IDEA

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To Promote the Progress of Science and Useful Arts: Public Law and Technological Innovation

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When our Founding Fathers made provision for a patent system in the United States Constitution, they did so with a specific purpose in mind. That purpose is clearly indicated in article I, section 8: "The Congress shall have Power . . .To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." The key words here are " . . .To promote the Progress of Science and useful Arts. . . ."

The British, during the War of 1812, considered the United States patent system and the technological information stored in the patent library to be of such major importance to British welfare, that the patent library was left untouched when they burned Washington, D.C.

The Britisher's confidence was not illfounded. Since the War of 1812, the American patent system has played a significant historical role in producing many of the world's most important technological innovations. Just as our patent system has proven to be a major incentive for technological innovation in the past, it will continue to do so in the future.

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percentage of patents issued to private citizens has decreased by 22% since 1963. In that year, independent inventors accounted for 27% of all patents granted; today, it is running about 21%.[5] In addition, the number of United States patents granted to foreign nationals has increased 85% and now accounts for about 23% of the patents issued.[6]

— *Rate of Technological Innovation*

The American rate of technological innovation is decreasing.[7] In the machine tool industry, for example, the United States has lost its position of leadership and now trails behind West Germany, Japan and France. The United States equals Russia in machine tool production, but they produce better equipment.[8]

— *New Product Failure Rate*

New product failure rates remain high. It is estimated that between 37%[9] and 80% of all new products fail.[10]

— *Productivity*

The United States now ranks 11th in its rate of productivity increase among the eleven developed nations. American growth in productivity from 1960-1973 was 3.4% annually. During the same period, European productivity increased 5.7% and Japan increased at the rate of 10.5% per year.[11] In a few years, American output per worker will slip behind that of West Germany, Japan and France. There has been little or no growth in productivity in the retail industry and little in manufacturing, but there have been substantial increases in agriculture. In the latter area, the United States has the highest level of productivity and the highest rate of productivity increases in the world.

— *Capital Investment*

American capital investment per worker is down. We currently

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[4] *Is American Genius Being Stifled?*, U.S. NEWS & WORLD REP., Dec. 23, 1974, at 46.

[5] Haber, *The Decline of the Better Idea,* THE SCIENCES, Oct. 23, 1974, at 46.

[6] Lein, *Synergistic Effects through Licensing,* LES NOUVELLES: J. LICENSING EXECUTIVES SOC'Y, Dec. 1975, at 223.

[7] *The Breakdown of U.S. Innovation,* BUS. WEEK, Feb. 16, 1976, at 56.

[8] Address by Henry Warren, University Business Development Center Advisory Meeting, Scottsdale, Arizona, Jan. 17, 1977 [hereinafter cited as Warren].

[9] BOOZ, ALLEN & HAMILTON, THE MANAGEMENT OF NEW PRODUCTS 12 (1968).

[10] *New Products: The Push is on Marketing,* BUS. WEEK, Mar. 4, 1972, at 38.

[11] *Statement of Mitchel P. Kobelinski Before the Senate Select Comm. on Small Business,* 95th Cong., 1st Sess. (1977).

The high cost and risk of innovation has caused many firms to reduce their R&D activity and to focus on product improvement rather than product innovation. According to *Business Week,* one of the prime villians in the breakdown of American innovation has been the no-risk, supercautious attitude of management. The economic impact of a more cautious management approach to innovation is illustrated by a comparison of the performance records of five leading high technology innovators (IBM, Xerox, Texas Instruments, 3M and Polaroid) and six typically mature or less innovative firms (Bethlehem Steel, GE, DuPont, P&G, General Foods and International Paper). From 1945 through 1974, the annual compounded growth rate of the innovators was 16.5% in sales and 10.8% in jobs. For the non-innovators, the corresponding increases were 7.8% in sales and 1.9% in jobs.[19]

There is an obvious need, then, to stimulate innovation in order to counteract this apparent management conservatism, and existing trends of technological breakdown.

A Technological Watershed

In a very real sense, the decade of the 1970s represents a sort of "technological watershed." Technological innovation has, in the past, been one of the cornerstones of modern civilization. We have coveted technological innovation because it led to a higher level of living. For example,

— electricity has expanded our productive capacity and extended the hours of human activity;

— the automobile greatly facilitated travel and transportation;

— radio made worldwide communication feasible and inexpensive; and

— X-ray advanced medical technology and has saved countless lives.

The history of the United States is intertwined with the history of invention and innovation. In modern societies, there is virtually no area which has been untouched by technological innovation.

This interdependency will continue into the future. As we face the 1980s and beyond, technological innovation will play an even more critical role in maintaining our current standard of living and, perhaps, the basic fabric of modern civilization.

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[19] *The Breakdown of U.S. Innovation, supra* note 7.

An innovation is " . . . a complex series of activities, beginning at first conception where the original idea is conceived, proceeding through a succession of interwoven steps of research, development, and management decision making . . . culminating when a product, which might be a thing, a technique, or a process, is accepted in the marketplace."[22]

The Innovation Process

This definition is illustrated in *Figure 1*.

