Appendix H
INDUSTRIAL INNOVATIVE PROCESS

Innovation

If the **United States is to remain a leader** in the development and use of space technology, it will be necessary to enlist a greater share of private resources to augment the contributions of the Federal Government. In each of the four technologies dealt with in this report, the opportunities for private investment have increased dramatically in very recent times. In its attempts to encourage industrial participation, the National Aeronautics and Space Administration (NASA) has not only identified many potential commercial applications for space technology, but has developed new institutional mechanisms for increasing the flow of Government expertise and resources to the private sector. With a few exceptions, however, the private sector has remained unenthusiastic about the prospects of investing in space.

The purpose of this appendix will be to take a brief look at the process of innovation in order to establish a framework within which to discuss the issue of commercializing space technology. Because the subject of industrial innovation is complex, and highly dependent on subtle factors such as the willingness to take risks and the acuity of technical and business judgments, generalizations in this area can be deceptive. Nevertheless, it is useful to identify some of the key factors that motivate the private sector to allocate resources to the pursuit of product development and improvement.

Innovation is generally defined by economists to be the first commercial application of a new or improved product or production process. The process by which innovations are developed can be viewed as a sequence of three interdependent events.[1]

- ***Generation of an idea,*** involving the synthesis of a market need and the recognition of a technical capability for meeting that need.
- ***Problem solving*** including the setting of specific technical goals and the search for alternate methods of meeting those goals.
- ***Implementation or commercialization,*** consisting of engineering design, tooling for production, plant construction, production and marketing start-up, and first commercial introduction.

Analyzing these three stages, it becomes apparent that the management of technical innovation requires much more than the maintenance of a productive research and development (R&D) laboratory. It is a corporation-wide task that involves the skills and personalities of everyone from the scientists and engineers in the lab to the top legal and financial management. Because of this wide spectrum of interested parties, the process of project selection is highly dependent on the flow of information within the firm. The object of scientists and engineers is generally new knowledge, and they tend to focus on the problem of technical success.

Managers, on the other hand, are concerned with marketing a profitable product and therefore focus on development time, risk, and potential return on investment. This marked difference in interests and goals may result in a communication gap that prevents management from getting the technical information that it needs to assess projects accurately.[2]

This problem is particularly significant in the context of NASA's desire to involve the private sector in the commercialization of space technology. The process of project selection within a firm is already complex. When the administrative problem of coordinating NASA's management structure and technical expertise with that of the firm is added, such a project may appear unattractive. NASA'S Joint Endeavor Agreements (discussed in ch. 8) and related institutional arrangements are designed, in part, to address this problem.

The Decision to Innovate

Innovation is one means used by firms to stimulate growth and to compete with other firms within an industry. Improvements in a product or process can lead to a reduction in the costs of production or improvements in performance or quality. In this manner, innovation can increase a firm's market share, profits, or both. Innovation may also be directed to the development of new products targeted for existing or potential markets.

Innovation is not the only way, and often not the best way for individual firms to stimulate growth and to compete. These goals can also be accomplished by noninnovative methods designed to maximize sales, such as advertising or new marketing strategies, or to minimize cost, as by standardizing production techniques. A firm is also not limited to internal development, but can pursue growth and a competitive edge through merger, acquisitions, and diversification.[3]

[1] James M. Utterback, "Innovation in Industry and the Diffusion of Technology," *Science*, vol. 183, Feb. 15, 1974, p. 621.

[2] Edwin Mansfield, *The Economics of Technical Change, 1968,* pp. 59-61.

[3] Attilio Bisio and Lawrence Gastwirt, *Turning Research and Development Into Profit, 1979,* p. 37.

Within the industrial sector a small number of specific industries make a disproportionate contribution to the total annual amount **of R&D expenditures. Table** H-1 demonstrates that five industrial categories–aircraft and missiles, electrical equipment, machinery, motor vehicles, and chemical products—accounted for over 75 percent of total industrial spending in 1978. The large interindustry differences in R&D expenditures illustrate the fact that different firms and different industries do not attach the same importance to R&D investment.

