INVENTION AND INNOVATION SUPPORT IN MINNESOTA

Final Report to the Legislature

June 30, 1989

Department of Trade and Economic Development
900 American Center Building
150 East Kellogg Boulevard
St. Paul, MN 55101

INVENTION AND INNOVATION SUPPORT IN MINNESOTA

Final Report to the Legislature

June 30, 1989

CONTENTS

INTRODUCTION

The Legislature in 1988 directed the Business Promotion Division of the Department of Trade and Economic Development to:

> "...contract for the study and design of a comprehensive, integrated, invention and innovation support and marketing system. The study must examine the feasibility of locating an invention and innovation center in the Twin Cities metropolitan area, with a statewide network involving Twin Cities' suburban and greater Minnesota communities. The design must include an educational component to encourage greater interest in innovative and inventive methods. It must also provide proposals for linking Minnesota-based invention and innovation activities with similar efforts occurring nationally and internationally." 1988 Minnesota Laws, Chapter 686, Article 1, Section 14(h).

The legislation required the Department to submit an interim report to the Legislature by January 15, 1989, and to submit a final report to the Legislature by June 30, 1989.

This document is the final report required by the legislation.

BACKGROUND

There is considerable national interest in programs to expand technology, invention and innovation.

At the federal level President Bush has announced the formation of the President's Competitiveness Council to make recommendations on topics like:

* Amendment of current antitrust laws to ease formation of joint innovative and production activities;

* Changes in patent and trademark law to make it easier to license intellectual property;

* Easing of regulatory burdens on the introduction and marketing of regulated products (e.g., biotechnology products);

* New tax incentives for research and innovation.

Three major bills have been introduced in the 101st Congress to encourage cooperative research and joint commercial ventures.

Two bills were likewise introduced to make permanent the federal R&D tax credit.

In Minnesota, legislative interest in the area of invention and innovation is not new. In earlier years the Legislature funded:

* A grant to the Minnesota Inventors Congress to establish a focal point for developing an invention support system, coordination of a regionally-based invention support system, primarily in the form of semi-autonomous regional centers, promoting existing inventor and invention support activities, promoting invention research to be disseminated to the state's educational systems, and developing a fiscal design for statewide invention support. 1985 Laws of Minnesota, 1st Special Session, Ch. 13, Sec. 28, Subd. 7.

* A technology transfer tax credit (in place from 1983 through 1986), which authorized a credit against the transferor's income tax of up to 30 percent of the first $1,000,000 of the net value of technology transferred to qualified small businesses. 1983 Laws of Minnesota, Ch. 342, Art. 8, Sec. 13, Subd. 2, codified as Minn. Stat. 290.069, Subd. 2.

* A small business assistance office tax credit (in place from 1983 through 1986), which authorized a credit against income tax of up to $25,000 for contributions to qualified nonprofit organizations which provided assistance to inventors and entrepreneurs. 1983 Laws of Minnesota, Ch. 342, Art. 8, Sec. 13, Subd. 3, codified as Minn. Stat. 290.069, Subd. 3.

This legislative support augmented the work of other invention-related organizations in Minnesota, including:

* The Minnesota Inventors Congress, which serves as a focal point for invention support in the state. An annual Inventors Congress provides an opportunity for inventors to display their inventions and to receive public reaction and exposure. The Inventors Congress operates two resource centers to assist inventors and the general public with questions about idea development, patents, trademarks, copyrights, marketing and general invention support.

* The Minnesota Inventors Hall of Fame, which honors Minnesota inventors and brings to the attention of the public the economic and social importance of their contributions.

* The Young Inventors Fair, sponsored by the Twin Cities Educational Cooperative Service Unit and the Science Museum of Minnesota. This organization offers workshops and other events to teach and encourage students to invent.

* The Inventor and Technology Transfer Society, which prepares instructional materials for inventors, and presents various workshops.

* The Minnesota Small Business Assistance Office, which provides information and assistance to inventors and entrepreneurs in all aspects of business start-up, expansion and operation.