Inherent in the innovation process is the fact that at the different stages, different types of skills are necessary. For example,

- — at the idea generation (invention) stage, creativity is probably the key ingredient;
- — analytical ability and technical and business acumen tend to dominate the idea evaluation and analysis stages;
- — technical know-how is paramount during the technical R&D stage;
- — whereas a thorough understanding of the marketplace is more important during the product (market) R&D stage.

The point to be made here is that the innovation process requires different players; both inventors and innovators, possessing both technological and business skills.[23]

Sources of Technological Invention

Where, then, can we turn to for this necessary innovation? Since all technological innovation begins with technological invention, it is appropriate that we identify the several sources of invention in the United States. Since the framing of the Constitution, the term "inventor" has developed several new dimensions; inventions are the output of several diverse groups, as illustrated in *Figure 2*.

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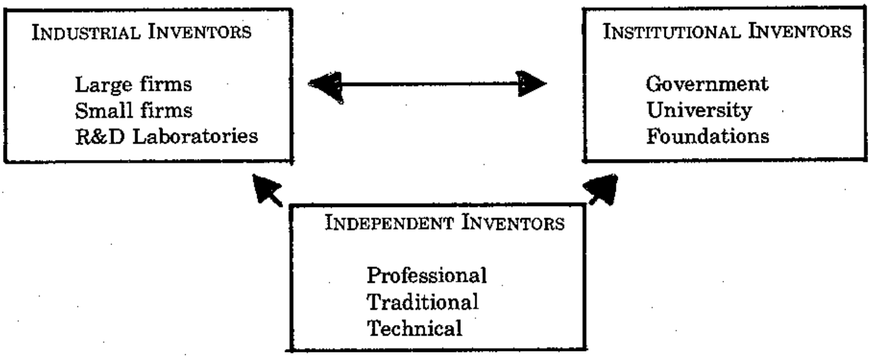
22 Johnson, *Inventions, Innovations and Incentives,* THE PUBLIC NEED AND THE ROLE OF THE INVENTOR 6 (National Bureau of Standards, 1976).

23 For additional information on the nature of the innovation process, *see* E.A. PESSIMIER, PRODUCT MANAGEMENT (1977).

Figure 2
Sources of Technological Innovation



As *Table 1* indicates, expenditures for technological research and development have, likewise, taken on new dimension and new costs.

Table 1
1975 Estimated United States R&D Expenditures by Source of Funds and Performer (in Billions $)

	Source of Funds		Performer*	
	$	%	$	%
Total (Institutional & Industrial)	37.7	100.0	37.7	100
Industrial[1]	15.5	41.0	25.3	67
Large Corporations	4.0	37.0	22.8	60
Small Firms[2]	1.5	4.0	2.5	7
Independent R&D Labs	—	—	—	—
Institutional*	22.3	59.0	12.5	33
Federal Government	20.0	53.0	5.7	15
University	1.5	4.0	5.3	14
Foundations (& other non-profit)	.8	2.0	1.5	4
Independent				
Professional	—	—	—	—
Traditional	—	—	—	—
Technical	—	—	—	—

[1] Based on National Science Foundation estimate of 1975 R&D expenditures; *see* NATIONAL SCIENCE FOUNDATION, NATIONAL PATTERNS OF R&D RESOURCES (1973).

[2] These categories are estimated at 10% of total R&D expenditures. *See* Peters, *70% of New Products Come From Small Companies*, ADVERTISING AGE, January 13, 1969.

* Defined as the one who does (performs) research, such as a University conducting federally funded R&D.

There is no doubt that our nation's corporations have become a very important source of technological innovation. However, to assume that industry has become the *only* source of technological invention is not borne out by recent American experiences.

Institutional Inventors

The data in *Table 1* clearly indicate that the largest source of funding is institutional in nature. Although the federal investment in R&D ($20 billion) is immense, the number of patents held by the federal government is small.[26] Of the nearly one million "live" United States patents, the government owns only 22,000, or slightly more than 2% of the total. On an annual basis, the government receives less than 8% of the more than 70,000 domestic patents granted each year.[27] The government's track record in transferring that technology has not been particularly noteworthy.

Universities employ approximately 13% of the scientists and engineers engaged in R&D activities in the United States and account for about 16% of R&D expenditures. However, they hold only about 2% of the patents.[28] Thus, the nation's universities are not likely to singlehandedly bail the United States out of its technological doldrums.

Independent Inventors

As noted in *Figure 2,* there are three basic types of independent inventors: professional, traditional and technological. Professional inventors are those persons who make their living by inventing. Their number is small, but their output significant. The traditional inventor is basically a creative problem solver who, when faced with a problem, *invents* a solution to that problem. This group is much larger than the professional group. It draws its members from a cross section of society and includes the tinkerer, the housewife or anyone else capable of creative and innovative problem solving. This group comes closest to fitting the current stereotype of the independent inventor. The third group, technological inventors, represents a technically elite segment of society. This group is composed of scientists, engineers and other technologically trained individuals who invent outside of a corporate or institutional framework even though they might be employed within such an environment.

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[26] R&D RESOURCES, *supra* note 13.

[27] Johnson, *supra* note 22.

[28] R&D RESOURCES, *supra* note 13.

