THE ROLE OF SMALL BUSINESS IN RESEARCH, DEVELOPMENT, TECHNOLOGICAL CHANGE AND INNOVATION IN NEW ENGLAND

by

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Introduction

The decline in recent years of American ingenuity and venturing spirit, that together accounted for this land's bountiful enterprise of science and industry, threatens our technological supremacy and the vigor of the economy. This trend has become a cause celebre, a question of national pride, and a matter of wide debate -- culminating in the Carter Administration's exhaustive Domestic Policy Review of innovation, now under study at the White House.

Innovation -- the process by which a scientific or technological insight is transformed into a new product ready for market -- is a wellspring of economic growth.\(^\text{1}\) It is nurtured by

\(^{1}\)The terms invention, innovation, research (basic and applied) and development have distinct and generally acknowledged meanings in a discussion of this nature:

Invention -- The act of coming upon something useful for the first time, after study and experimentation, in the form of a device or process that reflects ingenuity.

(Continued)
research conducted in firms, and a large financial commitment on their part is required to translate the fruits of discovery or invention into a viable product by the risky procedures of development. Research is the precursor of innovation, and development its handmaiden. The contribution of R&D in the private economy to the total output of goods defies measurement, but we know instinctively that the wheels of production turn faster whenever U. S. industry is in an innovative frame of mind.

(Continued)

Innovation — The course of events by which some new idea (often the outcome of research) proceeds from the concept or invention state to the marketplace, passing through problem-solving and development until it emerges as a product ready for sale. An innovation within a firm is the launching of a product which is new to that organization. Innovation begins when an idea is recognized as the seed of a product that, once perfected, can fill some perceived need; it ends when the idea has been transformed into the envisioned product. The process spans research and development.

Research — Investigation or experimentation directed to the discovery and interpretation of facts, the revision of facts, the revision of accepted theories or laws in light of new scientific knowledge, or the practical application of such facts, theories or laws in pursuit of a commercial opportunity.

Basic-Research — Research that does not have specific commercial objectives, though such work may be in fields of present or potential interest to the firm. Also called fundamental research, its pertinence is usually established after the results are known.

Applied-Research — Research that has specific commercial objectives with respect to products or processes of interest to the firm.

Development — Investigations concerned with non-routine problems met in translating the results of research, or general scientific knowledge, into a product or process.
New England is not immune to the national malaise of diminishing productivity. Unfortunately, this comes at a time when its traditional industries are in dire need of rejuvenation, because of shifting markets and advancing technology that leaves products obsolete in its wake.\textsuperscript{20} We have good reason in this region to fret about the sluggish pace of innovation in businesses. What is causing it? Can the tide be turned and, if so, at whose initiative? What does a falling off in new-product offerings, and a decreased investment in the research that leads to innovation, mean in real terms to New England's economy and to the success of firms? Are there countervailing policies that can be set in motion at the state and Federal level to stimulate research and innovation — especially in smaller organizations — even though inimical forces at work in the economy remain, for the time being, unchanged? This paper addresses such questions.

This study considers the relative role of small and large businesses in developing new technologies and products, emphasizing the small high-technology firm and using "some measure of income and employment multiples" in the analysis. Leonard E. Smollen, in his paper on the same subject that is treated here, has followed this latter line of inquiry. My

\textsuperscript{20}The Joint Center for Urban Studies of Massachusetts Institute of Technology and Harvard University is presently conducting a thorough study of 12 New England Industries, in an effort to gain a better understanding of the region's industrial decline. This project, funded by the Economic Development Administration, is not expected to release its findings until late 1979.
investigations focus, therefore, on another facet: the exogenous factors which inhibit innovation in companies that are the producers of things -- those of political, economic or societal origin. In positive terms, the central objective is to examine the conditions which, if extant in the business environment of the firm, mitigate in favor of successful innovations and a more stalwart approach to new-product venturing. Public policies and government actions that foster such conditions are discussed.