* The Greater Minnesota Corporation, which was established in part to stimulate economic growth and job creation through applied research, technology transfer, and product development.

* The Office of Research and Technology Transfer Administration, University of Minnesota, which promotes the transfer of technology developed at the University to companies for commercialization. The Office also negotiates and administers sponsored research agreements with industry and provides advice and assistance to faculty, staff and students about discoveries, patents, industrial research contracts, and relationships with industry.

* The Minneapolis Public Library, which maintains a patent depository library to assist inventors and others in researching patent information.

* Independent consultants, which provide counseling and related services to inventors. Many of these services are fee-based, but in some cases consultants have arranged with state Technical Institutes to provide low-cost assistance to Technical Institute clients in office space provided by the Technical Institutes.

* The U.S. Small Business Administration, Small Business Development Centers, SCORE organizations, and an array of other groups, which provide counseling and referral services to inventors and entrepreneurs.

As the above indicates, a substantial number of individuals and organizations provide assistance to inventors and entrepreneurs. There has been, however, substantial anecdotal evidence that these services and resources are often fragmented, incomplete, and in some cases unavailable outside the Twin Cities metropolitan area.

A major focus of the study, therefore, was to examine the range of resources and services available to inventors and entrepreneurs, and the process of delivering those services, and to determine the feasibility of coordinating service delivery through a statewide system.

APPROPRIATION

The Legislature appropriated $100,000 for the study.

CONTRACTOR SELECTION

Study proposals were solicited through the State Register and direct contact with potential contractors. The proposals were evaluated by a panel of individuals from the Minnesota Department of Trade and Economic Development, the State Board of Vocational Technical Education, the Attorney General's office, and the U.S. Small Business Administration.

Following the evaluation, the contract was awarded to the Institute for Invention and Innovation, a non-profit organization located in St. Paul.

SCOPE OF WORK

The contract directed the contractor:

A. To examine the feasibility of locating an invention and innovation center in the Twin Cities metropolitan area, with a statewide network involving Twin Cities' suburban and greater Minnesota communities. The contract provided that the study must include, at minimum:

   1. A taxonomy and a detailed description of the financial, informational, legal, marketing, referral, and other support available to inventors and innovators in the Twin Cities metropolitan area, and in each of the state's economic development regions.

   2. A detailed description of gaps in financial, informational, legal, marketing, referral, and other support available to inventors and innovators in the Twin Cities metropolitan area, and in each of the state's economic development regions.

   3. A detailed description of barriers to the development of a comprehensive, integrated, invention and innovation support and marketing system to remedy those gaps that will serve both Twin Cities metropolitan area and greater Minnesota area residents.

4. The contractor's recommendation on the feasibility of locating an invention and innovation center in the Twin Cities metropolitan area, with a statewide network involving Twin Cities suburban and greater Minnesota communities, together with reasons for the recommendation.

5. A detailed description of the contacts the contractor has established and maintained during the study with invention-related organizations and the nature of their contributions to the study.

B. Following completion of the study, to design a comprehensive, integrated, invention and innovation support and marketing system, to include at a minimum:

1. A detailed program for invention and innovation support and service delivery within the Twin Cities metropolitan area, in suburban areas, and in greater Minnesota. The program must include the contractor's recommendation on the objectives, structure, work program, and staffing requirements for the invention and innovation center, and the reasons for the recommendation.

2. An education component to encourage greater interest in innovative and inventive methods. This component at minimum must identify existing educational resources and curricula and discuss specifically how those resources and curricula will be used in education programs. Where there are gaps in educational resources, the education component must describe specifically how supplemental education programs will be developed. This component also must describe in detail methods for teaching invention and innovation, and disseminating invention research information to the Minnesota educational system.

3. Proposals for linking Minnesota-based invention and innovation activities with similar efforts occurring both nationally and internationally.

4. A detailed proposal for coordinating the efforts of individuals and organizations involved in providing invention and innovation support within Minnesota.

The contractor was also directed to submit monthly progress reports to the Department, and to cooperate with the Department in preparing reports to the Legislature.

