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Federal Procurement: An Instrument to Increase The Rate of Innovation

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Preface

The author's conception of the idea of using Federal procurement to stimulate innovation in public service programs was formulated during his summer employment in 1964 in the Office of the Secretary of Defense while drafting a subcommittee report to the Committee on the Economic Impact of Defense and Disarmament. A President's Science Advisory Committee panel met to discuss a similar proposal on November 15, 1965, at which time it became apparent that other Federal agencies had given prior thought to implementing the proposition. As a student of business control, the author became interested not so much in whether the proposal would work, but rather in its conceptual foundations and general significance for public policy. The latter is the general concern of this paper.

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Acknowledgements

An expression of gratitude for having provided the necessary information goes to officials in the Institute of Applied Technology. Discussions during the year in the Seminar helped the author form a perspective from which to view the proposition. The ideas proposed and questions raised during the year in Professor Kaysen's graduate course on business control led the author to question and reformulate many of his original ideas. And finally, a special debt of gratitude is owed to Arthur Barber, Deputy Assistant Secretary of Defense, for his assistance throughout the last year but most importantly for the ideas and questions which have never ceased to stimulate the author's thoughts. However, the author must assume the responsibility for the faults and shortcomings of the ideas presented below.

I. Introduction

Until the middle of the last century, the "mechanic" rather than the "scientist" provided the main source of technical change for economic and subsequent social progress. After 100 years, however, the scientific establishment has grown into a major institution in the American political and economic systems, not only as an institution for which "funds are appropriated almost on faith," as Dean Price [1] has noted, but also as an influential member in public policy decision-making. But as the 18th Century "mechanic" had little difficulty in applying his "products" to the engine of progress, the "scientist-technologist" policy decision-maker has become frustrated when he attempts to apply the knowledge and technologies developed in his laboratories to benefit society.

Nowhere have frustrations been greater than in the attempts to improve the quality of services in the public sector, and especially on State and local levels.[2] Indeed, the problem with which this paper is concerned is that efficient technologies are not being applied as quickly as possible in public service programs such as education, housing, transportation, among others. Moreover, the major obstacles to innovation are not technical in most cases but rather institutional, ranging from a lack of knowledge to political pressures to maintain the status quo. The argument made here is that, by overcoming these institutional obstacles and in some cases technical barriers, an increase in the rate of innovation will lead to an increase in economic performance and, hence, in the Gross National Product.

This paper will explore one instrument which could be used to increase the rate of innovation in public service programs - the purchasing power of the Federal government. The purpose of the paper then is: (a) to state the propostion explicitly, since heretofore it has been mentioned publicly only in passing,[3] and then offer several reasons why it is now being considered; (b) to explore the various rationales on which facets of the proposition can be justified; (c) to determine in a general sense the industries and markets which are affected by Federal procurement and in which increases in the rate of innovation would benefit State and local governments;* (d) to summarize problems of innovation in the "new science-technology" industries and in the so-called "mature" industries and then discuss economic and sociological factors which appear to influence the rate of innovation; (e) to develop strategies which might influence the factors affecting innovation; and, finally, (f) to discuss the various policy implications which might be drawn from the above proposition.

Any serious discussion of the relationship between science, technology, Goverrment procurement, and innovation clearly requires the burdensome task of defining terms. For present purposes, an "innovation" will mean the application of a new technique (organizational or technical) which increases performance at existing costs or achieves existing performance at reduced costs. "Technical obstacles" to innovation are those which require further research

*This information can be found in Appendix I.

and development before the technology can be applied. "Nontechnical" barriers are those other than technical which impede the rate of innovation or the rate of adoption. The difference between an organizational innovation and a nontechnical obstacle might be unclear. For example, the reorganization of local governments might be considered an innovation or the removal of a nontechnical obstacle previously impeding the use of a new transportation system. Such changes in the paper will be referred to as the removal of an obstacle.

The limitations to the approach mentioned above are without doubt "nontrivial." While most of them will be mentioned when their relevance in the text is important, several should be noted now. Performance rather than "productivity" was chosen as the criterion for distinguishing an innovation. Productivity in an economic sense is a function of demand rather than production.[4] Since demand, and hence the value of public services, is most difficult to determine, technical performance offers the next best measure. Indeed, to the degree which demand for public services is created through the strategies listed below, an economic measure of productivity would have a built-in productivity bias.

Since the objective of the policy instrument is to increase the rate of innovation, a standard by which the existing rate can be measured will not be developed. Similarly, the question as to whether or not the present rate of innovation is too rapid is "begged," at least until the last chapter.

The time period over which the rate of innovation can be expected to increase is very important. If the application of new technologies to Federal programs requires "standardization," then the increase in the initial period might be offset in a latter period by the potential difficulty of breaking through standards.[5] This limitation is based on the orgamization theory that innovation is inversely related to size and standardization.[6]

Similarly, if the proposal were implemented and effective over a very short period of time, the impact could conceivably mean a "one-time injection" of innovation, the rate of which could be increasing initially at an increasing rate, then at a decreasing rate of increase, and finally reaching a plateau or decrease over time, especially if the adverse effects of size and standardization are felt. A realistic appraisal of the above limitation would have to consider the dynamics of innovation, the secondary and tertiary effects felt in firms or industries other than those in which the innovation occurs initially. Also, attempts to reduce costs and increase performance in Federal programs through the application of new technologies will probably occur over time and in a piecemeal fashion, affecting only certain industries in the private sector rather than all industries which could conceivably be affected.

Lest the magnitude of the potential effect on innovation be overstated, the use of Federal procurement as an instrument to increase innovation would probably be small relative to expanded use of other policy instruments. For example, tax credits for research and development would probably be a greater inducement for inventive activity in industry than would this proposal. And on the demand side, the potential withholding of Federal grants to State and local governments would establish a stronger Federal bargaining position to persuade local officials to change building codes or to "subdue" the pressures of local businesses and labor unions. However, while having their advantages in the aggregate, these instruments, and others often used, are deficient for providing incentives for innovation in certain industries and at the same time could provoke adverse Federal-State-local political ramifications. The raison d'etre of this proposition is to overcome those technical and especially nontechnical obstacles which customary fiscal policy and political instruments are unable to influence effectively or without adverse political effects.

II. The Proposition Stated

The use of Federal procurement to increase the rate of innovation is a relatively new idea and to the author's knowledge, it has not been stated heretofore in published documents, except in a piecemeal or cursory fashion.[1] Therefore, the task of this chapter is to state the proposition, point out its salient differences from existing Federal programs to encourage innovation, and to offer reasons why it is being considered, and in some instances utilized, by the Administration at the present time.

The basic proposition is that the Federal government would apply existing technologies and/or those technologies which could be developed with marginal funding to its own nondefense public service programs, such as education and training for military personnel, public housing, and hospital care. The initial goal would be to reduce the costs of existing Federal programs and/or to provide a higher level of performance at present costs for existing and/or new and expanded programs. Since State and local governments perform many public service programs similar to those provided on the Federal level, the former will have an opportunity to apply those technologies applied successfully on the Federal level to their own programs. To develop and apply the technologies in the Federal program is a necessary condition; to demonstrate the efficiencies of the innovations to the State and local officials and constituencies is the sufficient condition for reducing the time lag between development and application. In certain industries, e.g., the

building industry, technologies developed, tested, and applied in Federal programs could have a potential spin-off into the commercial and industrial markets. In essence the proposition purports to influence the demand for, as well as the supply of, innovations.

Existing Federal programs to promote technical change can be classified into two general groups: (a) those which depend on the spin-off of technologies from present or past research and development (R and D); and (b) those under the general direction of the Department of Commerce.

The only defense-space agency to establish formally an office to promote civilian application of technologies developed by it or its contractors has been the National Aeronautics and Space Administration (NASA).[2] In 1962, the Technology Utilization Program (TUP) was initiated "to transfer to the public those scientific and technical results of the aerospace effort which might be used by business and industry."[3] An Industrial Advisory Committee works with the TUP and recommends methods for the identification, evaluation, and dissemination of innovations. Consultant engineers are often used "to identify and carry the knowledge of transferable items developed through its /NASA's/ research to the attention of decision-makers in nonmilitary industry."[4] In this sense, TUP in conjunction with its Office of Scientific and Technical Information not only publishes literature and abstracts of patents (pending,

or completed) but also provides evaluation of potential application.

The Department of Defense (DOD), which funds the major portion of Federal R and D, e.g., about $6 billion annually since 1960, does not consider advancing industrial technology as one of its main missions. As such, civilian application developed from defense-related R and D occurs usually through "unguided" spin-off. It has attempted, however, to provide scientific information generated by military R and D through the Armed Services Technical Information Agency (ASTIA). Yet, the magnitude of the service has not been too large.[5]

On the other hand, a recognized goal of the Atomic Energy Commission (AEC) is to find peaceful uses for atomic energy. In certain instances it has taken the initiative to find applications in the civilian sector as well as provide funds for their development. For example, the AEC opened a plant in Gloucester, Massachusetts last year for experimental irradiation of seafood. Findings will be available to all companies in the industry.[6]

A second group of programs encouraging technical change, found in the Department of Commerce, includes among others, the Office of Technical Services (OTS) which functions as a clearing-house for reports on R and D financed by the Army, Navy, Air Force, AEC and other Federal agencies. The bulk of the proposals for introducing technical change into the civilian sector has originated

in the Commerce's Office of Science and Technology, created in 1962. Attempts by that office to establish a civilian technology program have not been received too well by Congress. At the present writing, the Department of Commerce is preparing a proposal which will establish an industrial extension service similar to the agriculture extension programs carried out by the Department of Agriculture over the last 80 years.[7]

The proposition to use Federal procurement to increase innovation differs from the spin-off programs of DOD, NASA, and AEC in that the R and D funds which would be provided would be for nonweapons procurement; the specific procurement programs chosen would be similar to those performed by State and locals. Therefore, in either case the probability of benefits accruing to State and local governments is high. It differs from those existing Department of Commerce programs which provide information and technical services to industry, in that it is narrower in scope and it recognizes the importance of overcoming the nontechnical obstacles which impede the creation and in many cases the realization of the demand.

An obvious question could be raised at this moment: since so many cost-reducing technologies exist, why has not the Federal government already taken advantage of the opportunities? A very simple but realistic answer is that the Federal government in many cases has not been organized to analyze and implement cost-reduction efforts in some of its large nonweapons procurement

programs. Recent organizational changes have been made and these will be discussed later. For purposes here, it should be noted that the recognition of the need to reorganize or create certain new offices and the desire to apply cost-reducing technologies have been mutually reinforcing.

A second factor contributing to the recent interest in innovation has been the evangelical approach pursued by proponents of nonmilitary R and D, such as former Presidential Science Advisor Jerome Weisner,[8] and Assistant Secretary of Commerce J. Herbert Holloman.[9] Undoubtedly, the creation in 1962 of the Office of Science and Technology, headed by the President's Science Advisor, and its increasing influence as coordinator among the various departments and agencies, have provided an added impetus.