— technological innovation is an essential part of our economic, environmental and social future;

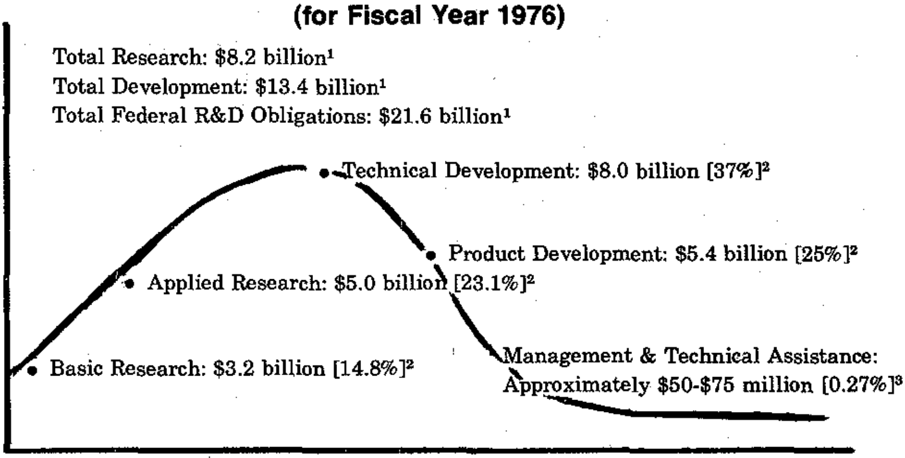
— our rate of technological innovation has been slowed to the point where we lag behind several other developed nations;

— the innovation process is a complex series of interdisciplinary and inter-related activities which begins with the conception of an idea and ends when a product, process or service is established in the marketplace.

The thesis of this section is that public law must recognize the complex nature of the innovation process if it is to stimulate technological innovation in an efficient and effective manner. That is, we will have to extend public incentives beyond the patent system (and funding of technological R&D) if we are to stimulate future technological innovation.

The general pattern of public expenditures for innovation related activities is illustrated by *Figure 3.*

Figure 3
Hypothetical Distribution of Public Funds for Innovation Related Activities*
(for Fiscal Year 1976)



* For purposes of illustration only; not drawn to scale.

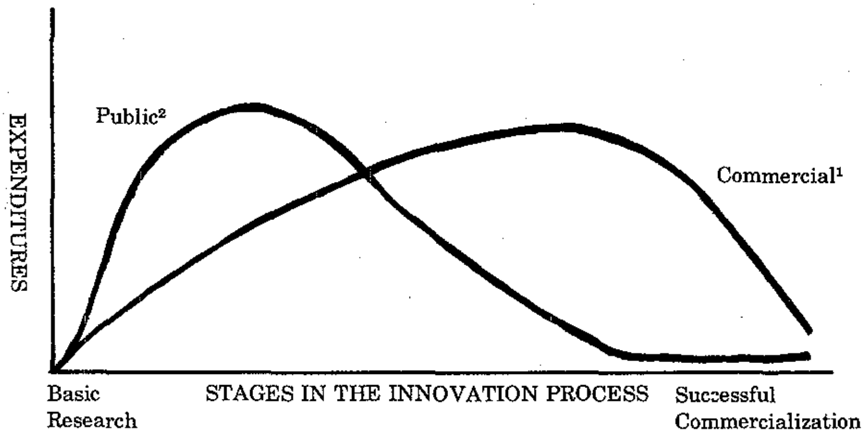
1 Federal Council for Science & Technology; estimates for 1976.

2 Combined NSF (National Science Foundation) and SBA (Small Business Administration) estimates for 1976 management and technical (non-farm) assistance.

3 Combined NSF and (Oregon) Innovation Center estimate.

Figure 4

Comparison of the Hypothetical Distribution of Public Funds Commercial Expenditures for Innovation Related Activities



[1] Extrapolated from *Figure 1*.

[2] *See Figure 3*.

George Russell, Vice-Chancellor for Research and Dean of the Graduate College at the University of Illinois, emphasizes the importance of basic research.[37]

> A careful analysis of successful solutions to some of the major problems this nation has faced in the past, whether it be in food production, communication, transportation, medicine,. . .will reveal two essential ingredients for success: a core of basic knowledge, generated in most cases from " non-relevant" research, and a cadre of well-trained individuals who can extend and expand or redirect their fundamental research to the solution of the pressing problems of the time. In the corn country of Illinois, we do not today reap 150-200 bushels of corn to the acre because we set this as a goal, and did "relevant" research to achieve that goal, but because basic "non-relevant" research in plant genetics helped to obtain the fundamental insights needed to make the slow but steady process in agricultural technology that was required.

Without public expenditures for basic research, innovation in this country could degenerate into little more than a marginal technology activity with an occasional accidental technological breakthrough. The point to be made here is that while basic and applied research, and technical and product development, are necessary they are not sufficient. Technological innovation requires a sustained commitment

[37] Opack, *Likenesses of Licensing and Franchising,* LES NOUVELLES: J. LICENSING EXECUTIVES SOC'Y, June 1977, at 107.

veloping and marketing new products. It simply means they are not (and quite understandably) willing to share their research findings with others, especially competitors.