CONTEXT OF THE STUDY

Since the 1942 publication of Schumpeter's work [1], there has been a tremendous amount of theoretical modeling and practical observation on the impact of innovation on firms, markets and the economy [2]. The result is a substantial body of work, much of it empirical, on the factors affecting the search for, development of, and adoption of invention and innovation [3]. That work provides a useful context for any discussions of public policies to support or promote inventive or innovative activity. Among the major findings are the following:

* The development and adoption of inventions and innovations remains very important to productivity growth and associated gains in economic growth. Two-thirds of U. S. productivity growth over the last fifty years has been attributed to the adoption of innovation [4]. Innovative technology-based industrial sectors generate an estimated fifty percent of the gross national product [5].

  On the microeconomic level, studies of new firm performance show the most success for those with innovative products and strategies [6]. Indeed, there is some evidence that, for publicly-traded firms, there is a positive relationship between a firm's innovative activity and its stock market value [7].

* The focus of invention and innovation has shifted from individual, independent inventors to in-house work of both large and small firms [8]. This change reflects the complexity of knowledge involved, the cost of work on innovative products and processes, and the need to integrate innovation early on into production and operations [9]. Most importantly, whatever the initial source of invention or innovation, it is the firm which commercializes, markets and delivers it -- with the attendant benefits to economic growth [10].

* Firms seek to develop and adopt inventions and innovations for a number of reasons:

  * To take advantage, in the market, of the irreversibility feature of innovation. That is, once an invention or innovation displaces an old product or process, the old is unlikely to recapture significant market share regardless of the relative price movement of both old and new. (That is, no matter how cheaply one can now make vacuum tubes, they will never displace transistors in electronic circuitry). [11].

  * To take advantage of "first mover advantages" in addition to those inherent in the invention or innovation. These include preemption of markets, first pick of channels of distribution, early advantageous access to suppliers, facilities and other production inputs <u>before</u> they are affected by the market change brought on by the innovation [12].

* To take early advantage of learning curves with subsequent effect on market share [13].

* To create entry barriers to competitors [14].

There are a number of factors which can constrain the ability of a firm to innovate.

* The nature of demand. All markets are not infinitely expandable [15]. There are many innovations which will never become commercialized. Failure to recognize this is a particular problem of "technology push" firms which are driven by the knowledge of a single entrepreneur and his commitment to a particular product. It is not uncommon for such firms to seek to build the market's best mousetrap when the market wants only a good mousetrap.

  Likewise, while many markets are contestable, in that they have few barriers to entry, they are not necessarily competitive [16]. Incumbents or large new entrants may already possess sufficient economic rents to dominate the market. IBM was a latecomer to the personal computer market -- but it was IBM, with all its benefits of reputation, production, design, sales, distribution and service.

* Cost. The development and adoption of invention and innovation involve bearing of substantial sunk costs -- both one-time costs and recurrent costs [17].

* Unanticipated consequences of innovation. Most frequently this takes the form of unexpected direct costs, often associated with costs of tax and regulatory compliance [18].

* Spillover benefits to competing firms. Many inventions and innovations are surprisingly easily and quickly appropriable [19].

* Regulatory and antitrust barriers [20].

* The availability and accessibility of financing [21].

* Lack of trained personnel [22].

* Lack of services to remedy firm incompetencies in basic areas of business organization and operation [23].

* Lack of services to communicate technological opportunity and the state of the art of products and processes (i.e., technology transfer). [24].

THE CONTRACTOR'S METHODOLOGY

Given that context the contractor's study was organized into the following components:

1. A personal interview survey of Minnesota inventors, innovators and varied support professionals who serve inventors.

2. Two focus groups to discuss issues that arose during the preceding survey.

3. A personal interview survey of Scandinavian inventors and support professionals.

4. A survey of invention/innovation-related activities in Minnesota public pre-collegiate and postsecondary educational systems.

5. A compilation of a taxonomy of existing Minnesota inventor/innovator support organizations now in place and the gaps therein.