The OST was instrumental in promoting the November meeting of the PSAC[10] at which representatives from the DOD and the Institute of Applied Technology proposed specific projects in which cost-reducing technologies could be applied.

Vacillating emphasis on the so-called "Heller proposal" to return several billion dollars to the States in unconditional grants has evoked the Administration's concern as to whether the States and local governments will spend the Federal funds efficiently. The general argument advanced is that the Federal government has an interest to make available to the lower level governments the most efficient technologies, even though there would be no conditions for mandatory use.

A fourth factor, partly explaining why the above proposal is presently being discussed, is related to the problems facing those firms who are largely dependent on defense markets. On the one hand, Administration officials in the Executive Office and in the DOD have viewed the $2 1/2 billion cut back in defense-related procurement over the last two years as an opportunity to utilize the problem-solving capabilities of these firms in nondefense public service areas, e.g., transportation, education, and ocean harvesting. The defense firms, who have attempted to diversify into these areas, on the other hand, argue that State and local jurisdictional problems, outmoded rules and regulations, and planning officials' attitudes prevent the application of the technologies which these firms could develop. As a result, frustrations on both sides have begun to focus on the barriers to innovation on local government levels - how to by-pass or change the fragmented nature of local government?; how to persuade the local officials to utilize the most efficient technological alternatives?;and how to provide an argument for local officials, once persuaded of the economies of the innovations, to resist the pressures of local labor unions, local businessmen, and suppliers of materials? - these were the important questions with which the innovative firms and Federal officials were concerned.

The last and probably most important factor, because of its encompassing nature, was the emphasis on the "Great Society."

The Presidential message to Congress emphasized that only one-fifth of 1% of the $34 billion spent on education in 1964 was directed toward R and D.[11] Both businessmen and education technologists lent attentive ears to the Administration's intentions to explore new methods of teaching and to increase in 1966 expenditures for research and demonstration projects, including educational television, designed to achieve effective teaching in public schools.[12]

To summarize, the proposition to use Federal procurement to increase the rate of innovation in governments' public service programs is relatively new, differing conceptually from existing programs by directing its attention toward "institutional" problems. Its formulation is a r e s u l t of economic merit and business and political pressures, grounded in the building of a different and, perhaps, great society.

III. Rationales

In the last chapter some reasons were given for the recent interest in public policy and innovation. Below, several political and economic rationales for justifying facets of utilizing Federal procurement to increase innovation will be explored. The concluding pages of this section will offer the rationale on which the subsequent discussion will be based.

Any policy which purports to increase the rate of innovation on State and local levels has to take into account the inherent differences between the private and public sectors. In the former, the market through its pricing mechanism allocates resources on a quid pro quo basis so that the consumer pays the price for the value he expects to receive. The political mechanism in a democracy, however, is based on the premise of "one-vote, one-man;" therefore, differing from the market where preferences can be revealed through paying a higher or lower price for a commodity, it does not take into account the intensity of the voter's preference.[1] Moreover, in the public sector, where the costs (e.g., taxes) are often tangible, the value of the benefits received are not. These differences led Anthony Downs[2] to conclude that "rational ignorance" results in a Federal budget in a democracy which is too small. He attributes this situation to several specific factors: (a) that taxes are paid by those on whom the benefits do not accrue; (b) that in public service programs which are not subject to the "exclusion principle"[3] those who would benefit have no incentive to pay; (c) that as long as there

But is government advertising a necessary condition to create a demand for public services, or especially germane to this paper, for new technolgical innovations (e.g., computer classrooms) to be used in State and local public service programs? Professor Duesenberry has attacked the assumptions underlying the traditional Keynesian interpretation of the production function: (a) that each individual's consumption behavior is independent of those of other individuals; and (b) that individual consumption preferences are fixed over a period of time.[11] By showing that these assumptions are inconsistent with the data available on the relationship between savings (or consumption) and income over time, he concludes that individual's wants are dependent on the consumption of others because of a "demonstration effect."[12] Furthermore, he argues, "/M/ere knowledge of the existence of superior goods is not a very effective habit breaker. Frequent contact with them may be /effective/" [13]

Professor Duesenberry's "relative income hypothesis" is based on the interdependence of individuals' preferences in the private sector. The question then follows: is there any reason to believe that the same kind of interdependence would not exist between Federal and State and local governments or among the many local governments? To the extent that new techniques are not being applied by State and local officials or their constituencies because of ignorance, diffussion of information through application in Federal programs will improve the efficiency of the allocation

mechanism. However, to the degree that innovation in Federal pro-grams will be emulated by State and local governments among each other through the "demonstration effect," then the creation of demand for public service innovation could be initiated by innovation in Federal programs.

While the preceding paragraphs have offered some hypothetical rationales, political pragmatism and expediency underlies the following. If the present trend of reductions in procurement by the DOD and NASA continues, the plight of some of the large non-diversified defense firms could present a political issue. And yet, partial treatment of these firms by the Government, e.g., tax credits, direct subsidies, etc., could cause a loss of political support from nondefense firms. The Administration would then be faced with this political dilemma: how to effectively aid those defense firms which are requesting assistance in their attempts to diversify out of defense-space markets without being overtly partial.

The conflict could be resolved in the following manner. First, the Government could let all innovative firms bid for contracts to reduce costs of existing Government public service programs through the application of new technologies. The technically-based defense-oriented firms would be qualified to bid and could receive a far greater proportion of these contracts than their counterparts in the civilian markets. Hence, overt partiality and its adverse political effects could be minimized.

are projects in the Federal budget which the voter does not like, he believes the budget is too large in relation to the benefits he receives; and (d) that there is a private cost for the taxpaper to inform himself and a political cost for the government to do so.[4] Downs concludes with an illustration;

> A striking example of this advertising is in the field of electric power. Whereas private power corporations advertise both the virtues of their own product and the evils of public power, government utilities cannot even advertise their existence for fear of being accused of wasting public funds.[5]

Arguing from a different premise, Professor Galbraith[6] has laid a logical framework which would support an inference from Down's conclusion. Emphasizing that social needs are not met in an affluent society, Galbraith contends that the revealed preferences of consumers have not been autonomously determined but rather have been contrived by the influence of advertising or in the process of production itself.[7] In order to redress the social imbalance between the public and private sectors, Galbraith recommends expanded sales taxation admonishing the American "liberal" who has resisted such taxation.[8] However, an interesting question to raise follows: given his advocacy of the concept of countervailing powers,[9] does it not follow logically that the public sector should not advertise to counterbalance the influence of Madison Avenue? This alternative would seem to be more effective than expanded sales taxation (especially if the burden is shifted to the consumer), if the objective is to break the conventional wisdom of the "superior prestige of private goods and inferior role to public production. . . ."[10]

Second, most of those defense-oriented firms who have no present commercial production have neither the sales promotion nor marketing capabilities to diversify into commercial markets due to prior Government contracting. In a sense, successful "demonstration" of cost-reducing technologies in Federal programs might perform part of the sales promotion function in creating markets for their products.

Hence, diversification of defense firms into nondefense public service programs would not require reorganization of their present structure, i.e., creating marketing and sales promotion departments; through cost-plus-fixed-fee (CPFF) contracts, some of the development costs of diversification could be subtly "subsidized;" and finally, the limited Federal market could provide a foothold into potential growth markets on State and local levels such as education and recreation. And for the Administration, adverse political problems could be averted.

The rationale providing the conceptual framework for the strategies discussed in Chapter IV is based on the nature of the problem: that existing technologies and/or those which could be developed with marginal Federal R and D funding are not being applied in State and local public service programs as quickly as they become economically efficient. Therefore, given the goal of increasing the rate of innovation, within the constraints of a limited budget and limited administrative manpower, public service programs should be selected so that the ratios of expected marginal social returns over expected marginal social costs (both properly

discounted) are equal among alternative programs. A prime consideration in program selection would be whether or not State and local governments would also benefit from the innovations in Federal programs.[14]

The rationale which we have chosen to follow conceptually is based, therefore, on an efficiency judgment. Hence, the rationale for the policy must be justified by giving reasons why the normal market mechanism and, in some cases, the political mechanism might not provide the necessary incentives for innovation, and in a general sense, inventive activity, thereby resulting in a discrepency between social benefits (costs) and private benefits (costs).

If one considers expenditures for R and D and/or innovations as capital investments rather than consumption, there are reasons to expect that the social rate of return might be greater than the private rate of return. Machlup has argued that at least two consequences of innovation might result in a difference between private and social returns:

> The prices of the products concerned are usually reduced, which will benefit the consumers, not the innovating producer. (2) The new technology is adopted sooner or later by his competitors, which may help them as well as the consumers but not the innovator. This does not mean that the investor in R and D and first user of the new technology will not benefit from his investment; it merely means that the benefits to society as a whole are not limited to the benefits accruing to the investor, and often exceed them substantially.[15]

Empirical studies, which have attempted to support the above argument, have found that the social rate of return is quite

high. For example, Griliches[16] concluded that the social rate of return on the average dollar spent for R and D in hybrid corn was almost 700% in 1955. Ewell[17] suggested that the rate of return on R and D over the entire economy was between 100 and 200%.

Following the general argument made by Machlup and others,[18] plus the support of empirical studies, one could argue that a nearer to optimal allocation of resources for inventive activity would call for public policy action. Since the marginal private returns to the firm on R and D investment seem to be less than the marginal social returns (assuming marginal social and private costs equal) and since the firm will equate marginal private returns with private costs, a justification can be made of increased Federal expenditures or a reallocation, tax cum subsidy, of existing funds.

A second justification for the above rationale results from the relationship between uncertainty and inventive activity and/or innovation. First, uncertainties arise in the capacity to do inventive activity. Parameters determining capacity include the accumulation of knowledge and the resources, both technical and financial, which are available. Uncertainties enter the second stage between the invention and its economic application, i.e., innovation. In the former case, production uncertainties exist; in the latter, those involving marketing.[19]

Uncertainty in the production process will usually cause a below-optimal allocation of resources in R and D under a perfectly competitive market unless the firms' preferences for risks are greater

than society's. However, this exception of overinvestment can usually be ruled out because of financial constraints.[20] Therefore, to the extent that social risk preferences exceed those of the individual firms, it follows that society should share some of the private risks to achieve an optimal allocation. This argument has been used to justify the various "cost-plus" contracts let by the Federal government to private contractors who have developed weapons systems for national defense.[21]

In marketing an innovation, uncertainties again hamper the efficient allocation of resources under a competitive market mechanism. If one considers "information" as if it were a commodity to be sold in the market, several points can be noted. First, information is not a scarce resource in that using it as an input to production does not reduce the total stock.[22] Secondly Arrow has pointed out that "the use of information is certainly subject to indivisibilities; the use of information about production possibilities, for example, need not depend on the rate of production."[23] And last as Arrow concludes:

> [T]here is a fundamental paradox in the determination of demand for information; its value for the purchaser is not known until he has the information but then he has in effect acquired it without cost. Of course, if the seller can retain property rights in the use of the information, this would be no problem, but given incomplete appropriability, the potential buyer will base his decision to purchase information on less than optimal criteria. He may act, for example, on the average value of information in that class as revealed by past experience.

