vary with the nature and scope of the firm's business activity. Table 8 gives a tabulation of paid-in capital at the time of founding for 21 spin-off firms classified by their major area of business activity.

Despite the small number of observations, the trends in the data are quite clear. The percentage of spin-offs reporting an initial paid-in capital of $10,000 or more increases as the business activity of the firms changes from a capability to a standard product and service orientation.[6] Two variables would seem to explain this trend. First, the amount of initial financing required to establish and operate a research and development or consulting firm, for example, is considerably less than the initial investment necessary for a firm planning to manufacture a product. This is a reflection of differences in the extent of required facilities, equipment, personnel and working capital. Second, most investors and financial institutions perceive a greater amount of business risk associated with a capability-oriented business such as research and development. Equity capital for initial financing is more difficult to secure because of the uncertainty

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[6]Because of the previous relationship established between university, primary industry and secondary industry spin-offs and the firm's initial business orientation, a relationship similar to that shown in Table 8 was found between the amount of paid-in capital and the type of spin-off firm. It is illustrated in Appendix Table C-5.

TABLE 8

Paid-in Capital at Time of Founding by Initial Business Orientation of Spin-off Firm
(Percent of Firms Reporting Each Range of Paid-in Capital)

Paid-in Capital at Time of Founding	Initial Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
$0-9000	37.5	28.6	16.7
$10,000 and over	62.5	71.4	83.3
Total	100.0	100.0	100.0
Number of firms	8	7	6

surrounding profits and the eventual development of an asset base. These conclusions are partially supported by previous research. Chastain and DeVries reported in their comparative study of R & D and new manufacturing firms that 57.8 percent of the new manufacturing firms found debt and equity capital readily available, while only 33.4 percent of the R & D firms reported a similar situation.[7]

The research findings would appear to have particular significance for those capability-oriented spin-off firms planning to change the nature of their business by the eventual development of a line of products and services. Because of the difficulty of securing adequate initial financing (particularly for the planned activity) the innovation process becomes even more time consuming and perilous. Innovative opportunities are frequently not fully developed or exploited because of inadequate working capital to finance the technical effort and commercialization.

The Significance of Technology Transfer

Because technology is transferred and acquired through a variety of mechanisms and channels, the concepts of technology transfer are not highly formalized. Technology is frequently defined in the context

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[7]Chastain and DeVries, Financing in Michigan, p. 11.

in which it is used. Consequently, many viewpoints exist. The most inclusive views technology as nothing more than scientific and technical information.[8] A more restrictive, but related, definition treats technology as an organized and systematized way of doing things derived from rational principles.[9] Technology, as used here, is viewed broadly to consist of a continuum of technical information. One extreme consists of scientific and technical knowledge which makes possible the conception, development and design of products, services and processes. The opposite extreme is highly refined technical information about the engineering, production or provision of specific products, services and processes.

Technology transfer by the spin-off process begins when technical information is transferred by an entrepreneur from a source organization to become part of the resource base required for the formation of a new business enterprise. The transfer is completed when actual utilization of the technology takes place. In the spin-off firms studied, utilization occurred over a period of time starting with evaluation during the pre-formation stage when the entrepreneur

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[8]John S. Gilmore et al., The Channels of Technology Acquisition in Commercial Firms and the NASA Dissemination Program, Contractor's Report prepared by the University of Denver Research Institute for the National Aeronautics and Space Administration (Washington, D. C.: Clearinghouse for Federal Scientific and Technical Information, June 1967), p. 7.

[9]Harvey Brooks, The Government of Science (Cambridge, Mass.: MIT Press, 1968), p. 255.

and his associates were formalizing the firm's business objectives, and ending with a satisfied market need or the solution to a difficult technical problem. The minimum requirements for the utilization of the technology require evaluation of the technical information in a proposed use but not necessarily application. In many of the spin-off firms studied application eventually took place, but it was often indirect or of minor significance to the final innovation.

The Extent of Transfer

An attempt was made to understand and assess the significance of transferred technology in the formation process. Respondents to the mail questionnaire were requested to indicate the extent to which the technical employment experience and knowledge of the principal founders contributed to the development of the firm's initial product, service or capability. The results, shown in Table 9, indicate that almost 84 percent of the firms responding to this question felt that the technical employment experience and knowledge of the founders led directly to the technical development. By area of technology this included 100.0 percent of the responding firms involved in optics and electro-optics, 75.0 percent in computers, 91.6 percent in materials, 75.0 percent in electronics, 100.0 percent in electromechanical equipment and 83.4 percent in consulting and the miscellaneous areas of technology.

TABLE 9

Importance of the Principal Founders' Technical Employment Experience and Knowledge in the Development of the Firm's Initial Product, Service or Capability

Degree of Importance	Number of Firms Reporting	Percentage of Firms Reporting
It led directly to the technical development	62	83.7
It contributed somewhat to the technical development	7	9.5
It contributed only slightly to the technical development	3	4.1
It was not related to the technical development	2	2.7
Total	74	100.0

Because of the small number of firms falling in certain areas of technology (computers, for example) definite differences in the importance of transferred technical information to the new firm were difficult to identify. Perhaps of most significance is the result that of the 12 respondents reporting that the technical knowledge and experience of the principal founders contributed only indirectly or was not related to the firm's initial technical development, 8 were primarily involved in electronics.

Combining the data of the 12 firms reporting less than a direct transfer of related technical knowledge and employment experience makes it possible to cross tabulate the responses with the firm's initial business orientation. This tabulation, illustrated in Table 10, indicates that for the firms studied the importance of the technical experience and knowledge of the principal founders depends on the nature of the spin-off's initial business activity. In general, this knowledge and experience is less important for standard-product-and-service-oriented firms than capability-oriented firms.

In the standard products and services category, five of the six spin-offs (29.4 of the 35.3 percent) reporting that the principal founders' technical experience and knowledge was indirectly related or not related at all to the firm's initial technical development were

TABLE 10

Importance of the Principal Founders' Technical Employment Experience and Knowledge in the Development of the Firm's Initial Product, Service or Capability by Initial Business Orientation
(Percent of Firms Reporting Each Degree of Importance)

	Initial Business Orientation		
Degree of Importance	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
It led directly to the technical development	100.0	82.9	64.7
It was indirectly or not related to the technical development	. . .	17.1	35.3
Total	100.0	100.0	100.0
Number of firms	22	35	17

involved in electronics.[10] With one exception the technology used in the products of these firms was not as sophisticated as that used by most of the other firms in this area of technology. This partially explains the smaller degree of reliance placed on the technical background of the founders. The balance of the difference is explained by the fact that all but one of the firms in this category acquired the necessary technical expertise by purchasing the assets of an existing business or by hiring experienced employees at the time of the firm's formation.

By comparison, 82.9 percent of the custom product and service spin-offs reported a direct technical contribution by the principal founders to the initial development. The balance of the firms (17.1 percent) in which the founders technical background was not directly related to the initial product or service represented five different areas of technology, but electronics again accounted for the majority of the six firms in this group. The major difference in the spin-off hiring in this category was that only one of the firms acquired the necessary technical experience from an alternative source. The remaining firms utilized neither the hiring nor the acquisition process to build

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[10]Three of these firms were secondary spin-offs. Aside from this cluster of firms, a similar cross tabulation of the responses on the transfer of technical information showed only a weak relationship to the type of spin-off firm.

the initial technical base of the business. These spin-offs clearly started business operations with less transferred technology. It is apparent that in addition to the spin-offs' principal founders, other important methods of technology acquisition are utilized by many firms. When these are all considered, 92.2 percent of the 76 firms investigated in this study were able to acquire, at the time of formation, the technical expertise that led directly to the development of their initial product, service or capability.

The Type of Transfer

In addition to these findings, personal interviews were also designed to further probe the circumstances surrounding technology transfer. These research findings would suggest a potential difficulty in assessing the significance of technology transfer, particularly in the capability-oriented firms. In these businesses the transfer often involves general engineering concepts or principles in a certain area of technology. Here it becomes extremely difficult to measure the extent of application to the firm's first technical development in spite of the fact that the business probably could not exist without it. This suggests that a related problem in assessing the importance of technology transfer lies in the variable nature of the technology itself. Sumner Myers puts this aspect

of the problem into focus when he states:

> Horizontal transfer often involves specific hardware or "frozen information." But a good deal of intermediate information is also transferred in the abstract form.[11]

Myers' statement confirms previous remarks that technology falls across a broad continuum. It consists of undeveloped scientific information at one extreme and highly developed technical information related to specific products, services or processes at the other. When evaluating the impact of technology transfer on the spin-off firm, the nature of the technology transferred must be considered in relation to the scope of the firm's business activity.

During the field interview phase of the research, each of the 32 firms contacted were classified into one of two possible categories which were used to describe the technology transferred to the new firm. One category described situations in which the technical information transferred consisted only of general scientific and engineering knowledge, design principles or concepts, and problem-solving techniques. Another included transfer situations in which the technology was directly related to the manufacture and provision of specific products or services or the development of a

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[11]Sumner Myers, "Summary of the Proceedings," Proceedings of a Conference on Technology Transfer and Innovation, NSF 67-5 (Washington, D.C.: Government Printing Office, 1967), p. 2.

specific manufacturing process.

Table 11 shows the technology transfer categories and cross tabulates the data by the spin-off's initial business orientation. The interviewed firms who were found to be initially engaged in research and development, testing and consulting, were most frequently the same firms transferring general scientific and engineering knowledge. The research and development firms often transferred scientific knowledge from new and undeveloped fields of technology where much of the application work was in the preliminary stages. By comparison, the engineering consulting firms were marked by the transfer of general engineering skills, design concepts and analytical techniques for solving certain kinds of problems. These firms, although technology oriented, were often working in more than one area of technology and using knowledge from a broad range of disciplines. They differed from the research and development spin-offs by their broader problem-solving orientation.

One industry research and development firm in Table 11 transferred technology related to a specific service. Because the technology and concepts were extremely new, the firm spent the first year of operations performing the necessary research and development. The firm financed this technical effort by doing engineering consulting, but within a year the business activity of the firm changed to a standard service operation.

TABLE 11

Type of Technology Transferred to Spin-off Firms by Initial Business Orientation
(Percent of Firms Falling in Each Category)

Type of Technology Transferred	Initial Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
General scientific and engineering knowledge	87.5	50.0	16.7
Specific product, service or process knowledge	12.5	50.0	83.3
Total	100.0	100.0	100.0
Number of firms	8	18	6

The custom product and service firms interviewed were evenly divided on the type of technology transferred to their businesses. Some of the firms were the typical "job shop" operations, while others were manufacturing a specific line of custom equipment for applications where a high degree of standardization was not possible. The job shops transferred only general engineering and design knowledge and were often involved in the manufacture of custom electronic instruments and controls. The other spin-offs transferred technology related to the engineering design and fabrication of one type of equipment. In these firms there was a definite trend toward some standardization through the use of common parts, similar designs, and manufacturing techniques. Many of the firms in this group eventually progressed to a standard product orientation.

Spin-off firms that began operations with a standard product or service were most often the same firms that transferred technology related to these specific items. Usually the firm's technology was well developed and this facilitated the development and market acceptance of standard products for large volume applications. Many of these spin-offs began in business by imitating or slightly improving the products or services marketed by the source organization. Industry spin-offs engaged in some aspect of electronics comprised over 50 percent of these firms.

An Integration of Concepts

The technology diffusion patterns shown in the previous chapter (see Table 4) suggested that most of the new technologies investigated tended to diffuse from the university spin-offs to the primary industry spin-offs and finally to the secondary industry spin-offs. To a large extent this explains the initial position of the different types of spin-off firms along the business activity spectrum. University spin-offs tended to transfer new, undeveloped technologies and were most frequently involved in consulting and research and development. A majority of the primary industry spin-offs engaged in custom product and service work transferred engineering and design principles from somewhat better developed areas of technology. The largest percentage of secondary industry spin-offs worked in the well developed areas of technology, transferred specific product, service or process information and clearly tended to cluster at the standard product and service end of the spectrum.

The relationship between the type of technology transferred and the type of spin-off firm was confirmed by field research (see Appendix Table C-6). Over 77 percent of the university spin-offs were found to transfer general scientific and engineering knowledge to their new business compared to 66.7 percent of the primary industry spin-offs and 12.5 percent of the secondary industry spin-offs.

This finding integrates the concepts developed and establishes the significance of technology transfer in the formation process.

The Significance of Market and Marketing Knowledge

Market Knowledge

While the transfer of technology was an important factor in the formation and initial technical development of a large percentage of spin-off firms, it was hypothesized that part of the motivation for their formation was supplied by the existence of prior market knowledge which indicated a possible application for the technology. As a group, a high percentage of the firms contacted in the field interview phase of the research reported market contact of an informal nature prior to starting business operations. However, they were not inclined to seek outside marketing assistance or perform formal market analysis prior to making the decision to start their firm.

Analyzing the market opportunity. Support for the previous statements comes from extensive field interviews with the principal founders of 32 spin-off firms.[12] The technical entrepreneurs of 28 or 87.5 percent of these firms reported some market contact

[12]All of the data reported in the text and tables of this section were derived from personal interviews.

related to the proposed business venture prior to starting business operations. In most cases it was highly informal—contact with friends and business associates in other technology-oriented businesses, occasional contact with potential customers, a casual review of the trade literature and communications with colleagues at professional society and trade association meetings.

By comparison, a formal approach to the collection of market information was quite rare. Only 12.5 percent of the firms interviewed sought outside marketing assistance, while 22.0 percent performed their own market analysis. Generally the studies were highly informal and were oriented to the identification of markets and potential customers, forecasting sales volume, and determining the time required to achieve market acceptance and penetration. A variety of techniques were used, but some of the most sophisticated and apparently successful included a probabilistic approach to determining the expected value of the first year's sales volume. Other studies were concerned with evaluating the strengths and weaknesses of competitive products, investigating methods of market representation and distribution, obtaining pricing information and determining the specific requirements of potential jobs.

A large number of studies were performed to confirm the presence of a market demand for a product, service, or capability that already existed or was quite well formalized prior to the firm's

formation. While this approach might be criticized, it was usually necessary because of the firm's heavy reliance on one particular area of technology.

Examination of the information seeking behavior of the interviewed firms revealed that only slight differences existed between the type of spin-off or the firm's initial business activities. In general, the secondary industry spin-offs showed a tendency to perform less market analysis prior to their formation than the primary industry and university spin-offs. This finding was probably a reflection of the fact that most of the technical entrepreneurs had been in a similar type of business before and knew the markets and potential customers.

The market knowledge acquired. Prior to conducting the research, it was hypothesized that marketing played a small role in the initial formation process, but assumed greater importance as the spin-off firm developed. A related postulate suggested that market information rather than knowledge of marketing functions or techniques plays the more important role during the formation process.

An indication of the significance of market knowledge to the formation of spin-off firms was provided by the field research

which showed that 93.8 percent of the firms interviewed were aware of a market need or unsolved problem prior to the formation of their business. Further, 75.0 percent of the firms were aware of specific customers or market segments for their intended products, services and capabilities and 84.4 percent of the firms were aware of potential competition. Beyond these overall conclusions, some rather interesting differences were noted among the spin-off firms engaged in the various areas of business activity. Table 12 highlights these differences by showing the types of market information available to spin-off firms (classified by initial business orientation) prior to starting business operations, With the exception of two research and development firms, most of the spin-offs had clearly established the existence of a definite market opportunity prior to starting business operations. In a few cases the information was rather general, but overall, most of the firms interviewed had established either the existence of a demand for their firm's initial market offering or the possibility of creating such a demand.

The founders interviewed were also questioned to further determine the amount of market information available prior to the formation of their firms. When asked if they were aware of specific customers or market segments for the application of their firm's technology, only the founders of standard product and service firms

TABLE 12

Summary of Market Information Available to Spin-off Firms Prior to Starting Business Operations by Initial Business Orientation
(Percent of Firms Mentioning Each Type of Market Information)

Type of Market Information	Initial Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Knowledge of market need or unsolved problem	75.0	100.0	100.0
Knowledge of specific customers or market segments	62.5	72.3	100.0
Knowledge of competition	62.5	89.0	100.0
Information about market requirements	50.0	94.5	100.0
Existence or promise of orders or contracts	37.5	33.3	66.7
Number of firms	8	18	6

responded entirely in the affirmative. As shown in the table, correspondingly smaller percentages of the custom product and service firms and research and development, testing and consulting firms were aware of specific customers. This declining trend is a direct reflection of the fact that these firms were often operating in the newer areas of technology. Many of the applications of technology made by the university and primary industry spin-offs that tended to engage in these business activities involved new innovations in existing or entirely new markets. Under these conditions it was considerably more difficult to define specific customers (see Appendix Table C-7).

Prior knowledge of competition and information about market requirements was also obtained by most of the product-and-service-oriented spin-offs. The firms manufacturing standard products, in particular, were keenly aware of competition and market requirements. This reflected the fact that their products were usually designed for existing markets in which similar competitive items were already available. However, many research and development and consulting firms and a few of the custom product and service firms had difficulty defining competition and market requirements because they varied from contract to contract depending on the customer and the problem. Initially, most of the firms were aware

of nearby businesses having a technical capability similar to theirs, but they were not always regarded as direct competition. In fact, many of the capability-oriented firms perceived little or no direct competition in their field of interest and this clearly motivated the formation decision. The market requirements were even more difficult for the capability-oriented firm to define prior to beginning business. They were vague because of the absence of standardization and the variety of different technical problems that offered the possibility of future business. They usually consisted of acceptable design procedures, the standards of various technical associations and most of all, customer satisfaction.

The existence or promise of orders or contracts was perhaps the ultimate in market information. On more than one occasion it was the most important information used to justify the formation of a spin-off firm. Standard product and service firms had a distinct advantage in this area because some of the primary and secondary industry spin-offs carried business from the source organization over to the new firm. The prior business experience and customer contacts of the entrepreneur proved invaluable to these firms in reducing the uncertainty surrounding the business venture. It should be noted, however, that many of the industry spin-offs took pride in the fact that they did not actively solicit business until their relationship with the source organization was completely severed.

University spin-offs formed by entrepreneurs who were previously involved in consulting activity also reported a high frequency of orders or contracts (see Appendix Table C-7) prior to formally starting business operations. The opportunity to carry this business over to the new firm as a source of revenue during the first few years gave these spin-off firms an important advantage often not available to their industry counterparts. Some of the university spin-offs involved in research and development, consulting and custom work spent the first year of business operations transferring these accounts over to the new business.

Some concluding observations. It seems apparent that market information, along with transferred technology is a crucial resource in the formation process. Most of the firms interviewed actively sought and analyzed some information prior to making the decision to form a spin-off firm. In some of the businesses it was used as the primary justification for the formation decision. The findings, summarized in the overall statistics presented for the field interview sample (see page 104), as well as in Table 12, strongly support the postulate that market information plays an important role in the formation process.

Unfortunately, the quality of market information was not always

good and the quantity was usually not sufficient. This is supported by the fact that of the firms who were aware of specific customers, fewer than 30 percent actually ended up doing business with these same firms. Of those that did, the volume of business usually turned out to be much smaller than expected and of inconsequential significance to the firm. In the words of one founder, "it was hardly enough to sustain even a small scope of operations."

The initial market opportunity, while correctly perceived, was also frequently disappointing. In product-oriented firms it was often based on a technical improvement or variation in the performance of an existing product that resulted in an advantage in a particular application or market segment. The failure or inability of the entrepreneur to quantify this market opportunity often meant that the first products were developed for markets that were not sufficiently large to permit a profitable level of operations.

Marketing Knowledge

Marketing knowledge in contrast to market knowledge is represented by an awareness of the marketing functions that must be performed by the spin-off firm to create and satisfy market needs. During the formation process, marketing knowledge is transferred to the spin-off firm by acquiring personnel having educational and/or business experience in the selling, promotion, pricing and distribution of

products, services and capabilities having a high technology content. Its significance to the spin-off firm is derived from the fact that it provides the motivation and direction to convert market knowledge into useful products and services.

Some data on the presence of marketing experience in the spin-off firm was presented in the discussion which assessed the transfer of business skills to the new firm. This section further considers the relative importance of marketing in the formation process and completes the evaluation of the postulate previously stated.

The research data strongly supported the role of prior market knowledge in the decision to start a spin-off firm. Almost 94 percent of the firms were aware of a market need or unsolved problem and 75.0 percent were aware of specific customers prior to the formation of the firm. Empirical support for the significance of marketing knowledge in the formation process is not as strong. Overall, only 36.8 percent of the 76 firms responding to the mail questionnaire indicated the presence of this business skill among the principal founders when they originally started operations. Some firms apparently recognized this deficiency and remedied it by supplementing the founder's skills with those of other employees. The percentage is increased to 43.4 percent when the marketing experience of other employees present when the firm initially started business is included.

Influence of classification. One classification variable previously shown to be related to the presence of marketing knowledge or experience at the time of founding was the type of spin-off firm. In Table 6 it was shown that 50.0 percent of the secondary industry spin-offs and 48.8 percent of the primary industry spin-offs reported marketing experience among the principal founders and employees compared to 28.6 percent of the university spin-offs. Most of this difference can be attributed to the source organization. It has already been demonstrated that entrepreneurs coming from a university environment had less practical business experience to transfer to their firms than those entrepreneurs coming from industrial organizations. Because many of the university spin-offs were initially engaged in research and development and consulting, the entrepreneurs were also less inclined to perceive an immediate need for marketing experience.

To a somewhat smaller degree the firm's business orientation was also found to be related to the existence of marketing experience at the time of founding. As previously indicated in Table 7, the standard-product-and-service-oriented firms showed a greater tendency to have marketing experience present than the capability-oriented businesses. The secondary industry and primary industry spin-offs falling in this category account for the difference. Only one of four university spin-offs initially classified in the standard product and

service category reported marketing experience at the time of the firm's formation.

Number of principal founders. A somewhat obvious relationship between the number of principal founders and the presence of marketing experience in the firm was also found. Of the spin-off firms having five or more principal founders, 89.0 percent reported marketing experience at the time of founding. As the number of principal founders declined, so did the percentage of firms reporting marketing experience. Only 34.8 percent of the spin-offs having 3 to 4 founders and 29.6 percent having 1 to 2 founders started business operations with some formal marketing experience. This research finding is a reflection of the fact that the greater the number of individuals involved in the formation process, the better the chance of having a broader range of business experience in the firm. In many cases this relationship occurred entirely by chance. In others the technical entrepreneur realized the need for business experience and actively sought others to participate in the venture to provide a balanced array of skills.

Relevance of initial markets. It was also theorized that the principal founders might anticipate the markets in which they planned

to do business and then select the necessary balance of marketing skills for the firm to reflect the nature of the selling job. To examine this possibility, each firm was classified according to whether they derived the majority of their first year sales revenue directly or indirectly from government agencies or from non-government commercial customers. Then each firm was examined for the presence of marketing experience. No overall difference was found between the source of first year business and the presence of marketing experience in the firm. However, when the university and industry spin-offs were examined as separate groups (see Appendix Table C-8), some differences were found. The primary and secondary industry spin-offs reporting their major source of first year business as non-government commercial showed a greater tendency to have marketing experience present in their firms at the time of founding than the industry spin-offs who reported their primary source of first year business as directly or indirectly from government agencies. In the case of the university spin-offs, just the opposite trend was noted. The university spin-offs who reported a majority of their first year business directly or indirectly from government agencies were more inclined to have marketing experience present in their firms than the university spin-offs doing a majority of their business with commercial customers.

Relation to technology transfer. An attempt was also made to examine the possibility of a relationship between the extent of technology transfer to the new firm by the principal founders and the presence of marketing experience in the firm at the time of founding. Such a relationship was appealing because it could be theorized that the firms formed by an extensive transfer of technical knowledge might have a tendency to rely less on marketing experience during the first few years of development. There was a slight trend in the data to indicate some support for the theory, but the differences were not of such a magnitude to be of much significance.

Confirmation by field interview. The field interview phase of the research also provided an opportunity to evaluate the significance of marketing in the formation process. During the field interviews the principal founders were asked how they visualized the marketing requirements for the product, service or technical capability they planned to sell. Each firm's response was then subjectively evaluated with respect to the type of effort required for effective marketing. The results confirmed those of the mail questionnaire. Only about one-third of the firms interviewed had really given careful consideration to the nature of the marketing job that would eventually be required by their firm. Answers such as "I didn't," "I thought I would do it," and "we thought we could eventually get someone else

to do it," were typical of many firms who started business without even a casual consideration of the requirements for marketing.

It is interesting to note that many firms were started without even the intention of developing a marketing capability. A typical strategy in product-oriented firms was to license the manufacturing rights or manufacture for another firm who would assume the marketing responsibility. In many cases, the financial resources available to the firm made this approach imperative, while in others it was viewed as the quickest way to put the firm on a profit-making basis. The end results were usually the same. A few years later the spin-off was closely tied to one customer for the majority of its sales volume. The firm's technical position was vulnerable because in many cases the concern doing the marketing also had developed the capability to manufacture the product. The greatest weakness, however, was the absence of market control. The spin-off had no franchise in the market and sooner or later management was faced with the decision of whether or not a continuation of the relationship was in the best interest of the company. In many cases it wasn't and the spin-off was confronted with the almost prohibitive cost of establishing a stronger market position.

A Conceptual Summary

The relationship between the business activity spectrum and the positions occupied by the different types of spin-off firms established the structural framework for a conceptual model. Figure 3 further develops the model and incorporates the analysis of the transferred resources and their significance to the spin-off formation process. The following summary is related to this figure.

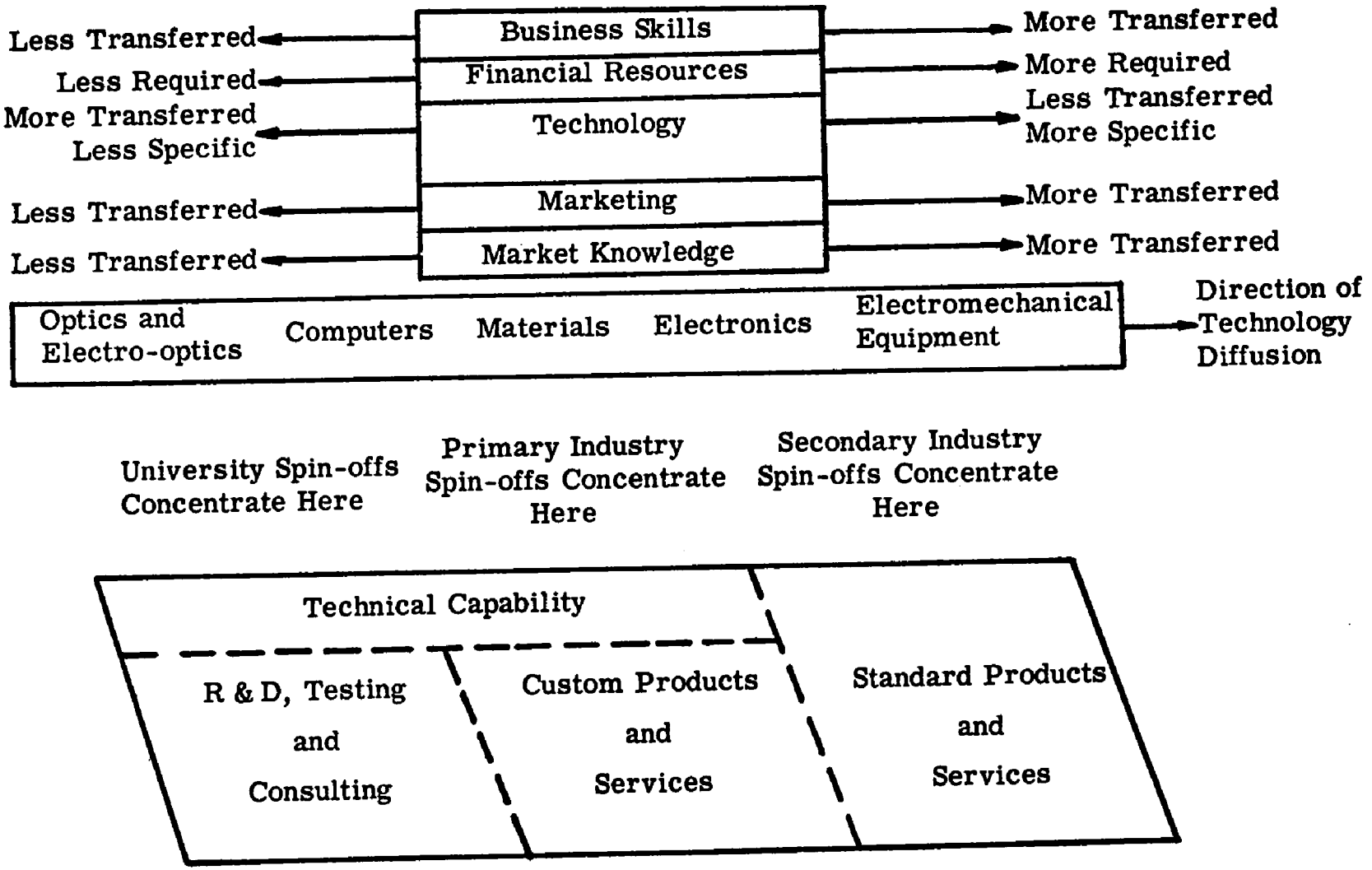
Both the educational level and the previous employment experience of the technical entrepreneur were found to be directly related to the earlier development of the model. In moving from university spin-off firms initially having a research and development orientation, for example, to secondary industry spin-offs having a standard product and service orientation, the level of educational achievement declined while the amount of previous job experience increased.