The decision by a firm to allocate resources to the pursuit of innovation can be viewed as a function of two major factors. The first is the firm's ***potential*** for innovation as dictated by external considerations such as the structure and maturity of the industry, the industry relationship with Government and the overall state of the economy. The second factor is the firm's *willingness* to innovate as dictated by internal financial, technical and human resources and the particular corporate strategy, or "personality," of the firm.

Potential for Innovation

Federal Government programs, incentives, and regulations have a significant role to play in the creation of an industry's operating environment, Federal Government support of the electrical equipment and aerospace industries is largely responsible for the fact that these two industries combined constitute almost half of the entire R&D expenditures in 1978 (table H-1). By supplying the funds or the financial incentive to conduct research, and by guaranteeing a market for new product and process innovations, the Government can encourage a level of R&D activity that would not otherwise be maintained. (This subject is discussed in greater detail later).

Of course, this is not to say that Government financial support is the main factor in stimulating industrial innovation in all industries. Certain industries, notably pharmaceuticals and chemicals, maintain very high **R&D to sales ratios and** receive very little Government support.[4] This is the result of the fact that competition in these industries is primarily based on new product development and improved product performance.

Another factor that affects the level of R&D spending is the structure of a particular industry. Whether or not it is profitable for a firm to invest in innovative activities is to some degree dictated by the number of potential rivals and the overall market profit potential. in an industry composed of many small sellers, such as home construction or brick manufacturing, the rate of innovation has been traditionally very low. This results in part from the fact that no single firm controls a significant enough portion of the market to make a sustained research endeavor profitable. Since market share directly affects revenue flow and the return that a firm may anticipate on a particular investment, firms with a small share of a particular market cannot afford to make large investments in R&D. S

Innovative activity tends to be greater in new industries and industries characterized by rapid growth and expanding markets.[6] Initially, competition in these industries is based on product quality and performance and a second-best product may have little value. However, as such industries begin to mature, competition starts to become based on price and the production process, and therefore the product becomes relatively standardized. Innovations that are pursued after this time tend to be incremental process innovations that will lower the unit costs of production. Eventually, as large investments are made in plant and equipment, manufacturers are less inclined to pursue radical innovations in either the product or the manufacturing process, as this could render their existing capital base obsolete.[7]

An interesting example of this can be seen in the U.S. satellite communications industry. Until 1973, NASA played the leading role in the development of advanced communications satellite technology. When the NASA program was phased down, it was assumed that the private sector would continue to finance and develop the communications systems necessary to meet future needs. Though the communications industry did continue to fund R&D programs, most of the research was dedicated to improving the operational capabilities and the reliability of existing systems. As a result, the U.S. satellite communications industry may face strong competition from the Japanese and the Europeans, both of whom have begun to develop the high-frequency satellite systems that may be necessary to meet the future demand for satellite communication services.

Industrial innovation is also affected by the overall health of the economy. An economy characterized by a high rate of inflation and generally volatile financial markets has an adverse effect on all types of investment but is particularly damaging to investment in innovation. Under such conditions firms show a preference for short-term, low-risk investments. Radical innovations, which by their nature are risky and often require long periods of time between concept identification and eventual commercialization, do not compete well for corporate resources.

[4] D. Schwartzman, *Innovation in the Pharmaceutical Industry.*

[5] Mansfield, op. cit.

[6] Utterback, op. cit.

[7] Christopher T. Hill and James H. Utterback, *Technological Innovation for a Dynamic Economy,* 1979, p. 53.