* * * * *

The chief point made here is the difficulty of creating a market for information if one should be desired for any reason.[24]

Since information becomes valuable only after it is not needed and with private costs greater than the optimal zero value, neither the buyer nor seller will have the incentives to create an optimal quantity demanded. Therefore, according to Arrow, "There is a strong case for centralized decision-making under these circumstances."[25]

For the present purposes if one considers the relationship between innovation and information, uncertainties exist in two stages: (a) in the creation of an initial demand for the new technology, the performance of which is uncertain; and (b) in the operations of a mechanism by which information about the performance of the innovation is being made available to potential purchasers. Since private risks involved in marketing an invention might result from uncertainty of performance, an argument could be made that the Federal government should share the initial risk when potential social benefits are high. By providing a limited demand in Federal programs, the Federal government, because of its size, could afford a risk which most individuals could not.

Moreover, if one is interested in creating a demand for innovations in public service programs on State and local levels, the functioning of the political mechanism becomes important. To

the extent that State and local officials are willing to take the risk of being accused of "wasteful spending" through informing their constituencies of the efficiencies of these innovations, the role of the Federal government could be minimized. However, to the degree that the officials are risk-averters and are influenced by local pressure groups to withhold, or at least fail to disseminate information, the optimal demand will not be achieved. Indeed, a basic assumption implicit in the proposition to use Federal procurement to influence local governments is that lower government officials do avert risks, that they are influenced by local pressure groups who impede innovation (e.g., labor union pressures to retain obsolete building codes) and that the existing dissemination of information about the performance of new efficient technologies has resulted in a suboptimal demand. In such cases there is a strong argument that the Federal government provide additional incentives by reducing private risks, thereby creating a nearer optimal demand for innovation, the value of which cannot be determined until its performance is known.

To summarize, an argument to redress the social imbalance between the private and public sector can be based on Galbraith's concept of countervailing powers linked with a hypothetical application of Duesenberry's "demonstration effect" to the public sector. Downs offers reasons why the political mechanism might lead to a too small budget in a democracy. As a solution to the Administration's dilemma regarding possible defense reductions,

limited nondefense Federal markets appear politically desirable. And finally, the proposition can be argued on the grounds of reducing private market and production risks and providing the information necessary for creating optimal demand on the part of State and local governments.

in nature, with economic significance only in the aggregate. The exceptions to this generalization are: (a) in the textile industry, the development of synthetic fibers; (b) in the machine tools industry, the development of carbide tools and numerical controls systems; and (c) in the building industry, as the Little report concludes, "There has been no one major innovation of this magnitude, but a wave of change. . . ."[6]

Major innovations in the textile industry can be attributed to developments in the chemical industry; in the machine tools industry, to the diffusion of the principle of numerical controls from the aerospace industry, and in the building industry, to the borrowing of methods and techniques from industrial manufacturing, which has lead to the industrialization of building. Accordingly the Little report concludes:

> It is the primary finding of this report that the principle source of major technical change in mature industry is innovation by invasion.[7]

Fragmentation of production, a major characteristic of mature industries, results in two problems for introducing innovations. First, the smaller firms do not have the necessary financial means to support the R and D which might lead to innovation. But most important, even if the individual firm can find the finances, the incentive to innovate is dampened since a change initiated by one firm often requires similar changes in other firms who might not have the necessary finances.[8] Because the industries are not organized to view the whole process as a system and few if any firms

IV. Problems and Factors Affecting Innovation

If one scans Appendix I, it seems apparent that the Federal government is a large purchaser from certain industrial markets. Some of these industries have been referred to as "mature"[1] or as the "new" science-technology[2] based industries, many of whose origins and/or present sales are dependent on defense-space markets. In this chapter, the problems of innovation in these two types of industries will be explored. Having noted major problems unique to each, the subsequent pages will summarize the factors which appear to influence the rate of innovation. This cursory review will draw heavily on empirical studies conducted by Rogers[3] and Mansfield.[4] The working hypotheses discussed here will then serve as the bases for strategies developed in the following chapter.

Problems of Innovation in Industry

To define what constitutes a given industry is difficult enough; to separate all industries into "new" and "mature" further complicates the problem. For this paper the distinction is for reference purposes. "Mature" industries has been classified as those having the characteristics similar to those of the building, textile, and machine tools industries.[5] To the extent that these characteristics, including structure and performance, exist in other industries, one might speculate that problems of innovation might be similar.

Other than the age of the industry, the process of innovation in mature industries has been evolutionary rather than radical

can without excessive costs influence all phases essential to the process, technical change breaks down quickly once it is introduced.[9]

A second factor creating an obstacle to innovation is the emphasis on present production. In the textile industry "there is massive and often effective resistance to any innovation that would require a significant change in production."[10] And what innovation that is sought is usually relatively minor. For example, Mansfield found that over 70% of R and D expenditures in textiles were expected to be recovered within three years.[11] In machine tools, the Little report found, "/T/he industry as a whole is subject to a tendency on the part of much of American manufacturing industry to stick to its commitment to methods and machines of manufacture."[12] Brown found in his study of the machine tool industry that innovation took place at low levels of demand when production would not be lost during the training period or the change-over period.[13] Although loss of production in the building industry is probably less than in the other two because of the smaller capital investment, as building becomes more industrialized (e.g., greater off-site manufacture of prefabricated components), the problem could conceivably arise in the future.

A third problem which stiffles the incentive to innovate is the resistance of social systems. In the machine tool industry the small firms are usually built on a single technology around which has developed a specialized labor force. According to the Little report, management also resists change:

> In the machine tool industry, for example, the 400-odd members of the M.T.B.A. [Machine Tool Business Association] know one another, have wide areas of agreement in views, and tend to regard themselves as a tightly-held private club in whose interest it is to resist outsiders, proposals for radical change, government interference, and the like.[14]

In the building industry, social resistance to change is an acute barrier to innovation. Baker has argued:

> [N]o building operator, no building company can put up a structure independently of craft union influences. There is no piece of land on which a structure can be erected without the craft union's directing how it should be done. The construction industry cannot even undertake an experiment.[15]

Commitments are strongly attached to certain methods on which skills and division of labor are based. Labor's resistance to off-site production, the use of power tools, and labor-saving components and building management's resistance to architectural conceptions offer illustrative cases.

The circular reinforcing resistances to changes does not appear in the "new industries." Its distinguishing features are: (a) firms have sophisticated technical bases in which science and technology have fused to a very great extent; (b) although many of firms have reached a degree of economic maturity (in terms of declining prices and productive capacity), the industry as a whole is characterized by potential and perpetual technical change. Innovation is largely dependent on the widening of business parameters for which the industry can supply its high-quality "component" products.

A critical problem for innovation in these industries is the creation of markets. To those firms which have produced largely for defense-space programs, the Federal government, or its prime contractor, has provided a market establishing performance requirements for the product or component demined. For those providing goods mainly for the civilian markets, unique buyer-seller relationships have evolved.

In his study of new science-technology industries in the Boston area, Shimshoni found that "communication of market needs is critical and often more difficult than communication of technology, particularly for new products, understanding or processes. . . ."[16] The entire system, its specifications and implications, requires interaction between competent representatives of firms and a close market relationship between purchaser and seller, especially when tailor-made products, rather than standardized components, are produced. Moreover, Shimshoni argues:

> Segmentation by virtue of specifications requiring unusual performance and rare qualities, can give a firm an advantage if there exists a demand or it can be created.[17]

While new technologies can create a new demand, this occurs usually "only after their potential can in some way be demonstrated to the user . . . which may require an investment of considerable time and money."[18] His preliminary findings concluded:

> For nearly all cases examined, there was a visible market potential . . . and the entrepreneur had developed either special competence in a field or a specific

> technology within the parent organization, to a point where the initial market goals could be identified, and where comparatively small efforts were needed to demonstrate the needs for the technology or the capability of the new firm or its founders.[19]

Supporting many of the Shimshoni's findings, Schon's[20] study of the semiconductor industry stressed two additional points. First, even if the initial price for a device is rather high, if it can find a limited market and gain market acceptance, ". . . their use grows and their costs decrease until they are either available at low prices or are eclipsed by the next generation of new devices."[21] Second, the Federal government played an important role in the growth of the industry: (a) by "providing a market for new and improved semiconductor devices in the space and military programs;[22] and (b) by providing funds for R and D, especially after 1956, and paying for 'almost all engineering design and development. . . .'"[23]

The above studies provide some basis for comparison of problems of innovation in "mature" and "new" industries. While in the former, fragmentation presents a problem, in the latter it might give a firm an initial advantage. For "new" industries, marketing is a critical problem,[24] while the major problems in mature industries appear to be a lack of financial resources to invest in R and D but most important the lack of individual incentives to break an almost ceaseless vicious circle of resistance to change. Innovation in mature industries has been through

invasion; in new industries, as Schon pointed out, "/T/here was no modification of the old industry to accept the new developments. Rather, new businesses and new plants were formed to accomodate the new discoveries."[25]

Factors Affecting the Rate of Innovation

The following pages will summarize factors, both economic and noneconomic, which have influenced innovation. The purpose here is to determine the factors on the supply and demand sides which influence innovation. The several strategies, discussed in the following chapter, are designed to influence some of the factors discussed below.

Studies of the impact of sociological factors on the rate of innovation have centered largely on the rate of diffusion of technology in agriculture. For our purposes, however, problems of innovation in agriculture are similar to those with which we are concerned: for the problem was not to develop technologies but rather to apply existing technologies often developed in the Department of Agriculture laboratories and experimental stations.[26] In order to increase the application of new techniques, home and field demonstration agents, as well as demonstration and experimental farms, were necessary. Based on studies by Rogers[27] and others, the following is a summary of the important factors affecting innovation in agriculture.

First, the "change agent," defined by Rogers as a "professional person who attempts to influence decision in a direction

that he feels is desirable,"[28] plays an important role in promoting change as well as impeding it. The adoption process consists of five stages: awareness, interest, evaluation, trial, and adoption.