Similarly, the transfer of business skills assumed less significance for research and development, testing and consulting spin-offs than for spin-offs initially engaged in a standard product and service activity. In a similar fashion they were clearly transferred less frequently during the formation of university spin-offs and more often in the formation of secondary spin-offs.

It was theorized (and supported by empirical evidence) that both the availability and the requirements for equity capital were related

Figure 3

Relationship of the Transferred Resources to the Conceptual Model



to the firm's initial position on the business activity spectrum. Research and development firms usually required less equity capital for initial financing but found it difficult to secure. Standard product and service firms required larger amounts of equity capital but by comparison found it easier to obtain.

Technology transfer from several sources was found to play an important role in the spin-off process. In addition to direct transfer from the source organization by the technical entrepreneur, technology was also acquired by purchasing the assets of other spin-off firms and by hiring employees knowledgeable in certain fields of technology. Both the nature and extent of technology transferred by the different types of spin-offs was found to be related to the firm's initial business activity. The principal founders of spin-offs engaged in research and development, testing and consulting were found to transfer more technology than the founders of primary and secondary industry spin-offs, but the transfer was more likely to consist of general scientific and engineering knowledge. By contrast, secondary spin-offs appeared to rely less on the technical contributions of the principal founders, but the technology transferred was usually related to the specific products, services and processes.

Market information was found to be of greater significance in the formation process than the existence of prior marketing knowledge as represented by the formal educational and employment

experience of the principal founders. Most entrepreneurs collected market information prior to the formation of their firm, but it was often insufficient and did not adequately define the nature of the business opportunity available. The existence of prior marketing experience did not always mean that the firm had the capability to market successfully. A number of instances were observed where the change in context from a large well-financed organization, to a small inadequately financed firm, made the previous marketing experience of the founders extremely difficult to apply. In general, both the quality and quantity of prior market information and marketing knowledge increased in moving from the spin-off firms at the research and development end of the spectrum to the firms at the standard product and service end.

CHAPTER IV

The Innovation Process

An Overview

In the formation stage of the spin-off firm, the technical entrepreneur and the principal founders usually have one basic idea or concept to which they are committed.[1] Often a large part of the first year of the spin-off's operations is devoted to exploring and defining in greater detail the necessary technical and market requirements so that the idea can be commercially developed.

Innovation describes the process of developing and transforming an idea or concept into use.[2] In the spin-off firm this transformation occurs in a variety of different ways, but it usually involves an ordered sequence of technical activities. A discussion of the innovation process and the technical activities are an important part of this chapter.

Successful innovation results in new products, services and processes which can change the nature and scope of the spin-off's business activity. Beyond the beneficial impact on the firm's sales and employment growth, innovation can also change the nature of the

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[1]U.S. Department of Commerce, Technological Innovation: Its Environment and Management (Washington, D.C.: Government Printing Office, 1967), p. 21.

[2]Ibid., p. 2.

firm's market and competitive environment. The balance of this chapter is devoted to evaluating some of the implications of successful innovation for marketing. This discussion provides a natural transition for the three chapters on marketing which follow.

Definition and Concepts

In the broadest sense, innovation is defined as all the activities engaged in by a business enterprise in translating an idea or concept into the economy.[3] For the spin-off firm, the scope of this definition is too broad. Because of limited financial and human resources the innovative activities of the spin-off firm are primarily technically oriented. The innovative process can be viewed as a sequence of technical activities performed by spin-off firms in the development and transformation of technology. Although the sequence in spin-off firms is not always well ordered, it is clear that it extends from research to market development and that innovative ability and transferred technology are the two critical inputs.

Ellis Mottur's conceptual model of the processes of technological innovation suggests that while innovative events are usually complex, creative and unpredictable, they often constitute "a set of interrelated processes rather than a collection of disconnected

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[3]W. Paul Strassman, Risk and Technological Innovation (Ithaca, N.Y.: Cornell University Press, 1959), pp. 9-10.

activities."[4] The model is built on the concept that innovation can occur when four major interrelated modes of technological activity interact with the firm's goals, resources and technological knowledge. These related functions, as defined by Mottur, represent a spectrum of overlapping activities through which technology passes as it is developed and transformed into an innovation. They include basic and applied research, invention and development, engineering, and operations.[5]

It was believed that some of the model's concepts could be applied to identify the presence of innovative activity in the spin-off firms studied. Preliminary research indicated that the spin-off firms involved in innovation were the same firms that reported the performance of a broad range of technical activities similar to those suggested by the model. However, it seemed clear that not all spin-off firms could be classified as innovators. Some firms defined their business to include the performance of only one technical activity such as research and development, engineering design, or testing. Their function was essentially one of providing technical resources as inputs to the innovative sequence of the customer's organization.

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[4]Ellis Mottur, The Processes of Technological Innovation: A Conceptual Systems Model, Report prepared for the National Bureau of Standards and the U.S. Arms Control and Disarmament Agency, NBS Report 9689, March 15, 1968 (Washington, D.C.: National Bureau of Standards, 1968), pp. 11-12.

[5]Ibid., p. 37.

Surprisingly, a number of these firms were identified by the mail questionnaire.

Examples of Innovation

During the conduct of the field research, Michigan spin-off firms were identified with a number of product, service and process innovations. Product innovations were the most common, and a number of examples were observed where electronic instruments having unique design and performance characteristics found new uses in non-destructive testing, pollution control, oceanographic exploration and other applications.

A contract engineering firm (also a university spin-off) designed and fabricated an electronic code verification instrument to be used in the product packaging process of a large Michigan drug firm. Although the company lost money on the original engineering contract, the hardware concept was further developed into a standard product which the firm eventually began to market on a national basis. The success of this product initiated a search for similar applications in other industries. Some new uses for the technology were found in verifying the integrity of metals and testing metals for hardness. After a small amount of technical design modification, the company introduced two technology-related non-destructive testing instruments

to serve the newly discovered markets. These innovations occurred over a relatively short period of time. Their success was related to the ability of the entrepreneur to apply the new technology in a changed context.

Service innovations were less frequently observed. In one case, a unique service and technical management package was pioneered by an Ann Arbor spin-off firm specializing in the solution of transportation problems. For several years the firm worked on a new market segmentation approach to public transportation. The technical effort resulted in the development of a service designed to help medium-sized cities put public bus transportation back on a profit-making basis. The process started with a research study which became the basis for a program of action. Similar studies performed in other cities enabled the generalization of concepts and the evolution of a standard package.[6]

Process innovations were somewhat less common and usually more difficult to identify. Many were exploited internally by the firm in their own manufacturing operation and not sold outside. They were

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[6]In solving the problem, the spin-off firm also opened up several new applications for the electronic instrumentation used in implementing the proposed program. As is generally true in programs of this type, the sales revenue generated from the hardware will greatly exceed the revenue obtained from the sale of the service.

frequently described as a result of "being in business" despite the fact that they had a substantial impact on the firm's competitive position. These innovations included the development of entirely new manufacturing methods to produce plastic materials having unique physical properties and the development of new or improved techniques of manufacture resulting in substantial cost reductions for existing products.

The Innovation Sequence

Not all spin-off firms can be truly classified as involved in the complete process of innovation, although they make important contributions to the innovative effort of other firms. Some complete only part of the sequence, while others are content to do little or no innovation at all. These firms have explicitly defined their business as either consulting, research and development, testing, and contract engineering or manufacturing; and this philosophy pervades their organization. Many of the firms are in business for several years before taking advantage of innovation opportunities, while others refuse to exploit them or license them to others for further development. For those spin-offs that do aggressively innovate, the implications are clear. Continued success usually means the performance of a broad range of technical activities ranging from research and development to engineering and manufacturing. It also means change in the business orientation of the firm and major adjustments in the operating philosophy.

Initial Business Orientation

The mail questionnaire data indicated that from the very beginning of business operations a great many spin-off firms were involved in more than one aspect of the innovation sequence. Overall, 65 percent of the firms performed research and development, evaluation, and testing during the first year of business operations, while at the opposite extreme, nearly the same percentage of firms reported some manufacturing or service activity.[7]

The technical activities conducted during the first year of business operations were related to the type of business activity the firm engaged in. This relationship is illustrated in Table 13 for the 76 spin-offs responding to the mail questionnaire. The firms having a research and development or similar orientation were most often the same firms engaged in the performance of research and development, evaluation and testing. Exceptions included a few consulting firms who reported their technical activities as primarily engineering, as opposed to research. The smallest percentage of firms engaged in manufacturing or a related service activity were classified in this business activity category. Although the 39.1 percent reporting the manufacture of products or provision of services is small by comparison, it does

[7]The technical activities comprising the innovation sequence were aggregated into three major groups as shown in Table 13. Each group contains a logical and distinct portion of the sequence.

TABLE 13

Technical Activities Performed in Spin-off Firms During First Year of Business Operations by Initial Business Orientation (Percent of Firms Mentioning Each Activity)

Technical Activities	Initial Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Research, development, evaluation and testing	87.0	55.5	58.8
Engineering and prototype or pilot manufacture	69.5	72.3	70.6
Manufacture of products and provision of general services	39.1	75.0	100.0
Number of firms	23	36	17

indicate that many of the spin-offs had progressed completely through the sequence during the first year of operations.

An opposite trend exists for the product-and-service-oriented spin-offs occupying the other end of the activity spectrum. They all engaged in the manufacture of products or the provision of general services during the first year of operations, but were less frequently involved in the other technical activities. Only 58.8 percent performed research and development or related activity, and less than 71 percent performed engineering and prototype or pilot manufacture.

Many of the firms initially in this category were secondary spin-offs. It was not uncommon to find these firms well along in the engineering phase of their business at the start of operations and actively engaged in a manufacturing activity at the end of six months. One entrepreneur interviewed developed nine products during the first year of business. Prior to starting operations he had completed the design and much of the engineering for these products so that most of the first year of business was devoted to developing a manufacturing capability and organizing a distribution network.

The relationship between the technical activities performed by the spin-off firm and the business orientation of the firm is interesting in other respects. It has often been incorrectly assumed that all science-oriented spin-offs performed research and development regardless of the type of business the firm was engaged in.

This is not necessarily true during the early stages of development when working capital is tight. The spin-off emphasizes the activities that generate revenue and provide a source of cash flow for the business. In research-and-development-oriented firms this means the performance of contract research. In product-oriented spin-offs it means the manufacture and marketing of standard products.[8]

Type of Spin-off Firm

The relationship between the initial business orientation and the technical activities performed by the firm seems quite natural. Because of the close correspondence between the type of spin-off firm and the tendency to be involved in a certain type of business activity, a similar relationship might also be expected to exist between the different types of spin-off firms and the technical activities they perform. Some connection was found (see Appendix Table C-9) when the firms were reclassified to examine this possibility.

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[8]The reader should be aware, however, that due to the method of classifying spin-off firms in the business activity category which provides the largest proportion of their sales revenue, it is possible for spin-off firms classified as standard product and service oriented, for example, to generate some revenue from the performance of contract research or simply perform these technical functions as necessary support for the firm's major business activity. This accounts for the performance of all technical activities by many of the spin-off firms in this business activity classification.

The secondary spin-offs exhibited some unique characteristics. They were not only more often involved in the manufacture of products and provision of services during the first year of business, but like the university spin-offs they were also active in research, development and related activities. This trend, although obvious, is not easily explained. One possible reason for the difference might be related to the difficulty of entering a market already partially developed. Because the technology transferred by the secondary spin-off is frequently related to the products and services of the source organization, the initial business activity often consists of offering nearly identical items to the same markets. The problems of entering an established market, the presence of other competitive firms and the knowledge of opportunities for product improvement are reflected in a greater frequency of research, development and engineering activity. The financial resources to support this broader range of technical activity are also more likely to be available in these firms. As a result of their initial product and service orientation, secondary spin-offs are usually able to secure larger amounts of venture capital to fund the technical activities so critical to continued success.

Area of Technology

Spin-off firms were also classified by their primary area of technology and examined for differences in the performance of each

group of technical activities. It was believed that because each area of technology was in a different stage of technical development important differences might be found in the percentage of firms engaged in each different group of technical activities. A higher percentage of firms working in the areas where the technology was well developed and diffused (such as electromechanical equipment and electronics) might be expected to be involved in the manufacture of products than the firms engaged in the development of newer technologies such as optics. Similarly it was anticipated that a greater proportion of the spin-offs involved in the newer technologies such as optics and computers would be engaged in research, development, evaluation and testing. The distribution of the research data, shown in Table 14, indicates that differences by area of technology did exist but that there was no consistent pattern.

Two reasons seem to account for the absence of a consistent pattern in the data. First, although each firm could be easily classified by its major area of technology, the variations in the scope of possible business activity within each area were large. In computers, for example, both hardware and software firms were included. This contributed to the diversity within each technology area and tended to wash out any noticeable trends. Related to this reason is the continual emergence of new technical developments (microelectronics, for example) within each area of technology. These

TABLE 14

Technical Activities Performed in Spin-off Firms During First Year of Business Operations by Primary Area of Technology
(Percent of Firms Performing Each Activity)

Technical Activities	Primary Area of Technology					
	Optics and Electro-optics	Materials	Electronics	Computers	Electromechanical Equipment	Consulting and Misc.
Research, development, evaluation and testing	57.1	41.7	45.5	80.0	42.8	66.7
Engineering and prototype or pilot manufacture	71.5	41.7	84.8	60.0	100.0	66.7
Manufacture of products and provision of general services	71.5	66.7	78.8	80.0	57.1	33.3
Number of firms	7	12	33	5	7	12

developments also have a tendency to modify any uniform patterns that might otherwise exist in the data.

Technological Progression

The technical aspects of innovation have been related to three distinct groups of activity. Together they comprise an overlapping sequence ranging from research, development, evaluation and testing at one extreme to the manufacture of products and provision of general services at the other. Some combination of these technical activities is performed either sequentially or simultaneously by many spin-off firms as they transform technology into useful products, services and processes.

While the relationship between the technical functions performed and the spin-off's initial business orientation was strong, a significant number of firms in each business category were also engaged in all the areas of innovative activity. Product-oriented firms were found to be performing research and development, while consulting firms were often engaged in engineering and prototype work. The drive to undertake and perform technicial activities beyond the scope of the firm's initial business exists in many spin-offs. When it is intentionally supported and encouraged it results in new innovations and movement along the business activity spectrum.

Identifying Innovative Activity

A method of determining the presence of innovative activity in spin-off firms was needed to verify progression through the series of technical activities comprising the innovation sequence. Such a method was devised as part of this research. The firms surveyed with the mail questionnaire were presented with an array of the individual technical activities used to construct the groups previously shown in Table 14. Each firm was requested to check the technical activities they performed in their firm during the first year of business and in 1968, the last year of business surveyed. Tabulation of the responses resulted in a comparative technical profile which showed the change in the technical activities performed by the firm over a period of time and the direction of progression.

Over 80 percent of the firms responding to the mail questionnaire that had completed more than one year of business operations reported a change in the technical activities performed in their business. In many instances, the changes were dramatic. Research and development firms performing only contract research during the first year of operations were involved in engineering design, prototype fabrication and manufacturing operations two years later. Contract engineering spin-offs involved in prototype design the first year were found to be engaged in the complete sequence of technical

activities from research and development to manufacturing within a few years of their initial contract. Innovative activity was present in many of these spin-off firms and it was expressed in the rate and extent of their progression through the sequence of technical activities.

Table 15 illustrates the almost natural innovative tendency that exists in most spin-off firms. All of the firms in the table have completed at least two or more years of business operations and are classified according to the major area of their business activity during the first year of operations. A well-defined relationship exists between the technical activities performed and the firm's initial position on the business activity spectrum. However, as the spin-offs develop there is a natural tendency for the innovative firms in each group to perform a broader range of technical activities. This change takes place over a period of time and can be observed by comparing the technical activities performed by the spin-offs in each business area during the first year of operations and 1968.

The Dynamics of Innovation

The research and development, testing and consulting firms shown in Table 15 have completed an average of 5.8 years of business operations. The major change in the scope of technical

TABLE 15

Technical Activities Performed in Spin-off Firms During First Year of Business Operations and 1968 by Initial Business Orientation
(Percent of Firms Mentioning Each Activity)

	R & D, Testing and Consulting		Custom Products and Services		Standard Products and Services	
Technical Activities	First Year	1968	First Year	1968	First Year	1968
Research, development, evaluation and testing	84.3	89.5	57.7	65.4	50.0	83.4
Engineering and prototype or pilot manufacture	68.5	79.0	73.1	69.2	75.0	75.0
Manufacture of products and provision of general services	31.6	63.2	65.4	88.5	100.0	100.0
Average age of firms (years)	5.8		5.7		7.5	
Number of firms	19		26		12	

Excludes 4 firms acquired by merger and 15 firms completing only one year of business operations.

activities performed is marked by the increase in the percentage of spin-offs reporting engineering, prototype or pilot manufacture, and product or service activity. This progression through the innovation sequence occurs as the result of a variety of different circumstances, but in one frequently observed case the changes in the technical functions performed resulted from a follow-on contract to explore the engineering aspects of a problem solution suggested in the original research and development effort. The contract led to the fabrication of a prototype and then to the award of a competitively bid contract to manufacture a larger production order. The technical entrepreneurs responsible for these new products perceived well-defined development sequences spanning the full range of technical activity from research to the production of hardware. They typically included applied research and development, engineering and prototype fabrication and manufacture.

The innovation process is not always this well ordered even though the same technical activities are performed and progression takes place. Research and development firms often benefit from new innovations that "fall out" from the successful performance of previous contracts. A Detroit research and development spin-off designed and fabricated an electronic gas atmosphere controller to perform a government contract in the environmental and life sciences. After

completion of the research, the controller and the technology developed to perform the contract were further refined into standard products which found applications in aerospace and medical markets. A short time later, this same spin-off demonstrated the ability to apply the technology in a different context by developing an electronic controller for a broad range of industrial manufacturing processes.

The results of the successful performance of innovative activity were almost always the same. What originally was a capability-oriented research and development firm slowly changed to become a business oriented to the provision of products and services for large volume markets.

The 26 spin-off firms in Table 15 initially involved in providing custom products and services have completed an average of 5.7 years of business operations. It is not surprising that 73.1 percent of these firms performed engineering and related activities during the first year of business operations. Many of these firms developed their initial business by performing custom engineering design and fabrication to solve a specialized class of problems for individual customers. As they became established through the performance of many jobs in their area of technology, opportunities for technical innovations became obvious. In many instances the entrepreneurs began to see a common need in the problems they worked on which suggested the

opportunity to generalize the concepts and procedures developed to solve similar problems. Further repetition of the technical effort enabled the concept to be translated into routine design procedures and standardized components or subassemblies. Over time a generalized hardware package was developed for a successively broader range of applications. During the process, research and development and related technical activities were performed to refine the concepts and broaden the area of application.[9]

Sometimes the innovative opportunity was unrelated to the firm's business, but instead resulted from the interaction of a strong technical capability in one area of technology and frequent market exposure to unsolved problems. A Detroit area engineering firm (also a primary industry spin-off) engaged primarily in the design of electromechanical machine tools took advantage of a product opportunity by designing and manufacturing hardware to solve a problem that was common to many of their clients. Although the firm had not engaged in a product development and marketing effort before, the frequent client contact required

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[9]When the innovation pattern described above resulted in the development of a complex system or process (such as computer time-sharing or holography), new opportunities were also created by the demand for accessories or components to add flexibility to the major hardware or software system. Although the development of these new areas of business seemed like a natural progression for the spin-off, many completely overlooked them because of financial constraints. However, the opportunities did not go untouched. They were found to be an important source of business for the secondary spin-offs.

in the custom engineering business gave their engineers easy access to the problem and the market. The firm's president viewed this development as an opportunity to stabilize an historically fluctuating service business and provide his engineers with some new creative activity.

Firms initially starting business with a standard product or service were faced with the necessity of developing new products or services to broaden a line which usually started with one item. As business developed, it also became necessary to make technical improvements or modifications in existing products and services to develop new applications and remain competitive. The trend (shown in Table 15) toward a much larger percentage of the firms performing research and development, testing and evaluation during 1968 represents the changes reported by 12 spin-offs which averaged 7.5 years of business operations.[10]

For almost 60 percent of these firms the change in technical activities performed was marked by a movement toward a custom

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[10]In general, the pattern of technical progression in Table 15 which indicated an increase in the percentage of all firms performing research, development, testing and evaluation over the time period was a reflection of the financial ability and need to refine the product concepts and demonstrate technical feasibility. The overall impact on the firm was progression through the innovation sequence and movement along the spectrum of business activity toward the development of a line of proprietary items.

product and service or research and development orientation. Some of the firms moved back to contract research and development out of necessity because of unsuccessful product efforts after an initial success. Others developed and produced custom products for individual firms with the hope that additional customers and large applications would eventually be found.

Nearly all of the standard product and service spin-offs financed their own technical efforts during the first year of business operations. This partially accounts for only 50 percent of the firms performing research, development and related activities. However, as the firms increased in size and became financially stronger they were able to support the cost of innovation. Many of the firms in this category reported that they financed their own technical effort during 1968.

Although the patterns of innovation differed substantially among the spin - off firms having different business orientations, it was clear that the innovative process did not occur entirely by chance. Major innovations were usually planned in some detail and reflected strong leadership and a definite company philosophy. The president of one spin-off stressed the view that the development of products should be a natural extension of the firm's technical capability. He remarked that these developments "give the firm an opportunity to share on a continuing basis the things they have been doing for other companies on an hourly basis."

The Implications of Innovation

While the technical aspects of the innovation process were reported by many spin-off firms to require from 1 to 2 years to complete, the time required for commercialization and a noticeable impact on the composition of the firm's sales was usually much longer. For the innovative firms the change was marked by growth in sales and a movement toward a standard product and service orientation. For the firms who decided to limit the innovative risks, it usually meant little or no change in the nature of their business and an eventual ceiling on the rate of sales growth.

Impact on Growth

One important consequence of successful innovation is continued growth of the spin-off firm's sales and employment. The firms intentionally taking advantage of innovative opportunities and capitalizing on them through successful technical and market development were frequently the same businesses experiencing annual increases in sales volume.

Empirical support for these statements is presented in Table 16 where spin-offs are classified by 1968 sales and the existence of innovative activity in the firm's business operations.[11] A group of 46

[11]Firms showing technical progression between their first year of business operations and 1968 were classified as being engaged in innovative activity.

innovative and 11 non-innovative spin-offs resulted from this classification. Although the innovative firms on the average had completed fewer years of business operations, they were more likely to be found in the $500,000 and over sales range. By comparison, the 11 non-innovative firms had completed an average of 7.5 years of business operations. In spite of the fact that most of these firms had been in business longer, they tended to concentrate in $0-499,000 sales range. Several of these businesses were testing and consulting firms whose owners were content to maintain a small-scale, low-overhead level of operations indefinitely. Professionally, the entrepreneurs of these spin-offs were scientists and engineers rather than businessmen.

Similar conclusions also apply to the level of employment (see Appendix Table C-10), only the differences are more dramatic. The innovative spin-offs had completed fewer actual years of business operations but were more frequently classified in the larger employment range. This, of course, is a reflection of the need for manpower to support a higher level of sales activity.

A Changing Business Orientation

Because the movement of innovative spin-offs along the business activity spectrum is reflected by a change in the percentage of sales derived from the different possible business activities it was possible

TABLE 16

Range of 1968 Sales of Spin-off Firms Classified by the Existence of Innovative Activity
(Percent of Firms Having Each Range of 1968 Sales)

	Existence of Innovative Activity	
Range of 1968 Sales	No Technical Progression	Technical Progression
$0-499,000	81.8	60.8
$500,000 and over	18.2	39.2
Total	100.0	100.0
Average age of firms (years)	7.5	5.4
Number of firms	11	46

Excludes 4 firms acquired by merger and 15 firms completing only one year of business operations.

to reclassify those firms that had made major changes since their first year of business operations. Using the same procedure that was originally used to classify spin-off firms by major type of business activity, the changes in classification were determined by examining the percentage distribution of the 1968 sales data reported in the mail questionnaire. Of those firms completing more than one year of business operations, almost 70 percent showed some change in the nature and composition of their business. In 28 percent of the firms the change was substantial enough to require reclassification.

The spin-off's progression to a new business orientation was found to be related to the number of years of business operations, the primary area of technology and the level of sales. Each variable is discussed in the text that follows.

Number of years of business operations. To illustrate the movement of spin-offs along the business activity spectrum, each firm was classified according to the number of years of continuous business operations. Spin-off firms completing 5 years of business or less comprised one class, while the firms in business 6 to 15 years made up the second classification. The firms were then cross tabulated to provide a distribution of business orientation (1968) by the number of years of business operations. Table 17

presents this distribution for 59 of the spin-off firms that were reclassified according to the composition of their 1968 sales.[12] The table shows that the change in business orientation of many innovative university and primary industry spin-offs is not instantaneous but instead occurs over an extended period of time. This transition can be observed by comparing the percentage classified in each business activity category during the two periods of time. The distribution of the percentages in each period suggests that the direction of movement over time is toward a standard product and service orientation, with 38.5 percent of the spin-offs in the 6 to 15 year age class falling in the category compared to 15.2 percent of the firms in the 1 to 5 year age group.

Examination of some of the individual firms helps to explain the dynamics of the changes which are taking place. Of the 10 spin-offs comprising the standard product and service category of 6 to 15 year old firms, 2 were initially classified as research and development firms, 3 as custom product and service firms and 5 originally started business in the standard product and service area. Only 5 similarly classified firms were in the 1 to 5 year age classification. Two started business as custom product and service firms, while 3 were originally in the standard product and service classification.

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[12]The reader should note that this table excludes 13 secondary industry spin-offs. The reasons are explained on page 151.

TABLE 17

Business Orientation of Spin-off Firms by Number of Years of Business Operations
(Percent of Firms Having Each Business Orientation)

	Number of Years of Business Operations	
Business Orientation	1 to 5 years	6 to 15 years
R & D, testing and consulting	21.2	23.0
Custom products and services	63.6	38.5
Standard products and services	15.2	38.5
Total	100.0	100.0
Number of firms	33	26

Excludes 3 primary industry spin-offs and 1 secondary industry spin-off acquired by merger; and 13 secondary industry spin-offs.