Public Law and Non-Corporate Innovation

Despite the fact that small businesses lack the financial and managerial resources of the large corporation, they still play a major role in producing major technological innovations. Less tied to the skirts of their existing product lines and better endowed with the spirit of innovation, technological entrepreneurs and small businesses represent a significant source of technological innovation. For the most part, this is in spite of their lack of necessary financial and interdisciplinary resources.

There are more than 100 different programs in over ten federal agencies which provide assistance to businesses.[39] Unfortunately, these programs of financial, technical and managerial assistance are frequently not coordinated and rarely focus on technological innovation. The Small Business Administration, for example, provides $3 billion in financial loan assistance and has a total staff of nearly 4,000 employees to process and supervise these loans.[40] In contrast, it has only 425 personnel with a budget of $27 million devoted to management assistance.[41] It is readily apparent that this program, like other federal programs, is heavily oriented toward financial assistance.

At this point, it is appropriate to put the federal program of management and technical assistance to small business into proper perspective. There are an estimated 9 to 10 million small businesses in the United States.[42] According to recent SBA estimates, each of these businesses receives an average of $2-3 in management and technical assistance.[43] This is hardly enough to have much impact upon the national rate of technological innovation. In contrast, approximately $600 million is devoted to managerial and technical assistance (and research) for farming in the United States.[44] It is probably no mere coincidence that American agriculture leads the world in both productivity and the rate of increase of productivity.

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39 The Eugene (Oregon) Register Guard, June 30, 1977, § B, at 12.

40 SBA FACTS, *supra* note 34, at 3.

41 *Id.*

42 *Id.*

43 Warren, *supra* note 8.

44 *Id.*

impeded.[48] In recognition of this problem, Congress has created the Energy Extension Service.[49] This service, patterned somewhat after the Cooperative Extension Service, is designed to increase user awareness of energy conservation and alternative energy technologies.

Another example of a horizontal incentive is the proposed Small Business Development Center Act.[50] This act would authorize funding for the establishment of a number of university-based centers to provide management and technical assistance to small business. While these centers are not specifically oriented toward technology-related small business, recognition of the need to tie financial assistance with management and technical assistance is inherent in the language of the legislation.

In the Public Interest

The concept that it is in the public interest to promote technological innovation is well established. However, the quest to protect the public interest in this area has sometimes been counter-productive. The patent system itself has long been the target for criticism of those adverse to "patent monopolies." In addition, publicly funded patentable inventions are frequently the target of special restrictive and sometimes discriminatory covenants in public law. For example, many states (and several federal agencies) require university inventors to disclose their inventions to the university. This, in turn, would disclose the invention to the sponsoring agency which may elect to grant non-exclusive licenses to all who are interested.

In many cases, the reaction of the faculty inventor is to refuse to disclose the invention or to publish findings, thereby placing the invention in the public domain. In the case of inventions requiring further commitment of R&D resources and effort the results are usually quite deadly. The absence of a patent monopoly, in effect, has destroyed the economic incentive for prospective innovators since many innovators would be reluctant to incur the cost and risk of innovation only to see the marketplace flooded with competitors as soon as the new product is established.

The same desire to protect the public by avoiding the grant of special economic advantages through the use of public funds has proba-

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[48] For a more complete discussion of these and other market-oriented barriers to innovation, *see* G. Udell, M. O'Neill & K. Baker, Guide to Invention and Innovation Evaluation (National Science Foundation, 1977).

[49] Act of June 3, 1977, Pub. L. No. 95-39, 91 Stat. 180.

[50] *See* S. 972, H.R. 5754 and H.R. 7261, 95th Cong., 1st Sess. (1977).

errosion of the rate of technological innovation in our economy. Public policy must recognize the complex nature of the innovation process and the realities of innovation in a modern complex economy. We cannot continue to rely on vertical incentives, but should provide horizontal incentives throughout the innovation process. This is not to say that the heavy expenditure of resources for research and development is inappropriate. Quite the contrary, the nature of the innovation process dictates that substantial investments in basic research and applied R&D are often required. However, it also suggests that horizontal incentives in the latter stages of the innovation process might be necessary to trigger technological innovation.

This does not mean that a massive public program of management and technical assistance to the private sector is necessary. The corporate problem regarding the rate of technological innovation probably cannot be corrected through management and technical assistance. Their problems are, in large part, attitudinal and are more closely tied to the "state of the art" in new product development. Corporate needs are better met through basic research into the nature of the innovation process and the development of better new product decision making tools. Publicly funded management and technical assistance should be reserved for those sectors of the economy which still exhibit an element of creativity and the entrepreneurial spirit necessary for technological innovation to become a reality.

These essential ingredients are found in the entrepreneurs and small businesses of the United States. Unfortunately, entrepreneurs and small business frequently lack the management and technical skills necessary to traverse the path to successful innovation. Hence, their effectiveness as technological innovators is diminished. This is a loss that society can ill afford. If it is to survive, society has no choice but to innovate. And innovation is, and has been since the founding of this country, a matter of public law. That law, however, must take on a new dimension.

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bly inhibited the development of a more effective and efficient means to stimulate technological innovation. Briefly, by providing incentives early in the innovation process, the results are available to anyone and the problem of special favors is avoided. This is an awkward situation since without specific management and technical assistance to the individual innovator, budding technology may wither and die; however, special assistance to some would put non-recipients at a competitive disadvantage, which obviously raises a moral issue.