Second, the "extent of promotional efforts by change agents is directly related to the rate of adoption of an innovation."[29] Rogers continues by arguing that commercial change agents are more important during the trial stage, for earlier adopters than for later adopters, because the latter put less credibility in commercial sources. Yet, complete adoption takes longer for the early adopters than for the later adopters; the former seem to hedge while the latter appear to incorporate the innovation into their entire program once successful application is demonstrated.[30] Studying rates of diffusion in education, Ross found that rate of adoption of driver training programs by high schools was much greater than adoption of other education innovations. He attributed this rapid rate of adoption to promotion efforts of car dealers, insurance companies, and the American Automobile Association.[31]

Third, citing the conclusions of his own previous surveys, in addition to others, Rogers concludes: "There is little evidence that lack of knowledge about innovation actually delays their adoption."[32] Mass media seem to be ineffective in the adoption stage; especially in the evaluation and adoption stage, personal contact is most important. Moreover, "the change agent's clients must perceive a need for an innovation before it can be successfully introduced."[33] Similarly, the change agent should be more concerned with

improving the client's competence in evaluating new ideas rather than attempting to promote innovation per se.[34]

A second group of factors influencing innovation are embodied in the "crisis" theory of innovation. Although the cause of the crisis might be economic or political, the crisis itself is the contributing force to the intrcduction of the innovation. Sutherland[34] found that a large factor accounting for innovation in 16 textile mills in postwar England was the extreme labor shortage caused by the war and rehabilitation thereafter. In his study of school building systems in England, Ehrenkrantz attributed the rapid increase in the use of prefabricated components to the war damage and acute shortages of building materials.[36]

Another factor which some regard as very significant for influencing innovation is the presence or lack of a "champion." Schon has argued that "the first and most essential step [in the innovation process] is recognizing resistance to change and accepting it rather than driving it underground."[37] According to the Little report, the champion, seldom present in mature industries, "fight [s] uphill against funded resistance to change. His incentive is apt to be not only profit but the adventure of radical change, and to these ends he is willing to take high risks both inside and outside his company."[38] Maclaurin found in his study of the radio industry that "the most successful companies have been dominated by strong personalities who were innovators; . . . and none of them was dominated by an inventor."[39]

As one considers the economic factors influencing innovation, one sees an unsettled argument abounding in the literature: whether or not a quasi-monopolist structure is more conducive to innovation than as a competitive market structure. Schumpeter[40] and Galbraith[41] argue that competitive forces preclude technical development. Nutter,[42] Schmookler,[43] and Carter and Williams[44] doubt or deny the necessity of "bigness" for innovation. Settlement of the argument, if in fact there exists a clearly unambiguous answer, is not offered here. Rather for our purposes, the relevant question is this: if large firms do respond to innovation more quickly than small firms, what factors contribute to this advantage? If these factors then can be influenced by public policy, the alledged advantages of bigness regarding innovation could conceivably be made available to smaller firms without the adverse effects of bigness and monopoly power.

In his study of 14 major innovations in the bituminous coal, iron and steel industries, Mansfield found that the response of firms to an innovation tends to be inversely related to its size. He attributes this size advantage to three factors:

> First, the costs and risks involved in being among the first to use a new technique are likely to loom much larger for small firms than for big ones. Because of their larger financial resources, bigger engineering departments, better facilities for experimentation, and closer ties with equipment manufacturers, bigger firms can play the role of the pioneer more cheaply and with less risk than smaller ones.
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> Second, large firms, because they encompass a wider range of operating conditions, have a better chance of containing those conditions for which the innovation is applicable at first. This is important because

> when an innovation first appears, its application is often restricted to certain operating conditions, and improvements occur later that extend its usefulness. . . . Third, because they have more units of any particular type of equipment, large firms are more likely at any point in time to have some units that will soon have to be replaced. Thus, if an innovation occurs that is designed to replace this type of equipment, they probably can begin using it more quickly than smaller firms.[45]

A second factor which influences the rate of innovation is the expected profitability from investment in the innovation: the higher the expected profits, the greater the willingness of the firm to gamble on the application of a new technique at the onset. Mansfield concluded "/I/f the innovation is considerably more profitable for one firm than for another (of equal size), the probability is generally quite high that the former will be quicker to introduce it."[46]

Although research and development, especially the former, usually are separated from innovation by a period of time, its general relationship to technical change is seldom rejected. Mansfield has pointed to three significant findings regarding the relationship between innovation and R and D expenditures by the firms. First, if the size of the firm is held constant, "there seems to be a close relationship over the long run between the amount a firm spends on R and D and the total number of important inventions it produces."[47] Yet, if R and D expenditures are held constant and the relationship between size of firm and the productivity of R and D spending is considered, Mansfield found that "the inventive output per dollar of R and D expenditure in most of these cases seems to be lower in

the largest firms than in the large and medium-sized firms."[48] And last, with size of firm constant, an increase in R and D expenditures leads to a more than proportional increase in inventive activity only in the chemical industry, i.e., the only one indicating economies of scale in research activities.[49]

In a similar study of the chemical industry, Minasian[50] found that R and D expenditures explained a large part of the 18 firms' increases in productivity and profits. He also suggested that investment in R and D and in innovations in plant equipment "are competitive rather than complimentary."[51]

A fourth factor influencing innovation is related to profits but in a unique way. Mansfield has called it the "bandwagon" effect.[52] Initial market and investment uncertainties make it difficult to estimate profits from innovation and as Mansfield explains:

> As more information and experience accumulate, it becomes less risky to begin using it. Competitive pressures . . . occur. . . . /T/he mere fact that a large proportion of its competitors have introduced it /innovation/ may prompt a firm to consider it more favorably. Both interviews with executives in the four industries and the data . . . indicate that this is the case.[53]

Concluding this rather cursory examination of the variables which appear to influence innovation and more generally inventive activity, the task of the next chapter is to develop strategies which might affect the above, thereby increasing the rate of innovation.

V. Strategies for Using Federal Procurement to Increase the Rate of Innovation

The preceding chapters were designed to provide a framework on which to develop the following three general strategies. Discussion of each will be concerned with models on which each might be based, the problems involved in implementation of application, and the anticipated influence of each on the rate of innovation.

The purpose of the first strategy is to create a limited demand for existing techniques and technologies by introducing innovation into Federal public service programs. An initial objective would be to reduce the costs of existing programs or the more probable case of achieving a higher level of performance at existing costs. Two slight variations of this strategy will be distinguished: (a) to substitute performance language in procurement policy, and (b) to choose large-unit programs to which a "systems" approach can be applied.

The purpose of substituting performance language and test methods designed to measure performance for detailed product specifications is to provide a market opportunity for firms whose products can perform new functions, either separately or as a component of a system. The emphasis is on applying known technologies rather than a plea for further research and, in most cases, development.

Several arguments can be advanced for this proposition. First, product specifications do not usually change as quickly as technology advances. As a result, the incentive for the contracting firm to initiate product improvement, which might not meet the physical specifications, is deadened.

Second, product specifications limit the competition from innovating firms. Indeed, the utilization of performance requirements rather than product "specs" used by the DOD, the Services, NASA, and prime contractors in requesting bids for large weapon systems contracts is one of the few means of promoting competition initially in defense-space markets. If similar performance criteria were required in nonweapons areas of procurement, not only would "old" firms be free to innovate but "new" firms would have the opportunity to compete for Federal markets.

Federal procurement programs which could be affected by the substitution of performance language are innumerable ranging from pencils to building systems," as one Administration official has stated.[1] Performance criteria has recently been applied in the procurement of automobiles by the General Services Administration and other Federal agencies. A team of experts in GSA, directed by Congress, has recommended that 17 new safety features, based on performance criteria, be incorporated into all 1967 models which it will buy.[2]

Government housing offers another potential for incorporating performance language into procurement contracts. One of the largest problems in housing today is the presence of obsolete building codes, originally designed for safety but acting now as a barrier to innovation.[3] If the Federal government were to increase the use of performances criteria in its own residential buildings (20,417 units

of military housing in 1960),[4] the standards developed and tested in Federal programs could then provide guide lines for State and local governments as well as for Federal Housing Administration (FHA). The impact of the latter on innovation is so great, according to a PSAC panel, "that it is almost impossible to achieve any major utilization of innovation in materials, equipment or construction techniques in the housing industry without first getting FHA approval."[5] The Federal government through its purchases and grants and loans programs influenced more than $8.7 billion worth of building and construction or about 14% of total volume of building and construction in F Y 1964. Using loan guarantee programs of the FHA and VA, private citizens purchased $10 billion of housing, of which $3 billion was residential construction. Not only is the "FHA minimum property standards" influential directly, but also indirectly since many lending institutions granting conventional mortgages require FHA standards.[6]

Since it would appear that merely changing to performance language would be administratively easy, why has not this occurred? Rather than answer that question, a discussion of some of the problems which are involved is in order.

In the first place the difference between performance criteria and "specs" (design or product) is a matter of degree rather than kind. Moreover, there exists the difficulty of

finding a trade-off between flexibility and standards which have to be defended. If uncertainty of expected performance exists, the conservative tendency to adhere to the old and the proven often dominates.

Secondly, administrative problems exist because of the filtering down process between performance development and application. As one study noted:

> Procurement offices generally are charged with the preparation and over-all implementation of research and development contracts, while negotiations, selection of contractors, and active supervision of contracts are usually the responsibility of programming offices.[7]

Aside from the administrative problems resulting from bigness, a third problem is finding technically competent officials who can review and analyze existing programs of nondefense procurement in light of new efficient alternatives whose technical characteristics might perform certain new functions. Therefore, determining the performance criteria and test methods could present a problem.

However, this problem could be minimized by establishing internal technical liason staffs. Technical competence existing in NBS, AEC, and NASA labs could be used. The staff, not necessarily a permanent part of the procuring agency, could function in a similar fashion to the Merchandise Testing and Development Laboratory (MDTL) of Sears, Roebuck and Co., which buys and distributes, rather than sells. On the basis of the function and market value to the customer, the buyer decides what the customer will purchase; then,

the buyer consults the MTDL which considers the legal, economic, asthetic, etc. parameters of product development. The necessary performance within relevant price ranges are formulated and in turn serves as a basis for soliciting suitable responses from commercial sources of supply. The buyer is concerned with performance and function; the technical staff enables him to establish a working basis with potential suppliers. The important aspect is the feedback between the buyer and the consumer, the buyer and the staff, and the buyer and the sources.[8]

The second variation of the first strategy emphasizes relatively large-scale Federal projects to which systems analysis can be applied and provides additional incentives and advantages for influencing innovation. A model, which at the least could be used as a conceptual guide, is the School Construction Systems Development Corporation (SCSD), established in California in 1963. Headed by architect Ezra Ehrenkrantz, SCSD has introduced a new approach to school construction in the U.S. It was based in turn on an approach taken in the U.K. after World War II.[9]

Working on the premise that the construction of one school would not provide incentives for manufacturers and contractors to provide their own funds for R and D in building materials and components, Ehrenkrantz contacted 13 school districts who were to build 22 schools over the next five years. Accordingly, bids were requested from manufacturers on all the schools at one time in order

to provide the large-scale market.[10] The project staff worked with school officials and their architects to develop performance specifications of the structural system, air conditioning, lighting-ceiling, and interior partitions, which together accounted for about 50% of total construction costs. As Professor Ehrenkrantz emphasized:

> Different manufacturers would, we knew, take different routes to meet the performance criteria, but performance would provide a basis for competitive bidding.
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> The basic idea here is to develop new products. Once they are developed and used in a sufficient number of schools, if they are useful and the approach is successful, they can then be used thereafter on an individual basis by any architect.[11]