Similar differences can also be noted in the custom products and services group. Over 63 percent of the spin-offs in the 1 to 5 year age class fell in this category, but only 38.5 percent of the similar firms 6 to 15 years old. Firms that had made major classification changes were again evident but not as numerous. It is worthwhile noting, however, that a number of firms in the 6 to 15 year age group had developed standard products but the impact on their business was not yet sufficient to warrant a change in classification.

Influence of technology. Not all firms make the transition to a new business orientation at the same rate. While much of the innovative process takes place over an extended period of time, the spin-off's area of technology was also found to be an important variable influencing the opportunity for innovation and change. A detailed examination of 22 electronics spin-offs (see Appendix Table C-11) showed a similar distribution of business orientations between the different age classes with the exception that a much larger percentage of the firms completing 6 to 15 years of business operations fell in the standard product and service classification. The data suggest that the innovative firms in this area of technology are able to make the transition faster than similar firms in other areas of technology.

The stage of development of the technology appears to be a major reason for this difference. Electronics technology, compared to optics and much of computer technology, is further technically developed in terms of having standard product applications and broad market acceptance. It seems that this difference makes the opportunity for innovation greater and reduces the time required for diffusion and an impact on the firm's business.

Intentionally excluded from both Table 17 and Appendix Table C-11 are the primary and secondary spin-offs acquired by merger prior to the end of 1968 and all other secondary industry spin-offs. The firms that had merged sometime in the time period between their first year of business and 1968 were excluded from this aspect of the analysis because after acquisition they were no longer considered to be spin-offs as the firms were originally defined. The secondary spin-offs were excluded because the majority started business in the standard product and service classification and the balance moved in this direction much more rapidly than the university or primary industry spin-offs. For example, of the 14 secondary spin-offs included in this study, 50 percent were initially classified as firms falling in the standard product and service area. By the end of 1968, 77 percent were classified in this area. The important point,

in addition to the magnitude of the change, is that these spin-off firms had only conducted business operations an average of 3.2 years. Including them in the previous tables would have removed the transition pattern which is so characteristic of the university and primary industry spin-offs.

Relationship to sales volume. As the number of years of business operations increase, the innovative firms grow in size and complexity. Employment grows as the scope of operations expand in response to increasing sales. Previous analysis linked innovative activity in the spin-off to the firm's sales volume. The businesses willing to assume the risks of innovation were frequently the same firms having annual sales of $500,000 or more. A similar relationship was found between the firm's business orientation and sales volume. Table 18 illustrates this finding by classifying spin-offs (including secondary spin-offs) by their 1968 sales and business orientation. It is evident from the table that a time-related variable such as sales volume can also be used to explain the firm's position on the business activity spectrum.

While it is difficult to determine the existence of a cause and effect relationship, the data do suggest that a large percentage of

TABLE 18

Business Orientation of Spin-off Firms by Range of 1968 Sales
(Percent of Firms Having Each Business Orientation)

	Range of 1968 Sales	
Business Orientation	$0-499,000	$500,000 and Over
R & D, testing and consulting	25.4	9.4
Custom products and services	51.0	28.6
Standard products and services	23.6	62.0
Total	100.0	100.0
Number of firms	51	21

Excludes 3 primary industry spin-offs and 1 secondary industry spin-off acquired by merger.

the firms eventually reaching an annual sales volume of $500,000 or more are those that have either started with standard products and services or developed them through successful innovation. Both situations occurred, but over 50 percent of the standard product and service spin-offs were initially research and development, custom product and service or similar firms that changed their orientation through the development and marketing of products and services.

The Market Environment

Successful innovation has other important implications for the spin-off in addition to a change in the firm's business orientation and continued growth in sales volume. Many firms experience a changing market environment marked by the development of new markets and the arrival of increased competition. For the innovative firms experiencing a change in the scope of their business operations, the implications are clear. More sophisticated marketing techniques are required to capitalize on new business opportunities and combat increased competition.

A Changing Market Profile

During the early stages of their development most of the Michigan spin-off firms studied relied heavily on Michigan industry as a major

source of business. This was often necessary because of the nature of the firm's initial business activity. Many of the spin-offs began business with nothing more than a technical capability. Under most circumstances it was both difficult and expensive to market beyond the local area in which the firm was located. In part, this is a reflection of the technical uncertainty involved in many of the projects. Close and frequent communication was frequently required as the problem became better defined and modifications in the scope of the technical effort became necessary. Communication over great distances to resolve these difficulties was both expensive and ineffective. Limited financial resources provided a related reason for limiting the scope of the firm's marketing effort to a local and easily accessible market region whenever possible.

As the spin-off firm grows through successful commercial development of product and service innovations, the scope of the firm's marketing activity changes. New markets are required to sustain the necessary volume required for a profitable product and service operation. Table 19 shows some of the changes that occur in the firm's sources of sales revenue. The table confirms that Michigan spin-offs are clearly commercially orientated during the early stages of their business development. This is a reflection of the absence of large government contractors and defense/space installations in the

TABLE 19

Sources of Sales Revenue of Spin-off Firms by Range of 1968 Sales
(Percent of Firms Mentioning Each Source)

	Range of 1968 Sales	
Sources of Sales Revenue	$0-499,000	$500,000 and Over
Directly from government agencies	28.0	57.2
Indirectly from government agencies	50.0	67.0
Non-government commercial customers	100.0	100.0
Number of firms	50	21

Excludes 3 primary industry and 1 secondary industry spin-off acquired by merger.

state as well as the close proximity of industrial markets. As the firms grow in size the financial and geographical limitations are removed. The credability gap is bridged through successful technical performance and satisfied customers. Spin-offs expand and develop new business either directly with government agencies or indirectly from the government through contracts from prime contractors and subcontractors.

The details of this change in market environment are presented in Table 20, where the spin-offs' major types of customers are classified by the range of 1968 sales. Some of the important differences in this table are worth noting. First, the difference in the government as a major customer for the two groups of spin-offs is marked by a greater frequency of the larger firms doing business with the Department of Defense, the National Aeronautics and Space Administration, the Atomic Energy Commission and the Department of Health, Education and Welfare. These four agencies are large sources of funding for research and development and related activities, and are highly receptive to new applications of technology. Another difference is the increase in importance of the electronics, aerospace, and automotive industries as major customers for the larger spin-off firms. One change that appears to be taking place is a concentration of

TABLE 20

Major Types of Customers of Spin-off Firms by Range of 1968 Sales
(Percent of Firms Mentioning Each Customer Type)

Major Types of Customers	Range of 1968 Sales	
	$0-499,000	$500,000 and Over
Government		
DOD	23.4	45.0
NASA	19.2	45.0
AEC	2.1	15.0
HEW	6.4	20.0
Other government	4.3	10.0
Commercial		
Electronics	31.9	65.0
Aerospace	27.6	60.0
Automotive	44.7	55.0
Chemical	19.2	20.0
Other commercial	46.8	20.0
Other		
Institutions and foundations	25.6	35.0
Number of firms	47	20

Excludes 3 primary industry spin-offs and 1 secondary industry spin-off acquired by merger.

technical and marketing effort on these three large industries.[13] It is worth noting that the electronics, aerospace and more recently the automotive industry have been known as technology-receptive industries.

A Changing Competitive Environment

Success, as measured by sales and their annual rate of growth, creates another change in the market environment for the innovative spin-off firm. During the early development stages of the business, a unique technical capability or product innovation usually makes a minor impact on the market. However, as the technical capability becomes more specifically defined and the markets for products and services develop they are often imitated by competitors in identical or closely related businesses.[14] The impact on the firm is the emergence of a specific group of competitors.

This change is presented in Table 21 where the number of major competitors of spin-off firms is classified by sales revenue. The difference in the table indicates an increase in the number of major

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[13]The difference in the percentage of firms reporting the aerospace industry as a major customer is a reflection of the trend toward indirect government business from government prime contractors and subcontractors shown in Table 19.

[14]Often secondary industry spin-offs.

TABLE 21

Number of Major Competitors of Spin-off Firms by Range of 1968 Sales
(Percent of Firms Having Each Category of Major Competitors)

	Range of 1968 Sales	
Number of Major Competitors	$0-499,000	$500,000 and Over
0 to 4	43.5	15.0
5 to 9	23.9	35.0
10 and over	32.6	50.0
Total	100.0	100.0
Number of firms	46	20

Excludes 3 primary industry spin-offs and 1 secondary industry spin-off acquired by merger.

competitors with increasing sales volume. Some idea of the magnitude can be obtained by combining the two largest categories in the table. If this is done, it can be noted that 56.5 percent of the spin-offs in the $0-499,000 sales range reported 5 or more competitors in 1968. By comparison, 85 percent of the firms reporting $500,000 or more in sales during 1968 reported 5 or more major competitors in their business. The table clearly indicates a progressive diffusion toward increased competition.

Summary

Innovative activity plays an important role in the development of the spin-off firm. When actively encouraged and supported by management it results in the transformation of technology into new products, services and processes. Each of these three types of innovations were observed in Michigan spin-offs during field interviews.

The occurrence of a major innovation is both random and unpredictable. However, some order can be observed in the process by examining the technical activities performed by the spin-off firm in the process of developing technology. In the mail questionnaire, the firms reported performing (1) research, development, evaluation and testing; (2) engineering and prototype or pilot manufacture; and (3) the manufacture of products and provision of general services.

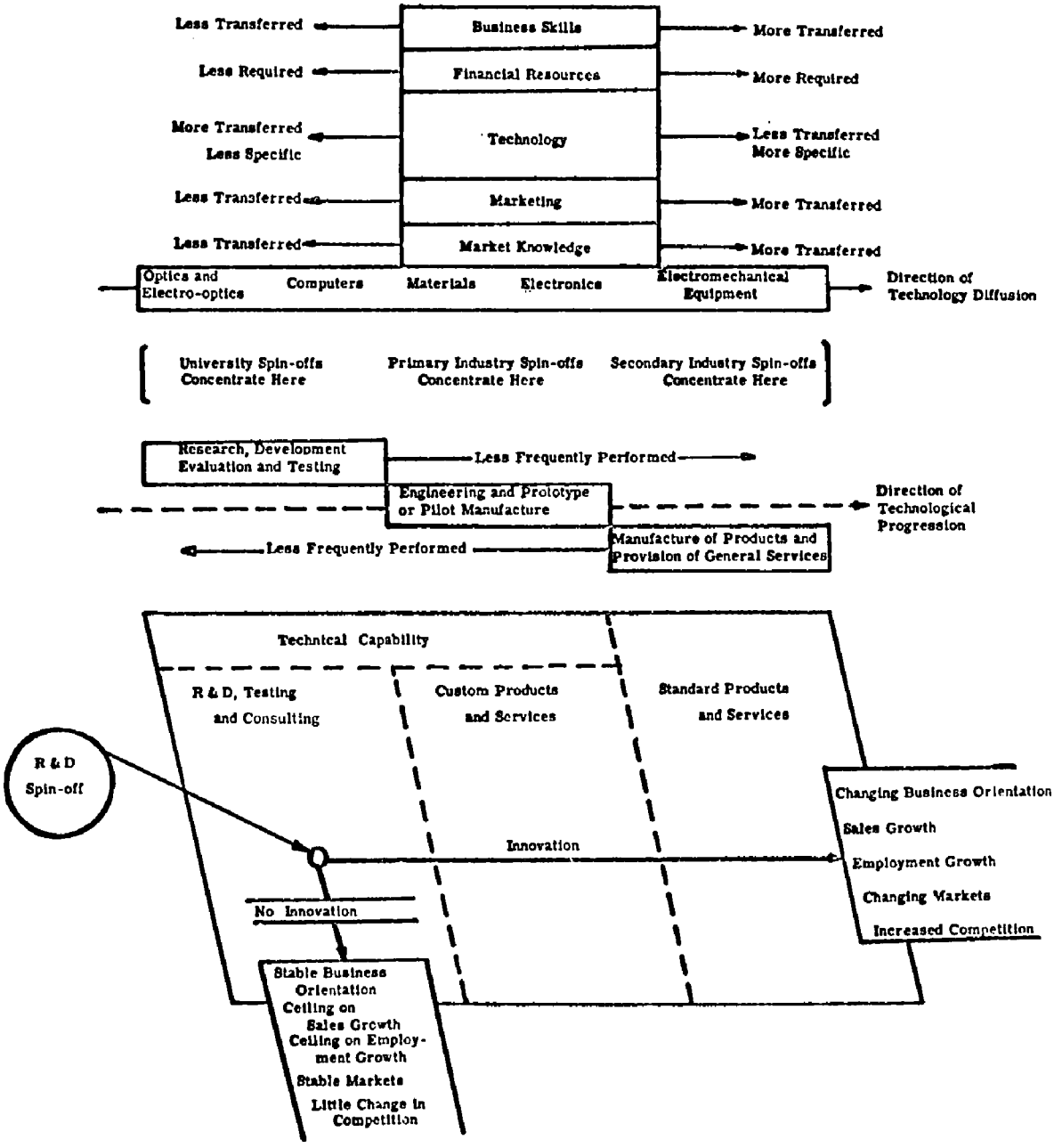
Many of the innovations identified were found to progress through this or a similar sequence of technical activities.

A relationship was found between the percentage of firms performing the different technical activities and the spin-offs' initial business orientation. The largest percentage of firms engaged in the technical activities at the beginning of the innovation sequence were research and development, testing and consulting spin-offs. Similarly, the standard product and service spin-offs were most frequently engaged in the manufacture of products and provision of services. This relationship is shown in Figure 4 where the major research findings of this chapter are integrated into the conceptual model.

The presence of innovative activity in the firm was identified by progression through the sequence of technical activities over a period of time which includes the spin-off's first year of business operations and 1968. In general, the innovative firms were those most likely to be developing or marketing products and services and experiencing steady growth in sales and employment. Not all firms, however, were innovators. Some entrepreneurs simply refused to accept the risks inherrent in the process and were willing to trade the benefits of change for a relatively stable business with a ceiling on the growth of sales and employment. In Figure 4, these are the firms that remain in one area of business activity such as consulting or research and development.

Figure 4

Integration of the Innovation Process into the Conceptual Model



Successful innovation often means a gradual change in the scope of the firm's business activity. In research and development spin-offs, for example, this change is marked by a movement toward the standard product and service end of the spectrum and a new business orientation. The research indicated that the firm's position and rate of progression was related to the number of years of business operations, the area of technology and the level of sales. Generally, spin-offs that had completed 6 to 15 years of operations in a well developed area of technology were involved in a product and service activity and were inclined to have sales in excess of $500,000.

Concurrent with a change in the firm's business orientation, innovation also creates a new market environment for the firm. Increased depth in a greater number of markets is usually characteristic of the process and in the sample of firms studied there was a definite trend toward increased participation in government defense/space and environmental research markets.

The movement of the firm from a capability orientation to a product and service orientation also results in a sharper definition of the competitive environment. Competition was found to increase both as a result of new firms being attracted into the spin-off's market area and as a result of the ability to define the firms offering competitive substitutes.

CHAPTER V

The Major Markets, Their Characteristics and the Buying Process

The Role of Marketing

Regardless of the nature and scope of the spin-off firm's business activity, the need for some type of marketing program or effort will always exist. The ability of a research and development spin-off to win government research contracts often depends on a proposal which relates the research capability of the firm directly to the ideas, preferences and alternatives of the customer.[1] The prospects for successful marketing of a new product are also enhanced by an input of market information early in the innovation process and the creation of a marketing program designed to fit the customer's buying pattern.

Successful marketing programs are built around an understanding of what the company has to sell, who the customer is and how he buys. For technology products and services, defining what the firm has to sell is usually not too difficult. The technical features of the products or the parameters of the service eventually reflect the research capability of the firm. However, problems arise in translating technical features into performance benefits which are meaningful to the customer and can be evaluated in terms of his own specific applications.

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[1]Russell F. Murphy, "Selling Aerospace Technology to the Federal Government," Journal of Marketing, XXLII (January, 1968), 46.

The technical capability is more diverse and difficult to define. It is reflected in the capacity to bring together technical skills to solve new and very specialized problems for which the critical dimensions are usually not known. The problem encountered here is that the hardware or software often does not exist before the sale and is not available for the customer's evaluation. Instead, the spin-off's technical expertise and reputation become essential features which must be converted to benefits in order to motivate a purchase decision. The important point to be recognized is that the nature of the marketing task will vary depending on what the firm has to sell. A marketing program entirely adequate for selling a technical capability may be a dismal failure when applied to the marketing job required for the firm's first hardware product.

The following discussion of the major markets of the spin-off firms studied provides perspective for the analysis of the marketing programs used to sell the products, services and capabilities. Preliminary research indicated that industrial, governmental and institutional markets were of primary importance to Michigan spin-off firms. They form the framework for this portion of the analysis, which evaluates the significance of major customers within each market area.

The buying process serves as a focal point for the firm's marketing strategy and provides a frame of reference for an evaluation of the marketing programs used by the spin-off firms studied. A brief discussion of market characteristics and buying patterns follows the market analysis and leads naturally to the next chapter which contains an empirical investigation of the marketing programs and strategy used by the spin-off firms.

The Major Markets

The market profile of the 76 firms surveyed clearly indicated that this group of Michigan spin-offs was oriented to developing business in commercial markets. During 1968, all of the firms reported doing some business with a variety of different industries and 86.1 percent of the spin-offs reported the commercial segment of the economy as the source for the majority of their sales revenue.

Government markets were concentrated primarily in the defense/space programs and related technology procurement areas although some spin-offs reported doing business with state governments. By comparison, government markets were not of much significance to the majority of spin-off firms. Overall, 34.2 percent of the firms reported doing some business with the government and 11.2 percent of the firms reported this market as their major source of sales revenue.

The institutional markets were almost as important as the much larger markets in the governmental sector. This is a reflection of the fact that Michigan has many excellent academic institutions and hospitals using the latest available technology in their research and teaching.These institutions were found to play an important role in the adoption and diffusion of the new innovations of numerous Michigan spin-off firms. More than 35 percent of the spin-off firms responding to the mail questionnaire reported doing business in the institutional market with hospitals and universities being mentioned most frequently. Less than 3 percent, however, mentioned this market as their major source of revenue.

Within each major market area a number of important customers were identified as sources of business for the Michigan spin-offs studied. Table 22 presents the customer profile developed from the responses to the mail questionnaire. The data are cross tabulated by the firm's latest (1968) business orientation and the major customers are those reported for 1968.

Government Markets

From the table it can be noted that as a final consumer of technology-oriented products, services and capabilities, the Federal Government's importance as a buyer was clearly concentrated in two

TABLE 22

Major Types of Customers of Spin-off Firms Classified by Business Orientation
(Percent of Firms Mentioning Each Customer Type)

Major Customer Type	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Government			
DOD	50.0	13.8	34.8
NASA	28.6	20.6	39.1
AEC	. . .	. . .	17.4
HEW	14.3	3.4	17.4
Other government	. . .	10.2	8.7
Commercial			
Electronics	14.3	51.7	47.8
Aerospace	35.7	34.5	43.5
Automotive	42.8	48.3	47.8
Chemical	14.3	20.7	30.4
Other commercial	50.0	34.5	43.5
Other			
Foundations and institutions	21.4	27.6	39.1
Number of firms	14	29	23

federal agencies--the Department of Defense (DOD) and the National Aeronautics and Space Administration (NASA).[2] The bulk of these purchases consisted of highly engineered military weapon and space hardware designed and manufactured to the buyer's specification. The balance went to support basic research, applied research, and development in the engineering, physical, environmental and other sciences.[3]

The research and development, testing, and consulting firms doing business in government markets were all either university or primary industry spin-offs, the majority of which were funded by DOD. Those doing work in engineering materials, propulsion and the environmental sciences were most successful in securing government contracts. Subcontracts were relatively important to the spin-offs involved in government markets and about 40 percent reported doing business indirectly with government agencies. In a

[2]The importance of military procurement among the total purchases by the government is striking. In the fiscal year 1969, the estimated expenditures of the DOD were $76.7 billion, or almost as large as the grand total for all civilian agencies. Further, the estimated purchases of the Atomic Energy Commission and NASA ($2.6 billion and $4.6 billion respectively), with respect to the type of product and method of contracting were more closely related to the military than to the civilian agencies. For additional details see: U.S. Bureau of the Budget, The Budget of the United States Government (Washington, D.C.: Government Printing Office, 1968), pp. 191-459.

[3]Federal research and development expenditures for fiscal 1969 are estimated at $17.3 billion. Of this total, $8.5 billion will be purchased by the DOD and $4.4 billion by NASA. For additional details see: National Science Foundation, Federal Funds for Research, Development and Other Scientific Activities, NSF 68-27, XVII (Washington, D.C.: Government Printing Office, 1968), 5-9.

few cases, the subcontract volume accounted for 60 percent of the firm's sales revenue.

Custom product and service firms were generally not as successful in developing business with the government. The firms that did obtain business were university and primary industry spin-offs working primarily with the DOD and NASA in electronics and optics. Subcontracting was fairly common among these firms, particularly in contracts calling for subassembly and finished assembly work. Compared to the research and development, testing and consulting firms, subcontracts were more frequent, but generally not a significant proportion of the firms' sales.

The government market for standard products and services was considerably broader than the markets for research and development or custom work both in terms of the federal agencies involved in the procurement and the areas of technology represented. University and secondary industry spin-off firms in all areas of technology reported doing business with the federal agencies listed in Table 22 as well as with the Department of the Interior and state and foreign governments.[4] The market breadth is explained by the fact that the bulk of the purchases made by these agencies are for hardware items. This naturally increases the chance of obtaining business. There is

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[4]Some concentration was noted in computers and electronics.

also a tendency for the spin-off to develop broader market coverage as the business progresses toward a product orientation.

About 54 percent of the firms reported subcontract work, which verified a trend toward greater market participation of this type at the standard product and service end of the activity spectrum. Electronics, computers and optics were the technologies most often associated with these subcontracts.

Commercial Markets

Commercial markets provided the main source of business for the spin-off firms investigated in this study. Nearly all of the firms reported doing business in at least one of the industrial markets listed in the table. Regardless of the market level, it was clear that the automotive industry in the midwest has been a key factor in the recent growth of the scientific complex in southeastern Michigan. During personal interviews many respondents cited the increasing trend toward technical sophistication to reduce costs and improve vehicle safety as primary motives for increased interest in the technology products, services, and capabilities of Michigan spin-off firms. Many expect this trend to continue and spread throughout the other durable goods industries in the state.

As a source of research and development, testing, and consulting contracts, the automotive and aerospace industries were of major importance. Many areas of technology were represented, but materials testing and electronics research and development were the most frequently mentioned by respondents to the mail survey. University and primary industry spin-offs dominated this market area with many reporting both non-government commercial business and indirect government business through contracts with prime contractors or subcontractors.

Commercial markets were of even greater importance to the spin-offs engaged in custom product and service activity with the firms showing greater market penetration in all of the industries but aerospace. Electronics and automotive markets were of greatest importance to spin-offs in this business area with many firms supplying components to the electronics and computer industry and instrumentation or controls to the automotive and related transportation equipment companies. University and primary industry spin-offs also dominated this market area with electronics, optics, and electro-optics being the predominant technologies although all areas were well represented. Some industrial subcontract business was reported, but compared to the government subcontract markets for custom products or services it was not as frequent. Research indicated that some

of this business was contract manufacture of subassemblies for OEM accounts.

In addition to participating more actively in government markets, the standard product and service firms also showed a higher overall frequency of participation in industrial markets than the spin-offs in any other area of business activity. The majority of firms in this group of product and service markets were secondary industry spin-offs. University and primary industry spin-offs were less frequent in numbers but generally as active in the different industries. Electronics and electromechanical equipment were the technologies most often mentioned and a large number of these firms were doing business with the aerospace, automotive and electronics industries. Industrial subcontracting was prevalent among this group of firms and over 50 percent reported some business of this type.

Institutional Markets

Institutional markets were important to many spin-offs, particularly as a source of business during the early stages of the firm's development. Several entrepreneurs mentioned that they worked closely with researchers at The University of Michigan engineering and medical facilities and some firms developed their first products in conjunction with the professional staff in these research units.

Generally the markets were for custom or standard products and services in the areas of electronics, electromechanical equipment, and computer hardware or software. University and secondary industry spin-offs were most successful in selling to the institutional market.

Many other market areas were also mentioned by the spin-off firms responding to the mail questionnaire. Some of these included public utilities, foundries and steel mills, construction, electrical machinery, drugs and food, and consumer products.

Market Characteristics

Several characteristics of each market cause variations in the methods of procurement and thereby influence the marketing task. Often the characteristics vary with the particular industrial, governmental and institutional markets in question, as well as with the specific items being purchased. At the same time, however, there are some basic market-to-market differences which influence the spin-off's marketing efforts and merit consideration.

Government Markets

The research indicated that the government market for technology products, services, and capabilities was concentrated in

four major contracting agencies. Each agency was responsible for conducting and funding several multi-million dollar programs characterized by geographically scattered decision points and multiple buying influences. These features, when combined with the systems concept of purchasing currently being applied in many agencies, lengthens the procurement cycle and adds complexity to the buying process.

The complex nature of the market encouraged spin-off firms to focus their technical and marketing efforts on one agency and one or two specific programs.[5] When it was possible, they were careful to select programs where the decision points and buying influences were geographically concentrated to reduce travel expenses and maximize the selling effort. The spin-offs were not, however, able to exert much control over the requirements for the items they planned to market. The demand in each program was subject to large-step changes because of sudden shifts in policy resulting from international events and domestic political changes.[6]

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[5]This was particularly true where capability selling was involved. Firms selling standard products and services reported doing business with a greater number of government agencies.

[6]W.R. Purcell, Jr., ed., Commercial Profits from Defense-Space Technology (Boston: Schur Company, 1965), pp. 6-7.

Regardless of the government agency, the respective procurement officers are specifically charged with the responsibility of ensuring competitive procurement. Unless the item to be purchased is available from only one source, they must assure that a sufficient number of proposals or bids are requested from potential vendors to bring competition into the procurement process.[7] For this reason, most government markets were reported to be highly price competitive.

Because of the competitive factor, most spin-offs found that successful performance with one government agency or department did not materially influence their opportunity to do business with other agencies. Even though all of the contracting agencies of the government were part of one overall organization, each group was quite autonomous. Selling to more than one was similar to doing business with a number of different corporations.

In spite of the autonomy of the different agencies that comprise the market, the various contracting groups of the government are well organized to manage and control the different aspects of the procurement process.[8] Specialization exists in the various functional

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[7]Murray L. Weidenbaum, "The Federal Government as a Buyer," Journal of Purchasing, I (November, 1965), 22-23.

[8]Merton J. Peck and Frederic M. Scherer, The Weapons Acquisition Process: An Economic Analysis (Boston: Division of Research, Graduate School of Business Administration, Harvard University, 1962), pp. 79-82.

areas with separate groups responsible for contract administration and management, engineering liaison and support, and quality control; as well as the other procurement functions. This same specialization extends in another direction and includes the various phases of a multi-stage acquisition process. Procurement officers also specialize in the purchase of research and development, engineering and hardware.[9]

Commercial Markets

The commercial markets for Michigan spin-offs were concentrated both in terms of the number of industries involved and the number of customers within each industry.[10] Usually the larger firms in each industry were the most important customers for the Michigan spin-offs studied, although a number of businesses in the Ann Arbor area reported subcontracting business to other small firms.

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[9]Another organizational approach used by the government to increase the effectiveness of procurement is "projectizing." This technique involves the establishment of special project groups to integrate and coordinate the functional interests in complex programs. Projectizing is also used in industry, but none of the spin-off firms interviewed were utilizing it in their business. For a discussion see C. J. Middleton, "How to Set Up a Project Organization," Harvard Business Review, VL (March-April, 1967), 73-82.