Table H-1.—Funds for Industrial R&D Performance by Industry: 1968-78
(in millions of dollars)

Industry	SIC code	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Food and kindred products	20	164	199	230	240	259	269	296	335	355	398	431
Textiles and apparel	22,23	58	60	58	59	61	64	69	70	82	82	87
Lumber, wood products, and furniture	24,25	20	18	52	53	64	71	84	88	107	127	136
Paper and allied products	26	144	188	178	187	189	194	237	249	313	337	394
Chemicals and allied products	28	1,589	1,660	1,773	1,832	1,932	2,116	2,450	2,727	3,017	3,261	3,594
Industrial chemicals	281-82,286	965	1,007	1,031	1,009	1,031	1,119	1,299	1,391	1,524	1,446	1,570
Drug and medicines	283	398	444	485	549	607	698	807	981	1,091	1,157	1,281
Other chemicals	284-85,287-89	226	209	257	274	294	299	344	354	401	658	743
Petroleum and refining	29	437	467	515	505	468	498	622	693	767	920	,071
Rubber products	30	223	261	276	289	377	426	469	467	502	488	504
Stone, clay, and glass products	32	142	159	167	164	183	199	217	233	263	287	331
Primary metals	33	251	257	275	272	277	307	358	443	506	531	546
Ferrous metals and products	331-32,3398,3399	135	136	149	144	146	163	181	215	256	260	264
Nonferrous metals and products	333-36	115	121	126	128	130	145	177	228	250	271	282
Fabricated metal products	34	183	182	207	242	253	291	313	324	358	393	397
Machinery	35	1,483	1,546	1,729	1,860	2,158	2,549	2,985	3,196	3,487	3,952	4,459
Office, computing, and accounting machines	357	(1)	(1)	(1)	(1)	1,456	1,733	2,103	2,220	2,402	2,763	3,126
Other machinery except electrical	35 (balance)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	1,189	1,333
Electrical equipment	36	4,083	4,347	4,220	4,389	4,680	4,902	5,01	5,105	5,636	5,928	6,743
Radio and TV receiving equipment	365	55	57	70	64	48	49	51	50	52	61	54
Electronic components	367	2,520 (367 and 366 combined)	2,670	2,604	2,731 (367 and 366 combined)	330	406	489	549	691	746	834
Communication equipment	366					2,583	2,613	2,424	2,385	2,511	2,804	3,252
Other electrical equipment	361-64.369	1.508	1.620	1.546	1,594	1,719	1,834	2,047	2,121	2,382	2,317	2,603
Motor vehicles and motor vehicles equipment	371	1,499 (371 and 373-75,379 combined)	1,568	,591	1,768 (371 and 373-75,379 combined)	1,954	2,405	2,389	2,340	2,778	3,324	3,783
Other transportation equipment	373-75,379					56	72	87	90	94	121	131
Aircraft and missiles	371,376	5,765	5,878	5,219	4,881	,950	5,052	5,278	5,713	6,339	7,089	7,680
Professional and scientific instruments	38	663	742	744	746	838	961	1,075	1,173	1,331	1,466	1,689
Scientific and mechanical measuring instruments	38 ,82	8	23	131	133	63	86	22	266	325	373	452
Optical, surgical, photographic and other instruments	383-87	545	6 9	613	612	675	775	854	907	1,007	1,093	,237
Other manufacturing industries	21,27,31,39	o	121	128	13	1	58	177	205	217	250	280
Nonmanufacturing industries	07-17,41-67,737 739.807.891	603	655	705	704	707	715	768	735	845	978	52
Total		17.429	18.308	18.067	18,320	19,552	21,249	22,887	24,187	[illegible]	[illegible]	[illegible]406

[1]Data not tabulated at this level prior to 1972.
[2]Data not tabulated at this level prior to 1977.

SOURCE: National Science Foundation, *National Patterns of Science and Technology Resources* (March 1980).