Several nondefense programs carried out by Federal agencies offer potential for combining the advantages of performance requirements and "large-unit" markets. In the DOD two such projects have already been initiated. The first is a large-scale family housing program for service personnel designated as "Project 12." A PSAC subpanel on housing noted that the objective of the program were:

> . . . to test new construction techniques designed to increase productivity and reduce costs in the military family housing program. DOD's world-wide, extensive family housing program provides a unique opportunity for testing new techniques and materials. This program is unhampered by restrictions found in municipal codes and zoning regulations, as well as by the problems associated with marketing new end products. Cost-reducing and improved techniques resulting from such successful experiments will be passed on to the civilian housing industry which will collaborate in the program.[12]

At the beginning of the current year, the DOD initiated a large-scale project to reduce costs of providing hospital care

for military personnel and their dependents. The preliminary proposal includes the construction of three prototype hospitals: (a) a major 500-bed teaching hospital for highly specialized treatments; (b) a 250-bed station hospital providing limited specialized care; and (c) a small satellite hospital.[13] Although costs savings are expected, the increase in performance is even more certain:

> Innumerable unrelated research projects have been conducted to improve the efficiency of hospitals; however, there is no evidence that any research and development efforts to date have approached the hospital as a complete system in an attempt to properly relate all new developments to all hospital departments. Nor is there any known program which would take advantage of all the capabilities to the hospital as a system.[14]

An important objective of the proposal is:

> /T/o make maximum use of automated systems, advanced electronic communications, patient monitoring systems and other labor-saving devices. . . . Many features of this program will be adaptable to civilian medical facilities and other Government hospital operations. It is anticipated that this program will establish new patterns for medical care and treatment with material contribution to and acceleration of medical progress.[15]

Future attempts to progress along the lines of the DOD housing and hospital programs will be faced with several difficulties. First, the very nature of the Executive branch poses limitations on concerted efforts to consider entire programs analyzing their functions in light of new efficient technologies. For example, the "provision of health care" (broadly defined) is performed by the DOD, Department of HEW, the Veterans Hospitals,

and the Public Health Services among others. Interdepartmental and agency overlapping in many cases thwarts initiative to consider entire functional programs.

Jurisdictional problems existing within departments also dulls initiative. In the DOD, for example, a complete review and analysis of large support or civilian-type programs of procurement would mean crossing Service boundaries, office lines within the Office of the Secretary, as well as cutting across the mission-goal concept of defense budgeting.

A third problem involved in using Federal agencies to implement this strategy is that each agency has its own mission, which only implicitly is to reduce costs through applying new technologies. The DOD, for example, has usually taken the stand that its mission is to provide for national defense, not for "spin-off." Since military "hardware" is uniquely defense-oriented, the major proportion of its research and development funding has been for this type of procurement rather than for nonweapons areas.[16]

Congress also presents a problem, which Mr. Baker of Bell Laboratories has pointed out:

> There will be a serious effort in the near future to start laying out some of these priorities in forms which can elicit public understanding and debate. But this effort will have to face the fact that the first item in the budget which Congressmen usually slash is the section dealing with public understanding of science.[17]

A similar problem is likely to occur when DOD representatives request appropriations for new civilian-type projects in the defense

budget. Few Congressmen feel that they have the expertise to recommend reductions for highly-sophisticated weapons systems, but most feel that they are competent to make judgments in civilian-type programs such as housing and education. When the defense budgets are reduced, the latter usually receives the largest proportional cuts.

Given these problems, however, there are indications of changes conducive to implementing this strategy. The Bureau of the Budget (BOB) announced in April that it was using a large portion of the 25% increase in its own budget to establish an office which would perform costs analyses similar to those used in the DOD to reduce cost in large nonweapons procurement programs.[18] The office, headed by two former Rand Corporation economists, could conceivably review and analyze existing programs and could develop performance criteria to be used by procuring agencies. It should be in a central position enabling it to consider entire Federal programs to cross department boundaries when necessary and to provide a focal point for firms who wish to supply new "products" for the Government.

Assuming that the problems of implementing this strategy can be minimized, one can speculate on its potential effect on the rate of innovation. First, one of the critical problems facing the new science-technology based firms is creating or finding a market for its new products. By substituting performance language for product "specs," the Federal programs could provide limited

markets and inducements to experiment with new applications of technologies existing in laboratories. At the least, mere knowledge that the Federal government is emphasizing performance criteria could evoke a response from firms to contact procuring agencies - action which by itself could establish a buyer-seller relationship which might prove important for future markets.

Secondly, the development and testing of performance criteria in Federal programs would provide standards which could be used by State and local governments as well as by private industry. Indeed, performance standards tested in Federal housing projects, e.g., Project 12, could provide the empirical evidence on which the recently-appointed Commission on Building Codes could base their recommendations in its report to the President.[19] Such standards could stimulate innovation in the building industry.

Thirdly, following the SCSD example, the combination of performance requirements and large-scale Federal projects could provide the necessary incentives for firms to finance their own development and perhaps research efforts.[20]

The second main strategy is concerned with the rate of innovation as it is influenced by the inventive activity. The proposition is that the Federal government in its own interest to reduce (minimize) costs of existing (new) programs should allocate funds for R and D for procurement of those goods and services of which it is a relatively large purchaser. A priori, one might

expect that pay-offs from R and D would be highest in those industries whose firms spend relatively little on R and D. Since little of no applied R and D is financed in public service programs by State governments, a second consideration would be whether State and local government programs could apply innovations in Federal programs to their own.

A third consideration would be whether "parallel" R and D[21] efforts should be followed. Since, in most cases, the risks and uncertainties would be less and the time factor not as critical in nonweapons areas as that in weapons programs, one might naturally conclude that the "systems" approach would be the most efficient. Even one of the strongest advocates of "parallel R and D," Burton Klein, has conceded that if the technology "does not involve any new scientific principles" the systems approach might be desirable.[22] However, if one weighs heavily the importance of innovation through invasion (either by a firm, movement of technical people, or introduction of processes), then it is not all obvious which firm's product will provide the best performance. Indeed, one purpose of the strategy is to increase "functional" competition. For example, would the DOD allocate funds to develop more efficient refrigerators for meats or to underwrite the development of electronic freeze-drying techniques which would make the former redundant? A second limitation to the systems approach revolves around this question: are the scientific principles involved in existing technology known? Arguing against

standardization and the "wholesale" application of existing technologies in programmed instruction, the chief of staff of the Air Force Training Command maintains:

> This would be most unfortunate. Programmed instruction is truly in a primitive state as an art. No one should or ought to hazard a guess at this point as to the form this instructional technology will take 10 years hence.[23]

Considering the number of industries from which the Federal government purchases goods and services, one could enumerate many potential areas where costs reduction might result from additional R and D expenditures. For example, the DOD purchases about 7%[24] of all fuels and lubricants, sold in the U.S.; the costs reduction from marginal R and D funding could be significant. Perhaps, most important, it could require standards which would reduce the amounts of contaminants released during combustion. To the extent that "contaminant-free" fuels could be used by motorists, air pollution problems could be minimized.

Federal programs in education, presently following the strategy outlined above, are being carried out by the year-old Office of Economic Opportunity (OEO) and the Air Training Command in the Air Force.

Since 1961 when the ATC was created, it has become the largest automated teaching program in the U.S.[25] Over 8,000 ATC personnel now have some familiarity with the concepts, terms,

principles, techniques, and procedures of programmed instruction.

According to one of its creators:

> To date the Air Force has conducted a total of 17 special training courses; it has trained a total of 353 personnel for the Air Force as instructional programmers. . . . David Klause of the American Institute of Research estimated last year that the Air Training Command courses in programmed instruction, in essence, doubled the number of trained instructional programmers in the United States.[26]

The successful research, development, and application of education technology in the ATC could be emulated by the other two services. The Army has been developing a prototype computer classroom, initially designated Plato 1.[27] Yet Navy and Army attempts to utilize programmed instruction and audio-visual techniques have been relatively small compared to the ATC.

The OEO is probably the best example of the use of Federal procurement to develop and introduce innovation in the general area of education. The success of the ATC's output of programmed instructors is attested by the fact that the OEO has drawn upon programs used in the ATC, while its contractors have sought to hire ATC-trained personnel. A unique aspect of the Job Corps centers is that most of the contractor firms have received CPFF contracts, which have underwritten the development costs of certain education technologies.[28]

Of the 32 firms issuing bids for operating urban job centers, at least two have already developed education technologies and are looking to the centers as markets in which to prove their performance.[29]

Federal R and D for improving solid-waste deposit systems offers a third of potential area of application. About $2.7 billion are spent annually by the private sector and municipal governments. Only $70,000 annually of Federal funds have been spent on R and D in this area. The argument is that the DOD could develop performance requirements for solid waste disposal systems at military bases and provide an opportunity to generate innovation in this large area of local government procurement.[30]

The problems involved here are similar to those noted above in addition to persuading Department heads and Congressmen to authorize R and D expenditures; however, this strategy should provide additional incentives for encouraging innovations.

First, where development risks are involved, CPFF will reduce substantially these risks. It would appear that this factor has influenced the decisions of several firms, especially defense firms, to enter the education industry.

Second, if R and D expenditures by firms are competitive with investments in new technologies, as Minasian suggested above, and if federally-financed R and D funds are complimentary to privately-financed funds, then one might anticipate that federal funds might evoke more innovative activity.[31] Moreover, even without the "complimentary effect," since expenditures on R and D appear to be highly correlated with the inventive activity over the long run, one could anticipate encouraging results.

Although the last "strategy" is actually a "consideration," it has been given the former distinction because of its significance to the rate of innovation. The important consideration is to create a demand on the part of State and local governments for public service innovations by demonstrating their successful applications in Federal programs. While the previous strategies have been directly concerned with increasing inventive activity and innovation within industries or firms, this strategy purports to overcome the nontechnical obstacles to innovations by influencing local officials and/or their constituencies. Indirectly, to the degree that such a demand is created, the inventive activity within the firm and industry would increase.

The justification for this consideration has been elaborated in Chapter II.[32] The model which provides a conceptual framework is the agriculture extension program which has been conducted since before the beginning of the century.

The extent to which nontechnical obstacles impede innovation in State and local programs is difficult to prove for no one can define unambiguously the "best" rate of change for the economy. Administration officials, who have dealt with the problem, however, are convinced that these obstacles exist. Arthur Barber, a student of "industrial conversion," has argued:

> The major obstacles to such efforts /for defense firms to diversifyinto public service areas/ have proved to be not a shortage of skills and technology, or economically sound programs, but the habits and regulations of the American people. State, local, and Federal

governments, business, labor, and professional groups have regulated our society to such a degree that the introduction is very difficult. It is literally easier to apply modern technology to the design of living quarters for men in outer space than for men on the surface of the earth.[33]

Specific obstacles include among others: (a) local officials' desire to "buy locally;"[34] (b) the influence of labor unions on building codes;[35] (c) "inadequate information and limited vision;[36] (d) fragmentation of local governments;[37] and (e) custom and tradition, which tend to look for "product" needs rather than "functional" needs.[38]

Demonstration projects have been used in the past by Federal agencies other than the Department of Agriculture, but in limited measures. The House and Home Finance Agency had established, by the middle of 1963, 23 low-income housing demonstration projects, which tested new designs, materials, and methods of climate control.[39] About $8 million of the initial $20 million appropriated the "Northeast Corridor" transportation project will be allocated to "demonstration" projects to test new technologies in railway transportation and the response of consumer demand to different modes of travel.[40]

Considerations which might prove significant for maximizing the demonstration effect should be noted. Given the political constraints, where should the demonstration projects, e.g., Job Corps centers, be located? What approach will minimize the traditional "Federal-State-local" problems and still get the job done? The OEO appears to be influencing local governments through the contractor

firms with which it has contracts. Since the Federal government has no "advertising department," should it include in contracts as allowable costs some of the marketing costs expended by these firms?