[10]This concentration was most evident for those spin-off firms marketing a technical capability.

The individual industrial customers of Michigan spin-offs were widely scattered geographically, but the major buying influences were usually located within the organization at the point of procurement. In general, they were easier to define than their counterparts in government markets and this simplified both the buying and selling process. The purchases were also smaller and did not generate the pyramid of subcontractor levels typical of large government systems contracts. This, of course, reduced the attendant problems of directing and coordinating the suppliers' efforts. It also minimized the chance of the spin-off firm to be placed in a conflict role by having to assume the position of a subcontractor, while having systems responsibility.

Much of the selling was concentrated on a few individuals at the engineering management level although the solicitation pattern depended on the nature of the expenditure, the complexity of the items purchased and the role of the spin-off firm in the procurement.[11] Purchases were typically in the $10 to $5000 range for products and in the $1000 to $150,000 range for contracts utilizing the firm's technical capability. To a large extent, demand was determined by

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[11]A trend toward committee buying was reported in the sale of new installations involving complex systems and major capital equipment. The spin-off's role in the procurement of such items might be either that of a prime contractor or a subcontractor.

cyclical variations in business conditions.[12]

Unlike the government, the industrial buyer is under no obligation to use competitive quotes or bids in the purchasing process. Depending on the urgency of the need and the importance of the purchase a contract was negotiated with either one or a number of potential suppliers. Many spin-offs reported obtaining sole-source awards from industrial customers, particularly after the firm was established as a supplier.

Regardless of the pattern of awards, competition is always present in the industrial buying process. Even on sole-source awards, the buyers are able to make the procurement competitive. Techniques such as value analysis, technical evaluation of the supplier's cost structure and negotiation are used to assure a fair price for the buyer.

The firms in industrial markets are not as well organized as the government agencies to control and manage the buying process for technology items. Purchasing departments in profit-making organizations are normally organized on a commodity basis, with buyers specializing in the purchase of particular lines. This offers an advantage in the purchase of the standard products which account for the majority of their expenditures. However, many of the products, services and capabilities of the spin-off firms do not fit the traditional procurement patterns

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[12]This was particularly true of a technical capability. Industry usually purchases this item to supplement an existing in-house capability. Demand was closely related to the level of business activity.

because they are either non-standard or purchased infrequently. Most of the key decisions regarding the technical approach to a problem and the selection of alternative sources are made in the early stages of the procurement prior to the final negotiation stage. The result is that the management personnel in the technical departments are the major buying influences and they assume the primary role in the buying process.

Market differences are particularly apparent in the purchase of a technical capability such as a research and development. Industry generally does not buy this item on a continuing basis so they are not specifically organized to evaluate and purchase it. Some firms compensate for this lack of expertise by securing a number of proposals for the same requirement and then playing the suppliers against each other until the lowest possible price is obtained.

Institutional Markets

Institutional markets were concentrated in educational institutions, hospitals and other non-profit organizations actively engaged in performing or funding research.[13] In many respects the markets had characteristics common to both the government and commercial markets. The

[13]Frank R. Bacon, Jr. and Kenneth E. Bayer, Research Emphasis in Michigan Universities (Ann Arbor, Mich.: Institute of Science and Technology, University of Michigan, 1964), pp. 9-52.

customers were usually the institutions in each state that were doing work for government and industry. For custom products or services, the marketing effort was concentrated on the principal researcher and his staff. The purchasing department played primarily a service role with the determination of needs and specification of requirements handled by the using departments.[14] However, purchasing played a more important role in the procurement of standardized equipment having alternative suppliers.[15]

The extent of competition in institutional markets depends on the type of purchase. For many of the custom items that are used in research programs, little or no competition exists because the markets are specialized and the applications are small. In the larger institutional markets where purchases are made for operating equipment and supplies, many of the organizations are under obligation to buy competitively whenever possible.

Commodity specialization usually does not exist in institutional purchasing. Both the structure of the organizations and the service philosophy of the purchasing departments dictate that procurement be structured along departmental lines.[16] This means that the

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[14]Rex V. Call, "Purchasing in the Academic Institution," Journal of Purchasing, IV (May, 1968), 75.

[15]Previous research has also noted a trend toward centralized purchasing among certain groups of institutional buyers. See for example: H. Ralph Jones, Constraints to the Development and Marketing of Medical Electronic Equipment (Ann Arbor, Mich.: Institute of Science and Technology, The University of Michigan, 1969), pp. 84.

[16]Call, "Purchasing in the Academic Institution," 74.

advantages of specialization by product or service are not always achieved. It also explains the strong role of the user departments in the purchase of technology-oriented products and services.

The Buying Process

Regardless of the market area, the customers of spin-off firms were purchasing (1) a technical capability in the form of research and development (and related services) and (2) products and services having a high degree of standardization. Conceptually there are certain common steps in the buying process of the customers in each of the major market areas. These steps include recognition and communication of needs and the selection of sources. Beyond these general similarities, there are differences in the buying process that make each major market somewhat unique from the standpoint of marketing. They are reflected in the following discussion.

Recognition and Communication of Needs

Typically the procurement cycle begins with recognition and investigation of a need by a potential customer such as a government agency or industrial corporation. In the case of a government procurement, the need may originate from a major space or defense program sponsored by one of the federal agencies, while in many corporations the needs are expressed in the demand for new

products and process changes or improvements. They frequently originate in the technical, quality control, manufacturing, and maintenance departments of these organizations.

R & D and related capabilities. When the procurement involves research and development or a related technical capability, the need is usually expressed as a general problem requiring a solution. Usually it is vaguely defined and communicated by the customer in general terms. A more specific definition occurs only after several potential suppliers make suggestions on the alternative approaches to performing the necessary technical work and achieving the customer's objectives. In this respect, the customer relies on the suppliers to help determine the best approach to the problem and identify the vendor characteristics and technical variables that are crucial to achieving a solution.

Depending on the nature of the market, different methods are used to communicate the requirements. In government procurement of research and development or in the purchase of specialized equipment requiring substantial technical development, there is a tendency toward the use of a formal communication network. This includes the compilation and screening of lists of potential suppliers, formal requests for research proposals, published documents defining needs, technical

conferences, and individuals charged with the responsibility of disseminating procurement information. A conscious attempt is made to communicate needs and requirements to the greatest extent possible. Buyers are generally well informed about the capabilities of many firms as well as their past contract performance.

By comparison, industry and many institutions purchase research and development and related technical capabilities in a much more informal manner. Neither organization is formally structured to purchase these items because the need is not a recurring one. Much of the demand is to supplement an existing in-house capability. The buyer information system is also less organized and this probably inhibits the communication of needs. As a result, customer referrals were found to play an important role in the sale of a technical capability to industrial and institutional markets. Spin-off firms having a reputation for technical competence and high-quality work frequently were able to develop new business without much active solicitation.

The referral system also worked to the advantage of some of the new firms. If the spin-off was fortunate enough to have technical personnel who were established and well known in their fields, the credibility gap which plagues many new businesses was often not a problem in the firm's early development. Industrial and institutional customers sought these individuals to perform contract work in their specialty.

The referral system was reinforced because of the tendency of the capability-oriented spin-off to market in a limited geographic region. This enhanced the opportunity for communication among the firm's customers.

Standard products and services. In the case of a purchase involving a standardized product or service, the requirements are more specifically defined. Performance standards or design specifications are often helpful in communicating the need to potential suppliers. Buyers are also more knowledgeable about the range of products and services available for the application and the alternative sources of supply.

Government buyers use these features to bring competition into the procurement process. Specifications and requirements are made available to all interested firms through the Commerce Business Daily, bidders conferences, and formal proposal requests to qualified vendors. Further, a contemplated purchase is advertised well in advance so that any interested supplier will have time to participate.

A similar situation exists in institutional purchasing but it is not as formally organized. Nevertheless there is a tendency toward a broad communication of the standard needs. This, of course, is

also a reflection of obligation and the fact that much of the budget and the regulations governing the expenditure of funds is closely tied to the programs of the federal and state government. To some extent they reflect the expenditure patterns of these organizations.

By comparison, the purchasing of standard items by commercial buyers is even less formally organized. Generally intentional attempts are not made to inform all potential suppliers of an impending purchase. Industrial organizations often prefer to work in confidence with only a few suppliers and purposely limit the number of alternative sources considered. In general, they are under no obligation to make their requirements widely known. This usually meant less competition for the spin-off firm that had established relationships with the industrial buyer.

Evaluation and Selection of Sources

After requirements have been communicated to potential suppliers, proposals are received from the interested firms and the vendor evaluation and selection process begins. Most of the technology-oriented products, services and capabilities were purchased by negotiation with individual spin-off firms. A few highly standardized items (usually products supplied from inventory) were purchased on the basis of competitive bids.

In spite of the similarities in the buying process, this part is also marked by variations which reflect the items being purchased and the characteristics of the different markets in question. These differences merit consideration because they influence the selection and evaluation process.

R & D and related capabilities. In the purchase of research and development as well as a technical capability, negotiation with potential suppliers was the preferred method of purchasing. This part of the buying process is generally broken down into several sequential steps. It starts with the solicitation of technical proposals from potential suppliers. Interested spin-off firms respond with a suggestion of how the work is to be performed and a preliminary price quotation.[17] Depending on the uncertainty in the project, the formality of submitting a proposal was usually preceded by some informal pre-sale activity in which the spin-off firm's personnel worked closely with the customer's technical staff to further specify the problem and prepare a competitive price quotation.[18] The negotiation process served the

[17]Unsolicited proposals on products, problems or systems which the spin-off believed would be of interest to the customer were also used to initiate the buying process. The knowledgeable spin-offs usually preceded this approach to a sale by informal market contact to try and verify the existence of a need or the customer's interest in receiving such a proposal.

[18]This method of purchasing was often used by governmental and industrial buyers for a preliminary design competition in which the procurement consisted of a working hardware design and prototype.

purpose of further defining the customer's requirements while simultaneously exploring the possible range of prices. Negotiations are carried on with potential suppliers until sufficient information is exchanged to enable a rational choice.

Negotiation between the buyer and the spin-off firm usually involves some form of strategy which reflects the needs of each party. In government markets, the spin-off was usually interested in how much additional business the customer had to offer. This was because multi-phase purchasing is a characteristic of government procurement. Research and development awards are usually followed by engineering and hardware contracts which offer attractive possibilities to the spin-off firm.[19] Many firms reasoned that participation early in the procurement phase would increase the firm's chances in the next step. This was generally not true because most of the firms were unable to develop the manufacturing capability to enable them to participate in the later phases.

Some multi-phase purchasing was also observed in commercial and institutional markets, but it was not always a major consideration

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[19]Multi-phase purchasing also offers important advantages to the government buyer. It breaks the risk into several smaller segments and allows the government agency to bring competition into each successive phase. The latter advantage is important because it enables the buyer to continually tap the technological resources of new firms.

because many of the organizations possessed the capability to make as well as buy in the later phases. Here, the ability of the customer to supply additional unrelated business became a major consideration. One exception was the purchase of capital equipment utilizing a new technology. Here industrial buyers preferred to break the purchase into several stages to reduce the risk. The purchases consisted of an initial feasibility study, a design and engineering contract, and finally a hardware contract. Usually separate contract competition was held for each successive stage.

The government buyer is frequently in a stronger position to negotiate with customers than industrial and institutional buyers. This is a reflection of his extensive experience in purchasing a technical capability and ability to bring competitive forces to bear on the process. Sole-source awards were relatively common among the capability-oriented firms doing business primarily with industry and institutions. However, they were less frequent among firms engaged in government work at least until the spin-off was well established.

After proposals are received, they are technically evaluated to determine those which best accomplish the job. Whether or not a contract is awarded depends on the responsiveness of the proposals to the customer's need. Frequently a small group of potential contractors is selected and additional negotiation takes place on price as

well as other technical features of the proposal.

Perhaps the greatest market-to-market difference in the buying process for a technical capability is the customer's ability and willingness to perform a detailed and objective evaluation of competitive proposals.[20] The government buyer has technological resources far more extensive than his industrial and institutional counterparts when it comes to appraising the cost-performance aspects of the proposed solutions to technical problems. Technological achievement is often the major purchasing objective in government and institutional markets where the purchase involves a technical capability.[21] The government buyer may be contracting for the spin-off to undertake a program of research and development which includes the delivery of the product resulting from this effort. Essentially the buyer is concerned with obtaining a highly reliable product of superior quality. Cost considerations are important, but often secondary since estimates of total costs are tentative and of limited reliability in the early phases of the procurement cycle.[22]

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[20]Sol F. Divita, "Selling R & D to the Government," Harvard Business Review, XLIII (Sept.-Oct., 1965), 64.

[21]Weidenbaum, "The Federal Government as a Buyer," 22-23.

[22]In addition, there are a number of other factors which the government purchaser is required to balance in each contract decision. Beyond specific procedures for initially qualifying suppliers, evaluation is also influenced by the firm's management capability, prior experience and performance on similar projects, quality control organization and cost controls, understanding of the scope of the work and other criteria which sharpen the objectivity of the decision process.

Institutional purchases from spin-off firms often begin with orders for "one-of-a-kind" equipment to be used in research programs. Usually the firm's personnel work directly with the institution's researchers who select and specify the equipment to be purchased. Lowest cost is not always a primary objective in the institution, except in those areas where the products and supplies have a low technology content or are highly standardized.[23]

In purchasing a technical capability in industrial markets, the buyer frequently puts more emphasis on achieving the best possible balance between cost and technical performance. The value of technological perfection and high quality are important only in relation to the cost savings and reliability that can be achieved.[24] This was found to be true even though many of the custom products purchased from Michigan spin-offs were not used as parts or subassemblies for manufactured products. Price as well as reliability in the intended environment were frequently important purchasing criteria. Financial responsibility and the spin-off's technical resources were also important, but they were not evaluated as critically as in government markets.

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[23]Call, "Purchasing in the Academic Institution," 72.

[24]Purcell, Commercial Profits From Defense-Space Technology, p. 6.

Standard products and services. Negotiation was also used in the purchase of most standard products and services although highly standardized "off-the-shelf" items were purchased by competitive bids or the outright issue of a purchase order.

If the products or services were such that they could be specified by performance features or physical characteristics, the buying process was simplified. When negotiation was used to arrive at prices, fewer individuals were involved, the negotiation process was shorter in time duration, and more of the process centered around the determination of price.

Although cost is important to buyers in all markets, these considerations are perhaps less important in government and institutional markets when proposals are evaluated. Again, emphasis is on technological achievement because rapid advances in technology increase the obsolescence rate of product designs. Service and delivery are generally not as important to the government buyer and these factors were not always a basis for negotiation. The government performs much of its own service work and delivery dates are often flexible because of the length of the procurement cycle.

Buyers in industrial markets place more emphasis on cost in the proposal evaluation process. Although changes in technology outdate products and services, the greater emphasis on economy of use slows

the obsolescence process. Both industrial and institutional customers relied on the spin-off firm to perform after-sale technical service on many of the products, and service contracts often became part of the price quotation. The contracts were attractive to the spin-off because they provided the basis for a continuing relationship with the customer. Delivery schedules were also a basis for negotiation because of much shorter lead times and the urgency of needs in many of the research and development applications.

On purchases of some standard products and services, prices were arrived at through competitive bidding. This last aspect of the buying process is initiated by the request for quotation. Government and most institutions are required to purchase by the competitive bid system whenever possible although this method accounts for a small volume of their technology purchases. Under the government system, purchases are advertised and the lowest responsible bidder is awarded the order. If no bids are acceptable, the purchasing agent or contracting officer rejects them and calls for a new round of bids. Prices were more important to making the sale under the competitive bid system because the other aspects of the contract such as quality and delivery could easily be specified.

In industrial procurement of highly standard products and services, purchasing was done by competitive bidding, but prices were often subject to the forces in the open market. The outright issue of a purchase order for the product or service in question was frequently used when vendors had established a close relationship with the industrial customer.

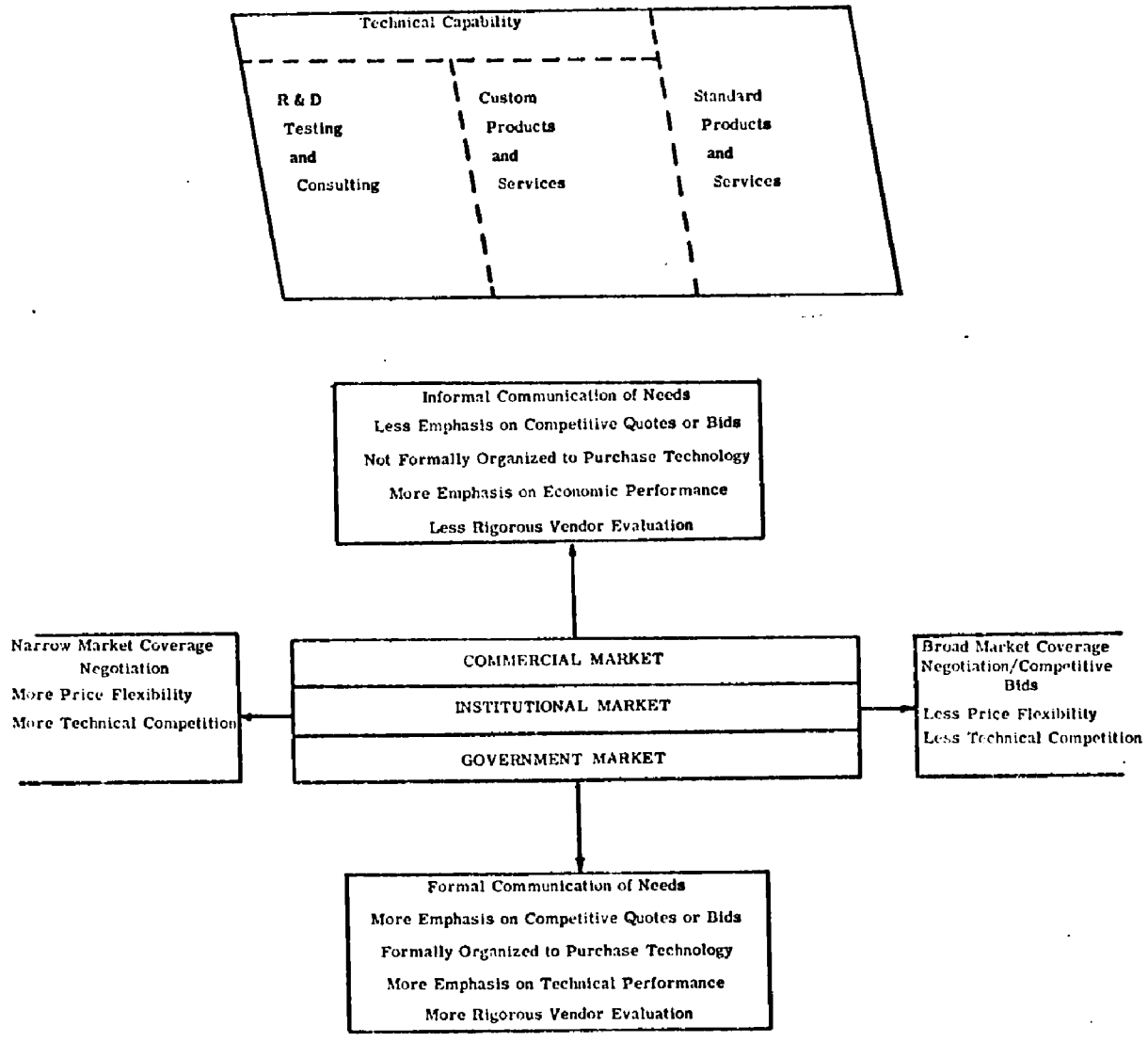
Summary

The major markets, their characteristics and the customer's method of buying can influence the marketing capabilities required to sell technology-oriented products, services and capabilities. The purpose of this chapter was to explore these influences so they could be related to the marketing programs being used. Figure 5 incorporates many of the concepts established in this chapter into the conceptual model. It becomes the basis for the following integrative summary.

The Michigan spin-offs included in this study were marketing to three major markets. Commercial markets were the most important to the majority of firms with a high percentage reporting business in the electronics, aerospace and automotive industries. Government markets of importance included DOD and NASA, while the most important customers in the institutional market were hospitals and academic institutions. In general, the government markets were

Figure 5

The Major Markets and Their Relationship to the Business Activity Spectrum



more important to the firms involved in a standard product and service activity, but there was a tendency for the firms to increase their breadth of coverage among the different customers in all markets as the business changed from a research and development orientation to a standard product and service orientation.

Certain characteristics of each major market influence the buying process for technology-oriented products, services and capabilities. In general, government markets are characterized by multiple buying influences, a long procurement cycle and a demand which can fluctuate widely. The buying agencies in these markets are well organized to control and coordinate the procurement process. Specialization by function as well as by the type of purchase make the government procurement process highly objective and competitive for prospective suppliers.

By comparison, institutional and commercial markets are marked by geographically scattered customers and buying influences which are generally easier to identify. The purchasing departments of these organizations are typically not organized to purchase non-standard technology-oriented items, particularly research and development or related technical capabilities. For this reason, much of the buying responsibility is assumed by technical personnel. The number of alternative sources evaluated in the procurement process varies somewhat

with the type of organization. Institutional buyers are obligated to solicit competitive proposals whenever possible, while industrial buyers are free to limit the number of proposals considered if they desire.

In the buying patterns for technology-oriented products, services, and capabilities, there are certain conceptual aspects and buying procedures which are common to all markets. These include the recognition and communication of needs, the selection of sources and the preference for negotiation in the buying process. Beyond these similarities, several market-to-market differences appear which influence the nature of the marketing task.

Formal procedures for communicating needs to prospective suppliers are used in government markets and a concerted effort is made to bring all qualified firms into the procurement process. This benefits the government buyer and enables him to negotiate from a position of strength. Federal agencies are generally well informed about the qualifications of a potential supplier before contracts are awarded because certain criteria have to be satisfied before the supplier is qualified to submit a proposal. In addition, objective vendor rating systems are used to evaluate proposals and select sources of supply. The government resources for appraising the technical and management aspects of the firms and their proposals are probably unequaled by those

in any other market. Technological achievement in addition to a number of other criteria form the basis for many of the contract decisions.

Compared to the formal character of the government markets, the industrial market and institutional market (to a smaller degree) are more informally structured. A large number of unrelated buyers exist, each of which purchases in an independent manner. Prescribed procedures for the communication of requirements generally do not exist and the extent to which suppliers are informed of impending procurements is frequently left to the judgment of the buyer. Institutions are an exception on the purchase of highly standardized products and they try to secure a number of proposals whenever possible. However, because many of their requirements for technology-oriented items are specialized, they often experience difficulty in attracting enough qualified suppliers to create a competitive environment.

Unlike the government's approach to qualifying and selecting vendors, the industrial and institutional buyers select suppliers on a less rigorous basis. Although buyers are concerned about financial responsibility and technical competence, cost and patronage motives are also important. In general, these organizations place most of their emphasis on the purchase of standard items. They

are usually not specifically organized to purchase a technical capability or a high technology product.

In moving across the business activity spectrum from a research and development orientation to a standard product and service orientation, there are some interesting differences in the buying process. A technical capability is usually purchased by competitive quotes and negotiation with suppliers. Standard products and services are also purchased by negotiation, but in procurement situations where the requirements can be specifically defined, competitive bids may also be used.

Because of the difficulty in defining needs at the research and development end of the spectrum, more emphasis is placed on technical competition and there is somewhat more price flexibility although market-to-market differences may influence the weights given to each criterion. By comparison, the customer often specifies the technical requirements for standard items or purchases one of a number of competitive alternatives. Understandably, there is less emphasis on technical competition and a smaller degree of price flexibility.

CHAPTER VI

The Marketing Interface

The Programs and Required Capabilities

The earlier discussion of the need for a management supported and directed program of innovation to sustain the sales growth of spin-off firms leads naturally to a consideration of the marketing strategy used to sell the resulting products, services and capabilities. This analysis emphasizes that innovation alone is not the sole determinant of a firm's growth. Continued success depends on the development of effective marketing programs designed to reflect the unique characteristics of the spin-off and its customers. This chapter evaluates those programs. Considered are (1) innovation strategy, (2) contracts and price strategy, (3) advertising and sales promotion, and (4) market representation and sales strategy.

The analysis of the markets and the buying process presented in the previous chapter contributed background for a continued evaluation of the second major research hypothesis. The balance of this chapter will also be devoted to an examination of the postulate that additional marketing techniques and capabilities are required by the firms who successfully progress to a standard product and service orientation.

Innovation Strategy

Several alternative innovation strategies for new products, services and capabilities were observed during the field research. In general, they were related to the business orientation of the firm, the available financial resources and the ability and willingness of the principal founders to accept risk. One example of a successful strategy was related by the president of a spin-off firm manufacturing printed circuits:

> My company spent $135,000 for research and development on a gamble of getting a large-production contract valued at $1.24 million. The gamble paid off and put this company in business.

Very few spin-offs were in the financial position to accept the risk implied in the above strategy. More typically the firms reported their approach to product and service development with comments like:

> We started as a research and development company with product spin-off. Actually we had a vague idea about products but nothing solid. We felt we would build a company in any way we could.

The first example is an extreme case of a strategy that is employed by many standard product and service firms and some custom product and service firms. The spin-off absorbs the entire risk in the development in return for an exclusive manufacturing contract, a proprietary product, royalties on the product, or some licensing arrangement designed to compensate for the risk assumed. The second situation characterizes most research and development, consulting and custom product and service firms marketing a technical

capability on a contract basis. The spin-off performs the technical work for the customer in return for a fee which hopefully covers costs and profit. The firm assumes less risk, does not make a substantial investment in the venture, and the customer retains exclusive rights to the results of the technical effort.[1] However, some of the funds from the contract work are often used to finance a proprietary effort designed to develop new products or services. The strategy employed is to carefully select contracts which contribute to the firm's proprietary effort so that a maximum amount of technical knowledge and engineering can be transferred and re-employed.[2]

R & D, Testing and Consulting Firms

Table 23 illustrates the changing emphasis on the performance of technical activities on a contract or fee basis in spin-offs classified by business orientation. From the table it can be noted that the research and development, testing and consulting firms were most frequently performing the technical activities at the beginning of the

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[1] The spin-off assumes the technical risk of solving the problem for a price which is usually fixed prior to the start of the work. There is often a substantial investment in engineering time, but if the project is successfully completed all or most of this cost is recovered.

[2] The entrepreneur of a well-financed spin-off commented that this strategy was called a bootstrap operation.

TABLE 23

Technical Activities Performed on a Contract or Fee Basis in Spin-off Firms by Business Orientation
(Percent of Firms Mentioning Each Activity)

Technical Activities Performed on a Contract or Fee Basis	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Research, development, evaluation and testing	80.0	53.1	36.0
Engineering and prototype or pilot manufacture	60.0	68.7	48.0
Manufacture of products and provision of general services	33.3	65.7	64.0
None	. . .	9.4	24.0
Number of firms	15	32	25

Excludes 4 firms acquired by merger.

innovation sequence on a contract or fee basis.[3] The overall importance of contract work to these firms made it difficult to implement a well-directed innovation strategy. Most of the firms were performing contract research and development or consulting out of necessity to develop expertise in a particular field and hoping that products would eventually fall out from the effort. Others were successful in bidding on follow-on contracts after winning a preliminary design or research competition and they used this work as a basis to build a product capability.[4] Several examples were observed in which technology was transferred from a completed contract to become the basis for a new product.[5] The new products developed in this manner were

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[3] Three consulting firms performed only engineering activity on a contract or fee basis in 1968. This accounts for only 80 percent of the R & D, testing and consulting spin-offs reporting contract work in research, development, evaluation and testing.