The stimulus to innovate may also stem from critical shortages or a sharp rise in cost of the resources necessary for production. For example, intensive research on synthetic rubber was only undertaken after certain cartel agreements caused the price of natural rubber to increase dramatically.[8] A more recent example is the aerospace industry's attempts to design jet engines with greater fuel efficiency. This decision was undertaken in response to rising fuel costs and the threat of temporary fuel shortages. Rising labor costs have also contributed significantly to innovations in robotics and industrial automation.[9]

Willingness to Innovate

At the broad level of R&D strategy, individual firms must assess the relative advantages of innovation v. imitation. Innovation is attractive if being first yields a strong market position and if barriers to entry (e.g., patent protection, capital requirements, control over distribution) can be erected which limit the ability of other firms to copy or improve upon a product.[10] On the other hand, the risk assumed by the imitator is much lower, and if the innovator is very successful he may create a market large enough to accommodate the imitator. The R&D strategy of a firm can have many different orientations to the market:[11]

- First to market—based on strong R&D, technical leadership, and risk taking.
- *Follow the* leader—based on strong development resources and the ability to act quickly as the market starts its growth phase.
- ***Applications*** engineering—based on product modifications to fit the needs of particular customers in mature markets.

For each new product or service being sought or considered, the firm must also assess the effects of that product or service on the firm's present manufacturing, distribution, and office facilities. New product development can be sought to enhance an existing area of competence such as a distribution system, a production capability, or promotional skills. Such development may also be primarily defensive in character, as when a firm pursues a product in order to spread the risks of its involvement in a highly cyclical industry.

The decision of a firm to allocate resources to innovation is a subjective determination on the part of management that takes into consideration the need to innovate, the probability that a given project will be a technical and commercial success, and the financial ability of a firm to undertake the project. Although formal, quantitative project selection techniques can be used to project such factors as rates of return and pay-out periods, in the final analysis the decision to innovate is a strategic choice that depends upon a corporate manager's business and technical acumen.

Some analysts have charged that U.S. corporate managers have underestimated the need for innovation. They contend that this has resulted in the decline in innovation and productivity growth and deficits in the balance of trade. A recent article charged that

> **By their preference for servicing existing markets rather than creating new ones and by their devotion to short-term returns and "management by numbers," many (American managers) have effectively forsworn long-term technological superiority as a competitive weapon.**

Because of the existence of other factors such as inflation, tax laws, labor costs, Government regulation, fear of capital shortages, or the price of imported oil it is difficult to gauge the truth of this assessment. It is important to note, however, that to the extent that corporate managers do rely on quantitative project selection techniques, there is some evidence that such techniques tend to be biased against ambitious projects with potentially large payoffs.[13] These techniques often utilize formal market surveys to compare the estimated returns on investment for alternative projects. Reliance on such surveys can be misleading in that consumers are often unable to appreciate the value of major innovations before they are commercialized.[14] A Though major innovations may have a much greater profit potential than modest product improvements, they are more difficult to justify using formal market surveys.

This fact has important ramifications for potentially commercializable space applications. Because such projects involve both technical and market uncertainties, industry has viewed them as unattractive investment. It is difficult to assess, at this point, whether industry's cautious view of space is the result of myopic management techniques or insight based on experience in dealing with complex investment decisions.

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[8] G. W. Stocking and M. W. Watkins, Cartels **in Action, 1964, p. 73.**
[9] John D. Fisk, *Industrial Robots in the U. S.: Issues and Perspectives,* **Congressional Research Service, March 1981.**
[10] Bisio, op. cit., p. 37.
[11] Bisio, op. **cit., p. 38.**

[12] Robert **H. Hayes and William J. Abernathy, "Managing Our Way to Economic Decline,"** *Harvard Business Review,* **July-August 1980, p. 70.**
[13] Edwin **Mansfield, et al.,** *The Production and Application of New Industrial Technology, 1977,* **p.** *43.*
[14] Hayes, op. cit., p. 71; Hayes and Abernathy point out that: "The **argument that consumer analyses and formal market surveys should dominate other considerations when allocating resources to product development is untenable. It may be useful to remember that the initial market estimate for computers in 1945 projected total worldwide sales of only 10 units. Similarly, even the most carefully researched analysis of consumer preferences for gas-guzzling cars in an era of gasoline abundance offers little useful guidance to today's automobile manufacture in making wise product investment decisions. Customers may know what their needs are, but they often define those needs in terms of existing products, processes, markets, and prices. "**

The answers to such questions may be forthcoming as Europe and Japan target specific space technologies for commercial application.