Affirmative answers to some of the above questions could provide firms with the necessary incentives to enter new public service programs. However, to the extent that State and local demand can be created, and then realized once having been created (e.g., through Federal grants or loans), the long-term profit potential might be high enough to draw new "invaders" into these markets. Referring to companies bidding for Job Corps center contracts, the Wall Street Journal noted that these companies "view the Job Corps as an opportunity to get a foothold in the growing field of basic education."[41] From the evidence available, it would appear that the industry response to programs in the Great Society supports Mansfield's "bandwagon effect."[42]

In summary, the strategies which have been listed above purport to increase the rate of innovation in public service programs by: (a) providing limited markets for technologies developed by the "new industries, thus reducing market risks; (b) by reducing the development risks through CPFF contracts or providing R and D funds; (c) by promoting innovation through invasion (e.g., in building) by substituting performance language and considering large Federal projects on a functional basis; (d) by assuming the

role of the "early adopters," experimenting and testing in the "trial" stage and providing the information for State and local governments during the "evaluation" stage; and (e) by creating an optimal demand for innovations on the part of State and local governments.

VI. Policy Implications and Significance

The purpose of this paper has not been to determine the extent to which Federal procurement can be used to increase the rate of innovation. Indeed, if the reader scanned its pages with the hopes of arriving at a definite conclusion, he has missed the importance of its content - for the implications of and inferences drawn from our discussion are most significant.

Students of innovation and technological change marvel at the possibilities which science and technology offer society. Yet, frustrations arise when they read that man can orbit the earth in less time than he can drive to work or find that building codes will not permit him to use relatively cheap, nationally-advertised aluminum studs in his new house. Yet when he reads that hundreds of longshoremen could be displaced overnight by computer-directed docking and loading equipment or that computers can now perform the marketing role in a firm displacing the traditional salesman,[1] he can appreciate the question raised by Dr. Baker:

> How much change can you impose on people before the social structure breaks down? Can we afford a much faster rate of change. This consideration seems to impose some restraints which suggest that we should be looking for the places where we can safely innovate and not simply assume that we need more innovation in general.[2]

For our purposes the question could be phrased differently: at what point do the nontechnical obstacles to innovation become warning signposts on the road to "progress?" Since this paper was concerned with increasing the existing rate of innovation rather

than discovering that rate which is "best" for society, no answer is offered here. Moreover, a realistic appraisal of the expected impact of this proposition on the rate of innovation compared with other fiscal policy instruments is probably relatively limited. Raising the above question then implies, if any, indictment of motivation rather than effect.

A second inference drawn from the above discussion is that over the last decade the Federal government has, in fact, acquired a sector of industry which has grown under Federal "nurture" to almost $20 billion annually. A majority of the companies in the aerospace, electronics, and shipbuilding industries are not "firms" in the usual sense of the word but rather appendages of the DOD and NASA, organized for the most part for production without marketing and sales promotion capabilities. Their technical manpower and problem-solving "teams" can be used efficiently in few alternatives. One President maintained, "Only Governments need the large and complex systems we are organized to produce."[3] In the large aerospace companies, 80 or 90% of the capital equipment and physical plant is Federal property. Even if some could diversify into consumer or industrial equipment markets, normal fiscal policy instruments (e.g., tax incentives, new investment credits, etc.) would not provide sufficient incentives; direct subsidies might, but here the political problems noted earlier arise.

Without doubt the question of Federal responsibility toward these "defense-oriented" firms has been uppermost in the minds of Administration officials. The encouragement of these firms to diversify into government "nondefense" programs has provided a partial answer to the present problem. However, the important point to note is not whether in the short run this Federal "guidance" might be resulting in a misallocation of national resources.[4] Rather, the policy discussed in this paper is significant in that it indicates that a unique business government partnership has been established in defense "business," and is now expanding to nondefense public service programs.

The Government-defense firm partnership, however, is only one example of a current trend significant for the student of business control and unique to a peacetime economy - a quasi-partnership founded on "moral suasion" with slight and subtle overtones of "indicative planning" used in several of the Western European countries. An obvious example is the continued emphasis on "wage and price guide posts" established during the Kennedy Administration. A more recent example was the Executive branch request earlier this year that businessmen curtail foreign investments and import expenditures in order to help redress the balance of payments problem.

In a direct sense, business is increasingly being consulted, and even participating, in the planning of many of the new Federal programs. Litton Industries, for example, provided John Rubel, one

of its vice presidents, to advise Sargent Shriver on projects in the Job Corps.[5] And it appears that many of his recommendations for using private industry in the Job Corps have been accepted.[6] While providing the companies with footholds in new growth markets, the Administration appears to be using its contractor firms to influence local officials, thus by-passing thorny Federal-local governments problems.[7] And by providing jobs for Job Corps graduates, the contractors are guaranteeing the political success of the programs.[8]

The approach being taken by the OEO appears to be novel; yet, as Rubel commented in his initial memorandum:

> It doesn't seem to me that what I am suggesting here is anywhere nearly as radical as the new directions in which our country is already going in its relations between the public and the private sector and the undertaking of major projects by private enterprises.[9]

Undoubtedly, he had in mind the mixed public-private ownership and management of COMSAT, the company established to create a space-satellite communication system. Another "major project" which fits the above description is the so-called "Northeast Corridor" project, which according to Fortune:

> . . . /T/he mixed semipublic and private corporation . . . is winning favor in Washington, for the great success of COMSAT indicates that the public is ready and willing to invest in long-run technological ventures in which both the government and major industrial elements are represented.[10]

The "quasi-partnership" approach, of which the policy topic of this paper is only a facet, indicates one trend in

business control. The policy to use Federal procurement to influence innovation is significant for another reason.

Professor Kaysen[11] has argued that "progressiveness" is a desirable economic result which antitrust policy should promote. An important inference which might be drawn from the discussion throughout this paper is that Federal procurement can be used to promote a similar end, especially by influencing innovation in those industries which sell goods and services to the Federal government. By allowing for R and D costs in Federal contracts and at the same time requiring performance standards, the Government could influence innovative activity increasing both product and functional competition.

That Federal procurement could be utilized effectively as an instrument to promote progressiveness in firms, industries, or in the aggregate, would deperd on a host of other considerations among which might include: (a) the patent policy with regards to inventions resulting from Federal contracts, i.e., whether the contracting agency retains title or license rights;[12] (b) the market shares and performance of the firms within the industry; and (c) the existing structure of the industry, including concentration of market shares and privately financed R and D.

Without examining the above considerations in detail, one can imagine the serious study which would be required for effective use of Federal procurement to influence progressiveness through increasing the rate of innovation and at the same time to promote

competition. Yet, given the above considerations, the magnitude of procurement and the bulk purchasing power of the Government, the mere fact that the Federal government has monopsony power and does not operate under the market mechanism is reason for concern. Hopefully, this power will be used to encourage innovation rather than impede it.

Appendix I

Patterns of Federal Procurement

Although this paper is concerned with the conceptual idea of using Federal procurement to influence innovation, a rough approximation of the potential effect requires some discussion of the magnitude of Federal and State and local purchases from certain industries and the functional programs carried out on Federal as well as lower levels.

First, what percent of an industry's output is sold to the Federal and lower governments? These figures, shown in Table I, Columns 3 and 4, will give a rough approximation of the monopsony power of the Federal government on that industry as well as the magnitude of potential cost reduction benefits through innovation.

Second, in order to provide an approximation of the potential benefit which State and locals might receive from innovations induced by Federal procurement in industries, Table I, Columns 1 and 2 shows the percentages of the governments' budgets spent directly for industrial output.

The figures in Table I provide an indication of the products purchased by the Government rather than the functions for which they are used. Indeed, any effort to reduce costs of Federal programs and increase spin-off to lower governments will have to consider functional expenditure programs. Table II will give an indication of the magnitude of direct expenditures by all levels of governments in functional public service programs.

The data on Federal expenditures per functional program (Column 2), however, do not include the DOD-NASA funds allocated for programs such as housing, education, etc.; rather, these programs are lumped under "National Defense and International Relations."

Next, in order to determine what procuring agencies could be used to implement a program to increase innovation by changing procurement regulations, specifications, etc., Federal procurement in FY 1964 was broken down into purchasing agencies. Of the $34.04 billion of goods and services purchased in that year, the DOD accounted for $26.23 billion, of which $5.5 billion was spent on "other than hard goods" and $1.8 billion on services.* The DOD is by far the largest single purchaser of nonmilitary procurement followed by GSA with $1.18 billion. Table III shows the breakdown of DOD and GSA procurement of "other than hard goods" and its magnitude in relation to national shipments. Since new construction appears to be one of the largest areas of procurement for both Federal and State and local governments, Table IV is presented in order to show the functional breakdown of this procurement area.

The above data do not prove that Federal monopsony power can increase innovation. However, it does point several relevant observations: (a) that the Federal government is a relatively large

*This information was provided by the IAT. See Memorandum by Don Schon, National Bureau of Standards, to Patrick Conley, Nov. 2, 1964.

purchaser of goods and services from many industries;* (b) that in many industries from which the Federal government would receive the benefit of cost reducing innovations, State and locals also would probably benefit; and (c) that the DOD is the largest single purchaser of goods and services in both weapons and nonweapons areas.

*Using the 1958 interindustry indices, Benoit estimated that the Federal government had purchased annually over the last three years over $100 million from 39 of the 85 industries listed in the 1958 input-output study. Cf. Benoit, op. cit., p. 11.