[4] This strategy was difficult to implement in government markets. The use of multi-phase procurement made it possible to introduce new competition at each phase and this reduced the opportunity for spin-offs to participate in succeeding contracts. Only a few of the research and development spin-offs interviewed reported success beyond the fabrication of an initial prototype.

[5] This was a common strategy, particularly among spin-offs involved in government contract research and development. The technology was internally transferred by the spin-off to develop a product for commercial markets. However, due to the greater emphasis on economic performance in commercial markets, these products were not always successful. For an excellent discussion of the problems typically encountered see: W.R. Purcell, Jr., ed., Commercial Profits From Defense-Space Technology (Boston: Schur Company, 1965), pp. 1-12.

usually related only through the technology which they employed. Because of the inability of the firm to exert much control over the development process, the products were frequently aimed at widely different markets or applications. The financial limitations facing most firms made it extremely difficult to conduct effective marketing programs under these conditions. As a result, the marketing rights of many of the products were licensed to others for commercial development.

Custom Product and Service Firms

These businesses relied less on contract research and related activity but placed more emphasis on engineering, manufacturing and service work.[6] Many of these firms were marketing products and services and were in a better position to internally finance and control some of the development effort.[7] A number of criteria were used to select contracts, but when possible the emphasis was on picking projects which were directly related to the direction of

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[6] Some research and development work was performed. On many jobs it was a necessary part of fulfilling the contract.

[7] More of these spin-offs were financing part of their own development effort compared to the R & D, testing and consulting firms (see Table 23).

technical development that the principal founders had charted for the business. This meant that in addition to the contracts ability to partially support the internal operation, they were also appraised with respect to the potential for follow-on business and the possibility of using the same hardware or design principles in a product application.

On a number of occasions, custom product and service spin-offs were given the opportunity to share in the benefits resulting from their innovative effort. Firms were approached by manufacturers looking for joint development contracts in which the spin-off would absorb the research and engineering costs in return for exclusive manufacturing rights on the hardware. These joint ventures were usually unsuccessful. Most of the spin-offs reported that they were unable to recover their costs because, "the business simply didn't materialize."[8] Depending on the circumstances, these risks were often difficult to evaluate. Some obvious mistakes included working with an OEM who was attempting to develop a new product for a market already extremely competitive and conducting a joint effort with one potential subcontractor

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[8]These costs, regardless of risk, were usually capitalized in an asset account (along with contract overruns) and expensed over a period of several years. Many firms following this accounting procedure were able to show profits early in their development. Later when the business did not materialize, the costs were expensed and substantial losses reported. Often the losses far exceeded profits earned in previous years.

for a highly competitive hardware contract. A few successes were reported, but these were generally projects involving the redesign or re-engineering of a product for a manufacturer "already having a substantial amount of business and having the technical and marketing capability to follow the project through to the market."

Custom design and build firms working in the newer areas of technology such as electro-optics frequently found the opportunities for successful innovation limited by the amount of time required for the development, evaluation and adoption of the technology in large-volume applications. They were forced by the prospect of future financial limitations to pursue an alternative product strategy. It typically involved the proprietary development of a line of products using the same or a similar technology, but requiring only a short-range technical effort. The products were inexpensive compared to the custom items and designed for specialty markets receptive to the technology. When this strategy was successful, the products served as a source of funds to finance the firm's longer range development effort. Unfortunately, they also offered considerably less sales and profit potential because the markets were highly competitive.

Standard Product and Service Firms

Among the firms involved primarily in a standard product and service activity in 1968, there was a definite tendency to perform less technical work on a contract or fee basis. According to Table 23, only 36.0 percent of these spin-offs reported contract research, development, evaluation and testing, while 48.0 percent performed contract engineering and prototype or pilot manufacture. Nearly all of the firms studied in this activity category conducted their own research programs financed at least partly from company funds. It can also be noted from Table 23 that 24 percent of the firms reported no contract work at all. These firms financed their entire technical effort.

Compared to the spin-offs classified in the other areas of business activity, the innovative efforts of this group of firms were more carefully directed and controlled. Because of the lower frequency of contract work there was less tendency to sacrifice the firm's development and engineering effort through the performance of jobs not directly related to the spin-off's goals. The innovation risk, however, was correspondingly greater. Not only did the spin-off assume the complete technical risk that the product would perform properly in the intended application, but the firm also assumed the risk that the product would be accepted in the marketplace.

By accident or intention, the product-oriented spin-offs were often found to be developing hardware for specialized applications in which the firm had a price or performance advantage and the market was not large enough to attract large corporations as competition. This strategy was not without its disadvantages. The absence of a potential market of substantial size and the need for market development to create demand often meant that the traditional methods of marketing and distribution were not available to these companies. Many product-oriented companies marketing high technology products were forced to use direct mail during the early stages of market development to reach highly fragmented markets.[9]

Summary Remarks

Overall, the innovative strategy of most spin-off firms was characterized by insufficient market contact and planning during the product development stage. A number of instances were observed where the marketing considerations became important only after the product or service was completely developed. Only then did the spin-off discover that the product did not fit the

[9]This was also true of the other spin-offs engaged in a product development effort. In these firms the absence of a distribution network as well as the failure to plan for one often left direct mail as the only alternative for reaching the market.

traditional marketing channels. Not all of the spin-off firms were guilty of this oversight. The problem was usually concentrated in new businesses and spin-offs involved in research and development, consulting and custom product and service work.

Many products were developed without a consideration of the marketing capabilities required to successfully reach the market. Examples were found where the products price and other characteristics made it ideally suited to a distributor or manufacturers' representative organization, but the product was simply too complicated to be sold by these market intermediaries. Although marketing channels were eventually arranged for the products, the sales were usually disappointing because of the inability of the intermediary to sell the product or service concept.

An underestimation of the time and costs involved in getting to the market was another problem encountered in spin-offs attempting to sell their first product. The need for conventional sales materials such as office equipment and supplies, brochures, data sheets, invoice forms, and demonstrators pushed sales expenses far beyond those anticipated by the firm. Crash or crisis marketing programs resulted which were both expensive and ineffective because of the failure to properly plan and coordinate the effort with the technical development.

Technical entrepreneurs were remarkably optimistic about the eventual success of their first products despite the high probabilities associated with new product failure. Sometimes the optimism led to an incomplete technical and marketing effort. Products were designed for applications without a clear understanding of the performance and service requirements. The pressure to recover research and development costs often meant that the products were not well developed technically or use tested before their sale.

Contracts and Price Strategy

Two fundamental types of contracts were negotiated by the spin-off firms investigated during the field research. One type resulted in the quotation of a firm or fixed price to the customer, while the other resulted in a flexible-price quotation. Each was preferred and implemented in a certain set of circumstances. Combinations and variations of each type were also observed, but generally the basic differences were the same. For this reason, the following discussion of pricing will be confined to one or the other of these two basic types.

Table 24 illustrates that both flexible and firm-fixed price contracts were used by many spin-offs, but the form used in the majority of the firms' sales was related to the major area of business activity.

TABLE 24

Primary Type of Price Contract Used in Spin-off Firms by Business Orientation
(Percent of Firms Reporting Each Type of Contract)

Primary Type of Contract	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Flexible price	80.0	14.3	. . .
Firm-fixed price	20.0	85.7	100.0
Total	100.0	100.0	100.0
Number of firms	5	14	13

In general, flexible-price contracts were preferred by research and development and some testing and consulting firms, while fixed-price contracts were most often used by firms providing custom or standard products and services.

Contractural Arrangements

A unique aspect of the procurement of technology products, services and capabilities is that the price is generally set by negotiation with the customer rather than in response to impersonal market forces. Two specific types of flexible-price contracts were negotiated by the spin-off firms studied. Cost-plus-fixed-fee contracts were utilized in the purchase of research and development and occasionally on initial production contracts. In this contractural arrangement the customer paid the actual cost of the project plus a fixed fee for profit.[10] Time and materials contracts were used in the sale of consulting services, custom services such as computer programming and data processing, and contract manufacturing. Under this agreement, the customer buys the spin-off's capability in units, paying an hourly rate for the time consumed in completing the contract plus the price of the materials consumed (if any) with an appropriate charge for handling.

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[10]The contracts often had a ceiling price or fixed level of effort.

Spin-off firms used firm-fixed price contracts in the sale of research and development as well as in the sale of standard products and services. With this contract the spin-off furnished everything at a specified fixed price, often with no provision for adjustment.[11] In the case of systems sales or other large equipment installations, a formal contract specified the relationship between buyer and seller. However, when the products to be purchased were highly standardized "off-the-shelf" items (such as electronic components) standard commercial prices prevailed which were fixed by the forces of the market.

Relationship to the firm. The price and the specific contractural arrangement that is negotiated by the spin-off firm and his customer usually depends on the amount of risk involved in the sale, the ability to estimate the risk, and the willingness of each party to assume or share the risk. Just as a relationship between the business orientation of the spin-off firm and the use of a particular price arrangement was shown to exist, a similar relationship was found between the specific contractural form used and the firm's business orientation. The

[11]Some fixed-price contracts contained a provision for renegotiation. It was usually automatic if the customer made a change in the scope of the technical effort or requirements.

relationship is shown in Table 25, where the spin-offs investigated during the field research are classified by business orientation and the type of contracts used in their business.

R & D, Testing and Consulting Firms

These firms used all the contractural forms in their business, but the majority of the sales were made on cost-plus-fixed-fee and time and materials contracts. Projects involving research and development, in particular, were handled in this manner because of the difficulty in defining the scope of the technical effort and estimating the risk involved.[12] Often neither the spin-off or the customer had the benefit of prior experience with the specific problem, so an arrangement evolved where both the customer and the contractor shared the risks. On flexible-price contracts, such as cost-plus-fixed-fee and time and materials, the customer assumed the largest share of the risk. He gambled that the research would result in a solution to his problem or that the product resulting from the technical effort would perform in his application.

Fixed-price contracts were also used by the spin-offs involved

[12]This was particularly true in government markets. Many of the government research and development contracts were negotiated on a cost-plus basis. This is probably a reflection of the emphasis on technological achievement and the ability of the customer to evaluate the risks involved.

TABLE 25

Type of Contract Used in Spin-off Firms by Business Orientation
(Percent of Firms Mentioning Each Type of Contract)

Type of Contract	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Cost-plus-fixed-fee	80.0	. . .	. . .
Time and materials	40.0	28.6	. . .
Fixed-price quotation	80.0	100.0	61.6
Standard commercial price	20.0	42.8	61.6
Number of firms	5	14	13

in research and development, testing and consulting work.[13] This form was preferred for jobs where the technology and analytical approach was understood and the firm had a previous history of successful performance in the same or a similar area.[14] When the scope of the technical effort was well defined, these contracts had a greater profit potential. However, profit was by no means assured for the firm. The inexperienced personnel of new firms, in particular, underestimated the technical requirements (as well as their fixed costs) and frequently exceeded the contract's price. Overruns were common among new firms—especially those working in the newer areas of technology.

Cost-oriented pricing. Because the value of the results of the technical effort were not known until after the sale, the pricing in these firms was cost oriented. The cost to complete the work, the uncertainty in the contract, historical costs and bids from similar jobs, and the opportunity for follow-on production contracts were some of the factors considered in the negotiation process. Extreme competition for contracts (particularly in

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[13]Generally fixed-price contracts were preferred by industrial buyers.

[14]Some of these firms were also marketing a standard product. They were always sold on a fixed-price basis.

government markets) reinforced this approach. Most of the time a number of firms were technically qualified to perform the work and equally in need of the business. The result was that price competition became extremely keen during final negotiations.[15] Most new spin-off firms reported that their first awards were made primarily on the basis of price. A number of firms followed a strategy of initially pricing low to gain market entry.

Custom Product and Service Firms

This group of firms, shown in Table 25, indicated a definite trend away from the use of flexible-price contracts toward the use of fixed-price contracts. Although some manufacturing and computer programming was performed on time and materials contracts, all of the spin-offs interviewed reported doing business on a fixed-price basis. Further, a substantial number of firms had also developed standard products and services. Over 42 percent were using standard commercial prices in part of their business.

[15]Despite the intensity of competition, final price quotations usually varied over a fairly wide range. Alternative technical approaches to the problem and the difficulty of anticipating contingencies made the cost estimates different for almost every potential supplier. This problem, when combined with the almost impossible task of estimating the final value to the customer, left a wide range over which prices were flexible.

With the exception of engineering contracts that required research to design and build a custom product or other long-range technical efforts for "first-of-a-kind" hardware or software, the uncertainty in many of the projects was easier for both the spin-off and the customer to estimate. In many jobs, performance requirements could be specified because the project was part of an existing system, while in others a working design already existed for the hardware to be purchased. Competition, a lower level of perceived risk and the buyers relatively stronger bargaining position, usually shifted most of the risk to the spin-off firm through the negotiation of a fixed-price contract.

Evolution of a pricing strategy. Price quotations were typically cost oriented with allowances made for contingencies and modifications in the scope of the work. Estimated costs were based on the spin-off's perception of the technical complexity of the problem and an understanding of the customer's needs. Most firms made extensive use of historical cost information, particularly when similar jobs had been performed in the past. However, in addition to the costs estimated to perform the work, a number of other factors influenced the level of the spin-off's price quotation.

An important factor was the current operating level of the spin-off's plant. Firms operating well below capacity frequently priced just above marginal costs to generate enough business to keep their

engineers employed and busy. This was a necessary strategy in many of the firms involved in the sale of complex systems or major installations because of fluctuating demand. The potential of the customer to provide additional business either in the form of a follow-on manufacturing contract or a new application was also used as justification to deviate from a quotation covering full costs and profit.[16] Larger corporations usually benefited from this strategy. Finally, special consideration was given to potential customers having projects or problems which offered potential for (1) transferring the knowledge generated to jobs for other prospective customers or proprietary development projects and (2) opening a new field of technology to the company or expanding the scope of the firm's existing technical capability.[17] To most spin-offs, business of this type was attractive because the customer was financing part of the firm's learning experience. A number of firms reported taking contracts at a slight loss to take advantage of these benefits.

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[16]Some of the custom product and service firms followed a strategy of entering government and industrial markets at the hardware stage of a multi-phase procurement.

[17]The last consideration was frequently cited as a reason for actively soliciting business in government markets.

Price competition and non-price factors. Most of the technical entrepreneurs in custom product and service firms believed price competition was an important factor in their business, but not necessarily the most important consideration in the award of a contract. Although variation in the importance of vendor selection criteria existed between markets, technical competence, management capability, the approach to the problem, and the firm's reputation for quality work were frequently mentioned as being of primary importance. However, when entrepreneurs were questioned about why they lost contract competition nearly all cited either the "customer's failure to understand the complexity of the problem" or price as the main reason. For jobs which involved some technical competition, non-price factors were clearly important in the preliminary phases of the competition to screen out proposals that were obviously not appropriate. Once a group of technically qualified vendors was selected and a common understanding of the requirements achieved, the emphasis of the competition shifted to price. An acceptable range of price quotations was obtained and combined with the non-price factors to select the proposal which maximized the value to the customer.[18]

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[18]Price was even more important on contract manufacturing jobs where the prospective contractors were given a set of specifications or a design on which to base the price quotation.

Price was probably a more important part of the marketing programs of these firms than the entrepreneurs cared to admit. Compared to the research and development or consulting firms, for example, more qualified vendors were available to quote on contracts and the applications were usually defined more specifically. Consequently, there was usually less flexibility in the range of possible prices.

The custom product and service firms having a line of standard products which made an important contribution to sales were financially able to isolate their business from some of the price competition. They carefully screened the available jobs and selected those which offered the best opportunity for success and made the greatest contribution to the firm's longer range objectives.

Standard product and service firms. All of the firms interviewed during the field research used fixed-price contracts. This is shown in Table 25, where over 61 percent of the firms in this category reported using fixed-price contracts and standard commercial prices. Most of the contracts were for production items or hardware systems and did not provide for uncertainty adjustments or renegotiation. The entire risk of the sale was shifted to the spin-off firm and payment was made after delivery and acceptance

by the customer. Similar circumstances prevailed for the products sold from inventory at commercial prices. The spin-off warranted their performance for a given use or application and completely accepted the liability involved in the sale.

Compared to the risk involved in contract jobs requiring extensive research and development or engineering, the risk in the applications for standard products or services was usually smaller and easier to evaluate. Generally the intended use for the product or service was specified before the sale and the spin-off had a reasonable estimate of the performance and reliability that would be required. The buyer was also in a stronger position to make the best possible procurement decision. Because of the tendency toward standardization at this end of the activity spectrum, alternative suppliers and the available products or services were more numerous and sharply defined. Selection was facilitated because the performance advantages could be evaluated with respect to a known application. These factors narrowed the range of acceptable prices.

Some value-oriented pricing. For the products and services having a number of available alternatives, the price was determined by market forces and the price levels of larger competitive firms. More often, however, the products and services of spin-off firms offered

cost or performance advantages not duplicated by existing commercial items. In these situations a value-oriented approach was used by many firms to establish the level of price. In some cases this meant using the competitive product's price as a target and then adjusting the price of the spin-off's product to reflect the performance advantages. In others, the approach was characterized by a careful evaluation of the customer's application, his product alternatives and the cost savings offered by the new product. A number of firms indicated success using this approach to pricing and a few had even worked out formulas which incorporated the concept.

Because the spin-off's product or service often occupied a unique market segment, direct price comparisons were difficult to make. To some extent this isolated the firm from intense price competition; at least until identical substitutes became available on the market. Non-price factors such as product performance and reliability, functional capability, quality, service, and availability assumed importance to buyers and were emphasized in the firms' marketing programs.

Problems in pricing. Problems related to the pricing of standard products and services were usually the result of inexperience and insufficient market information. In new spin-off firms, products and services were typically underpriced because of an inadequate history of cost

information. Mechanisms were not established to gather competitive price and cost information and many of the entrepreneurs had no previous experience to use in establishing guidelines. Overhead costs, service costs, selling costs, and promotion costs were typically underestimated and the sales volume that could be generated on the basis of a given level of marketing expenditures was vastly overestimated. This last problem deserves emphasis because most of the spin-off firms planned from a technological standpoint and failed to realize the true marketing implications of their plans. In most cases the technological goals far exceeded the marketing capabilities available.

Entrepreneurs of some of the product-oriented firms that had been in business for a number of years reported that during their first few years of operations they lost orders because they intentionally priced too low. They emphasized the need to price for recovery of research and development costs over the estimated life of the product and to consider warranty and installation costs when they were applicable to the sale.

Advertising and Sales Promotion

In discussing the marketing of advanced technology products, services, and capabilities, the function of advertising and sales promotion was occasionally dismissed by comments such as "it's

not necessary in our business," and "I know who all the contacts are." Typically, these statements were made by the entrepreneurs of spin-off firms doing business in government markets or in markets where a few customers accounted for the majority of purchases. Even with these "not so apparent" exceptions, it became clear during the research that not all firms made extensive use of promotional material as part of their marketing effort. Both the promotional items selected, the objectives to be achieved, and the extent of their use depended on the type of business the firm was involved in.

Table 26 illustrates the relationship between the six different types of sales promotion used and the business orientation of the firm. From the table it can be observed that sales promotion played the most important role in the marketing programs of firms engaged in the marketing of standard products and services, while it was of least importance to the marketing efforts of research and development, testing and consulting spin-offs. The difference, however, was not clean-cut. Some of the firms marketing both a technical capability and a standard product or service made use of all the promotional items in their marketing programs.

R & D, Testing and Consulting Firms

Spin-off firms in which the primary area of business interest was marketing research and development, or testing and consulting services

TABLE 26

Type of Sales Promotion Used in Spin-off Firms by Business Orientation
(Percent of Firms Mentioning Each Type of Sales Promotion)

Type of Sales Promotion	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Brochures and data sheets	80.0	78.6	84.6
Trade journal advertising	40.0	50.0	69.2
News releases	40.0	14.3	61.5
Trade shows	20.0	35.7	61.5
Direct mail	. . .	21.4	38.5
In-house promotional publications	. . .	. . .	23.1
Number of firms	5	14	13

made little use of advertising and sales promotion. In general, the opportunities for creative sales promotion were limited because of the overriding importance of the technical proposal, the problems involved in defining needs, and the difficulty of making highly specific appeals.

Emphasis on the capability brochure. When sales promotion was used, it usually took the form of a capability brochure designed to inform potential customers of the spin-off's technical capability and establish recognition as a leader in a particular area of technology.

The better capability brochures contained a description of (1) the firm and the business, (2) the facilities and special research or test equipment, (3) the key personnel and their areas of technical expertise, (4) the important research projects completed, and (5) examples of hardware if it was part of the firm's technical effort. When the firm also offered a product for sale, an additional section of the brochure was devoted to pictures and a description of these items. Trade journal advertising, trade shows, and publicity releases were usually not used by these businesses unless the spin-off also had a proprietary product to promote to potential customers. In these situations, the product usually received the primary emphasis with the firm's technical capability being promoted less prominantly.

A wide variation in quality. While the capability brochure was the most effective means of sales promotion, the quality of the brochures varied widely. In the case of firms marketing to the government, they usually consisted of a few mimeographed pages at the end of the proposal.[19] The form was appropriate but for the most part they were poorly organized, presented entirely from a technical standpoint and generally ineffective in communicating the firm's capability to the customer.[20]

Some of the brochures used by firms selling primarily to industrial customers were professionally prepared and did an excellent job of making an intangible capability highly meaningful to the customer. The firms having these brochures reported success with their use, particularly in helping the business bridge the credibility gap.

Reprints of technical papers written by the spin-off's personnel and published in professional journals were also reported to be highly effective by the few firms that used them. Surprisingly, no

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[19]In general, the spin-offs marketing to the government placed little or no emphasis on sales promotion. This appears to be a reflection of the structured nature of the market, the emphasis on objective technical competition and the importance of the research proposal in communicating the spin-off's technical capability.

[20]It is interesting to note that most of the firms felt this was a rather unimportant part of the proposal once they had been qualified to do business with a particular agency.

one conceived the idea of combining them with the capability brochure to make a more effective and authentic package.

Custom Product and Service Firms

The firms involved exclusively in the sale of custom products and services also relied on the capability brochure as the most important sales promotion item. Trade journal advertising was used infrequently because many of the firms marketed in a local area and lacked a formal marketing department or representative organization to follow-up on the sales leads. It was also difficult to communicate the firm's capability to potential customers in the limited amount of space and exposure frequency which they could afford. Trade shows were generally not considered effective for capability marketing because they were often geared to demonstrating products and provided insufficient exposure to the company having a broad technical capability.

The capability-oriented firms also reported very little success with direct mail promotion both in terms of response rate and new business generated. While it is always difficult to market a technical capability by mail, much of the responsibility for the poor results lies with the spin-off firm. Mailing lists were often ineffective because of the inability of the firm to identify potential customers and buying influences. Too often the mailings themselves were

incomplete. They contained only a brief introductory letter and no promotional brochure describing the company, the people, and the areas of technology in which the company was qualified to do work. New spin-offs attempted to use direct mail before they had defined their business and identified the most likely prospects.

Increasing opportunities for promotion and strategy. Promotional opportunities were enhanced for the custom product and service firms also having proprietary items to market. These are the firms in Table 26 that reported using trade journal advertising, trade shows and news releases featuring new products. The capability brochures featured the products and detailed examples of successful applications. They were backed up by data sheets providing the technical specifications and instructional material on the product's use. Trade journal advertisements were used principally to promote products, but also featured the company's technical capability to build hardware or develop software. In some spin-offs the promotion strategy involved using horizontal publications during the beginning of a new product introduction to probe and identify the potential markets and then changing to vertical industry publications as the applications became more specifically defined. Trade shows were most effective for new product introductions, but in

conjunction with this activity they were also used to promote the firm's technical capability. Technically complex products (including some custom equipment) requiring concept selling were effectively sold at trade shows because of the opportunity to demonstrate the complete product to a large number of potential buyers.

Constraints to effective use. The extent of the advertising and sales promotion programs varied widely among the different custom firms studied. The spin-offs doing business in narrow markets with a well-defined group of customers typically did not have promotional programs until they began to develop products for broader industrial markets. Job shops that were willing to take on a variety of different (and often unrelated) technical problems used nothing more than a few pictures of past jobs to demonstrate the firm's technical capability. Financial restrictions in these firms made it necessary and desirable to trade off the benefits of a program of sales promotion for a direct sales effort.[21] However, the innovative spin-offs having a few proprietary products and a definite corporate philosophy regarding the firm's area of technical

[21]Even without serious financial constraints, the spin-offs doing a large percentage of their business with the government intentionally made this trade-off. Advertising and sales promotion specifically directed to government markets was rare. Personal selling was believed to have a much higher return for an equivalent expenditure.

interest usually managed to reflect this direction in a well-designed sales brochure and supporting program of journal advertising and trade shows. These programs were needed to effectively market the proprietary items. In many cases the rest of the marketing program benefited because it was convenient and economical to promote the technical capability at the same time.

Substantial quality variations were apparent in the promotional literature. The first brochures and data sheets were usually designed and written by the principal founders. They were technically oriented and reflected the entrepreneur's difficulty in defining needs and identifying the level of technical sophistication of the buying influences. As the spin-off became financially stronger, the promotional literature was revised and prepared by professional agencies. With one or two exceptions, too many entrepreneurs wasted their time preparing these items.

Standard Product and Service Firms

Compared to the spin-offs involved in the other areas of business, the standard product and service firms shown in Table 26 made considerably greater use of the available sales promotion tools in their marketing programs. Almost 85 percent of the firms reported using sales brochures and data sheets, while 69.2 percent made use of journal advertising, 61.5 percent used news releases and trade shows,

and 38.5 percent of the firms used direct mail. Three of the spin-offs had their own in-house publications that they used regularly to communicate with their customers.

Favorable conditions for the use of promotion. A number of reasons accounted for the expanded use of sales promotion, but one of the most important was the need to reach widely dispersed markets and customers. Unlike many of the capability-oriented firms which marketed in a regional area, the standard product and service firms supplied items that depended on broad national exposure to generate sufficient sales volume to enable recovery of research and development costs. The products and services were also better suited to a sales promotion effort. In most cases, the concept was well defined and the market and potential applications were known. This enabled the design of highly specific promotional literature and the selection of trade shows and journals that had a high probability of reaching the right customers.

The factors influencing the use of promotion also made it possible to achieve more specific objectives with the programs. In addition to informing potential customers about the spin-off firm and its products, more emphasis was placed on advertising and sales promotion specifically designed to generate sales leads, bring

in orders and support distributors and representatives.

Influence of firm size. In the well-established companies the sales promotion programs played the role of supplementing and balancing the firm's overall marketing efforts which often included direct sales or a network of manufacturers' representatives and distributors. New product introductions were timed to coincide with trade shows where the company's technical and marketing personnel could meet potential customers. Promotional literature and catalogs were imprinted and provided to the firm's representatives and distributors and direct mail and journal advertising were used to create a selective demand. The programs were well coordinated in those firms having a formal marketing organization. They contributed to the sales process, but were usually not the only means available to close a sale.

The newer product-oriented spin-offs definitely relied more on sales promotion in their marketing efforts. In many cases the entire marketing program consisted of a few trade shows, some journal advertising and a professionally prepared sales brochure. Expensive electronic instrumentation was sold in this manner and so were lower priced electronic components and devices. The sales were frequently disappointing, but the strategy was to only skim the

market and generate enough revenue to cover development expenses and support a more in-depth selling program. While this bootstrap approach could be easily criticized, in many cases it was the only alternative available to the company. The firms were unable to finance a direct sales effort and distributors and manufacturers' representatives were reluctant to take on new companies having products with an uncertain demand. The entrepreneur was left without a choice. He gambled everything he had on a trade show or direct mail promotion to demonstrate the products' market acceptance and hopefully develop an alternative means of reaching the market.