How small or young companies behave in bringing forth new products, compared to larger and established firms, is a topic already covered in the literature [Abernathy and Utterback, 1978]. Although patterns of innovation differ based upon the vital statistics of the enterprise, impediments to technological creativity must be reckoned with in all firms irrespective of size. Smaller companies past their infancy have fewer innovation problems due to management inadequacies than new ventures or medium-to-large scale firms, whereas barriers presented by marketing, regulatory or technological events -- beyond control of the firm -- appear with the same frequency in the path of both large and small entities [Myers and Sweezy, 1978]. Because corporate size and stage of life are often noncritical when an external hindrance to innovation is seen from the vantage point of the firm, they are mentioned in this paper only when relevant to the issue.

A recent General Accounting Office report of manufacturing productivity disclosed that 97% of U.S. factories employ less
than 500 people. With about 5% of all manufacturing employment in the country, New England (excluding Connecticut) has a proportionate share of the nation's small industrial enterprises, since it claims 4.2% of the U.S. population. But of the nine regions into which the United States is divided by the Bureau of the Census, New England has the highest percentage of total manufacturing employment in labor-intensive industries -- 77% compared to the U.S. average of 64%. Three of the five states in the region have low population density. Maine, Vermont and New Hampshire rank 34, 29 and 19 nationally in number of inhabitants per square mile. This combination -- relatively few capital-intensive industrial firms, and the handicap of isolation from markets and technology suffered by manufacturers in most areas of these three states -- is a distinguishing characteristic, albeit negative, of New England's industrial sector. Its significance is commented upon in appropriate parts of the discussion.

An honest attempt was made to give this paper a regional frame of reference, yet the obstructions encountered by businesses in their quest for new products and technologies transcend the boundaries of New England. In sum, the survival and growth problems of a small company in this region, that are linked to technological progress and innovation, do not differ markedly from those faced by a firm of the same genre in some other part of the United States. We shall consider them from a regional perspective, but against a larger backdrop -- the
vagaries of the national economy and other realities brought on by the caprice of rapidly changing times.

R & D, Innovation and Productivity: Patterns and Economic Impact

During the 1970's, American productivity -- the index of output per hour worked in the private business sector -- has been improving an average of only 2.3% a year compared to a healthy 3.4% in the 60s, and we now find ourselves well behind all other industrialized nations except Great Britain in this aspect of economic performance. In fact, our productivity growth since 1977 has virtually stopped, presaging persistently high unemployment and rampant inflation. Excessive regulation that saps corporate resources, inadequate capital investment in labor-saving machinery, and demographic changes in the work force which flood the job market with inexperienced help are all factors that adversely affect productivity. Most pundits agree that the lagging pace of U.S. innovation is another important cause. Although the reasons for the slowdown in industrial output are not fully understood, it is widely accepted that we cannot sustain the apparatus of production, or capture a fair share of world markets, without a steady stream of competitive new products born in American industry -- the progeny of innovation [McConnell, 1979].

Total national expenditures for fundamental research (in constant dollars) from 1953 to 1968 increased at an average annual rate of 11.8%, and has been falling at an average yearly
rate of about 2% ever since. The 11.8% figure was fueled by our frenetic pursuit of aerospace dominance and is not a realistic or desirable benchmark; yet the present pattern is of great concern when one considers that half of the key technological innovations from the 50s through the 70s were spawned from basic research.

The Federal government, once the principal underwriter of research, has reduced its backing of R&D from 3% of G.N.P. in 1964 to barely 2% this year -- not even enough to keep up with inflation. Once the U.S. space program wound down and the Viet Nam war ended, Federal monies for research evaporated. The effects were far-reaching [Black, 1969]. Meanwhile, R&D spending by industry has stayed just a trifle ahead of inflation, but well off its former stride.

Despite record profits since the mid-70s, industry's contribution to the nation's investment in fundamental research has been dropping steadily from over one-third 25 years ago to 15% today, and the proportion of in-house R&D budgets allocated to this activity has been cut by 50% since 1963, to a mere 3.5% [Nason and Steger, 1978]. Corporate outlays for applied research are shrinking too -reflecting the general reluctance of management, in these uncertain days, to commit significant resources for chasing technology. Despite the fact that industry is expecting to spend 4.5% more this year than last to expand productive capacity, McGraw-Hill's annual survey of business plans for R&D expenditures reports that U.S. companies anticipate
putting only 2.1% of their 1979 sales into research and development -- the smallest share since 1956.