6. A first-phase, general survey of the literature relating to invention/innovation.

7. A discussion of barriers to a comprehensive, integrated invention/innovation support and marketing system to remedy identified gaps.

8. The preceding steps resulted in conclusions and recommendations regarding the feasibility and design of a statewide, comprehensive, integrated invention and innovation support and marketing system, including a Twin Cities metropolitan area invention and innovation center, which also would serve its suburbs and Greater Minnesota.

9. Those same steps also led to proposals for (a) linking Minnesota-based, invention/innovation and marketing activities to similar national and international efforts and (b) coordinating efforts of Minnesota individuals and organizations which do or could more fully support invention/innovation and marketing.

Based on these efforts the consultant concluded about current services to inventors:

1. There are a number of basic-to-sophisticated services which are needed by or useful to inventors. These can be consolidated into the following service categories:

* product research and development
* business planning and consulting
* financial support and assistance
* marketing research/feasibility studies
* marketing planning and consultation
* legal assistance and consultation
* education and training

2. There are substantial gaps in inventors' knowledge and capabilities in these areas.

3. Inventors lack knowledge and awareness of the availability and accessibility, breadth and depth, of services now being provided. Providers of services have a similar lack of knowledge of the universe of available services and instead have a narrow band of knowledge about their specific expertise and others who provide it.

4. Inventors are concerned about the quality and usefulness of services currently being provided.

About invention and innovation in schools the consultant concluded:

1. Invention and innovation are perceived positively by faculty members and administrators throughout Minnesota's precollegiate and postsecondary educational systems.

2. While most postsecondary respondents were able to identify inventions and innovative activities in which they or their institutions were involved, very few examples were provided of explicit courses designed specifically to enhance student inventive and innovative behavior.

3. Responding K-12 educators identified important current opportunities for their students -- such as the Minnesota Student Inventors' Congress -- but felt that these opportunities need to be expanded to include larger numbers of students.

4. There appears to be a strong need for systematic support for and coordination of activities related to invention and innovation among faculty; between faculty and students; among schools and campuses within the precollegiate and postsecondary systems and between schools/campuses and the community.

About invention/innovation support systems in Scandinavia the consultant concluded:

1. Sweden ranks high in its commitment of national resources to research and development. The Swedish government assists the private sector in financing a number of research institutes, mostly operated by or adjacent to six major Swedish universities.

2. Through the universities and government-financed support, Sweden encourages and funds technical development in high priority technological fields.

3. Further government support for research and development is reflected in the active involvement of the Swedish Ministry of Industry in the research and development process.

4. In Denmark, the Danish Invention Center, as part of, the Technological Institute is a government chartered non-profit organization actively engaged in evaluating, encouraging and facilitating invention and technology transfer.

5. In Norway, with little active government support, individuals within the invention/innovation community are organizing an informal national support and communications network.

The contractor summarized these sets of findings in five "Conclusions and Recommendations":

1. Inventors and innovators require a broad range of support services, all of which are important, but within the present infrastructure, are delivered in a random, disorganized and incomplete fashion. A centralized, coordinated resource is necessary to provide a focal point of support services to Minnesota inventors and innovators.

2. The present and near-term future for invention and innovation is generally perceived as favorable. There is ample evidence to indicate that invention and innovation will thrive in the post-industrial society; there is an equal body of evidence to indicate that a coordinated "single-source" of invention support is necessary if invention is to be exploited for purposes of economic growth.

3. Sweden sponsors and maintains a comprehensive program of invention support with many elements that deserve consideration as a Minnesota model for an invention and innovation support and marketing system. Denmark supports a comprehensive Danish Invention Center which also is suggestive.

4. A program of invention and innovation support must utilize more fully the skills, capabilities and facilities of the Minnesota education/learning community. Special attention should be given to forging and strengthening relationships between the Minnesota education system -- from the earliest grade level -- and the invention, innovation and invention support infrastructure.

5. Special efforts should be undertaken to broaden and strengthen educational programs and curricula to assist the inventor and innovator improve understanding of the invention process.