Market Representation and Sales Strategy

Just as the role of sales promotion in the spin-off's marketing program was related to the different areas of business activity, the appropriate market representation and sales strategy was also influenced by the composition of the firm's business and the type of product, service or capability to be sold. The differences were more than subtle. Entirely different sales capabilities were required in the sale of research and development or complex systems, for example, than were necessary for the sale of products such as amplifiers or electronic components. This relationship between the

nature of the business activity and the type of market representation used is shown in Table 27.

R & D, Testing and Consulting Firms

All of the research and development, testing and consulting firms in Table 27 reported that the principal founders were also active in a sales capacity. In companies having only a technical capability to sell, the entrepreneur was usually the key market contact. If the firm was also fortunate enough to have a product to sell, his efforts were occasionally reinforced by those of direct sales people or market intermediaries. As shown in Table 27, only a small percentage of the firms were in this position.

Emphasis on direct selling. The complex nature of the problems encountered, the length of the sales and contracting cycle and the tendency to market in a limited geographic region made the sale of research and development, and testing and consulting services ideally suited to the direct type of market representation used by most of the firms. Personal selling by the firm's principal founder with assistance from the engineers, scientists and other technical personnel

TABLE 27

Type of Market Representation Used in Spin-off Firms by Business Orientation
(Percent of Firms Mentioning Each Type of Market Representation)

Type of Market Representation	Business Orientation		
	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Principal founders on a part-time basis	100.0	71.0	62.5
Manufacturers' representative or industrial distributor	7.7	12.9	16.7
Combination of manufacturers' representative or industrial distributor and direct sales personnel	15.4	19.4	29.2
Full-time direct sales personnel	....	12.9	20.8
Number of firms	13	31	24

was the main thrust of the firm's marketing program.[22] Most of the engineering and technical management people who were the key buying influences for this capability preferred it this way. Because of the need for technical definition of the problem or project and frequent changes in the scope of the work requiring negotiation, the sales process was technically oriented and usually handled best by the firm's employees who were doing the work and making the decisions. With the exception of the firms soliciting government business, there was very little creative marketing and aggressive selling. The emphasis was on high quality and the referral system to provide invitations to quote on new jobs. Marketing commenced after the demand for the firm's capability was created.

Custom Product and Service Firms

Among the custom spin-offs in Table 27 that were marketing a technical capability, there was a trend toward shifting the sales

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[22]This was particularly true in government markets. The buying influences in these markets prefer to do business directly with their management counterparts in the supplier organization. This "opposite numbers" concept broadens and diffuses the spin-off's selling role in government markets to include top management as well as technical personnel. Most of the spin-offs employed this strategy. For additional details see: Divita, "Selling R & D to the Government," 64-65.

responsibility to either direct sales personnel or a market intermediary. Part of the change in emphasis occurred because many of the firms had developed the sales volume and financial means to support some type of formal marketing organization. The balance can be attributed to the development of new products which required an alternative means to reach the market.

An evolving sales strategy. When only the marketing of a technical capability was involved, the sales function was usually performed by the principal founder or the firm's own direct sales personnel. At the later stages of the sale the spin-off's technical staff also became directly involved because most of the effort was directed at the engineering level and the potential customer was interested in evaluating the people who would perform the work.[23] This use of technical team selling during the later stages of the sale was practiced by many firms and considered to be highly effective. Some spin-offs reinforced this approach to selling by featuring it in their capability brochure.

For the firms building hardware or licensing processes, the plant facility was an important part of the selling program. Plant visits by potential customers were used to demonstrate special equipment, processes, and hardware concepts as well as introduce

[23]Prior to the negotiation stage the firm's technical staff was involved in the formulation of the proposal.

the firm's technical staff to the customer. This approach was very effective for firms working in new areas of technology where the equipment or hardware systems used new concepts. Four of the spin-offs that were building non-portable equipment for the processing of engineering materials maintained applications laboratories where the customer could bring samples of materials for evaluation on the firm's equipment. These installations were reported to be effective in situations which required a large amount of concept selling.

Increasing role for the market intermediary. The custom product and service firms in Table 27 that reported using manufacturers' representatives and industrial distributors were usually marketing products in addition to a technical capability. These market intermediaries played an important role in the marketing programs of the newer spin-offs where the firm had (1) a narrow product line, (2) limited financial resources and the need for a quicker cash flow, and (3) products which had an established demand and happened to fit the markets served by a particular organization. However, many types of selling situations were observed where this type of market representation was not effective.

When the marketing task involved the sale of a custom capability, the role of the manufacturers' representative was limited to that of establishing the existence of a need for the company's capability and managing the relationship between the spin-off and the potential customer. This was particularly true when the marketing task involved the sale of major custom installations or a systems capability where the major decisions were made in the technical stages of the buying process. In general, the entrepreneurs interviewed felt that the need for a broad knowledge of the spin-off's capability, the long sales cycle, and the need for missionary selling precluded the manufacturers' representative from being effective in selling a technical capability. Many firms, however, retained these organizations as a means of representation just to have market coverage and a source of sales leads.[24]

The custom product and service firms involved in marketing both a technical capability and a few proprietary items were confronted with the need for a diverse marketing capability in their organization. A direct selling effort was needed to effectively market the firm's

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[24]Government markets were an exception. Only one firm reported using a manufacturers' representative to sell in these markets. The representatives' function of generating sales leads has been replaced by the formal programs that exist to communicate the needs of various agencies. In addition, government buyers prefer to deal directly with the supplier whenever possible.

technical capability, while manufacturers' representatives or distributors had to be selected and trained to handle the marketing of the firm's products. Too often, the principal founder had to direct both of the programs. Very few of the firms interviewed had the necessary personnel and capabilities to manage these efforts effectively.

Standard Product and Service Firms

Compared to the capability-oriented spin-offs shown in Table 27, the firms marketing standard products and services made greater use of market intermediaries and direct sales personnel (and combinations of these two) as methods of market representation. Correspondingly, these same firms relied less on the principal founders for their selling effort.

Increasing market representation. The trend toward greater use of direct sales personnel and market intermediaries is a reflection of the fact that nearly all of the standard product and service spin-offs were confronted with the problem of reaching widely dispersed national markets. The type of sales representation preferred depended primarily on the products or services to be marketed and the size and financial strength of the firm.[25]

[25] The treatment of this topic has been intentionally limited in scope and depth of coverage. The major problems encountered by product-and-service-oriented firms in achieving market representation are discussed in detail in Chapter 7.

Large, well-established spin-offs having $2-3 million of sales and fairly broad product lines were usually using direct sales personnel to call on customers or to work with distributor organizations when the product required this type of marketing effort. Some firms needed both. One large spin-off selling environmental and medical electronic instrumentation also manufactured a line of disposable products which complemented the instrument line. The firm used a direct field sales force with regional sales offices to sell the instruments, but sold the disposables (and related products) through four national medical distributors having a total of 600 salesmen. Obviously, this firm was involved in conducting and coordinating two major marketing programs.

The smaller spin-offs usually used manufacturers' representatives instead of company sales personnel because they were unable to finance a direct selling effort. When direct factory sales were employed, the personnel were often called applications engineers; technically trained individuals who would follow-up on the representatives' sales leads and work directly with the customer until the proposal was submitted and the procurement decision made.[26] These

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[26]The use of the applications engineer reflects the fact that even though the product's benefits and the customers' needs are well defined, the selling job is still primarily technical in nature. Most of the key buying decisions are made by the technical personnel of the customer's organization.

programs were usually plagued with management problems. The spin-offs typically were not in a strong bargaining position during the selection process as a result of their small size and inexperience in selecting a manufacturers' representative or distributor to handle their products. An unsatisfactory arrangement often resulted and the relationship between the spin-off and the intermediary slowly deteriorated as the sales of the firm's products failed to materialize.

Too often the spin-off firm had unreasonable expectations of the market that could be developed for the product and the level of effort that would be provided by the representative. Many new firms literally dumped the complete marketing task on the representative while failing to provide him with a well-engineered functional product, sales training and technical assistance, accurate sales literature and national adveritisng to create a demand for the product. The marketing programs of several small spin-offs were doomed from the very beginning because of their failure or inability to secure the best possible market representation and then properly support it.

The Marketing Programs Reviewed

The purpose of this chapter was to evaluate the marketing programs used by spin-off firms and examine the evidence in support of the postulate which stated that:

> The marketing techniques and capabilities required by the standard product and service firms are more extensive than those required by the firms having a research and development or similar orientation.[27]

The data and research findings presented in this chapter strongly support the postulate. They also lend additional support to the major marketing hypothesis which suggests that marketing plays a small role in the initial formation process, but assumes greater importance as the spin-off firm develops.

This final section reviews the different programs and summarizes the evidence in support of the postulate. The major findings are integrated into the conceptual model which is illustrated in Figure 6. It provides the framework for the following summary.

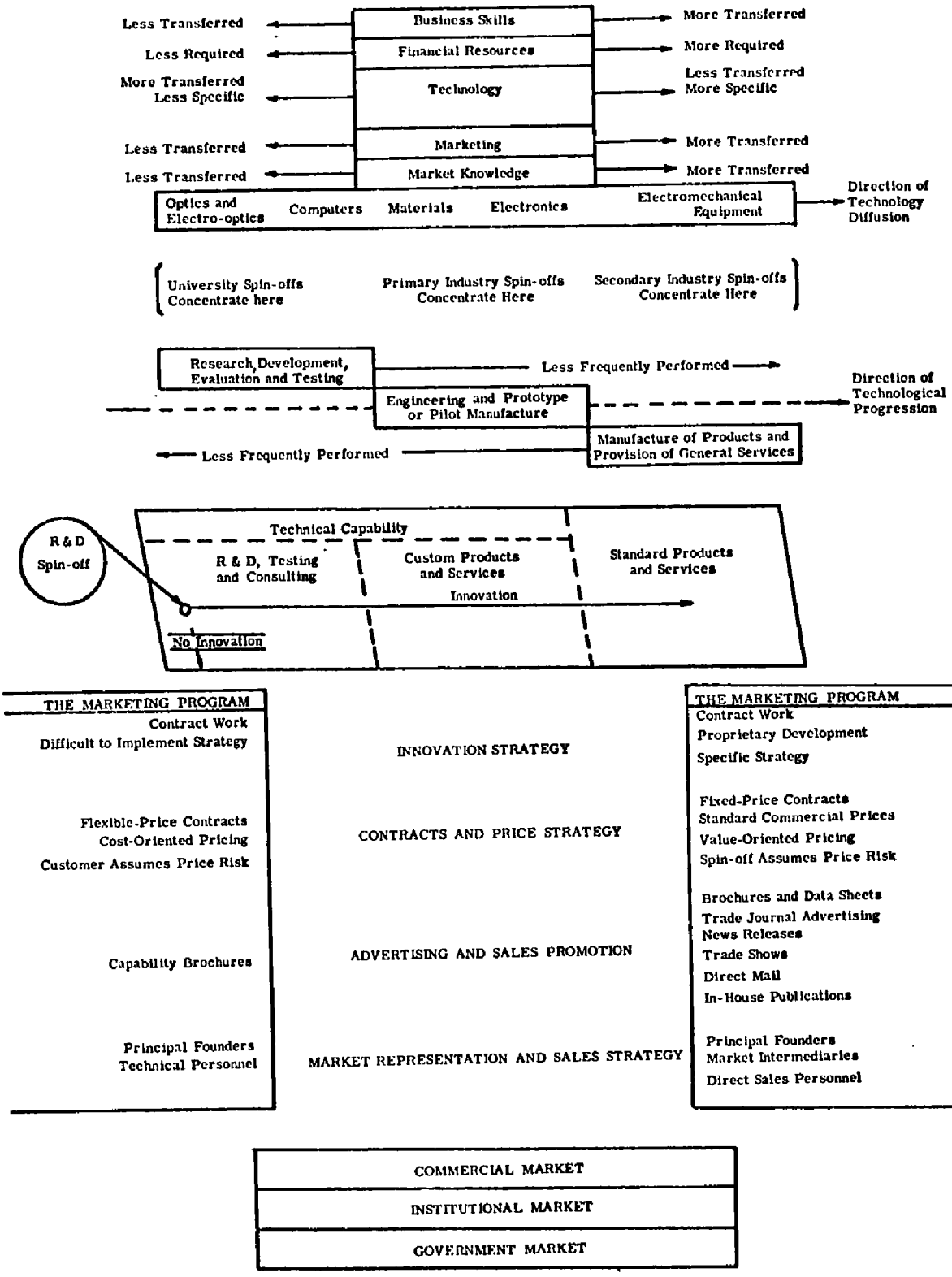
R & D, Testing and Consulting Firms

The marketing programs of the research and development, testing and consulting firms were oriented to developing new contract business. They placed primary emphasis on sales engineering performed by the firm's principal founders and other technical personnel. The scope of the effort was usually limited because of the tendency to market in local or regional areas and the importance of the referral system. Exceptions included the government markets where a greater level of direct effort was usually required. Some spin-offs used capability brochures to support their sales effort, but in general they were poorly

[27] The term "extensive" refers to the scope of the marketing effort as indicated by (1) the functions performed and the personnel required, (2) the degree of sophistication, and (3) the need for a formal marketing program.

FIGURE 6

Integration of the Marketing Programs into the Conceptual Model



designed and inadequate to communicate the firm's capability to potential customers.

It was difficult to implement a definite strategy of innovation in these firms because almost all of the technical effort was performed for others on a contract or fee basis. However, some firms were able to transfer technology from completed contracts and apply it to the development of a proprietary product or service. Multi-phase procurement also offered similar opportunities, but most of the spin-offs were unsuccessful in quoting on follow-on engineering and hardware contracts.

Because of the large amount of uncertainty in the projects and the difficulty of specifying the customers' needs, a contract was usually negotiated where the customer assumed most of the price risk. Cost-plus-fixed-fee contracts were the most common arrangement, although some business was conducted on a fixed-price basis.

Pricing was primarily cost oriented at this extreme of the business activity spectrum because of the difficulty involved in determining the value received by the customer prior to completion of the technical work. Most of the firms reported that price competition was keen among the firms that had technically qualified proposals. However, in any contract competition, a range of quotations was usually received which was combined with the technical proposals to arrive at the combination which would best meet the customer's needs.

Custom Product and Service Firms

The marketing programs of the custom product and service firms tended to be more comprehensive. Spin-offs marketing a technical capability relied heavily on sales engineering performed by a technical team, but also used plant visits and laboratory facilities to demonstrate the technical ability of their company. Most of the sales effort was concentrated at the engineering management level because the key buying decisions were made by the individuals in these departments.

Capability brochures were also widely used in the marketing programs of these spin-off firms. They emphasized the firm's personnel, the equipment and facilities, and the hardware or software developed by the firm when it contained important technical achievements.

Accurate pricing was important because there was a definite shift of the price risk to the spin-off firm through the negotiation of a fixed-price contract. This shift was a reflection of the ability of both the spin-off and the customer to define needs more specifically and reduce much of the uncertainty in the projects. Overruns on contracts were common among these firms and in many cases they were the result of a definite business strategy. Price competition was always present since a variety of pricing strategies were available to the firm. Most of the pricing was cost oriented.

A number of custom product and service firms followed a contract strategy which maximized the opportunity for the development of proprietary products and services. Simultaneously, many engaged in proprietary development programs which also resulted in standard products or services. When successful, these technical developments added another dimension to the spin-off's marketing program. Sales literature, journal advertising, news releases, and trade shows were often required in the marketing of these items. If they were used, they also became a convenient vehicle for promoting the firm's technical capability.

At the same time, the need to achieve broader market representation to generate product sales was recognized by many firms. Major decisions were required to select the best methods of reaching the market. Large, well-financed spin-offs frequently optioned for a direct sales effort, while the smaller firms usually selected market intermediaries.

Standard Product and Service Firms

The marketing programs of the spin-offs selling standard products and services were influenced by a sharper definition of the applications for the items to be marketed and the need to reach markets which were national in scope. Buyers were also more

knowledgeable. They were often aware of competitive alternatives if they existed and this increased the opportunities for a more detailed value analysis. These features enhanced the opportunity and made it necessary to expand the role of marketing in the spin-off firm.

Advertising and sales promotion played a comparatively greater role in the marketing programs because of the ability to make highly specific appeals. Trade shows, journal advertising, sales literature and direct mail were all used to reach potential customers. In the smaller firms that could not afford a direct sales effort or could not obtain indirect marketing channels, it was the most important part of the marketing program, while in firms having direct or indirect market representation it balanced and supplemented the sales effort. Eventually, all of the firms were confronted with the need for a selling effort of some type. Important marketing decisions faced the firms in selecting market intermediaries or deciding to sell direct, but many of the spin-offs were unprepared to make the decisions wisely.

Because the technical effort of most firms was internally funded, products or services which offered unique performance benefits were frequently developed. To some extent this isolated the firms from direct price competition and encouraged a value-oriented approach to pricing. Nevertheless, many new firms were unable to determine value and underpriced their products and services because of the

lack of historical cost information.

All of the firms reported negotiating fixed-price contracts or quoting standard commercial prices that were fixed by the forces of the market. While price competition was always present, there was less flexibility in pricing because both value and costs could usually be determined prior to the sale. Many of the firms competed on a non-price basis since price variations were usually closely related to differences in quality or performance.

CHAPTER VII

The Major Marketing Adjustments

An Overview

The major markets, the buying process and the marketing programs for technology-oriented products, services and capabilities have been empirically examined. The analysis of the role of marketing in the spin-off firm is concluded with a consideration of the major marketing adjustments that the innovative spin-off firm must make as it progresses to a standard product or service orientation.

For the spin-offs planning to market a technical capability on a limited scale, only minor adjustments are necessary in the marketing effort. Increased technical competence, improved literature which makes the firm's capability more meaningful, and more sophisticated sales engineering to identify new customers and increase penetration in existing markets are all that is required to maintain a competitive position.

The spin-off firms planning to develop and market proprietary products and services or expand an existing line face a series of important marketing adjustments which are critical to continued success. They include obtaining market representation and developing a formal

marketing organization to implement programs and guide the firm's innovative effort. These topics are the focus of this chapter.

This chapter completes the conceptual model being developed. The analysis also evaluates the last postulate which stated that progression from a research and development or a similar orientation to a standard product and service orientation requires major adjustments in the spin-off's marketing effort.

Selecting Initial Market Representation

One of the major marketing adjustments that takes place in the development of innovative spin-offs occurs when the firm develops the first proprietary product or service and is faced with the problem of finding the best method of reaching potential customers.

Usually the firm is reluctant or unable to develop a direct sales force to provide the scope of market representation required. The alternative is to compensate a market intermediary to perform this important aspect of the marketing task until it becomes economical or necessary to make a change.

A few exceptions were observed during the field research and, in general, three considerations influenced the initial selection decision on the most appropriate type of market representation. These included: (1) the spin-off firm itself, (2) the characteristics of the firm's markets, and (3) the products and services to be marketed and their technical features. Each of these considerations is discussed below.

Company Considerations

The company's overall size and financial strength influenced the methods used to reach the markets. Small, financially weak firms that were marketing products preferred to delegate some of the marketing tasks to intermediaries by using commission methods of selling. Some of the larger firms having greater financial resources used a direct selling effort if other characteristics were favorable, but most of these firms initially used market intermediaries.[1]

For the spin-off firm that is relatively small and has a sales volume less than $500,000, the problem of selecting market representation must be faced when the business is least prepared to make the decision. Usually, one or a few products exist and the firm's financial position is weak. As illustrated in Table 28, many of the spin-offs having less than $500,000 of sales relied on the principal founders and the market intermediary (often supported by one or a few direct salesmen) to reach potential customers, while only 8.3 percent of the firms used full-time direct sales personnel.

The larger spin-offs face the problem from a slightly different perspective. Some of the firms are in business a number of years before the first product evolves and they are in a financially stronger position. Yet the need to market on a much broader scope to generate

[1]Throughout this chapter, the terms market intermediary, indirect market channel and middlemen will be used interchangeably as a generalized expression for both manufacturers' representatives and industrial distributors.

TABLE 28

Type of Market Representation Used in Spin-off Firms Marketing a Standard Product or Service by Range of 1968 Sales

(Percent of Firms Mentioning Each Type of Market Representation)

Type of Market Representation	Range of 1968 Sales	
	$0-499,000	$500,000 and Over
Principal founders on a part-time basis	83.3	33.3
Manufacturers' representative or industrial distributor	8.3	13.3
Combination of manufacturers' representative or industrial distributor and direct sales personnel	25.0	53.3
Full-time direct sales personnel	8.3	33.3
Number of firms	24	15

sales for less expensive products often means a radical change in the firm's approach to marketing and the need for new capabilities. [2] When the product and market characteristics are favorable, a few of these firms immediately implement a direct selling effort. More often they begin with market intermediaries and eventually make the transition to a direct sales effort as volume expands and the line of products or services increases to the point where it becomes feasible. This transition is shown in Table 28 where it can be noted that 33.3 percent of the firms reporting a sales volume of $500,000 or more used full-time direct sales personnel. In addition, a higher percentage of these firms also reported using indirect marketing channels (13.3 percent in Table 28) as well as a combination of indirect channels and direct sales (53.3 percent in Table 28).

Exceptions were observed during the field research. Some firms always sold their products through industrial distributors but eventually developed a sales force to work directly with the salesmen of these organizations. Other spin-offs made the transition from selling through manufacturers' representatives to direct selling (as previously indicated) while a few had no other choice than to sell direct as soon as possible.

The spin-off's business orientation (see Table 27) was also found to influence the decision on the most appropriate market representation.

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[2] The changing role of marketing was discussed in Chapter VI. See for example, Figure 6 which illustrates the need for new marketing capabilities to effectively market products and services.

Field research indicated that research and development and custom product firms having only one or a few products typically used market intermediaries. This was also true of the small standard product firms, but there was a greater tendency to use some direct sales when the product line was wide and the markets were well defined.[3]

Market Characteristics

The desirability of using market intermediaries was influenced by the nature of the company's markets. Firms selling to markets in which the customers were geographically concentrated or limited in number, usually used a direct selling effort. This was found to be true for expensive electromechanical equipment and large non-destructive testing installations where the major customers were concentrated in one region such as the midwest, or limited in number like the automotive accounts. [4] In markets where the product or service was purchased by many industries and national market coverage was required, a combination of direct and indirect channels was often used.

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[3] New firms were not always successful in obtaining market representation. Many used "mail order selling" to establish a demand for the product before changing to a market intermediary or direct sales.

[4] As previously mentioned, an analogous situation was discovered in government markets. Spin-offs concentrated their efforts on one or a few programs where the buying decisions were made at one location. These customers were usually sold directly by the firm's principals or other technically trained personnel.

Computer time sharing provides an excellent service example. Direct selling with regional sales offices was used by one company in markets where the customers were concentrated geographically and the business was highly competitive. The same company installed a franchise system to serve the regions having small potential sales volume because of the higher cost of financing a direct effort.

Product and Service Features

The technology content of the spin-off's product or service was frequently the determining factor in deciding the type of sales effort that would be most satisfactory. Highly complex products or systems which required a large amount of concept and missionary selling were usually best suited to direct sales because of the difficulty of finding middlemen with the requisite technical knowledge or the willingness to invest the time needed to make the sale. Many firms (particularly the newer product-oriented spin-offs) were forced to use manufacturers' representatives to sell these items due to their inability to support a continuous direct sales effort. [5] The majority of firms in this situation were only moderately successful because the entrepreneurs of these firms failed to anticipate the complexity of the selling task.

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[5] This was particularly true of products using new technologies such as optics and electro-optics. As these technologies continue to be refined and the products develop broader market applications, they will be more successfully sold by indirect market channels.

Lower priced products using established technologies and having a high degree of standardization were well suited to indirect market channels. When the product was an inexpensive electronic device or component having scattered markets, specialized industrial distributors were ideally suited to provide the firms with the market coverage and the level of service required by the customer. Microwave components, amplifiers, medical electronic devices, and optical devices were successfully sold in this manner.[6]

More expensive products requiring a higher degree of technical sales effort were usually sold by manufacturers' representatives when the firm's product line was narrow or the customers were widely scattered. Electronic instruments and controls frequently met these requirements and were sold by middlemen if the company could not

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[6] The spin-off manufacturing and selling microwave components discovered that the level of selling effort provided by the typical electronic component distributor was not always sufficient to assure the sale of the firm's product. To overcome this problem a number of manufacturers' representatives were developed that stocked inventory and provided a level of service almost equivalent to that of the distributor. By using this "hybrid" organization the spin-off was able to obtain the required combination of technical selling effort and product availability.

This use of a "stocking representative" is a unique solution to the problem of marketing inexpensive products having a high technology content. However, it should be noted that a distribution network of this type requires considerable time and financial resources to implement as well as a perceptive management to recognize the need.

finance a direct sales effort. When the product had well developed applications and the selling task was similar to that already performed by the representative, these arrangements had a good chance of working out satisfactorily.

Manufacturers' representatives and industrial distributors were also found to be well suited to handling standard products where repetitive purchases were made or where the representative could capitalize in some other manner on a previous sale. Electronic components and instrumentation that could be combined into larger systems were typical examples of products handled successfully by this method of representation.

The Manufacturers' Representative

About 60 percent of the 32 firms interviewed reported that they were using manufacturers' representatives.[7] Another group of firms indicated that they had used them at some point in their development or that they had attempted to secure representation but were unsuccessful in attracting an organization under conditions that were mutually satisfactory

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[7] Three firms also reported using industrial distributors for some products. Because of the many similarities to the manufacturers' representative, a separate discussion is not provided, but the differences are noted where it is important to the development.

to both firms. Overall, this marketing channel played a key role in the marketing programs of a large number of spin-offs. In many cases the success of the firm's products or services depended entirely on the ability of the spin-off's principals to attract and select a strong representative organization.

The Problem of Selection

Despite the critical importance of good market representation to the spin-off firm, the selection process was often performed in a haphazard manner. Too many firms simply hired the representative because he was a personal friend or happened to have a "piece of business." Only a few even bothered to construct a list of candidates for further screening to increase the chance of finding the right man or organization. [8] Improper selection resulted in a quick deterioration of the relationship between the representative and principal. In some of the cases observed, the representative simply did not perform well for the company because of the lack of ability or interest. Just as often the problem was due to lack of support from the spin-off firm. Failure to meet delivery schedules, restrictive prices, product quality

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[8] This occurred despite an abundance of information. See, for example, the membership directory of the Electronic Representatives Association, Chicago, Illinois. This directory is published annually and lists more than 1,500 member firms and branches, along with information indicating the types of products they handle, the territory covered, the types of customers to which they sell, and the special facilities they have available.

problems and poor sales support were reasons prominantly mentioned by the manufacturers' representatives.

Because of the importance of the manufacturers' representative to the new innovative spin-off firm, field interviews were designed to investigate the selection criteria used by both types of businesses. Part of the interviews with spin-off firms were devoted to exploring the principal-representative relationship. A series of interviews was also conducted with the manufacturers' representatives that sold the products of Michigan spin-off firms to determine the criteria they used in selecting products.

Selection Criteria--Spin-off Firms

During the field interviews, the entrepreneurs of spin-off firms using manufacturers' representatives were asked to describe the criteria that were used in the representative selection process. These criteria are listed in Table 29 according to the frequency that each was mentioned.