Table I

Selected Nonmilitary Industrial Outputs
Sold Directly to Governments: 1958

Industry	Percent of Total Governments' Expenditures (1) Federal	(2) State and Local	Percent on Industry's Output Purchased Directly (3) Federal	(4) State and Local
New Construction	6.32	29.75	6.5	23.0
Maintenance and Repair Construction	1.98	8.28	6.3	19.9
Scrap, Used, Secondhand Goods	.22	.84		
Transportation and Warehousing	2.70	.99	4.2	1.2
Motor Vehicles and Equipment	.57	1.00	1.3	1.9
Chemicals and Selected Chemical Products	1.38	.60	6.1	2.0
Petroleum Refining and Related Industries	1.35	.94	4.0	2.1
Food and Kindred Products	.41	.67	.3	.4
Electric, Gas, Water, and Sanitary Service	.65	1.20	1.7	2.4
Printing and Publishing	.17	.43	.7	1.4
Drugs, Cleansing, and Toilet Preparations	.25	.44	2.0	2.7
Office, Computing and Accounting Machines	.14	.22	3.3	3.9
Communications (excluding Radio and TV Broadcasting)	.32	.47	1.8	2.0
Medical, Education Services and Nonprofit Org.	.22	.77	.5	1.4
Chemical and Fertilizer, Mineral Minings	.02	.03	1.9	2.1
Miscellaneous Fabricated Textiles	.19	*	4.5	*
Paper and Allied Products (except Containers)	.13	.01	7.0	.1
Rubber and Plastic Products	.22	.18	1.7	1.1
Stampings, Screw Machine Products and Bolts	1.7	.01	2.5	.1
Materials Handling Machine and Equipment	.25	.12	2.4	4.5
Other Fabricated Metal Products	.21	.11	1.7	.7
Machine Shop Products	.08	.09	2.6	2.2
Service Industry Machines	.12	.05	2.9	.9
Automobile Repairs and Services	.24	.20	1.6	1.0
Office Supplies	.14	.33	5.5	9.7

Source: U.S. Department of Commerce, "Interindustry Structure of U.S.," Survey of Current Business (November, 1964), pp. 11, 14.

* Less than .005 %

Table II

Direct General Expenditure by Function, by Type of Government: 1962
(in millions of dollars)

	(1) All Governments	(2) Federal Government	(3) State Government	(4) Local Government	(5) (2) as % of (1)	(6) (3) as % of (1)	(7) (4) as % of (1)
Education	22,814	598	4,270	17,946	2.6	18.7	78.7
Institution of Higher Learning	4,042	(1)	3,634	408	-	89.9	10.1
Local School	17,739	-	202	17,537	-	1.1	98.9
Other	1,032	598	434	-	57.9	42.1	-
Hospital	4,791	1,118	1,878	1,795	23.3	39.2	37.5
Health	1,344	675	283	386	50.2	21.1	28.7
Police Protection	2,326	196	276	1,854	8.4	11.9	79.7
Local Fire Protection	1,124	-	-	1,124	-	-	100.0
Sewage	1,272	-	-	1,272	-	-	100.0
Sanitation Other Than Sewage	686	-	-	686	-	-	100.0
Local Parks and Recreation	886	-	-	886	-	-	100.0
Housing and Urban Renewal	1,701	548	8	1,145	32.2	0.5	67.3
Air Transportation	1,082	709	35	338	65.5	3.2	31.2
Water Transport and Terminals	1,388	1,096	91	201	79.0	6.6	14.5
Correction	846	51	508	287	6.0	60.6	33.9
Libraries	340	-	21	319	-	6.2	93.8
General Public Building (S&L)	603	-	130	472	-	21.6	68.8
Natural Resources	12,194	10,823	873	398	88.8	8.0	3.3
Highways	10,508	151	6,635	3,722	1.4	63.1	35.4
National Defense and Internat'l Relations	53,225	53,225	-	-	100.0	-	-

Source: U.S. Bureau of Census. Census of Governments: 1962, Vol. IV, No. 4, Compendium of Government Finance (Wash: GPO, 1964).

Table III

DOD Procurement of Other Than Major Hard Goods[a] (FY 1964)

	Procurement by GAS (FSS) $ Mill. (1)	DOD Procurement $ mill. (2)	Col. (2) As % of Col. (1) + Col. (2) (3)	DOD Procurement as % of National Shipments: 1962 (4)
1. Subsistence	4.8	778.1	99.3	2.00
2. Textiles, clothing & equipage	4.0	262.2	98.5	1.51
3. Fuels & lubricants	41.0	1,118.8	96.4	8.85
4. Military bldg. supplies	57.1	19.1	25.0	n.a.
5. Transportation equipt.	24.6	425.7[b]	94.5[b]	7.59
6. Production equipt.	28.6	59.5	67.6	n.a.
7. Construction equipt.	7.0	131.6	94.9	6.70
8. Medical & dental supp. & equipt.	9.8	82.4	89.3	1.94
9. Photo, equipt. & supplies	42.0	65.6	61.0	4.90
10. Materials handling equipt.	2.6	53.9	95.4	1.57
11. All other supplies & equipt.	613.9	689.0	52.9	.60
Total[c]	835.4	3,685.9	81.5	1.73[d]
Construction		1,118.0	100.0	1.83[c]
All actions less than $10,000		2,375.5		
Total[e]		7,180.2		

Notes: [a]Major hard goods include aircraft, missile systems, tank-automotive, weapons, ammunitions, and electronics and communications.
[b]Includes $425 million for noncombat vehicles.
[c]Percent of value of private and public construction.
[d]$3.68 billion as percent of $212 billion.
[e]Totals not added because of rounding.

Source: Col. (1), (2), and (3): Memorandum by Don Schon to Pat Conley, Nov. 1964.
Col. (4) calculated from Annual Survey of Manufacturers by Benoit, op. cit., p. 13.

Table IV

Public Construction 1958-1963
($ million)

	Federal		State & Local	
	1958	1963	1958	1963
Total	3,388	4,126	12,069	14,553
Residential	357	57	489	725
Industrial	407	448[a]	-	-
Educational	11	26[a]	2,864	3,017
Hospitals & Institutions	36	66	353	388
Administration & Services	123	214	408	592
Other Nonresidential Bldg.	31	316	421	457[a]
Military	1,402	1,222[b]	-	-
Highways	114	208	5,431	6,462
Sewage & Water	-	-	1,387	1,966
Public Service Enterprises	1	-	450	461[a]
Conservation & Development	885	1,393	134	222[b]
All Other Public Construction	22	75	132	289[b]

Notes: [a]below 1958-1963 peak.
[b]1962

Source: Excerpted from data in letter 12/3/64 to Emile Benoit from Mrs. Shirley Loftus - Nat. Income Division - U.S. Dept. of Commerce in Benoit, op. cit., p. 14.

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Footnotes

Chapter I

[1]Don K. Price, "The Scientific Establishment," Proceedings of the American Philosophical Society, Vol. 106, No. 3 (June, 1962), p. 235.

[2]Cf, U.S. Executive Office, Economic Report of the President, 1965 (Washington: GPO, 1965), p. 154.

[3]The use of Federal procurement to increase innovation was the topic of discussion of a President Science Advisory Committee (PSAC) meeting held in Washington on November 15, 1964. At the present writing, the report of the PSAC had not been completed. A similar proposal was suggested by the Subcommittee on the Problems and Policies for Industrial Conversion which reported to the Presidential Committee on the Economic Impact of Defense and Disarmament. Neither the Subcommittee's nor the Committee's reports have been published to date. A similar proposal has been made by the Organization of Economic Cooperation and Development (OECD), "Science, Economic Growth and Government Policy," Background Paper for Minsterial Meeting (Paris: OECD, 1963), p. 30

[4]See Edith Penrose. The Theory of the Growth of the Firm (New York: John Wiley and Sons, Inc., 1959), p. 81.

[5]There are some indications that the trend is toward standardization of certain types of Federal nonweapons procurement. See Kiplinger Newsletter (April 19, 1965), p. 1.

[6]See Peter B. Clark and James O. Wilson. "Incentive Systems: A Theory of Organizations," Administrative Science Quarterly, Vol. 6, No. 3 (Sept. 1961), pp. 129-166.

Chapter II

[1]The OECD recommended:

> Another way in which governments can favor technical innovation is by an appropriate contract policy. As the biggest single customer of the main sectors of industry such as construction, electrical, electronic and mechanical engineering, textiles, rubber, etc., the government has great possibilities of influencing industry so as to encourage technical progress, particularly in sectors where this progress is hampered by established habits and inertia of management. It is true that governments are already stimulating technical progress calling for competitive bids for government contracts; but much more could be done, especially in the so-called traditional industries.

[2]U.S. Congress, Senate, Subcommittee on Employment and Manpower, Readings on Convertibility of Space and Defense Resources to Civilian Needs: A Search for New Employment Potentials, Vol. 2, 88th Cong., 2nd Sess., 1964, p. 984.

[3]Robert Solo , "Gearing Military Research and Development to Economic Growth," reprinted from Harv. Bus. Rev. (Nov/Dec., 1962), in ibid, p. 886.

[4]OECD, op. cit., p. 30.
[5]According to Solo, of the 10,000 prime and associate contractors and more than 300,000 subcontractors, only 1,700 prime and associate contractors were being served by ASTIA at the end of 1962. See Solo, op. cit., p. 865.
[6]Cf. Edward Furash, A Preliminary Report on Technology Transfer (Arthur D. Little Inc., Cambridge, Mass., Mimographed) p. 29.
[7]For a brief discussion of the Civilian Technology Program presented to Congress in 1963, see David Allison, "The Civilian Technology Lag," reprinted from International Science and Technology (Dec., 1963), in U.S. Congress, Readings, op. cit., pp. 827-847.
[8]Cf. Jerome B. Weisner, "Science in Policy, Policy in Science," Bulletin of Atomic Scientists, Vol. 20, No. 2, (Feb., 1964) pp. 36-38.
[9]Cf. J. Herbert Holloman, "Science, Technology, and Economic Growth," Physics Today, Vol. 16 (Mar., 1963), pp. 38-46.
[10]Cf. supra., Chap. II, Footnote 1, p. 72.
[11]Cf. Washington Science Trends, Vol. 13, No. 16 (Jan. 18, 1965).
[12]Budget Statement for FY 1966 reprinted in New York Times (Jan. 26, 1965), p. 32.

Chapter III

[1]This theoretical interpretation of voting in a democracy has been attacked by those who argue that intensity can be revealed through "political influence." See Edward Banfield, Political Influence (New York: Free Press, 1961), pp. 330-337.
[2]Anthony Downs. "Why the Government Budget is Too Small in a Democracy," World Politics, Vol. 12, No. 4 (July, 1960), pp. 541-554.
[3]The exclusion principle holds that a person may be excluded from the enjoyment of any particular commodity or service unless he is willing to pay the stipulated price to the owner. See Richard A. Musgrave, The Theory of Public Finance (New York: McGraw-Hill, 1959), p. 9.
[4]Downs, op. cit., p. 553.
[5]Ibid., p. 553.
[6]Cf. John K. Galbraith, The Affluent Society (Cambridge: Riverside Press, coll. ed., 1960).
[7]See Ibid., pp. 153-160.
[8]Ibid., p. 316.
[9]Cf. John K. Galbraith, American Capitalism: The Concept of Countervailing Power (Cambridge: Riverside Press, 1952).
[10]Galbraith, The Affluent Society, op. cit., p. 137.
[11]See James S. Duesenberry, Income, Saving, and The Theory of Consumer Behavior (Cambridge: Harvard Press, 1949) pp. 1-3.
[12]Ibid., p. 27.
[13]Ibid., p. 27.