To implement these conclusions and recommendations the contractor has proposed creation of an invention/innovation and marketing system which is both a physical center and a programmatic activity. Located in Minneapolis, the center would have proposed branches in Duluth, Moorhead, Rochester and Marshall.

Initially and on an on-going basis, the center would have the following objectives which the contractor has spelled out in draft statutory language:

* to inventory, make accessible and continuously update invention, financial and marketing services;

* to develop linkage contact and appropriate relationships with current and emerging programs;

* to provide counseling, information, evaluation and referral services for the needs of the marketplace and the inventive community;

* to provide clearinghouse and educational functions for pertinent marketplace and inventive community needs;

* to promote realistically its first-phase activities clearly so they are accurately known to interested Minnesotans in the Twin Cities metropolitan area, and greater Minnesota thereby reducing typical, excessive expectations which cannot be immediately met;

* to seek ways to remove barriers, e.g., cultural, social, financial, legal and marketing, which impair marketplace acquisition of new products toward job creation and economic development as well as those which impair the inventive community from developing such requested products:

* to examine and utilize appropriate technologies in the pursuit of the preceding objectives.

* to pursue other and yet-to-be identified activities which facilitate Minnesota's continuous self-renewal through accelerated and quality invention/innovation and marketing strategies.

As long term goals for the center the consultant suggests that it:

* work with the Department of Natural Resources to identify sites to be used as pilot, invitational inventors' think tank/retreats.

* develop -- probably in collaboration with the University of Minnesota -- an Institute for Advanced Invention Studies.

* work with the Commissioner of Corrections to identify ways in which the center can be linked to the correctional system and the rehabilitation of incarcerated persons.

* develop an international version of Florida's Inventors World.

* propose to the Ford Foundation the creation of a Minnesota Center for the Study of Inventive Federalism.

* establish a for-profit foreign technology import business.

* establish an international consulting company to export the Minnesota model for an invention/innovation support and marketing system.

* develop an Inventor's Foundation to provide funds to inventors.

* use historic buildings for invention/innovation related purposes.

* develop information technology and software to assist inventors.

To link Minnesota efforts with invention/innovation efforts occurring nationally and internationally the consultant proposes:

* visits to other U.S. and Canadian invention/innovation activities, the National Science Foundation, the Patent Office and successful R&D efforts of private firms.

* membership by Minnesota organizations in the Swedish Inventors Association.

* establishment of a Twin Cities international counterpart to the annual Swedish Skapa Fair.

* encouragement of Minnesota firms to join the World Intellectual Property Organization and the International Federation of Inventors Associations.

* establishment of a for-profit technology transfer company to bring Swedish inventions to Minnesota.

To coordinate the provision of inventions and innovation support services in Minnesota the consultant proposes creation of a State Board of Invention with an initial FY 91-92 budget of $1,625,000. The Board would:

(1) receive and consider any requests for grants, loans or other forms of assistance;

(2) advise and serve as a technical resource at the request of sponsoring organizations and political subdivisions in the state on programs relating to invention;

(3) advise and recommend on existing or proposed activities of the departments or agencies relating to invention;

(4) accept gifts and grants to the board and distribute the same in accordance with the instructions of the donor insofar as the instructions are consistent with law;

(5) adopt by rule procedures to be followed by the board in receiving and reviewing requests for grants, loans or other forms of assistance;

(6) adopt by rule standards consistent with this chapter to be followed by the board in the distribution of grants, loans and other forms of assistance;

(7) distribute according to the above procedures and standards adopted pursuant to this subdivision, grants, loans and other forms of assistance for inventive activities to departments and agencies of the state, political subdivisions, sponsoring organizations and, in appropriate cases, to individuals engaged in the creation or performance of invention; provided that a member of the board shall not participate in deliberations or voting on assistance of groups or persons in which that member has an interest as officer, director employee or recipient;

(8) appoint advisory committees which the board determines are essential to the performance of its powers and duties under this section; provided that no member of an advisory committee shall within two years prior to appointment have received or applied for in the member's own name a grant, loan or other form of assistance from the board or its predecessor.