The cornucopia of products "made in America" is less abundant than before. Foreigners are the applicants for 33% of U.S. patents pending, contrasted to 15% in 1960. Countries that have had technology comparable to ours for some time, but were behind in their means to convert it into saleable products, have caught up in production techniques. Still others have assumed the lead in new technologies. We have taken a back seat in innovation to Japan, West Germany, Korea, Taiwan, Italy and Sweden for many product categories where we commanded the world market, and remain ahead in but a few industries such as agricultural equipment, computers and heavy electronics. U.S. exports last year were just 6.3% of G.N.P., leaving a trade deficit of $27 billion. West Germany, with a much smaller economy, had exports of $118 billion (only $3 billion less than ours) amounting to 27% of its output. (See the Tobin paper on foreign for a specific discussion).

For New England, these worries of the nation -- to maintain levels of innovation and productivity that will assure necessary growth and retention of market share -- translate into problems for key industries upon which the region depends heavily for disposable income and and its G.N.P. Women's and misses' outerwear, paper mills and leather footwear are three such industries here in a declining trend. None of them are particularly innovative. They are all important to New England's
economy—accounting for some 120,000 jobs—but losing employment now at an average annual rate of 1.4%, 1.6% and 5.0%, respectively, without much sign of hope that they might someday regain their former stature. Other industries, long major employers and producers in the region, are stable but not growing—for example, the aircraft engines/parts and metalworking machinery industries, which together hire about another 120,000 people.

The Impediments To Innovation And Their Remedies

The significant occurrences external to the firm that discourage innovation are notorious, and, for the most part, pervasive throughout the United States. They agglomerate, giving rise to an inhospitable climate for innovation that is debilitating to small and large firms alike, although smaller enterprises—short on momentum and surplus resources—find themselves less able to negotiate the obstacles. These are the principal antagonistic factors:

Overregulation—Excessive regulation by the Federal agencies that control some aspect of business (87 in all, which often apply contradictory policies) is stifling technological fecundity by adding to the time, complexity and already substantial risk of

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Two conditions that inhibit innovation have been explored by other authors contributing to this volume on New England, and so will not be treated here. They are:
(a) the excessive cost and poor availability of transportation, and
(b) foreign trade restrictions.

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research and product-development. It is estimated that compliance with Federal regulations alone will cost us over $100 billion this year (20% of the entire national budget), and that business must now invest about $10 billion annually, not to mention immeasurable human resources, just to satisfy government requirements in such closely-watched areas as product safety, labeling and advertising, working conditions, and environmental health.

There have been some isolated reforms (e.g., deregulation of the airlines, and an easing of O.S.H.A. rules applied to manufacturers), but it is wishful thinking to expect that our Federal bureaucracy will, without prodding, see itself dismantled to the degree business claims is necessary if the launching of new technologies and products can resume its former pace. The problem will not go away until the concerned industries speak out forcefully on their own behalf, to convince Congress that it must initiate a cost-benefit analysis of the entire regulatory process. Legislation is needed to eliminate conflicts and overlapping jurisdictions, and attach priorities to the abuses by business that do require close supervision. This is not a task to attack piecemeal, for it is the cummulative effect of over-zealous government control that is strangling innovation. (See the Wiggins and Puryear paper on regulation for a detailed discussion).

Regressive-Taxation -- Present tax policies favor consumption rather than investment, aggravating the fear of American business
that inflation and/or a recession will wipe out whatever profit new capital outlays for products and underlying technology can achieve. We are now spending only 9% of our national income on the expansion of productive capability, compared to Japan's 20% or West Germany's 15%. In effect, we are consuming, rather than redeploying, our capital.