In space applications, as well as other high-technology industries, the Government has played, and continues to play, a major role in product identification and development. It is important therefore to examine the nature of this role and Some of the methods by which it is accomplished.

Government Role in Innovation

The Government plays an extremely important role in the innovative process, particularly in the area of basic research. The impact of such financial support has been particularly significant in the aerospace, electronics and computer industries, where expensive basic research has been essential to product development. Government can provide financial support of R&D both directly and indirectly, through a variety of mechanisms. Such support does, however, raise important questions as to the appropriate roles of the public and private sectors in the development and operation of new technology. One way to address this problem is to identify the kind of benefit–public good or private good—that a new technology will provide.

A public good is one that cannot profitably be divided, priced, and sold to the individual members of a collectivity (i.e., a city, State or country). Governments traditionally have existed to provide public goods such as highways, sea and air navigation aids, and national defense. A private good, by contrast, is one that can be provided through a market transaction to those who desire it and are willing to pay the price set by the provider, Of course, it is often the case that a particular product or service produces mixed benefits, making it difficult for a private sector supplier to justify the cost of providing the benefit. In this situation, some argue that the Government should intervene to correct this lack of market incentive by using public funds to invest in technology intended for eventual use in the private sector.

Finally, and perhaps most fundamentally in the context of Government funding, the definitions of public good and private good are highly political in character. It is important to recognize that when discussing technologies that may benefit large segments of society, it is a matter of judgment and philosophy, not an issue for analytical resolution, which should be provided through Government programs and which through private activity.

The most controversial area with respect to R&D funding by the Government is that in which eventual commercialization is a major objective in the development program. Ordinarily, the private sector bears the total responsibility for funding R&D intended to be incorporated into commercial systems. However, over the past decade the Government has provided significant support, not only for basic research but also for applied research, technology and systems development, and even demonstration projects in such areas as space and energy technology.

A policy decision to support R&D in an area intended for eventual commercialization is a decision to augment or override market forces as a determinant of R&D investment. In the United States, the scientific and technological sectors that have advanced most rapidly in the 20th century, including space, are those that have received substantial assistance from the Federal Government.[15] This assistance has taken the form, among others, of direct financial support for R&D and of the creation of Government organizations to manage the research programs carried out with such support.

The establishment of NASA, and this organization's early work on communications satellites, are examples of substantial Government involvement in a commercially viable technology. Another example can be found in the development of electronic component technology. The reason for early U.S. domination of this industry is directly related to the R&D support provided by the Government. In the early 1950's, the military services, desiring to make their equipment more portable and to increase its reliability in the field, began to finance semiconductor R&D on a large scale. Between 1955 and 1961, the Government spent approximately $66 million on semiconductor R&D and production refinements.

Purchase Guarantees

In addition to direct financial support the Government may encourage innovation and the commercialization of new technologies in a number of ways, such as guarantees, technology transfers, and favorable tax treatment. One example of the influence of market guarantees can be seen in the integrated circuit industry. Though the basic inventions in this industry resulted from work done under Government contract, the technical breakthrough that allowed mass production was accomplished by Fairchild Industries without any Federal support.[16] The fact that there was a clear Government demand for these products and processes was an important factor in the firm's decision to undertake this research in the first place. Future

[15] J. Schnee, "Government Programs and the Growth of High-Technology Industries," Research Policy, vol. 7 no. 2 (1978), p. 4.
[16] OECD, *Gaps in Technology: Electronic Components,* 1968, p. 59.

developments in remote sensing may provide another example of the importance of a Government-guaranteed market. Several plans have been proposed that envision the transfer of the Landsat system to a private sector organization. All of these plans are contingent on the Government's agreement to purchase its remotely sensed data from such an organization, thereby guaranteeing that such a venture would have a stable financial base.