Providing Latter Stage Incentives to Non-Corporate Innovation

This inspires the question of how latter stage incentives should be applied. Again, the complex nature of the innovation process provides a clue. Financial aid to individual innovators to acquire the necessary technical and managerial skills would be expensive, inefficient and perhaps ineffective. Similarly, as noted earlier, the marshaling of the necessary managerial and technical skills within the federal government is probably not appropriate. The most logical delivery mechanism for latter stage incentives appears to be the nation's universities and colleges and appropriate private sector institutions and firms. Universities and colleges are, by the nature of their function, interdisciplinary and amenable to providing educational consulting services to private sector innovators. Similarly, firms, foundations and associations focusing on innovation are also likely delivery mechanisms. Perhaps a disclaimer of sorts is appropriate at this point. Latter stage incentives in the form of management and technical assistance to small and mid-sized businesses is not a simple answer to a complex problem. Neither is federally sponsored innovation-related research. At present, public law incentives to innovation tend to be simplistic and incomplete. As a result, our rate of technological innovation falls short of the mark.

Conclusions

The patent system will continue to play a vital role in American technological innovation; so will scientific and technological basic and applied research. However, neither are sufficient to shore up the country's sagging rate of technological innovation. We need to learn more about the process through which new technology is developed and implemented.

Research into the innovation process will benefit both large and small business and will indirectly impact upon our rate of technological innovation. However, research alone is not likely to deter further

Previously, we defined the innovation process as a complex series of interdependent and interdisciplinary activities. Public policy must recognize the interdependent and interdisciplinary nature of these activities if it is to effectively and efficiently stimulate technological innovation. This is especially true in the case of small business. As noted previously, small business frequently lacks the interdisciplinary skills and resources to traverse the path to innovation. As a result, viable technology is frequently lost by the innovator through improper financial planning or inadequate attention to marketing. In short, the fruits of technological incentives can be lost in the latter stages of the innovation process through non-technological failures.

In recent years, the importance of the entrepreneur and small business appear to have gained some recognition in public policy. For example, under the Federal Non-Nuclear Energy Research and Development Act of 1974,[45] the National Bureau of Standards is directed to evaluate energy related inventions submitted by individual inventors and small companies for the purpose of obtaining direct grants from the Department of Energy.[46]

Horizontal Incentives for Non-Corporate Innovators

To correct this situation, financial assistance should be linked to managerial and technical assistance. That is, incentives to innovation should be applied horizontally (on an interdisciplinary, multi-stage basis) rather than vertically (on an intradisciplinary, single-stage basis).

In some cases, it might be necessary to extend such incentives to the user. For example, energy conservation now has a high national priority. Huge sums of money are now being allocated to energy research and development of energy conservation technology.[47]

In some cases, this will not be sufficient to bring about the implementation of this technology. To the extent this technology violates existing use patterns, requires user education or increases either short or long term costs, adoption of the technology might be

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45 42 U.S.C. § 5913 (Supp. V, 1975).

46 *Id.*

47 For example, Congress has authorized the expenditure of $1,175,671,000 for non-nuclear energy research, development and demonstration of fossil, solar, geothermal and other forms of energy, for energy conservation and for scientific and technical education programs; *see* Act of June 3, 1977, Pub. L. No. 95-39, 91 Stat. 180.

throughout the process in order to bear fruit. Thus, public support of R&D suffers from the same deficiency as the patent system — it simply does not go far enough.

Corporate Innovation

There are two major players in the commercial innovation game: large corporations and small to mid-sized businesses. Large corporations are already making huge investments, estimated at between $39.7 and $51.7 billion in new products. However, as noted earlier, this investment is more oriented toward product improvement rather than product innovation. Thus, the problem of stimulating corporate technology is not financial, but centers around the supercautious attitude of management. This attitude is further fueled by high development costs and high failure rate of new products. As pointed out earlier, the most significant factor in product failure is poor management. Some of the most common management related errors contributing to the high failure rate are:[38]

1. overestimating initial and long term sales;
2. underestimating the strength of competitive response;
3. introducing the new product at the wrong time;
4. failure to provide sufficient marketing effort (advertising and sales promotion) to establish the product; and
5. underestimating the cost of "developing" and marketing the product.

How, then, do we improve the rate of corporate technological innovation? It is not likely that federal financial stimulants would have much of an impact on management related new product failures; nor are they likely to have much of an impact upon corporate attitudes toward innovation. What is needed is research into the innovation process itself and the development of better new product and management decision making tools.

If better techniques for managing innovation are to be developed, the responsibility for doing so would most appropriately be assigned to private research firms and the nation's universities. However, if the results of this research are to be widely disseminated through publication and education, it will probably have to be publicly supported. This does not mean to imply that corporations are not interested in developing more effective and efficient methods of de-

[38] PESSIMIER, *supra* note 23, at 8; *see also* T.S. ROBERTSON, INNOVATIVE BEHAVIOR AND COMMUNICATION 16-20 (1972).

The bulk of federal expenditures for innovation related activities is heavily oriented toward the early stages of the innovation process. Total federal R&D expenditures for fiscal year 1976 are estimated at $22.6 billion,[36] with research accounting for approximately 38%, development 62%, and management and technical assistance about .3% of the total federal expenditure for innovation related activities.