Most of the entrepreneurs agreed that the personal qualifications, selling experience, and technical competence of the prospective representatives were important. The spin-offs were concerned with "how they would fit into our way of doing things" and "whether or not they had the technical qualifications to sell our product." Engineering graduates were preferred, but an organization having men with broad technical selling experience in the firm's market area was acceptable

TABLE 29

Selection Criteria Used by Spin-off Firms to Select Manufacturers' Representatives

Selection Criteria for Manufacturers' Representatives	Number of Firms Mentioning	Percentage of Firms Mentioning
Personal qualifications, selling experience, and technical competence	13	68.4
Customers served and geographic market coverage	13	68.4
Other firms represented and compatibility of product lines	8	42.1
Financial responsibility and length time in business	6	31.6
Importance of product to the representatives product line	5	26.3
Opinion of representative's customers	4	21.1
Quality of the representative's sales contacts	3	15.8
Number of firms	19	. . .

if other factors were favorable. Equally important were the customers that the representative sold and the geographic market region that was covered. Many spin-offs had a group of customers which they believed were potential accounts. If the prospective representative organization already had contacts with these companies this was considered to be highly desirable. Some of the firms (15.8 percent in Table 29) even probed beyond this criterion and evaluated the quality of the market contacts with respect to organizational level and functional area. Technical contacts were desirable because of the nature of the buying process.

Spin-off entrepreneurs also judged the desirability of representatives by the other principals the organization represented and the compatibility of the lines with the firm's product. Non-competitive product lines were preferred, but this was becoming more difficult to achieve because of the product flexibility made possible by integrated circuitry. Generally the well-established organizations represented the products of major manufacturers. This was believed to be of value to the new manufacturer, particularly if the relationship had existed for a number of years.

Financial responsibility and length of time in business were mentioned by 31.6 percent of the firms interviewed.[9] The corporate

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[9] Financial responsibility was considered to be highly important for inventory stocking representatives and distributors.

form of business was desirable and when possible the spin-offs preferred to do business with established representatives because they were more likely to have adequate financing. However, very few spin-offs reported checking credit references such as banks and trade sources to verify financial responsibility.

The entrepreneurs found it difficult to evaluate the importance of their product to the prospective representative's product line, but over 26 percent attempted to do so. Ideally, they were looking for situations in which their product would become important enough to command the necessary sales effort. Some firms found that this criterion was difficult to satisfy if the representatives' top two or three lines accounted for over 75 percent of sales or profit.

About 21 percent of the firms mentioned that as a routine procedure they checked some of the representative's customers to verify the organization's qualifications. Many manufacturers' representatives encouraged this and even published a list of their customers to aid in the principal's selection process.

The representatives' viewpoint. Several of these organizations were also asked, "What should the small science-oriented manufacturer look for in selecting a manufacturers' representative to sell his products?" Most of the representatives mentioned the selection criteria suggested by the spin-off firm. They also emphasized that it was important to consider:

1. The type of selling effort required for the firm's product and whether or not the prospective representative could provide it.[10]
2. The potential customers for the spin-off's product compared to the major accounts of the manufacturers' representative.
3. The geographical market coverage needed by the spin-off firm and the sales territory covered by the representative organization. The possibility of realigning sales territories by replacing other representatives should also be considered at this time.
4. The compatibility of the representative's product line with the spin-off's product as well as with respect to the products the spin-off expects to develop and market in the future.
5. The turnover of the representative organization's salesmen and the addition of new product lines. New salesmen require training, while a number of new lines require a pioneering sales effort to establish. Both of these conditions leave less selling time for the spin-off's product.

While these considerations were essential, other factors were also suggested by the manufacturers' representatives interviewed. In organizations having a number of men, the commission structure used

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[10] This point reinforces the importance of understanding the procurement process and being able to identify the key buying influences for the specific product or service. If the spin-off firm has this information, specification of the nature of the selling effort needed and the type of representative required is greatly facilitated.

to compensate salesmen should receive some attention. Organizations which have incentive plans to compensate salesmen according to their individual efforts should be preferred as well as those that have bonus plans which "allow their men to share in the organization's growth."

In addition to a direct selling effort, most of the representative organizations offered services which complemented their sales activity. Items such as attractive facilities for technical seminars, supporting clerical personnel, branch sales offices (not answering services), and established procedures for communicating with principals were all benefits that the spin-off was advised to take advantage of if possible.

The sales promotion activities of the manufacturers' representative could also be of significant value to the spin-off firm that did not have a promotion program. Most of the larger organizations maintained mailing lists that were used to send literature to existing and prospective customers. The representative's facilities for handling large mailings, the quality of the mailing list (customers and types of individuals), and whether or not the representative assumed the promotion expense should be considered in the selection decision.

Selection Criteria–Manufacturers' Representatives

Spin-off firms were frequently at a disadvantage in selecting manufacturers' representatives because they were unable to attract the best organizations for initial consideration. Many firms failed to recognize

that the prospective representative organization also used well-defined criteria to select the products they would sell. Even fewer realized that the representative had to be sold on the spin-off as a company and then motivated to consider the product for his line.

To develop a feeling for the criteria that were used by representatives to select products, they were asked: "In making the decision to add a product to your line, what does your company consider?" The responses to the question indicated that there were three areas of interest--the company, the product, and the economics.

The company. Representatives reported that they preferred to do business with established firms having a past history of successful sales growth, and some experience in working with organizations similar to theirs. While they realized that this was not always possible, new firms were appraised with respect to their financial responsibility and management capability. The absence of either of these characteristics usually meant high turnover of personnel and inadequate sales support.

They also evaluated the ability of the firm to provide a package of supporting sales services. These included technical support, accurate product literature, demonstrators, after sales service and the ability to meet delivery schedules.

The product. Manufacturers' representatives were highly customer-oriented. Their selling strategy was to start with a specific customer

need and then find a product to fill the requirement. This means that products having an established demand among the representatives' existing customers were preferred because they provided a faster return on the selling time invested. However, products were also considered if they broadened an existing line, or gave the representative a new capability to sell.

The economics. The commission rate was considered by representatives, but was of secondary importance. Commission arrangements were about the same for similar classes of products. More important was the salability of the product and its effect on the sale of the other products in the representative's line.

Because of their continual market contact, these organizations were able to accurately evaluate the price/performance relationship of the product and determine whether it would be competitive in the intended application. Many spin-offs failed here because of their rigid pricing policy or their inability to supply enough market information to enable an accurate evaluation of the product.

Summary

The criteria used by the spin-off firm to select a manufacturers' representative must reflect an understanding of the marketing capabilities required to successfully sell the product. This approach increases the probability of selecting an individual or organization with the ability to perform the selling job.

Beyond the need to clearly understand the selling requirements for the product to be marketed, the spin-off must also be aware of the product needs of prospective representatives. Only when the spin-off's product satisfies a need (or creates one) can the firm be assured of the representatives' willingness to sell it. In many respects, the firm's marketing effort should begin with a program designed to obtain a manufacturers' representative having both the ability and willingness to sell the product.

Organizing for Marketing

As the sales of the spin-off's products or services expand, the time required to direct and coordinate the company's marketing program increases to the point where the principal founders can no longer perform the administrative duties without assistance. In most cases, marketing then becomes a full-time job and the firm hires a sales manager or vice president of marketing to assume the marketing responsibility for the company.

In firms marketing products or services through manufacturers' representatives or industrial distributors much of the marketing man's time was used trying to improve the quality of market representation. He made joint sales calls with the salesmen of these organizations to educate and train them to sell the firm's products.

Many times the formation of a formal marketing department marked the beginning step in the implementation of a direct selling program. [11] For these firms the decision to sell direct signaled an important adjustment in marketing strategy. It also meant that the firm was faced with the problem of acquiring and training salesmen, defining sales territories and developing a compensation package, and phasing out the existing marketing channels. Overall, this was the most important marketing decision that the firm would ever make.

Direct Selling

While the decision to establish a company sales force usually received many months of careful consideration, it was often made when the spin-off was facing serious and difficult marketing problems. Many of the problems that motivated the decision were noted during the field research. Some of the more frequently mentioned are described below:

1. A reduced rate of sales growth caused by the inability of the firm to increase its market penetration with the existing marketing channels.
2. The threat of direct product competition from larger corporations having national distribution and a superior marketing capability.

[11] The evolution of a direct sales organization was observed in many companies during the field research. Generally, the shift in responsibility occurred about the time the spin-off's sales volume reached the $500,000-$750,000 range. Some of the well-financed spin-offs, as well as those marketing products or services which could only be sold by a direct sales effort made the transition much sooner.

3. A recognition of the need to develop a broader customer base, increase brand recognition and exert greater control over markets.
4. Increased price competition from direct selling competitors making it difficult to maintain commission margins on indirect sales to volume customers.

Important considerations. In addition to the company, product and market characteristics already mentioned as influencing the firm's initial channel decision, several variables were also considered by entrepreneurs in deciding whether or not (and if so, when) to sell direct. Two fundamental considerations were cost and control. [12] How does the cost of selling direct compare with the cost of the present indirect marketing channels? Which method provides the required degree of control over the marketing effort? Other considerations were the ability to clearly define the market and the opportunities for broadening the firm's product line.

Cost. The cost of keeping a direct salesman on the road was one of the most important considerations. Most entrepreneurs estimated this cost between $25,000 and $40,000 per year, depending on the sales territory and the specific arrangements made for compensation and the sharing of expenses. The higher figure was appropriate when the costs

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[12]Edwin E. Bobnow, "Is the Independent Sales Agent for You?" The Agent and Representative, XXLII (June, 1969), 11.

included direct selling expenses such as travel, entertainment and sales commissions plus certain fixed expenses such as salary, office space, clerical help, communications, social security and the necessary fringe benefits.

If the entrepreneurs were paying a manufacturers' representative a commission rate of 10 percent on sales, this meant that sales territories producing between $250,000 and $400,000 a year had to be available to make the change feasible from an economic standpoint. Very few companies were able to satisfy this condition when they made the decision to sell direct.

The analysis also assumes that the direct salesman will be able to gain acceptance and maintain the existing contacts in the sales territory. This is not always assured because if the representative's contract is cancelled, he may take many of the spin-off's customers to a new client. In this case, additional expenses will be incurred just to rebuild the sales territory.

Control. In the new spin-off firms where there was pressure to achieve representation and generate a cash flow, very little consideration was given to the need for control over the firm's markets and the representative's selling effort. Exclusive representation arrangements were made and products were sold under restrictive private label agreements. If it became apparent that the sales representative could not perform the entire selling job or the firm was unable to exert much control over his

selling techniques, the need for an alternative selling approach became more urgent. This need was reinforced when one manufacturers' representative accounted for a high proportion of the firm's sales volume or the product development effort was stalled because of the inability to get a feedback of market information.

Very few of the smaller spin-offs truly appreciated that the representative's allegiance to their company and products was not total. Because he also served other clients, extra incentives were frequently needed to secure a larger proportion of his sales effort. More important, the customers he served were his and not the spin-off firm's. This representative philosophy was clearly expressed by the vice president of marketing for a large spin-off firm when he remarked, "My customers are my customers--principals come and go, but my customers are always the same." If these circumstances could not be tolerated by the spin-off, the direct selling alternative was attractive.

The product line. A frequent problem encountered by firms attempting to implement a program of direct selling was the need for a broader product line.[13] If the spin-off had only one or a few products, it was difficult to define territories with sufficient sales volume that were small enough to be economically handled by one salesman.[14]

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[13]Most entrepreneurs felt that a line of at least five products was needed for an efficient direct sales effort.

[14]This, of course, illustrates that the key role played by the manufacturers' representative in the marketing programs of spin-offs having only one or a few products. By aggregating the products of several principals the representative is able to provide a selling service which individual firms could not provide on a profitable basis.

A Detroit research and development spin-off having only a few proprietary products solved this problem by adding the products of other small manufacturers to the firm's line. The company actively searched for new products to complement their existing line. When they were discovered, the spin-off licensed the exclusive marketing rights. Several new products were obtained in this manner.

Another custom engineering spin-off solved the problem by establishing a separate sales company to market the standard products. By taking this approach, the new sales company was also able to act as a representative for other manufacturers. This strategy not only increased the number of products available for the company's salesmen, but it also made direct selling economically feasible at a much earlier point in the firm's development.[15]

The Marketing-Technology Partnership

Several of the entrepreneurs interviewed estimated the minimum costs of developing a direct sales force at $500,000. Others believed that this adjustment in the spin-off's marketing program could take as much as five years to complete. When these facts were combined with the risks involved in phasing out existing marketing channels and the need to move quickly to develop the sales potential of new products, many firms searched for an alternative approach. The most popular

[15]This business strategy had other important advantages. The contract engineering firm was relieved of product liability. Also, there were some minor tax advantages and the loan base of the combined firms was broadened.

alternative involved assigning the marketing rights on an exclusive basis to a large corporation having a national marketing organization.

The contractural arrangements for this alternative varied, but usually the spin-off received cash advances (to be credited against future product sales) from the corporation or sold part of the equity for cash. These funds were then used to finance the initial start-up and production costs for the firm's product.

The large corporations also benefited. A few of them were technologically obsolete compared to their more aggressive competition and they viewed this as an opportunity to remain competitive or gain entry into new markets. More important, they frequently obtained exclusive rights on the products to be developed in the future so they were assured of having product improvements and an expanding line.

Financially, these arrangements had advantages for both parties. The spin-off firm had the technology, the corporation had the marketing capability, and both were needed to make the venture a success. Beyond this, it was difficult to see how this arrangement solved the spin-off's long-range problem of developing a direct sales force. If the agreement was terminated by either party, the spin-off was left without a marketing capability and a much larger scale of operations to support.

The Evolving Marketing Organization

Concurrent with sales growth and the development of a direct sales force or network of market intermediaries, many spin-offs also began

to build a formal marketing organization. This trend is illustrated in Table 30 for the firms investigated during personal interviews. Almost twice as many firms in the $500,000 and over sales range reported having a formal marketing department compared to the spin-offs in the $0-499,000 range.

This final adjustment in the spin-off's marketing program usually started after the first product or service had been developed or when the volume of referrals was not sufficient to sustain the existing level of operations. Without exception, all of the firms began their marketing department with the addition of either a sales manager or a vice president of marketing. Subsequent additions were along functional lines and typically included regional sales management, advertising and sales promotion, and customer services such as order processing, bids and proposals, and field technical service. [16] These changes occurred while the firm's sales were in the $750,000 to $2,000,000 range.

Additional functions were considered peripheral to the everyday marketing operation and they were structured into the department when the firm's sales and financial strength made it possible. Most of these organizational changes took place in the $2,000,000 to $8,000,000 sales

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[16]The establishment of bids and proposals as a separate marketing function was characteristic of the spin-offs doing a large percentage of business either directly or indirectly with government agencies. This is a reflection of the importance of the technical proposal in selling to the government. There was also a tendency among these firms to establish regional sales (and technical service) offices in the cities where the important government customers were located.

TABLE 30

Type of Marketing Organization in Spin-off Firms Classified by Range of 1968 Sales
(Percent of Firms Reporting each Type of Marketing Organization)

	Range of 1968 Sales	
Type of Marketing Organization	$0-499,000	$500,000 and Over
Formal marketing department	40.0	76.5
No marketing department	60.0	23.5
Total	100.0	100.0
Number of firms	15	17

range. The functional specialties included product management, product and market planning, international marketing management, and market research.

The trend toward the development of a formal marketing department with increasing sales volume had other, related implications for the firm. New people had to be acquired and trained to work in the functional areas. This step in the firm's organizational adjustment is shown in Table 31 where the percentage of employees working in marketing is classified by the firm's range of 1968 sales. Here it can be noted that the majority of the firms in the $0-499,000 sales range had 0 to 5 percent of their employees working in marketing. By comparison, 50 percent of the firms having a sales volume of $500,000 and over reported employing 6 to 10 percent of their employees in marketing.

While the trend toward an increasing role for marketing in the spin-off firm was obvious among the product-and-service-oriented spin-offs having sales of $500,000 or more, the capability was not always easily developed. Some firms experienced difficulty in attracting and selecting people for these positions. Too many waited until the need was critical before actively trying to do something about it.

Review of the Major Marketing Adjustments

This chapter completes the evaluation of the final research postulate which stated that:

TABLE 31

Percentage of Employees Working in Marketing in Spin-off Firms Classified by Range of 1968 Sales
(Percent of Firms Reporting each Percentage Range of Employees Working in Marketing)

Percentage of Employees Working in Marketing	Range of 1968 Sales	
	$0-499,000	$500,000 and Over
0-5	50.0	31.3
6-10	28.5	50.0
11 and Over	21.5	18.7
Total	100.0	100.0
Number of firms	14	16

> Progression from a research and development or similar orientation to a standard product or service orientation requires major adjustments in the firm's marketing effort.

Strong empirical evidence was found to support this postulate. During the conduct of the research, three major adjustments were identified as being of significance to the marketing programs of innovative spin-off firms. The first occurred early in the spin-offs' development. Beginning with the decision to market the first product or service, the firm was confronted with the problem of selecting and developing a method of market representation.

Later, as sales volume expanded and the administrative requirements increased, additional adjustments were required in the firm's approach to marketing. The evolution of a formal marketing organization was often characterized by two major adjustments. The decision to sell direct was the most important marketing decision made by the firms interviewed and a number of years were required to develop a direct sales force. The change was often accompanied by the development of a formal marketing department. This second organizational adjustment usually marked the beginning of the firm's transition from a technically oriented spin-off to a market-oriented business.

The following discussion summarizes the important results of this chapter.

Selecting Initial Market Representation

The company, the characteristics of the product, and the nature of the markets influenced the initial selection decision. Financial limitations and narrow product lines were usually major constraints to direct selling and most of the firms initially used manufacturers' representatives and industrial distributors. The spin-off firm selected these organizations in a haphazard manner. Specific selection criteria were used by spin-off entrepreneurs, but they were frequently applied without a clear understanding of the marketing requirements for the product. Not enough firms probed beyond the initial product and market match to verify the ability and willingness of the representative to perform the selling job.

The interviews conducted with manufacturers' representatives provided an interesting contrast to the field research. Most spin-off firms did not realize that these organizations used well-defined criteria to select the products of firms they would represent. Even fewer spin-offs considered the importance of peripheral services such as branch sales offices, clerical help and facilities for sales meetings, technical seminars and direct mail promotion. Spin-off firms are advised to evaluate these supporting sales services when making the selection decision.

Because of the technical orientation of most of the spin-off firms, the representative-principal relationship was not always harmonious. Manufacturers' representatives complained about unsatisfactory sales

support, poor literature, and a non-professional approach to marketing, while the spin-off firms were quick to criticize the representative for his unwillingness to develop a sales territory in depth or perform missionary selling. A better understanding of each others needs and role is clearly required for more effective marketing.

Organizing for Marketing

The threat of increased competition and a reduced rate of sales growth were two factors which encouraged the firms to formally organize for more effective marketing. Implementing a program of direct selling was the most important marketing adjustment faced by the spin-off firm. The decision was usually made after considering the firm's need for control of the marketing effort, the costs involved and the number of products available. In general, the spin-offs faced the dilemma of requiring greater control over the marketing of their products, but not having the financial strength or the necessary number of products to conduct an efficient direct sales effort. Some spin-offs obtained products by purchasing the marketing rights of products developed by small manufacturers or forming a sales company which acted as a representative for the products of other manufacturers. Another alternative employed was to license the marketing rights to a large corporation having a national marketing organization.

As the firms developed standard products and services requiring national distribution, the need for a formal marketing department to

coordinate and direct the marketing program also became apparent. The departments were structured along functional lines and usually began with the addition of a sales manager or vice president of marketing. This change occurred when the firm's sales were in the $500,000-$750,000 range. Other functional specialties were then added when the spin-off was able to support them financially.

Because of the absence of market planning, spin-off firms were not always able to recognize the need for additional marketing expertise. Generally, the addition of a new marketing function occurred well after the need became apparent.

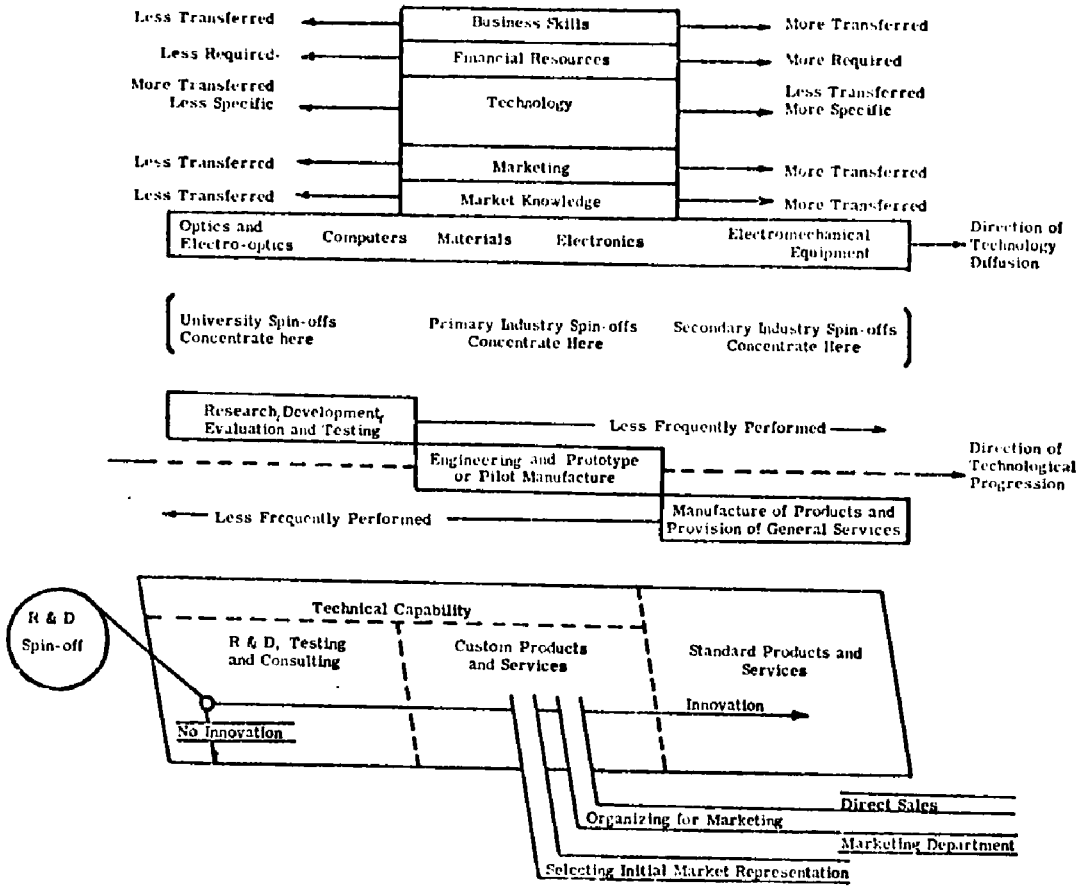
The Conceptual Model Completed

This chapter completes the conceptual model. The major marketing adjustments are integrated into the model in Figure 7, where each adjustment is viewed as a constraint to the movement of spin-offs along the business activity spectrum.

The model also summarizes much of the evidence supporting the major research hypotheses. The first hypothesis (as well as the framework for the model) was confirmed by the establishment of a relationship between the spectrum of possible business activities and the type of spin-off. Technology transfer was evaluated within this framework and differences were found in the extent and type of transfer among the spin-offs studied. Overall, however, transferred technology was important because it became the technical base for the firm's future development.

FIGURE 7

The Completed Model Showing the Major Marketing Adjustments



THE MARKETING PROGRAM		THE MARKETING PROGRAM
Contract Work Difficult to Implement Strategy	INNOVATION STRATEGY	Contract Work Proprietary Development Specific Strategy
Flexible-Price Contracts Cost-Oriented Pricing Customer Assumes Price Risk	CONTRACTS AND PRICE STRATEGY	Fixed-Price Contracts Standard Commercial Prices Value-Oriented Pricing Spin-off Assumes Price Risk
Capability Brochures	ADVERTISING AND SALES PROMOTION	Brochures and Data Sheets Trade Journal Advertising News Releases Trade Shows Direct Mail In-House Publications
Principal Founders Technical Personnel	MARKET REPRESENTATION AND SALES STRATEGY	Principal Founders Market Intermediaries Direct Sales Personnel

COMMERCIAL MARKET
INSTITUTIONAL MARKET
GOVERNMENT MARKET

More than 93 percent of the spin-offs either transferred or acquired (by purchase of assets or hiring) the necessary technology prior to starting business.

The changing role of marketing (the subject of the second hypothesis) was confirmed by examining the formation and development patterns of spin-offs. During the formation process, entrepreneurs actively sought market information to justify the formation decision. Although information related to market needs, customers, and competition was obtained, in retrospect it was always insufficient. Entrepreneurs failed to obtain enough market data to accurately describe the nature of the business opportunity available.

The spin-off's marketing program must reflect the nature of the business activity and the customer's buying pattern. Most of the firms did not recognize the need for a marketing capability during the formation process and as a result were unable to anticipate marketing problems and develop effective programs. All of the spin-offs would have benefited from a careful evaluation of the marketing requirements for the items they planned to sell.

For the innovative spin-offs, the capabilities required for effective marketing change rapidly during the early stages of development. However, very few firms realized that a continuous evaluation and adjustment of the marketing effort would be needed. The conceptual model is designed to assist entrepreneurs in anticipating and specifying the role of marketing in their firms.

APPENDIX A

The Mail Questionnaire and Tabulation of Responses

INDUSTRIAL DEVELOPMENT DIVISION

Institute of Science and Technology
Telephone 313 - 764-5260

The University of Michigan
2200 North Campus Boulevard
Ann Arbor, Michigan 48105

In view of the increasing importance of Michigan's small science-oriented business firms, we have initiated a study of the marketing of high technology products and services resulting from research and development activities. The purpose of this study is to develop some guides which will be useful in specifying the capabilities required by the smaller firms for successful marketing. The results of the study will be published by the Institute of Science and Technology.

We feel that this study will assist firms such as yours in the development of more effective marketing programs. The questions on the enclosed form are designed to provide basic information for this research. We ask that you take a few minutes to complete the questionnaire, which requires only a check mark for most of the questions.

Your response will be treated as confidential and will be used only for purposes of this research. On the questionnaire, identification of your firm is optional, but in the final report no participating company will be identified.

If you would like to receive the results of this phase of the study prior to publication of the final report, please sign the questionnaire on the last page or advise us under separate cover.

A self-addressed, stamped envelope is enclosed for your convenience in returning the questionnaire.

Thank you for your cooperation.

Sincerely yours,

Lawrence M. Lamont
Research Associate

LML/mlm

INDUSTRIAL DEVELOPMENT DIVISION

Institute of Science and Technology
Telephone 313 - 764-5260

The University of Michigan
2200 North Campus Boulevard
Ann Arbor, Michigan 48105

A few weeks ago we mailed a brief questionnaire to a number of small science-oriented business firms in Michigan. The return has been gratifying, but we have no record of response from your firm. Since this research is designed to assist Michigan firms such as yours in the development of more effective marketing programs, we are anxious to make our sample as representative as possible.

We are mailing this second request to all firms who have not returned a signed questionnaire. If you did respond, but preferred not to identify your company on the questionnaire, please disregard this letter.

It would be very much appreciated if you would note on the enclosed questionnaire as much relevant information as you feel you can furnish. We are interested in data relating to past as well as current operations. If the questions are not applicable to any of your past or present activities would you indicate this fact on the enclosed questionnaire and return it to us?

As we stated in our first letter, all answers will be treated as strictly confidential. If you do not wish to sign the questionnaire but would like to receive a report of this phase of the study, please advise us under separate cover.

Sincerely yours,

Lawrence M. Lamont
Research Associate

LML/mlm

INSTITUTE OF SCIENCE AND TECHNOLOGY
INDUSTRIAL DEVELOPMENT DIVISION
THE UNIVERSITY OF MICHIGAN

SURVEY OF MICHIGAN'S SCIENCE AND TECHNOLOGY INDUSTRY

Instructions: It is intended that the answers to this questionnaire be based upon your own immediate knowledge of your organization. Most questions have been designed to be answered with a single check mark in order to minimize your time in responding. Where percentage estimates are requested, we ask only that you give approximate figures at hand, rather than make a detailed check of your company records.