One of the more constructive policy suggestions of late to encourage capital formation and investment is a proposal, now before Congress, that would permit companies to take accelerated depreciation under a formula allowing a full write-off in just one year for equipment that the Federal government requires (like pollution-control apparatus), a 5-year depreciation on all other equipment, and a 10-year write-off for newly constructed plants or buildings -- instead of stipulating that depreciation be deducted over the estimated useful life of the asset. The plan that Congress appears to favor would yield an estimated tax savings for industry of $5 billion next year, rising to $30 billion after 1984. Hopefully, some of this newly found capital would be reinvested by corporate taxpayers in future growth through the sponsorship of in-house R&D. (See the Toscano and Feeney Paper on taxation for discussion of this issue).

Little-Federal-Support-For-Industrial-R & D -- Even with unexpected monies provided by new tax-saving provisions, U.S. industry is unlikely to consider stepped-up R&D spending as appropriate in an inflationary era. R&D expenditures offer a long-term return on investment, and many firms today view the
payoff as too chancy for maintaining a desired rate of growth. Management is tempted instead to hold on to funds that might once have gone into research — for a better balance sheet. Too often, R&D monies are available now only for low-risk projects that can be quickly converted into sales. Business confidence as we knew it cannot be restored until economic conditions improve significantly. In the meantime, the Federal government should take up the slack — channeling funds into research by industry and universities, directed to high-need peacetime applications (like the Department of Transportation's $100 million offer to the automobile industry, for studies centered on "reinventing" the car).

According to a recent survey conducted for the Department of Energy, total R&D expenditures over the 1980's would have to be increased about 10% per year in order to restore productivity growth to its historical rate of the post-war period [Cooper and Vanderford, 1977]. Given the present mood of U.S. industry, most of this would have to come from the Federal establishment for the time being.

Some imagination is called for in designing a workable policy of Federal support for research and innovation in the small-business sector, where firms do not have the "critical mass" of technology required to push a complex product from laboratory to marketplace or the patience to cope with a giant bureaucracy. The Department of Energy has come up with an effective formula in its program to encourage energy-related inventions, which is
tailor-made for the small inventor. Proposals receive fast
evaluation, and grants awarded finance the further development
and testing of worthy energy-saving ideas.

Whatever form Federal assistance to small-business
innovations might assume (including equity capital), the question
of who should have control of inventions arising from government-
financed research must be reexamined. Some 20 separate Federal
statutes and regulations specify how product rights stemming from
public R&D contracts shall be treated in the hands of the
inventing firm. Without an exclusive license for a reasonable
period of time, at the very least, there is little incentive for
a small company to engage in an innovation funded by some Federal
agency. This is especially so since a protected patent position
can be a precondition to obtaining venture capital needed to
bring the product to market.

Inadequate Capital -- Something ought to be said about
venture capital, even though that subject is separately covered
in another paper. When it comes to innovation, large enterprises
seldom look further than their own coffers. The companies that
accounted for 90% of all privately sponsored R&D in U.S. industry
for 1977 disbursed on the average $28.9 million for research and
development, taken from $83.5 million in profits left after $1.6
billion in sales. Denied economies of scale and mass marketing,
small firms do not, however, enjoy the margins that will sustain
ambitious R&D programs without outside help.
Venture capital is returning at long last. The Wall Street Journal reports optimistically (June 15, 1979):

"After languishing for years, the venture-capital market is booming. Among the reasons: recent spectacular successes by some companies financed by venture capital, increasing corporate acquisitions, and changes in the capital-gains tax and ... securities laws ... The resurgence ... is a key to the ... survival of new companies ... vital to the economy. Some ... develop technologies, compete successfully with older, stodgier firms and even spawn new industries ... In the ... last 30 years, such financing has come increasingly from firms set up specifically to help a number of entrepreneurs in return for equity in the fledgling business ... [especially] risky small companies that already have established products but need an injection of capital for rapid expansion."

It is estimated that managers of these venture-capital funds raised $215 million in 1978, and are well on their way to $300 million this year — for investment in portfolio companies.

Although there is venture capital today for small business to draw upon, it is typically found in caches at major banking centers. Fund managers gather in such places because they like to be near their money supply; they also prefer not to be too far from their investments. This fact of life poses some constraints for the small and remotely located New England firm in search of a backer. It may have to journey to some financial mecca, and
overcome the drawback of distance by the evident virtues of its venture [Kelley, 1973].