There are several factors not accounted for in *Figure 3* which affect the shape of the curve. First, National Aeronautics and Space Administration (NASA) and Department of Defense (DOD) R&D expenditures ($2.9 and $11.4 billion respectively) are hardware or product development oriented and thereby tend to inflate the amount of public funds devoted to latter stage R&D activities. Second, this would be offset by financial assistance to business in the form of Small Business Administration and other loan programs. Third, federal management and technical assistance includes funding of non-innovation related activities. The net effect of these factors is that the curve depicted in *Figure 3* should be shifted to the left. That is, when DOD and NASA are excluded, federal expenditures for innovation related activities place an even greater emphasis on the early stages of the innovation process.

It should be noted here that it is difficult to differentiate between "technical" and "market" research and development. The former is more oriented toward establishing technical and functional feasibility. The latter activity carries development to the point where the "technology" or "product" is ready to be put into use.

Despite these uncertainties about the precise distribution of federal expenditures for technological innovation, it is obvious that current public policy pays very little attention to the latter stages of the innovation process. *Figure 4* illustrates how well this fits the nature of the innovation process.

Obviously, public expenditures for innovation related activities do not follow the same pattern as commercial expenditures. However, this does not imply that the federal investment in basic and applied research and in technical development is misplaced. To the contrary, a public commitment to the early stages of the innovation process is essential, especially in the area of high priority technology, such as energy or health.

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36 FEDERAL COUNCIL FOR SCIENCE & TECHNOLOGY, REPORT ON THE FEDERAL R&D PROGRAM (1976).

Historically, independent inventors have played a major role in non-technical innovation. Jacob Rabinow, formerly Chief of the Office of Invention and Innovation at the National Bureau of Standards, points out that most of the major inventions of this century — with the exception of the transistor and color television — have come from individual inventors.[29] F.M. Scherer cites several studies which credit large corporations with no more than a third of the more important innovations.[30]

Small Business Inventors

Although small business inventors have been classified as industrial inventors in *Figure 2,* they are, in many respects, more like independent inventors. They, too, can be categorized into traditional, professional and technological inventors. While the latter two groups are a minority among the ten million or so small businesses, they contribute heavily to our overall rate of technological innovation.[31] In addition to being an important source of technological innovation, small businesses employ 55% of the American workforce and produce 44% of the nation's gross national product.[32] However, the small business failure rate is high. Nearly half (44%) of all small businesses fail within the first two years.[33] In over 93% of these cases, lack of adequate management skills is the primary reason for their failure.[34] In addition, the small business share of manufacturing had fallen from 50% of the assets and 41% of the profits in 1960 to 30% and 25% respectively by 1972.[35]

While there is apparently no data available on the rate of technological innovation in the small business sector, it seems reasonable to assume that it is probably declining as well.

Stimulating Technological Innovation through Public Law

To summarize what has been said up to this point:

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29 *Is American Genius Being Stifled?, supra* note 4.

30 Haber, *supra* note 5, at 12.

31 *Id.*

32 *Id.*

33 *Statement of Kurt Mayer Before the Senate Select Comm. on Small Business,* 94th Cong., 1st Sess. 425 (1975).

34 DUN & BRADSTREET, THE FAILURE RECORD THROUGH 1971 (1972); *see also* SMALL BUSINESS ADMINISTRATION, SBA FACTS 12 (1975) [hereinafter cited as SBA FACTS].

35 Address of Jimmy Carter, Presidential Nominee of the Democratic Party, Atlanta, Georgia, 1976.

It would appear that both the funding and performance of technological research is heavily concentrated within the institutional and industrial groups. But what is the potential of these groups to produce technological innovations?

Corporate Inventors

For the last several decades, it has become an increasingly popular notion that large corporations have become the dominate source of technological innovation. For example, Galbraith once stated:

> There is no more pleasant fiction than that technical change is the product of the matchless ingenuity of the small man forced by competition to employ his wits to better his neighbor. Unhappily, it is a fiction. Technological development has long since become the preserve of the scientist and engineer. Most of the cheap and simple inventions have, to put it bluntly and unpersuasively, been made . . . because development is costly; it follows that it can be carried on only by a firm that has the resources which are associated with considerable size.[24]

Now, twenty years later, there is still ample evidence to support his earlier conclusion:

— Technology has advanced substantially. While many worthy inventions do not involve new or high level technology, basic technological advances usually involve sophisticated technology requiring complex and lengthy development.

— Accelerating costs coupled with uncertainty have increased the risk of inventing. As indicated in *Table 1,* costs are substantial, and estimates of the new product failure rates are high.

— Today's marketplace is more complex. Regulations, product standards, production, finance and marketing create obstacles that are beyond the capabilities of the individual inventor or entrepreneur.