RECOMMENDATION OF THE DEPARTMENT OF TRADE AND ECONOMIC DEVELOPMENT

Since the 1988 commissioning of the contractor's study there have been a number of new initiatives which give promise of addressing major issues of availability and accessibility of specialized services as well as the quality, accountability and coordination of services. Among these are:

* continued support by the legislature of the Minnesota Inventor's Congress together with a clear articulation of the purposes for

which state appropriation dollars are to be used. Those purposes are: establishment of a focal point for development of an invention support system, coordination of an invention support system primarily in the form of semi-autonomous regional centers, promotion of invention research and dissemination of results to Minnesota education systems, development of a fiscal design for the statewide invention support system (Chap. 335, 1989 Laws, Sec. 25, Subd. 5.).

* creation by the 1989 legislature of Minnesota Project Outreach. A joint venture of the University of Minnesota, the Greater Minnesota Corporation and the Department of Trade and Economic Development, Project Outreach will:

    * facilitate the transfer of technology and scientific advice from the University of Minnesota and other institutions to businesses in the state that may make economic use of the information;

    * assist small and medium size businesses in finding technical and financial assistance providers that meet their needs.

  In addition the Project will work with the Department of Trade and Economic Development in the establishment of an evaluation mechanism to aid in determining the effectiveness of service providers in meeting client needs.

* coordination and administration by the Department of Trade and Economic Developent of the efforts of all the federally funded Small Business Development Centers in Minnesota. Efforts have already been put in place for coordinated service delivery planning, financial allocation planning and evaluation of services.

* operation of a number of new programs of the Greater Minnesota Corporation to include:

    * the Technology Research Grant Program to support early stages of research and development leading to new products or processes. In June 1989 the GMC awarded a total of $980,000 (of $3 million available this year) to seven awardees.

    * Business Innovation Centers which will offer product and process evaluation, access to technology data bases, assistance with adoption of new technologies by businesses.

    * the Minnesota Advanced Manufacturing Technology Corporation which will counsel individual firms on their operations and make recommendations for training, implementing technology or changing management practices. In addition, the Minnesota Manufacturing Institute will be established in the Minnesota Technology Corridor and as many as six Advanced Manufacturing Technology Centers will be established in outstate communities.

Given these new initiatives and their emphasis, the Department of Trade and Economic Development recommends no action on the consultant's recommendations at this time. Since an evaluation of service providers, both current and new, will be forthcoming as part of Minnesota Project Outreach, the Department instead recommends a review of the success of service providers and coordinated activities in 1991 for possible future legislative action.

ENDNOTES

[1] Joseph Schumpeter, Capitalism, Socialism and Democracy (New York: McGraw-Hill, 1942).

[2] A very excellent introduction is Giovanni Dosi, "Sources, Procedures, and Microeconomic Effects of Innovation," The Journal of Economic Literature (September 1988), pp. 1120-1171.

[3] See especially, G. Dosi et al (eds.), Technical Change and Economic Theory (New York: Pinter, 1988).

[4] John A. Young, "Technology and Competitiveness: A Key to the Economic Future of the United States," Science (15 July 1988), p. 314.

[5] Ibid. See also William J. Baumol, "Is There a U.S. Productivity Crisis?," Science (3 February 1989), p. 614.

[6] See, for example, William R. Sandberg, New Venture Performance: The Role of Strategy and Industry Structure (Lexington, Mass.: Lexington Books, 1986).

[7] See, for example, A. Pakes, "Patents, R&D and the Stock Market Rate of Return," in Zvi Griliches (ed.) R&D, Patents and Productivity (Chicago: University of Chicago Press, 1984).

[8] For two very recent accounts of this change see Thomas P. Huges, American Genesis (New York: Viking, 1988) and David A. Howshell and John K. Smith, Jr., Science and Corporate Strategy (New York: Cambridge University Press, 1988).

[9] See David J. Teece, "Technological Change and the Nature of the Firm," in G. Dosi (ed.) at note 3 supra.