With money harder to find than in the halcyon days of the late 60s, and in many ways to lose, professional venture capitalists are more selective. They hold out for provable innovations with a large potential market, and a capable entrepreneur boasting a better-than-average track record -- at the head of an organization that might someday be a tempting acquisition for a large company. Everyone seems to be looking for that small high-technology firm with the prospect of a bonanza -- like Qume Corporation, a producer of high-speed printers launched in 1978 with $2.5 million in venture capital and sold to ITT by 1979 for $130 million in stock.

A small business in need of the wherewithal to finance a promising new product of high technological content should be reminded that a joint venture with a larger corporate partner can be advantageous. Typically, the small company furnishes the technology, while the large firm supplies financing and marketing capability. This arrangement takes the best from two worlds, since studies have shown that as much as three-quarters of technological innovations originate in small companies, whereas big outfits have the money and marketing savvy [Biondo et. al., 1977].

Even with the comeback of venture capital, we still do not have a strong incentive to individuals for investment, or reinvestment, in smaller companies. It has been suggested that a
more creative and expanded use of the investment tax credit (through a change in the Internal Revenue Code) may be appropriate. The idea is to extend the credit to stakes in young or small companies, thereby offering the erstwhile investor an immediate tax benefit. This would provide taxpayers an alternative to tax-shelter plans, which tend to siphon capital away from productive equity investments. (See the Wetzel paper on credit and capital for a detailed discussion of venture capital.)

Lack Of A Regional Tradition In Venturing -- Without a firmly rooted philosophy that extols the virtues of invention and entrepreneurship, innovation declines. If a society (or region) does not have a collective sense of curiosity and a sychronous instinct to contrive things that improve the nature and quality of life, it sees few new ideas and little commerce from their pursuit. The classic role of the entrepreneur in this setting is crucial, for it is he who provides the catalyst without which the reagents that combine to yield viable products cannot interact [Hughes, 1964]. The regional institutions that influence entrepreneurial activity are, of course, important as well.

Happily, this is New England's long suit. Since colonial times, the people of this region have taken pride in their ability to fashion artifacts, or translate an emerging technology into something useful that others would buy. They were tinkerers, if not inventors, by inclination and necessity from the very start. Indeed, "Yankee ingenuity" is synonymous with
the productive genius of America (Ferguson, 1979). There is no hard evidence that technological virtuousity, as a regional characteristic, is on the wane. New England continues to make a strong showing in patents obtained (See Table I). Massachusetts reflects an unusually high number of patents issued per capita — with an annual figure 144% of what might be expected if total U.S. patents for new inventions were distributed solely on the basis of population. New Hampshire and Rhode Island are holding their own, with patents granted to residents running 98% and 94%, respectively, of their distributive share of the U.S. patent total. Only the two New England states with the lowest population density — Maine and Vermont — are well below the norm.

There is no indication that incipient entrepreneurs are in short supply, judging from the fact that graduate courses in entrepreneurship scattered among the area's schools of management and technology are invariably oversubscribed. These disconnected programs could, however, exert greater influence on the development of entrepreneurial talent if they were somehow organized into a cohesive regional effort — perhaps under the guidance and inspiration of an academic center for the training and assessment of entrepreneurs (Wetzel, 1974).

Data developed by David L. Birch of Massachusetts Institute of Technology, and by the Joint Center for Urban Studies of M.I.T. and Harvard University (in its study of 12 industries representative of New England) discloses a changing trend of
## PATENT ACTIVITY IN NEW ENGLAND STATES

### RELATED TO DEMOGRAPHY

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### Notes:

1. Excludes Connecticut.
2. Figures are for 1975, taken from U.S. Bureau of the Census "Current Population Reports, Series P-25".
3. Number stated is an average for 1977 and 1978, based on data contained in the "Annual Report of the Commissioner of Patents to the Secretary of Commerce" for these fiscal years.
4. These figures are for inventions; they do not, therefore, include reissued patents and those covering designs or plants.