— The marketplace is, to a degree, hostile to ideas from independent inventors. Most companies prefer to pursue an orderly, internal program of product development that reflects the needs, mission and direction of the company. Outside ideas represent a public relations headache and a legal hazard to the corporation.[25]

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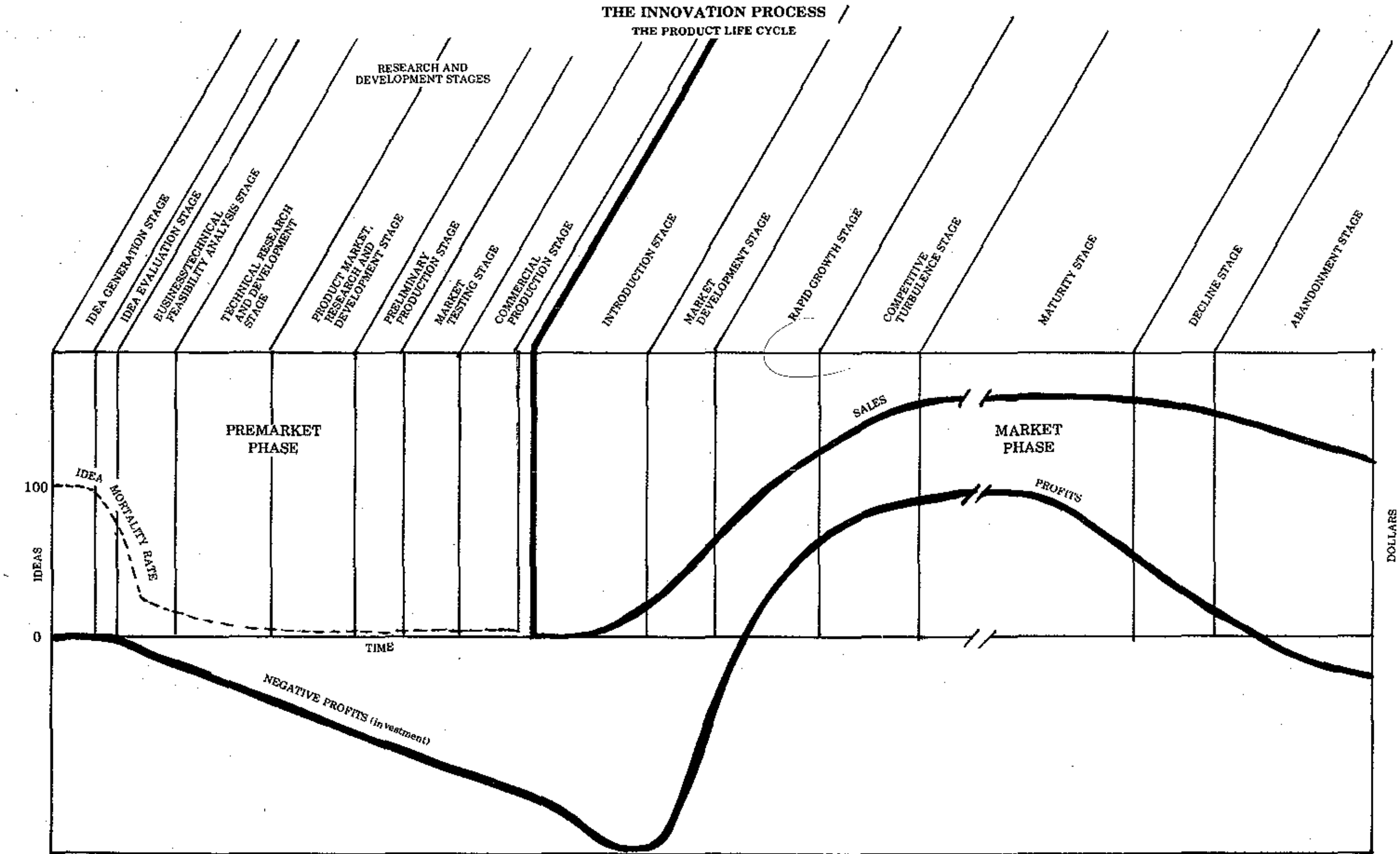
[24] J.K. GALBRAITH, AMERICAN CAPITALISM 86-87 (rev. ed. 1956).

[25] Hawkins and Udell, *Corporate Caution and Unsolicited New Product Ideas: A Survey of Corporate Waiver Requirements,* 58 J. PAT. OFF. SOC'Y 375 (1976).

Figure 1
The Innovation Process



Source: Innovation Center, University of Oregon.

Without innovation, we face a future of inevitable decline. As a matter of national policy, we must continue to innovate at an increasing rate if we are to achieve solutions to social, economic, environmental and material-shortage crises.

Distinguishing between Invention and Innovation

The words "invention" and "innovation" have created a considerable amount of confusion. Perhaps one of the reasons for this confusion is that they have been used as equivalents. Before examining the sources of technological innovation, it is appropriate that we pause to distinguish between "invention" and "innovation."

The patent system is designed to grant certain legal rights for inventions; that is, technological, intellectual property that is novel and non-obvious.[20] Unfortunately, public law sometimes treats certain stages of the innovation process as ends unto themselves, rather than as means to an end.