[10] G. Dosi, "... the increasing complexity of research and innovative activities militates in favor of formal organizations (firm's R&D laboratories, government laboratories, universities, etc.) as opposed to individual innovators as the most conclusive environment to the production of innovations." in G. Dosi at 3 supra, p. 223.

[11] The example is from Thomas M. Jorde and David J. Teece, "Innovation, Cooperation and Antitrust," Business and Public Policy Working Paper No. BPP-37, October 1988, University of California at Berkeley, Berkeley Business School.

[12] See Michael E. Porter, Competitive Advantage (New York: Free Press, 1985), pp. 186-188.

[13] The seminal work remains Boston Consulting Group, Perspectives on Experience (Boston: Boston Consulting Group, 1968). See also Barry Baysinger et al. (eds.), Barriers to Corporate Growth (Lexington: Lexington Books, 1981), especially Chapter 8.

[14] See, for example, W. S. Comanor, "Market Structure, Product Differentiation and Industrial Research," Quarterly Journal of Economics, Vol. 81 (1967), p. 639-657; "Research and Competitive Product Differentiation in the Pharmaceutical Industry in the United States," Economica, Vol. 31 (1964), pp. 372-384. Note also Dasgupta's comment, "A principal goal of R&D activity is the creation of entry barriers. The nature of inventive activity by existing firms defines limits to entry by new firms ...". Partha Dasgupta, "The Theory of Technological Competition," in J. E. Stiglitz and G. F. Mathewson, New Developments in the Analysis of Market Structure (Cambridge, Mass.: MIT Press, 1986), p. 523.

[15] A fact most succinctly put by Adam Smith in 1776: "The division of labor is limited by the extent of the market."

[16] See William G. Shephard, "Illogic and Unreality: The Odd Case of Ultra-Free Entry and Inert Markets," in Ronald E. Grieson (ed.) Antitrust and Regulation (Lexington, Mass.: Lexington Books, 1986), pp. 231-252.

[17] See, for example, D. Cousey, R. M. Isaac, M. Lake, V. L. Smith, "Market Contestability in the Presence of Sunk (Entry) Costs," The Rand Journal of Economics, Vol. 15, No. 1 (Spring 1984), p. 69-84.
L. Arvan, "Sunk Capacity Costs, Long Run Fixed Costs, and Entry Deterrence under Complete and Incomplete Information," The Rand Journal of Economics, Vol. 17, No. 1 (Spy 1986), pp. 105-121.

[18] To use an example from the direct experience of the Minnesota Small Business Assistance Office, a surgical products firm put in place an anticipated cost reducing innovation -- an ethylene oxide sterilizer - which did reduce variable costs but dramatically and unanticipatedly increased fixed costs of insurance because the gas used is poisonous in small amounts and carcinogenic in minute amounts.

[19] See, for example, Edwin Mansfield, "How Rapidly Does New Industrial Technology Leak Out?," The Journal of Industrial Economics, Vol. 34 (December 1985), pp. 217-223. See also H.P. Quimbach, "The Diffusion of New Technology and the Market for An Innovation," The Rand Journal of Economics, Vol. 17, No. 1 (Spring 1986), pp. 33-47.

[20] See Jorde and Teece, note 11 supra.

[21] On macro factors affecting the availability and cost of capital see G. N. Hatsopoulos, P. R. Krugman and L. H. Summers, "U.S. Competitiveness: Beyond the Trade Deficit," Science (15 July 1988), pp. 301-306.

[22] See, Young, note 4 supra, pp. 241-242. See also, National Academy of Engineering, The Competitive Status of the U.S. Electronics Industry (Wash. D.C.: 1984), pp. 17-27.

[23] To include also lack of availability and accessibility of those services or adequate information to allow for their use by an interested firm or individual. It is important to remember that the cost of such information can be high in terms of effort and time away from the business by its owner or manager. In the case of inventors/innovators - especially in seeking to introduce new products or processes to market - that information cost can rapidly transform into a real transaction cost.

[24] G. Dosi, note 2 supra, pp. 1130-1139.