### Table 1

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company ownership in manufacturing, away from the small entrepreneurial firm toward bigger entities — often via the route of acquisition. This does not necessarily mean that entrepreneurs as a class are disappearing here, but rather that they are finding it increasingly difficult to survive and prosper in a less-than-large organization.

Poor Access To Technology -- The process through which technology contributes to long-term economic growth in America is complex and obscure. In the annals of industry, the productivity of a given invention or innovation has often turned on the availability of complementary technologies that are often turned on in ways not readily apparent [Rosenberg, 1979]. An industrial economy cannot flourish, within a region or state, without the interlocking or different technologies that are mutually reinforcing. In New England, Massachusetts alone has a well developed technological infrastructure, which not only nurtures diverse technologies but provides the kind of arena where they can interface through the person-to-person exchange of information. The Route 128 phenomenon outside Boston — with its proliferation of some 250 new high-technology companies — is not a chance occurrence; given the right conditions, it is a natural outgrowth of the cross-pollinization that stems from a continuous dialogue between technologists in touch with their craft and the state-of-the-art [Burns, 1969].

The other New England states, with the exception of Rhode Island, do not enjoy this commitment to technology or the
synergism which it engenders. New Hampshire, Maine and Vermont house, for example, a disproportionately small number of doctoral engineers -- if one assumes that this group of highly-trained individuals should be scattered around the land on the basis of population [See Table II]. As a consequence, new ventures are rarely formed there around an idea of high technological content, and established firms are inclined to avoid innovations that will require the command of some technology new to the enterprise. Out of 86 manufacturers surveyed in a 1976 study for the National Science Foundation of innovation in Maine industry, only 29 had R&D budgets that formally addressed innovations of technological character. These three states are, for all practical purposes, denied use of the one renewable resource that is theoretically available to everyone in America -- technology.

The implications are serious, for it is universally recognized, and well documented, that smaller technology-based firms generate a plethora of innovations of the kind that increase productivity without adversely affecting employment in the economy as a whole. Better institutional arrangements are needed at the regional level to stimulate the transfer of technology, where this is not taking place indigenously, and to encourage the technically-oriented entrepreneur [Gruber and

22Leonard E. Smollen's paper, referenced earlier, reviews the relative role of small and large businesses in developing new technologies or products and in creating jobs, with particular emphasis upon the unusual leverage of smaller high-technology enterprises started and run by technical entrepreneurs.
DOCTORAL ENGINEERS RESIDENT IN

NEW ENGLAND STATES

RELATED TO DEMOGRAPHY

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1. Excludes Connecticut.

2. Figures are for 1975; taken from U.S. Bureau of the Census "Current Population Reports, Series P-25".

3. The numbers represent those receiving degrees between 1930 and June, 1972.


TABLE II

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Marquis, 1969]. We ought to have several clearinghouses in New England to which an entrepreneur can turn for professional assistance in launching a venture. These should be staffed by people who can also take the initiative in matching new products or technologies, at an early stage of development, with entrepreneurial talent seeking a worthy project to run.

The National Science Foundation -- through its Innovation Centers program -- has been testing the hypothesis that universities can help industry develop and commercialize new products. Under this experiment begun in 1973, four university-based centers have been created and operated -- using slightly different formats but with the same rationale: to stimulate the formation of ventures organized around some promising new product, and to train a corps of entrepreneurs and innovators who might otherwise have overlooked or avoided these callings. There is one in New England, at M.I.T.

These centers have met with varying degrees of success in terms of measurable impact on the regional economy they were meant to serve. Where the leadership lacks a strong real-world orientation, the responsibilities assumed tend to be largely didactic. Unfortunately, the M.I.T. Center has been content with establishing courses that increase the student's awareness of product development and the entrepreneurial role, and conducting research into the more esoteric aspects of the innovation process. It has skirted the need to boost economic development of its community by helping practitioners capitalize upon a
technology that has commercial merit but is not of "breakthrough" dimensions. If the goal is to encourage bona fide business activity in the region from which the university draws its constituents, an elitist approach in selecting projects and individuals deserving of support is to be avoided [Pearson, 1977]. Other centers in the N.S.F. program have demonstrated the feasibility of promoting, in an academic setting, actual and potentially valuable innovations that — without such help— were destined to sink beneath the waves; they have accomplished this in tandem with pedagogical efforts to foster technical creativity and entrepreneurship.