We would appreciate receiving a brochure describing your products or services if one is available.

1. In what year did your firm complete its first full year of business operations? _____

2. How many principal founders did your firm have? _____

3. For those principal founders indicated in question 2, how many were employed in industry, government or educational institutions *in their last job* before starting your firm?

   a. number of founders employed in industry _____

   b. number of founders employed in government _____

   c. number of founders employed in educational institutions _____

   d. other, please specify _____

4. Please check (√) the types of major employment experience represented in your firm by the principal founders and other employees (if any) *when it was originally founded.*

	Experience of Principal Founders	Experience of Other Employees (if any)
a. research, development or engineering	____	____
b. production	____	____
c. general management	____	____
d. accounting or finance	____	____
e. marketing or sales	____	____
f. other, please specify _____	____	____

5. If research, development, engineering, or production were checked in question 4, please check (√) the degree to which this technical experience or knowledge contributed to the development of your firm's *initial* product, service or capability.

	Experience of Principal Founders	Experience of Other Employees (if any)
a. it led directly to the technical development	____	____
b. it contributed somewhat to the technical development	____	____
c. it contributed only slightly to the technical development	____	____
d. it was not related to the technical development	____	____

6. Please check (√) the type of sales representation used by your firm in 1968.

   a. ( ) full-time direct sales personnel

   b. ( ) sales representation through manufacturers' representatives

   c. ( ) combination of the above

   d. ( ) principal founders on a part-time basis

   e. ( ) other, please specify _____

7. Please check (√) the *category or categories* below which describe the nature of your firm's business during the first complete year of business operations and in 1968.

Category	First Complete Year of Business Operations	1968
a. engaged in developing or marketing a product	____	____
b. engaged in developing or marketing a general service	____	____
c. engaged in providing R&D or consulting services	____	____
d. other, please specify	____	____
____		

8. Please check (√) the estimated range of employees employed in your firm during the first complete year of business operations and in 1968.

Range	First Complete Year of Business Operations	1968
1-4	____	____
5-9	____	____
10-19	____	____
20-49	____	____
50-99	____	____
100-249	____	____
250-499	____	____
500 and over	____	____

9. Please check (√) all the *revenue and non-revenue producing* activities that your firm engaged in during your first complete year of business operations and in 1968.

Activity	First Complete Year of Business Operations	1968
a. basic research	____	____
b. applied research and development	____	____
c. evaluation and testing	____	____
d. systems engineering, design engineering, process engineering, and other engineering activity	____	____
e. prototype or pilot manufacture	____	____
f. manufacture of products	____	____
g. provision of general services	____	____
h. other, please specify ____	____	____
____		

10. Please check (√) the activities that your firm *performed for others on a contract or fee basis* during the first complete year of business operations and in 1968.

Activity	First Complete Year of Business Operations	1968
a. basic research	____	____
b. applied research and development	____	____
c. evaluation and testing	____	____
d. systems engineering, design engineering, process engineering, and other engineering activity	____	____
e. prototype or pilot manufacture	____	____
f. manufacture of products	____	____
g. provision of general services	____	____
h. other, please specify ____	____	____
____		

11. Please check (✓) the range of total annual sales or revenues of your firm for the first complete year of business operations and 1968.

Range	First Complete Year of Business Operations	1968
under $100,000		
$100,000-$249,000		
$250,000-$499,000		
$500,000-$749,000		
$750,000-$999,000		
$1.0-$4.99 million		
$5.0-9.99 million		
$10.0 million and over		

12. How were the total sales or revenues indicated in your answer to question 11 allocated on an estimated percentage basis during the first complete year of business operations and in 1968?

Category	First Complete Year of Business Operations	1968
a. R & D, testing, and engineering consulting contracts	___ %	___ %
b. products or services: custom-designed	___ %	___ %
standardized	___ %	___ %
c. total	100%	100%

13. Please estimate the percentage of your firm's total sales or revenue that was derived from each of the following categories during the first complete year of business operations and in 1968.

Category	First Complete Year of Business Operations	1968
a. directly from government agencies	___ %	___ %
b. indirectly from government agencies through contracts with prime contractors or subcontractors	___ %	___ %
c. all other non-government related commercial customers	___ %	___ %
d. other, please specify _____	___ %	___ %
e. total	100%	100%

14. Please check (✓) the types of customers that were your firm's major sources of sales or revenue during the first complete year of business operations and in 1968.

Customer Type	First Complete Year of Business Operations	1968
I. Government		
a. DOD		
b. NASA		
c. AEC		
d. HEW		
e. other, please specify _____		
II. Commercial		
a. Electronics		
b. Aerospace		
c. Automotive		
d. Chemical		
e. other, please specify _____		
III. Other		
a. Institutions and Foundations		

15. How many major competitors did your firm have in: a. the year your firm was founded _____

b. 1968 _____

If you would like to receive a summary of the results of this questionnaire, please sign below:

Name _____

Name of Firm _____

Tabulation of Mail Questionnaire Responses

1. In what year did your firm complete its first full year of business operations?

Year	Number of Respondents	Percent of Total Respondents
1954	1	1.3
1955	. .	. .
1956	2	2.6
1957	3	3.9
1958	5	6.6
1959	3	3.9
1960	1	1.3
1961	3	3.9
1962	5	6.6
1963	10	13.2
1964	8	10.5
1965	3	3.9
1966	5	6.6
1967	9	11.8
1968	13	17.1
1969	5	6.6
Total	76	100.0

(Totals may exceed 100 percent of respondents because of rounding).

2. How many principal founders did your firm have?

Number	Number of Respondents	Percent of Total Respondents
1	22	28.9
2	22	28.9
3	13	17.1
4	10	13.2
5	3	3.9
6 and over	6	8.0
Total	76	100.0

3. For those principal founders indicated in question 2, how many were employed in industry, government or educational institutions in their last job before starting your firm?

	Total Number of Founders	Percent of Total Founders
a. Number of founders employed in industry	159	70.9
b. Number of founders employed in government	3	1.4
c. Number of founders employed in educational institutions	58	25.9
d. Other, please specify	4	1.8
Total	224	100.0

4. Please check (√) the types of major employment experience represented in your firm by the principal founders and other employees (if any) when it was originally founded.

	Experience of Principal Founders		Experience of Other Employees (if any)	
	Number of Mentions	Percent of Total Respondents	Number of Mentions	Percent of Total Respondents
a. Research, development or engineering	72	94.7	20	26.5
b. Production	24	31.6	13	17.1
c. General management	37	48.7	7	9.2
d. Accounting or finance	17	22.4	11	14.5
e. Marketing or sales	29	38.2	10	13.2
f. Other, please specify	5	6.6	1	1.3
No response	0	. . .	51	. . .

(Totals exceed 100 percent of respondents because of multiple response).

5. If research, development, engineering or production were checked in question 4, please check (√) the degree to which this technical experience or knowledge contributed to the development of your firm's initial product, service or capability.

	Experience of Principal Founders		Experience of Other Employees (if any)	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
a. It led directly to the technical development	62	81.6	15	19.7
b. It contributed somewhat to the technical development	7	9.2	4	5.3
c. It contributed only slightly to the technical development	3	4.0	1	1.3
d. It was not related to the technical development	2	2.6	1	1.3
No response	2	2.6	55	72.4
Total	76	100.0	76	100.0

6. Please check (√) the type of sales representation used by your firm in 1968.

	Number of Mentions	Percent of Total Respondents
a. Full-time direct sales personnel	9	12.7
b. Sales representation through manufacturers' representatives	10	14.1
c. Combination of the above	14	19.7
d. Principal founders on a part-time basis	49	69.1
e. Other, please specify	11	15.5
No response	0	. .

(Totals exceed 100 percent of respondents because of multiple response).

Data excludes firms merged into or acquired by other corporations prior to 1969.

7. Please check (√) the category or categories below which best describe the nature of your firm's business during the first year of business operations and in 1968.

Category	First Complete Year of Business Operations		1968	
	Number of Mentions	Percent of Total Respondents	Number of Mentions	Percent of Total Respondents
a. Engaged in developing or marketing a product	46	60.5	37	67.3
b. Engaged in developing or marketing a general service	27	35.5	23	41.8
c. Engaged in providing R & D or consulting services	26	34.2	22	40.0
d. Other, please specify	1	1.3	2	3.6
No response	1	. . .	3	. . .

(Totals exceed 100 percent of respondents because of multiple response).

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

8. Please check (√) the estimated range of employees employed in your firm during the first complete year of business and in 1968.

Range	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
1-4	37	48.7	7	12.7
5-9	16	21.1	13	23.6
10-19	12	15.8	10	18.2
20-49	5	6.6	7	12.7
50-99	3	3.9	8	14.6
100-249	. .	. . .	5	9.1
250-499	. .	. . .	3	5.5
500 and over	. .	. . .	. .	. . .
No response	3	3.9	2	3.6
Total	76	100.0	55	100.0

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

9. Please check ( ) all the revenue and non-revenue producing activities that your firm engaged in during your first complete year of business operations and in 1968.

Activity	First Complete Year of Business Operations		1968	
	Number of Mentions	Percent of Total Respondents	Number of Mentions	Percent of Total Respondents
a. Basic research	12	15.8	8	14.5
b. Applied research and development	37	48.7	42	76.4
c. Evaluation and testing	33	43.4	30	54.5
d. Systems engineering, design engineering, process engineering and other engineering activity	37	48.7	38	69.0
e. Prototype or pilot manufacture	37	48.7	26	47.2
f. Manufacture of products	40	52.7	39	70.9
g. Provision of general services	23	30.2	24	43.6
h. Other, please specify	4	5.3	5	9.1
No response	0	....	0	....

(Totals exceed 100 percent of respondents because of multiple response.)

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

10. Please check ( ) the activities that your firm performed for others on a contract or fee basis during the first complete year of business operations and in 1968.

Activity	First Complete Year of Business Operations		1968	
	Number of Mentions	Percent of Total Respondents	Number of Mentions	Percent of Total Respondents
a. Basic research	6	12.7	3	5.5
b Applied research and development	19	25.0	25	45.4
c. Evaluation and testing	19	25.0	19	34.5
d. Systems engineering, design engineering, process engineering and other engineering activity	27	35.6	27	49.1
e. Prototype or pilot manufacture	17	22.4	15	27.2
f. Manufacture of products	20	26.3	24	43.6
g. Provision of general services	14	18.4	17	30.9
h. Other, please specify	4	5.3	6	10.9

(Totals exceed 100 percent of respondents because of multiple response.)

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

11. Please check (√) the range of total annual sales or revenues of your firm for the first complete year of business operations in 1968.

Range	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
Under $100,000	56	73.6	12	21.8
$100,000-$249,000	14	18.4	15	27.3
$250,000-$499,000	3	3.9	8	14.5
$500,000-$749,000	1	1.4	5	9.1
$750,000-$999,000	. .	. . .	1	1.8
$1.0-$4.99 million	1	1.4	11	20.0
$5.0-$9.99 million	. .	. . .	3	5.5
$10.0 million and over	1	1.4	. .	. . .
No response	. .	. . .	. .	. . .
Total	76	100.0	55	100.0

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

12. How were the total sales or revenues indicated in your answer to question 11 allocated on an estimated percentage basis during the first complete year of business operations and in 1968?

a. R & D, testing and engineering consulting contracts.

	First Complete Year of Business Operations		1968	
Percent of Total Sales	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	15	19.7	5	9.1
75-99	4	5.3	3	5.5
50-74	5	6.6	6	10.9
25-49	5	6.6	4	7.3
Less than 25%	13	17.1	15	27.2
Total response	42	55.3	33	60.0
No response	34	44.7	22	40.0
Total	76	100.0	55	100.0

12 cont.
b. Custom designed products or services.

Percent of Total Sales	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	20	26.3	6	10.9
75-99	8	10.5	7	12.7
50-74	9	11.8	11	20.0
25-49	5	6.6	8	14.5
Less than 25%	9	11.8	11	20.0
Total response	51	67.0	43	78.1
No response	25	33.0	12	21.9
Total	76	100.0	55	100.0

12 cont.
c. Standardized products or services.

Percent of Total Sales	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	6	7.9	5	9.1
75-99	7	9.2	10	18.2
50-74	7	9.2	5	9.1
25-49	3	3.9	6	10.9
Less than 25%	1	1.3	5	9.1
Total response	24	31.5	31	56.4
No response	52	68.5	24	43.6
Total	76	100.0	55	100.0

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

13. Please estimate the percentage of your firm's total sales or revenue that was derived from each of the following categories during the first complete year of business operations and in 1968.

a. Directly from government agencies.

	First Complete Year of Business Operations		1968	
Percent of Total Sales	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	1	1.3	. .	. . .
75-99	1	1.3	3	5.5
50-74	4	5.3	3	5.5
25-49	3	3.9	3	5.5
Less than 25%	10	13.2	14	25.4
Total response	19	25.0	23	41.9
No response	57	75.0	32	58.1
Total	76	100.0	55	100.0

13 cont.

b. Indirectly from government agencies through contracts with prime contractors or subcontractors.

Percent of Total Sales	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	1	1.3	. .	. . .
75-99	2	2.6	2	3.6
50-74	6	7.9	7	12.7
25-49	7	9.2	4	7.3
Less than 25%	17	22.4	16	29.1
Total response	33	43.4	29	52.7
No response	43	56.6	26	47.3
Total	76	100.0	55	100.0

13 cont.
c. All other non-government related commercial customers.

Percent of Total Sales	First Complete Year of Business Operations		1968	
	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
100%	31	40.8	15	27.2
75-99	16	21.0	18	32.8
50-74	9	11.8	5	9.1
25-49	6	7.9	6	10.9
Less than 25%	6	7.9	9	16.4
Total response	68	89.4	53	96.4
No response	8	10.6	2	3.6
Total	76	100.0	55	100.0

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

14. Please check (√) the types of customers that were your firm's major sources of sales or revenue during the first complete year of business operations and in 1968.

Major Customer Types	First Complete Year of Business Operations		1968	
	Number of Mentions	Percent of Total Respondents	Number of Mentions	Percent of Total Respondents
Government				
DOD	17	22.4	19	34.6
NASA	8	10.5	14	25.4
AEC	2	2.6	4	7.3
HEW	4	5.3	6	10.9
Other government	5	6.6	3	5.5
Commercial				
Electronics	23	30.2	19	34.6
Aerospace	22	29.0	21	38.2
Automotive	25	32.9	23	41.8
Chemical	11	14.5	11	20.0
Other commercial	21	27.6	21	38.2
Other				
Foundations and institutions	19	25.0	14	25.4
No response	8	. . .	4	. . .

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

15. How many major competitors did your firm have in:

a. the year your firm was founded?
b. 1968?

	Year of Founding		1968	
Number of Major Competitors	Number of Respondents	Percent of Total Respondents	Number of Respondents	Percent of Total Respondents
0-4	35	46.1	20	36.4
5-9	13	17.1	15	27.3
10 and over	20	26.3	16	29.1
No response	8	10.5	4	7.2
Total	76	100.0	55	100.0

Data for 1968 excludes firms merged into or acquired by other corporations prior to 1969.

Data for firms completing first year of business operations in 1968 are tabulated under first complete year of business operations only.

APPENDIX B

Field Interview Outlines

Spin-off Firms and Manufacturers' Representatives

INDUSTRIAL DEVELOPMENT DIVISION
INSTITUTE OF SCIENCE AND TECHNOLOGY
THE UNIVERSITY OF MICHIGAN

Field Interview Outline—Spin-off Firms

Respondent _____

Title _____

Company _____

Address _____

Date _____

I. COMPANY HISTORY

First of all, we would like to ask some questions that go back to the time period just prior to when your firm was started.

1. Would you describe the business opportunity available at your company at that time?

Probe Areas

a. Aware of market need or unsolved problem
b. Aware of specific customers or market
c. Existence or promise of orders or contracts
d. Knowledge of competition
e. Information about design requirements, specs., quality

2. How did you visualize the marketing requirements for the product/service/technical capability you planned to sell?

a. Recognition of the need for selling activity
b. Recognition of the need for promotion
c. Need for distribution or licensing arrangements
d. Mention of price level or structure

3. Did you seek any outside marketing assistance prior to starting your firm?

Yes _____ No _____

3a. If no, did you perform any market analysis?

Yes _____ No _____

4. Was any development work done on your firm's first product/service prior to starting business operations?

Probe Areas

a. Extent of development
b. Where and when development was conducted

5. At what stage of the development process were you in when you formally started business?

Probe Areas

a. Product or service concept
b. Applied research & development
c. Prototype or pilot manufacture
d. Engineering
e. Manufacture of product or provision of service

6. Were you or any of the founders able to use prior employment experience in the development of your initial product/service/technical capability?

Probe Areas

a. Extent of technology transfer and development
b. Application to initial product/service/technical capability

7. We would like to get some information on the principal founders of your firm, their education, prior employment and the special knowledge or experience they brought to your firm.

Can you give me this data for your firm's principal founders?

Name	Education	Employment
a.		
b.		
c.		
d.		
e.		

Type of Work Performed	Special Experience or Knowledge
a.	
b.	
c.	
d.	
e.	

II. INITIAL COMPANY OPERATIONS

8. Would you describe your firm's business during the first year of operations?

Probe Areas

a. Nature of product/service/technical capability
b. Initial markets
c. Extent of initial availability
d. Initial customer reactions
e. Major limitations and how discovered

9. How did you sell your initial product/service/technical capability?

Probe Areas

a. Who performed the sales activity

10. Looking back at the types of business experience in your firm when you started business, could you have used additional experienced personnel in any areas?

Yes _____ No _____

10a. If yes, what areas?

III. CURRENT OPERATIONS

11. Would you briefly describe your firm's business in 1968?

Probe Areas

a. Major types of product/service/technical capability
b. Service requirements (if applicable)
c. Purchase frequency (if applicable)
d. Prices
e. Stage of demand
f. Product line expansion or changes since first year

12. How are your products/service/technical capabilities currently sold?

Probe Areas

a. Sales channels or intermediaries
b. Emphasis on selling versus sales engineering
c. Emphasis on fitting the product/service/technical capability
d. Competitors selling methods
e. Number involved in purchasing decision

13. Besides your product line, does your firm have any other advantages over competition?

Probe Areas

a. Superior technical capability
b. Unusual research, test or production facilities
c. Patent position
d. Advantages recently developed or present at firm's start
e. Emphasis in firm's marketing effort

14. Under what circumstances is the ability to design to specific customer requirements important to your firm?

Probe Areas

a. Change in importance
b. Emphasis in marketing effort

15. How does the geographic scope of your markets in your first year of business compare with 1968?

First Year 1968

16. What use does your firm make of trade advertising, trade shows, and sales promotion items such as brochures and catalogs in your marketing effort?

Probe Areas

a. Markets promoted by each method
b. Products/services promoted by each method
c. Objectives

17. How does the importance of advertising and sales promotion in your marketing effort during your first year of business compare with 1968?

Probe Areas

a. If change in emphasis, what factors account for it
b. Has role changed in terms of uses

18. About what percentage of sales did your firm spend on personal selling, and advertising and sales promotion during your first year of business and 1968?

	First Year	1968
a. Personal Selling		
b. Advertising		
c. Sales Promotion		

19. What types of pricing methods are used by your firm?

Probe Areas

a. Fixed price, flexible price, standard commercial price
b. Type of product/service/technical capability sold with each method
c. Types of customers or markets sold with each method

20. What percentage of your first year sales and 1968 sales were made by each method?

Price Method	% First Year	% 1968
a.		
b.		
c.		
d.		

21. Would you contrast the emphasis placed on price in your firm's selling effort during 1968 and your first year of business?

Probe Areas

a. On what products/service/technical capability is price important or emphasized
b. Reasons for change (if any)

22. What are some of the factors your firm considers in setting the price level for your products/services/technical capability?

Probe Areas

a. Emphasis on costs, value, competition, projected volume, market entry, return on investment
b. Market or product orientation
c. Problems in setting or determining prices

NOTE: Questions 23, 24, and 25 to be asked only to firms using market intermediaries.

23. What products/services does your manufacturers' representative/ industrial distributor handle and what markets does he serve?

Probe Areas

a. Proportion of sales volume handled, markets served and products sold
b. Marketing functions and services performed initially/interim/1968
c. Reasons for use
d. Trends in use of this method

24. On what basis did you select your manufacturers' representative/ industrial distributor?

25. What are the major problems you have had with this method of distribution?

Probe Areas

a. Specify problems to a point in time of firm's development

26. How would you describe your present marketing organization?

Probe Areas

a. Percent of employees employed full time in marketing
b. Organization structure (if any)

27. If substantial changes have occurred in the marketing organization, ask:

    When did most of the changes in your marketing organization occur?

Probe Areas

a. Timing of changes
b. Reasons for changes

28. Since your firm was founded, what types of skills have you added to your marketing organization by the addition of new people?

INDUSTRIAL DEVELOPMENT DIVISION
INSTITUTE OF SCIENCE AND TECHNOLOGY
THE UNIVERSITY OF MICHIGAN

Field Interview Outline--Manufacturers' Representatives

Respondent _____

Title _____

Company _____

Address _____

Date _____

1. What services does your firm provide for a principal?

2. In making the decision to add a product to your line, what does your company consider?

3. What are the characteristics of the product line that receives the greatest amount of your selling time?

4. What type of marketing assistance do you expect from the manufacturer you represent?

5. What are the problems that the small science-oriented manufacturer faces in marketing his products?

6. What should the small science-oriented manufacturer look for in selecting a manufacturers' representative to sell his products?

7. Does your firm represent companies who do work primarily on a custom design and manufacturing basis?

Yes _____ No _____

7a. If yes, what are the problems you encounter in this type of selling?

APPENDIX C

Statistical Tables

APPENDIX TABLE C-1

Time Period of Formation by Type of Spin-off Firm for Ann Arbor Area Spin-off Firms
(Percent of Different Types of Spin-offs Formed During Each Time Period)

	Type of Spin-off Firm			
Time Period of Formation	University	Primary Industry	Secondary Industry	Total
1954-1958	16.0	12.5	. . .	9.4
1959-1963	36.0	29.2	6.7	23.0
1964-1968	48.0	58.3	93.3	67.6
Total	100.0	100.0	100.0	100.0
No. of formations	25	24	15	74

Firms classified by date of incorporation or registration of business style.

APPENDIX TABLE C-2

Year of Incorporation or Formation by Type of Spin-off Firm for Michigan Spin-off Firms

Year of Incorporation or Formation	Type of Spin-off Firm			
	University	Primary Industry	Secondary Industry	Total
1954	1	2	. .	3
1955	2	4	. .	6
1956	. .	3	. .	3
1957	2	4	2	8
1958	1	3	3	7
1959	. .	. .	. .	. . .
1960	1	4	1	6
1961	2	6	. .	8
1962	4	5	1	10
1963	3	10	. .	13
1964	1	3	2	6
1965	. .	6	2	8
1966	4	5	4	13
1967	4	13	3	20
1968	3	4	8	15
Total	28	72	26	126

APPENDIX TABLE C-3

Educational Background by Initial Business Orientation for 32 Technical Entrepreneurs Interviewed During Field Research
(Number of Entrepreneurs Having Each Educational Background)

	Initial Business Orientation		
Education of Entrepreneur	R & D, Testing and Consulting	Custom Products and Services	Standard Products and Services
Ph.D.	1	3	1
Master's	3	3	1
Bachelor's	4	6	4
0 to 3 years college	. .	6	. .
Number of entrepreneurs	8	18	6

APPENDIX TABLE C-4

Employment Experience Present at Time of Founding in Spin-off Firms by Employee Type
(Percent of Firms Mentioning Each Type of Employment Experience)

Type of Employment Experience	University Spin-offs		Primary Industry Spin-offs		Secondary Industry Spin-offs	
	Principal Founders	Other Employees	Principal Founders	Other Employees	Principal Founders	Other Employees
Research, development or engineering	100.0	9.5	95.1	26.8	92.8	50.0
Production	9.5	. .	39.0	21.9	42.9	28.6
General management	23.8	. .	56.1	9.8	64.3	21.4
Accounting or finance	9.5	9.5	34.2	14.6	14.3	21.4
Marketing or sales	19.1	9.5	48.8	9.8	35.7	28.6
Number of firms	21		41		14	

APPENDIX TABLE C-5

Paid-in Capital at Time of Founding by Type of Spin-off Firm
(Percent of Firms Reporting Each Range of Paid-in Capital)

Paid-in Capital at Time of Founding	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
$0-9000	40.0	33.3	14.3
$10,000 and over	60.0	66.7	85.7
Total	100.0	100.0	100.0
Number of firms	5	9	7

APPENDIX TABLE C-6

Type of Technology Transferred by Type of Spin-off Firm
(Percent of Firms Reporting Each Type of Technology Transfer)

Type of Technology Transferred	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
General scientific and engineering knowledge	77.8	66.7	12.5
Specific product, service or process knowledge	22.2	33.3	87.5
Total	100.0	100.0	100.0
Number of firms	9	15	8

APPENDIX TABLE C-7

Summary of Market Information Available Prior to Starting Business Operations by Type of Spin-off Firm
(Percent of Firms Mentioning Each Type of Market Information)

Type of Market Information	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
Knowledge of market need or unsolved problem	88.9	93.4	100.0
Knowledge of specific customers or market segments	55.6	86.7	87.5
Knowledge of competition	77.8	86.7	75.0
Technical information about market requirements	77.8	86.7	75.0
Existence or promise of orders or contracts	75.0	33.3	25.0
Number of firms	9	15	8

APPENDIX TABLE C-8

Presence of Marketing Experience Among All Employees at Time of Founding by Type of Spin-off and Primary Source of First Year Sales Revenue
(Percent of Firms Responding Within Each Sales Revenue Classification)

Presence of Marketing Experience Among all Employees at Time of Firm's Founding	University Spin-offs		Primary Industry Spin-offs		Secondary Industry Spin-offs	
	Government Direct or Indirect	Non-Government Commercial	Government Direct or Indirect	Non-Government Commercial	Government Direct or Indirect	Non-Government Commercial
Marketing experience present	50.0	23.5	42.9	51.7	33.3	54.6
Marketing experience not present	50.0	76.5	57.1	48.3	66.7	45.4
Total	100.0	100.0	100.0	100.0	100.0	100.0
Number of firms	4	17	8	29	3	11

APPENDIX TABLE C-9

Technical Activities Performed During First Year of Business Operations
By Type of Spin-off Firm
(Percent of Firms Mentioning Each Activity)

Technical Activities	Type of Spin-off Firm		
	University	Primary Industry	Secondary Industry
Research, development, evaluation and testing	71.5	58.5	71.4
Engineering and prototype or pilot manufacture	61.9	73.1	92.9
Manufacture of products and provision of general services	66.7	65.8	85.7
Number of firms	21	41	14

APPENDIX TABLE C-10

Range of 1968 Employment of Spin-off Firms Classified by the Existence of Innovative Activity
(Percent of Firms Having Each Range of 1968 Employment)

Range of 1968 Employment	Existence of Innovative Activity	
	No Technical Progression	Technical Progression
1-49 employees	90.9	63.0
50 employees and over	9.1	37.0
Total	100.0	100.0
Average age of firms (years)	7.5	5.4
Number of firms	11	46

Excludes 4 firms acquired by merger and 15 firms completing only one year of business operations.

APPENDIX TABLE C-11

Business Orientation of 22 Electronics Spin-off Firms by Number of Years of Business Operations
(Percent of Firms Having Each Business Orientation)

	Number of Years of Business Operations	
Business Orientation	1 to 5 years	6 to 15 years
R & D, testing and consulting	7.7	11.2
Custom products and services	69.2	33.3
Standard products and services	23.1	55.5
Total	100.0	100.0
Number of firms	13	9

Excludes 2 primary industry spin-offs and 1 secondary industry spin-off acquired by merger; and 8 secondary industry spin-offs.

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