Technology Transfer

In addition to providing assured product demand, it is also significant that the Government develops technologies that have either a director indirect usage in the private sector. An example of this can be seen in the computer industry. Because of Government sales in this industry companies were able to fund their R&D programs at very high levels.[17] This resulted in a rate of technological progress that exceeded that which could have occurred in a normal commercial environment. In addition, military requirements with respect to computer size, speed, and reliability far exceeded what would have been requested by the business community. **As a** result, the technology that was transfered to the private sector was far more sophisticated than it would have been without Government involvement. Finally, because of the military's extensive use of this new technology, the computer industry was able to overcome the natural skepticism that would have existed in the business community toward an untried product. There are many examples of technology transfers in the aerospace industry that have resulted or may result in important commercial products. The obvious examples that have been mentioned above are advanced communication systems and remote-sensing technology.

Government Regulation

Though the effects of Government regulation on innovation are not completely understood, many are of the opinion that regulation is a factor in the recent decline of innovation in the United States. A recent report by the National Research Council tended, with certain reservations, to agree with this opinion.[18] It stated that though the reasons for the decline in U.S. innovation are varied and complex, there are a number of cases (such as new pesticides, certain chemical compounds and railroad shipping services), where solid documentation existed to prove that regulation contributed to this decline. *

Government regulation can also delay the introduction of new and useful products and processes. An example of this fact can be seen in the history of the use of satellites for domestic communications. In 1963, when NASA began launching its Syncom series of satellites utilizing the geosynchronous orbit, it became apparent that the use of this orbit would have important applications for domestic communications. Yet, it was not until 1974 that commercial domestic satellite service was available in the United States. **This long period between the technical realization and the commercial application of the technology was marked by scores of legal and organizational battles over systems ownerships involving the Federal Communication Commission (FCC), the Justice Department, the White** House and the numerous segments of private industry who wished to use the technology. The result of nearly a decade of struggling was that FCC, in 1972, announced its multientry decision which held that any qualified entity, subject to certain conditions, could own and operate a commercial satellite system. Meanwhile, Canada had been enjoying for years a domestic satellite system built by a U.S. company and launched by NASA.[19]

In the near future, Government regulation will have a significant role to play in the development of privately owned launch systems. **At** present, several different agencies, each with uncertain authority, are issuing regulations that have an effect on private launches. No lead agency has been designated to address critical issues such as aerial and maritime clearance, the development of new commercial launch sites, the need for a comprehensive indemnification scheme, and methods by which to authorize and license payloads. Because of the importance of these issues both domestically and internationally, it is certain that some form of regulation will be necessary. Whether or not such regulation will encourage or hinder the flow of private capital into this infant industry is yet to be seen.

Tax Incentives

The Government may also stimulate R&D expenditures by allowing industries to use the tax system to reduce the cost of such endeavors. Three of the main incentives in the present tax system are depreciation allowances, investment tax credits, and the deductibility of R&D outlays. Depreciation allows a firm to deduct as a business expense the cost of certain assets over the period of their useful life. Investment tax credits allow firms to take a certain percentage of new

[17] Schnee, op. cit., p. 10.

locational Research Council, *The Impact of Regulation on Industrial Innovation,* 1979, p. 9.

● **The NRC** *report* **does point out, however, that in certain instances Government regulation may act to stimulate innovation. For example, though it ap**pears that regulation has caused R&D capital funds to be used to meet regulations, it has also had the effect of stimulating the development of new socially desirable products **such as pollution-control equipment and technology.**

[19] M. Kinsley, *Outer Space and Inner Sanctums,* 1976, p. 131.

investment purchases as a credit against their tax liability. Section 174 of the Internal Revenue Code permits firms to deduct total R&D outlays in the year that the expenditures are incurred.