New England requires more than state or Federal aid in existing schools of management or technology, for bolstering curricula aimed at the aspiring inventor and entrepreneur. Outreach programs that offer legitimate assistance to inventors or venturers, and provide a nurturing environment for promising new enterprises, are of higher priority. Such efforts on the part of universities should have a multi-disciplinary base, for venturing demands legal, business and financial skills of a high order and in the right mix -- orchestrated under the stewardship of an able entrepreneur. It is unrealistic to regard innovation as the exclusive preserve of the gifted technologist. Unlike solitaire, it is a game that calls for many players.
Remoteness From Markets And Information Sources -- New England, as a maker of products, is an export economy whose prosperity hinges upon the acceptance of its goods elsewhere. Because its wares are destined for markets in far corners of the nation and the world, the region's producers need timely intelligence about these distant markets. Data General Corporation of Westboro, Massachusetts is a sterling example of a New England firm that has discovered how to satisfy a far-flung demand. Its imaginative line of computer systems has catapulted the firm this year into the ranks of "Fortune 500" companies, bypassing 97 other corporations that stood above it in 1978.

Most manufacturers here outside of the principal cities, particularly in the older industries, admit to being out of touch with their markets. The geographical isolation of firms from customers is one explanation, but so is the region's traditional detachment when it comes to worldly concern.

The analysis of innovation patterns in Maine mentioned above, covering 130 firms representative of the state's industries and small business environment, revealed that "failure to understand and perceive the market accurately is the single most serious deficiency in unsuccessful innovations" for that sample "and possibly for Maine industry in general". In Vermont, New Hampshire and Rhode Island as well, one rarely uncovers a communications network linking a firm, or group of firms with common interests, to a foreign (out-of-state) market. There is, therefore, no reliable view of markets beyond the firm's
environ. Since small New England companies cannot afford to buy current market data on their own, state governments could attack the problem by supporting industry trade associations -- in efforts to engage marketing specialists who would gather and maintain such information on behalf of members.

In areas far from the centers of commerce, our nation's diminishing involvement with innovation is observed by small businesses as a familiar syndrome, and the spreading of a regional disease that firms consigned to the hinterland have long felt could not be escaped. Companies from the technologically naive parts of New England are intimidated by the prospect of grappling with a new product that may demand of them engineering or scientific know-how not readily at their disposal. Even where the requisite technology is within their ken, they characteristically view the product creation process as a formidable undertaking beyond their capacity to pursue23.

This defeatist attitude will change only when New England industry is given access to the information that reduces the art of product conceptualization and development to a methodology which any small business -- with acumen and the instinct to

23 The wood shapers and turners industry is a case in point. Its members are faced with a shrinking market for their wares -- due both to the emergence of foreign competition and changing end-user requirements, and yet they seem incapacitated in their attempts thus far to turn their technology to the fabrication of end items that they themselves can sell to the consumer. The difficulty seems to be historical, for these manufacturers are at sea when it comes to anything that is not a component made from wood, for someone else to incorporate into his finished product.
survive—can follow [Ellin, 1978]. Despite the remarkable advances in communication, an entrepreneur in the provinces still believes that the difficulty in getting needed information is directly proportional to the distance between him and its source. If we are to see any significant improvement in the commitment of this region to innovation, we must take steps to place at the disposal of firms the knowledge they require for the design, financing and execution of new-product ventures.

A Summary Of Policy Recommendations

These are the principal policies suggested to Federal and state authorities, in the preceding section, as a means for improving or ameliorating those conditions in the small-business environment of New England that have a pernicious effect upon research or innovation in firms; they are restated in the same order as their appearance in the text:

- Initiate, in the Congress, a comprehensive cost-benefit analysis of the entire Federal regulatory process, and enact legislation to eliminate conflicting regulations as well as overlapping administrative jurisdictions— with the further intention of deregulating those areas of business activity that do not require close governmental supervision.