An invention — a new concept, discovery or device — is only the beginning. It has value only if it is put to use by society as (1) a building block for further developments (*i.e.,* inventions) or (2) a new process, product or service (*i.e.,* innovations). All of those activities, including invention, which precede the innovation are part of the innovation process. Therefore, while invention is a necessary precedent to innovation, it is not sufficient to complete the process. The "residual argument" concept applies here. If one wants to know the meaning and purpose of a phenomenon, it is necessary to look at the final outcome. Paul Billheimer uses an appropriate example:

> The automobile was once but a concept, an idea, a dream in the mind of a man. But that idea gave rise to a great enterprise. To manufacture the automobile, huge building complexes covering thousands of acres of land have been errected at astronomical cost. These plants have been fitted with sophisticated machines, tools and equipment, involving enormous amounts of capital. The operation requires limitless raw materials of many kinds from around the world in proportions that stagger the imagination. These industrial complexes employ millions of men and women from engineers to assembly line operators. And all of this for one purpose and one alone: a tiny automobile. When that first small vehicle comes from the assembly line, the purpose of this vast conglomerate of industries becomes perfectly clear. All that has gone before, including the huge outlay, the processing of raw material with its vast wastes in huge amounts . . . everything from the drawing board to the last bolt, is illuminated by one thing and one thing alone: the existence of a motor car.[21]

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[20] 35 U.S.C. §§ 100-104 (1970).

[21] P.E. BILLHEIMER, DESTINED FOR THE THRONE 30-31 (1975).

spend $223 annually per worker. Japan spends $336 and West Germany is investing in new plants and equipment at the annual rate of $700 per worker.[12]

— *Research*
Since 1968, total government and industry research spending has dropped more than 6% in real (non-inflationary) dollars. During the last decade, the real industrial investment for basic research has slipped 12% and federal funding on industrial basic research fell 45%.

— *Natural Resources*
Supplies of natural resources are diminishing. For example, 1976 world oil production was 57,210,500 barrels per day. At that rate of consumption, proven world reserves of 598,990,320,000 barrels will last less than thirty years.[14]

— *Balance of Payments*
Since about 1970, the United States has experienced a negative balance of payments.[15] As our dependency on external sources of supply for basic raw materials (such as oil) increases, we will become increasingly dependent upon the export of technological goods and services to offset our imports of raw materials.

The total current annual industrial investment in innovation probably is somewhere between $39.7 billion and $51.7 billion:

— Private R&D expenditures for 1975 are estimated at between $11.9 billion and $15.5 billion.[16]

— R&D expenditures are estimated to account for about 30% of the total cost of developing a new product.[17]

Booz, Allen and Hamilton estimates that about two-thirds of this investment is committed to new products which are either dropped before market introduction or fail to produce a satisfactory return.[18]

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12 Warren, *supra* note 8.

13 NATIONAL SCIENCE FOUNDATION, NATIONAL PATTERNS OF R&D RESOURCES (1973) [hereinafter cited as R&D RESOURCES].

14 *Worldwide Oil and Gas at a Glance,* OIL & GAS J., Dec. 27, 1976, at 105.

15 30 INT'L FINANCIAL STATISTICS 370-371 (1977).

16 R&D RESOURCES, *supra* note 13.

17 BOOZ, ALLEN & HAMILTON, A PROGRAM FOR NEW PRODUCT EVALUATION, PRODUCT STRATEGY AND MANAGEMENT 339 (ed. T.L. Berg & A. Shushman 1965).

18 *Id.*

Although periodic modifications to the patent system have been made, (and were finally codified in 1952[1]), the basic structure of the patent system has remained unchanged since 1836.[2]

Several attempts at patent reform have been made in recent years. Hearings on patent reform legislation were held in 1967, 1968, 1971 and 1973 by the Patent, Trademarks and Copyrights Subcommittee of the Senate Committee on the Judiciary, and culminated in 1976 with the favorable reporting of S.2255, a compromise bill.[3]

There is no question that the body of patent law codified in title 35 of the United States Code exerts a substantial influence on technological innovation. The theme of this article, however, deals with the need for public policy to go beyond the patent system if technological innovation is to be properly stimulated.

Going beyond the patent system encompasses, then, the need to recognize the interdisciplinary and interrelated nature of the innovation process. There have been several basic changes in the circumstances under which technological innovation takes place. Renovation of the patent system may be in order, but changes to the patent system alone will not be sufficient to shore up the current sagging rate of technological innovation in the United States.

The Declining Rate of U.S. Technological Innovation

High investment costs, new governmental regulations and controls, increasingly sophisticated technology, complex marketing procedures and shortened product life cycles have caused some observers to conclude that American innovation is breaking down. Unfortunately, this is happening just at a time when technological innovation is urgently needed.

Supporting this contention are some alarming national trends:

— *Patents*

We now rank fifth in the number of patents issued on a per capita bais. Four countries (Japan, Sweden, Germany and Switzerland) now issue more patents on a per capita basis than the United States (which is on par with the Soviet Union).[4] The

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1 35 U.S.C. §§ 1-293 (1970).

2 SENATE COMM. ON THE JUDICIARY, PATENT LAW REVISION REPORT, S. REP. NO. 642, 94th Cong., 1st Sess. 5 (1975) [hereinafter cited as PATENT LAW REVISION].

3 S. 2255, 94th Cong., 1st Sess. (1975). For an analysis of S. 2255 and a history of recent attempts at patent law revision, *see* PATENT LAW REVISION, *supra* note 2; *see also* Bowes, *Patents and the Public Interest,* 61 A.B.A.J. 1521 (1975).

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