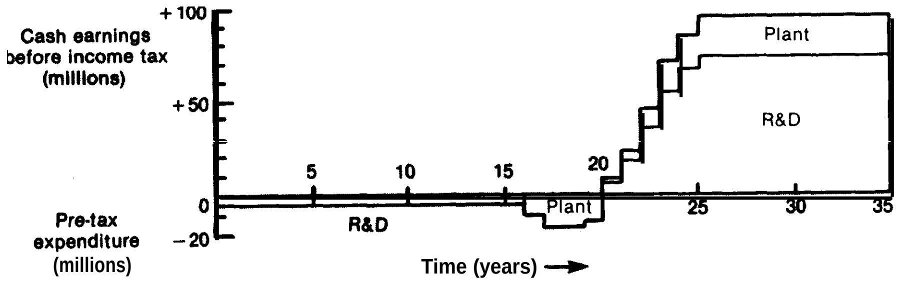
Though the intricacies of the corporate tax system are beyond the scope of this report, a simple example is helpful to illustrate some of the ways that changes in the tax structure can create the incentive to innovate .20

Figure H-1 depicts an R&D project with a 20-year development time and a 15-year market life. **It** assumes a research expenditure of $1 million per year, an investment of $50 million spread over 4 years to build the manufacturing facility, and a venture success rate of 100 percent. It also assumes that the tax regulations allow a 100-percent deduction for R&D outlays, an investment tax credit of 10 percent, and a depreciable life of plant and equipment of 14 years. Taking these factors into consideration, if a firm wants to earn a 15-percent return on investment, taking into account the time value or money, it must anticipate pre-tax earnings of over $90 million. **If the tax regulations in this example are altered to allow a 150-percent deduction on** R&D outlays, an investment tax credit of 25 percent, and a 5-year depreciation on the plant and equipment, the required pre-tax earnings to achieve a 15-percent return on investment would be cut in half. Figure 5 demonstrates the effect of these changes.

Although models set forth in figures H-1 and H-2 are in many ways overly simplistic, they do point out how the tax system can be used to help firms recover the cost of their R&D efforts. By making R&D expenditures easier to recover, firms will have the incentive to invest in more and longer research and development projects.

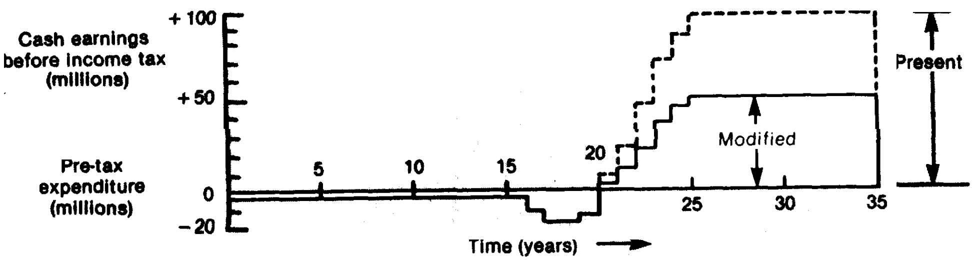
[20]John S Benjamin, statement on the Space Industrialization Act of 1979 (H. R, 2337), hearings before the Subcommittee on Space Science and Applications of the House Committee on Science and Technology, 96th Cong. 1st sess , 1979.

Figure H-1.— Results of Project Model for 20-Year Development Time



SOURCE: The Space Industrialization Act of 1979: Hearings on H.R. 2337 Before the Subcomm. on Space Science and Applications, 96th Congress, Ist Sess. 45 (1979) (statement of Dr. John S. Benjamin).

Figure H.2.—Effect of Tax Law Modifications on Project Model



SOURCE The Space Industrialization Act of 1979: hearings on H.R. 2337 before the Subcommittee on Space Science and Applications, 96th Cong., Ist sess. 45 (statement of Dr. John S. Benjamin).