- Amend the Internal Revenue Code to provide accelerated depreciation for equipment and plant, under a formula that does not restrict the write-off to the asset's estimated useful life, in order to offer an immediate tax saving that encourages capital expansion.

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• Devise a well-considered Federal program for channeling government funds into research by industry and universities, directed to the high-priority peacetime needs of the nation.

• Reexamine the 20 or so Federal statutes and regulations that specify how rights to inventions arising from public R&D contracts shall be treated in the hands of the inventing firm, and design a coherent approach which assures the private contractor a reasonable measure of protection for any commercial exploitation of the results (with appropriate changes in the patent laws where necessary).

• Extend the present investment tax credit of the Internal Revenue Code to individual investments (and reinvestment) in smaller companies, so as to encourage the private placement of capital in firms at an early stage of development and afford a meaningful alternative to conventional tax-shelter schemes.

• Create -- through combined state, Federal and private support -- several regional centers for "innovation and entrepreneurship", that would be university-based and modeled perhaps after the experimental centers funded in the last few years by National Science Foundation; unlike the N.S.F. centers, however, these facilities would give recognition to the evident interdisciplinary character of technology venturing, and strike a proper balance between the teaching of entrepreneurship or innovation and the conscientious assistance of small enterprises.
in introducing products that can have a salutary effect on the local economy.24

- Offer state financing to industry trade associations for the purpose of aiding them in efforts to gather — with the help of marketing specialists — current information concerning out-of-state markets and trends, for the use of their members.

Data Analyzed And Research Methodology

The approach to these investigations were empirical, relying heavily on experience and observations inasmuch as there is scant theory pertinent to the study that has been tested in practice.

24The mandate authorizing these centers should make it abundantly clear that they have a responsibility for the economic development of their region, and are meant to function in several capacities:

(a) As educators engaged in the development of entrepreneurs and innovators, or the training of professionals who render services to them in the start-up of new businesses (e.g., venture capitalists and lawyers representing entrepreneurs);

(b) As advisors to entrepreneurs, established firms, inventors and innovators who require technical or financial assistance in pursuing an innovation, forming a venture based upon a viable product, raising capital, or launching a newly created product (of technological origin) in the marketplace;

(c) As impresarios — to match promising products and technologies, in a formative state, with the entrepreneurial talent and financial resources required to organize, around them, a legitimate new venture.

Since these are complex functions demanding a multiplicity of skills and experience, each center should be organized, ideally, as the joint venture of a school of law, management and technology — located within easy reach of each other to facilitate the sharing of staff and expertise. It is astounding that this idea, of obvious merit, has not been embraced by any of the four existing "innovation centers" begun by N.S.F.
One finds even less system when it comes to the complexities of the innovation process, which is often carried on unconsciously by private enterprise. The conclusions offered are not, in the main, pinned to a strong quantitative base, for there is a dearth of data that tracks innovation as a national or regional phenomenon -- or that links product venturing and technological cognition to the success of firms. For example, no official source reports comprehensively the extent of research sponsored by firms or industries (nationally or by states). Information given here concerning current R&D expenditures by U.S. industry came primarily from Business Week's most recent annual survey of private-sector spending for this corporate activity.

A review of articles in scholarly and professional publications on the subjects of innovation, technological change and the management of research was conducted -- going back fifteen years. As many items as could be found in the popular press covering business (e.g., The New York Times, Business Week, The Wall Street Journal, Time, Fortune and Newsweek), on the timely themes of productivity and innovation, were read from late 1977 on.

Conclusions about the exogenous factors that impede innovation (i.e., conditions external to the firm that are beyond its influence) were corroborated through informal discussions with managers accountable for R&D in companies of varying size. The actual interviews conducted for 130 Maine businesses sampled in the 1976 survey of innovation by Maine industry were examined.
Tables appearing in this paper were derived from data provided by the U.S. Bureau of the Census, the Commissioner of Patents, and National Science Foundation.
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