[14]Ideally, criteria should be developed providing guide lines for choosing certain programs on the Federal level into which innovation would be introduced. However, the political and administrative constraints are so dominant that such refinement would be impractical for present purposes. Moreover, the problems and factors influencing innovation in each industry probably differ so greatly that each industry would have to be studied separately (for example, potential technological breakthroughs in each industry would have to be analyzed). Whether inventive activity, indicated by R and D expenditures financed by the industry, is already being undertaken, would be a consideration. Other considerations will be noted when the various strategies are discussed in Chapter V. However, when one considers the social costs of using this instrument, an interesting question arises: if the goal is to reduce costs of Federal programs, then would any additional funding be needed? If direct expenditures were the only cost consideration, the answer would be obviously "no." However, when opportunity costs are taken into account, the answer is not at all clear. For example, if DOD procurement is utilized to introduce labor-saving innovations into sewage disposal systems on military installations, the immediate economic gain (i.e., cost reduction) might be small since military personnel normally would have a low alternative use since they are restricted from civilian alternatives because of mandatory military obligations. In other cases outside the military, the allocation of funds and manpower to programs to apply existing technologies in education, for example, rather than funding basic research might involve social costs greater than the immediate social benefits. Even the most ardent advocates of machine learning, computer-classrooms, etc., are not convinced that the principles of automated learning are understood so clearly that further basic research is not warranted. See Gabriel Ofiesh, "Educational Technology in the United States Air Force," American Behavioral Scientists, Vol. 6, No. 3 (Nov., 1962), pp. 60-65.

[15]Fritz Machlup. The Production and Distribution of Knowledge in the United States (Princeton: Univ. Press, 1962), p. 188.

[16]See Zvi Griliches. "Research Cost and Social Return - Hybrid Corn and Related Innovations," J.P.E., Vol. 61, No. 5 (Oct., 1958), pp. 419-432.

[17]See R.H. Buell. "Role of Research in Economic Growth," Chem. and Engineering News (June 18, 1955). Solow has attributed 87% of the U.S. growth between 1910 and 1950 to other than capital accumulation, of which a large portion was undoubtedly due to technical change. See Robert Solow, "Technical Change and the Aggregate Production Function," Review of Economics and Statistics, Vol. 25, No. 3 (Aug., 1957), pp. 312-21

[18]A theoretical argument why the market mechanism does not provide the incentives for an optimal allocation of resources for basic research and development is made in Richard Nelson's, "The Simple Economics of Basic Scientific Research," J.P.E., Vol. 67, No. 4 (June, 1958), pp. 297-306.

[19]In most cases marketing inventions involve greater risks than producing them. See Edwin Mansfield, "Technical Change and the Rate of Imitation," Econometrica, Vol. 29, No. 4 (Oct., 1961), p. 742.

[20]Kenneth J. Arrow. "Allocation of Resources for Invention," The Rate and Direction of Inventive Activity, ed. Richard Nelson (Princeton: Nov. 1963), p. 612.

[21]However, such contracts have usually dulled private initiative to some extent. See ibid., p. 613.

[22] However, its value might decrease over time, as obsolescence reduces the demand for a particular type of information.

[23]Cf. ibid., p. 615.

[24]Ibid., p. 615.

[25]Ibid., p. 616.

[26]Meyerson has argued that building codes are the most unyielding force against innovation in the building industry but "the building trade unions play a stronger hand than any other organized group in setting the content and specifications of the codes." Martin Meyerson, et al., Housing, People, and Cities (New York: McGraw-Hill, 1962), pp. 130-131.

Chapter III

[1]Cf. Arthur D. Little, "Pattern and Problems of Technical Innovation in American Industry," Report to the National Science Foundation (Washington: Office of Technical Services, Department of Commerce, 1963), pp. 4-6.

[2]Cf. Dan Shimshoni, "Science, Technology, and New Industry" (unpublished thesis progress report, Department of Economics, Harvard University, Mar., 1965).

[3]CF. Everett Rogers. Rates of Diffusion (New York: Free Press, 1962).

[4]Especially relevant is Mansfield, "The Speed of Response to Firms to New Techniques," Q.J.E., Vol. 77, No. 2 (May, 1963), pp. 290-310.

[5]Little, op. cit., p. 4. The discussion of the problems of innovation facing mature industries relies heavily on this Little report.

[6]Ibid., p. 179.

[7]Ibid., p. 179.

[8]Ibid., p. 184.

[9]Cf. ibid., p. 184. See also William Baker, "The Dynamism of Science and Technology," Technology and Social Change, ed. Eli Ginzberg (New York: Columbia Press, 1964), p. 101. The problems of innovation resulting from fragmentation are also discussed in U.S. Executive Office, Office of Science and Technology (OST) "Better Housing for the Future," A Report to the Panel on Civilian Technology (Washington: GPO, 1963), p. 5.

[10]Little, op. cit., p. 85.

[11]Mansfield, "Invention, Patents, and Innovation." (Chap. 2, mimeographed, of forthcoming book) p. 10.

[12]Little, op. cit., p. 185.
[13]William F. Brown, "Invention in the Machine Tools Industry," O.J.E., Vol. 71, No. 3 (Aug., 1957), p. 425.
[14]Little, op. cit., p. 187.
[15]Baker, op. cit., p. 101.
[16]Shimshoni, op. cit., p. 16.
[17]Ibid., p. 37.
[18]Ibid., p. 37.
[19]Ibid., p. 37.
[20]See Little, op. cit., pp. 138-177.
[21]Ibid., p. 162.
[22]Ibid., p. 162.
[23]Ibid., p. 163.
[24]This problem is particularly acute for those defense-oriented firms who are attempting to diversify into commercial markets. Deputy Assistant Secretary of Defense Arthur Barber, who chaired the subcommittee on industrial conversion for the Committee on Economic Impact of Defense and Disarmament, has been emphasizing this point in speeches around the country. See, for example, "The Future for Defense Industries in a Changing World." Speech delivered before the American Management Association, New York City, July 9, 1964 (Mimeographed).
[25]Ibid., p. 159.
[26]An important difference, however, was that the technologies were concerned with improving the methods of producing "old" commodities, e.g., corn, wheat, etc. In general, the innovations in public service programs which concern this study would probably be considered "new" final goods by most constituents, e.g., a computer classroom. One might expect greater resistance to change in the latter than in the former.
[27]See Rogers, op. cit.
[28]Ibid., p. 254.
[29]Ibid., p. 258.
[30]Ibid., p. 119.
[31]See Donald H. Ross, "Rate of Diffusion for Drivers Education," Safety Education, Vol. 32 (1950), p. 16-32.
[32]Rogers, op. cit., p. 108.
[33]Ibid., 280.
[34]Ibid., p. 280.
[35]Alistair Sutherland, "Diffusion of an Innovation in Cotton Spinning," Journal of Industrial Economics, Vol. 7 (1950), pp. 118-135.
[36]The specific study stated:

> The available traditional materials were allocated basically to housing, making it necessary to develop new products and techniques to cope with the school building problem /400 new schools annually between 1945 and 1952/ With the large change over from war to peacetime production in industry, it was decided that the industrial potential of a number of manufacturers should be harnessed for the development of prefabricated school building systems.

School Construction Systems Development. A Report on British Prefabrication School Systems (Palo Alto: Stanford University, 1964), pp 7.

[37]Don A. Schon. "Champions for Radical New Invention," Harv. Bus. Rev., Vol. 41, No. 2 (Mar/Apr., 1963), pp. 77-86.
[38]Little, op. cit., p. 188.
[39]Rupert Maclaurin. Invention and Innovation in the Radio Industry (New York: Macmillan Co., 1949), p. 249.
[40]See Joseph A. Schumpeter, Capitalism, Socialism and Democracy (New York: Harper & Bros., 3rd ed., 1950), p. 430.
[41]See John R. Galbraith, American Capitalism: The Concept of Countervailing Power (Cambridge: Riverside Press, 1952), p. 91.
[42]O. Warren Nutter. "Monopoly, Bigness, and Progress," J.P.E., Vol. 65, No. 6, (1956), p. 527.
[43]See Jacob Schmookler. "Bigness, Fewness, and Research," J.P.E., Vol. 67, No. 6 (Dec., 1959), pp. 28-33.
[44]See Charles F. Carter and Bruce R. Williams, Industry and Technical Progress (London: Oxford Press, 1957).
[45]Mansfield. "The Speed of Response of Firms to New Techniques," op. cit., p. 29. Brozen has also argued that high capital costs do not inhibit larger firms from using "advanced" techniques as much as smaller companies. See Yale Brozen, "Invention, Innovation, and Imitation," AER, Vol. 41, No. 2 (1951), pp. 239-258.
[46]Mansfield, op. cit., p. 309. In an earlier study Mansfield found also that rates of imitation were faster for innovations which were more profitable and required relatively small investments. See Mansfield, "Technical Change and the Rate of Imitation," Econometrica, Vol. 29, No. 4 (1961), p. 763.
[47]Edwin Mansfield, "Industrial Research and Development Expenditures: Determinants, Prospects, and Relation to Size of Firm and Inventive Output," J.P.E., Vol. 72, No. 4 (Aug., 1964), p. 336.
[48]Ibid., p. 336.
[49]Ibid., p. 336.
[50]Jora R. Minasian. "The Economics of Research and Development," Rate of and Direction of Inventive Activity, op. cit., pp. 93-141.
[51]Ibid., 141.
[52]Mansfield, "Technical Changes and Rate of Imitation," op. cit., pp. 745-746.
[53]Ibid., p. 52. The four industries were bituminous coal, iron and steel, brewing, and railroads.

Chapter V

[1]Statement of Deputy Director, Institute of Applied Technology (IAT), PSAC meeting, Nov., 1964.
[2]GSA alone purchases 9,500 cars per year while the Government buys 60,000 annually. See New York Times, "U.S. Agency Spurs Safety in Autos" (Jan. 26, 1965), p. 1.
[3]Cf. U.S. Executive Office, "Better Housing for the Future," op. cit., p. 10 and Michaelis, op. cit., pp. 42-46 and OECD, op. cit., p. 30.

[4]See U.S. Executive Office, op. cit., p. 11.
[5]Ibid., p. 49.
[6]These rough estimates were made by the Deputy Director, IAT, at the PSAC meeting in November, 1964.
[7]U.S. Congress, House Select Committee on Government Research, Contract Policies and Procedures for Research and Development, 88th Cong., 2nd Sess., 1964, Rept. No. 1942, p. 21. For example, the programming office in the Army is the Army Material Command; under it are five subordinate commands contracting for R and D; then there are 10 district offices which might administer contracts in their respective districts. Moreover, each of the principal commodity (e.g., munitions, food) commands in the Army also has subordinate offices that contract for and supervise R and D activity, and some Army laboratories as in a like manner. See Ibid., pp. 21-22.
[8]The discussion on the MTDL was based on information supplied by the Institute of Applied Technology, "Performance Based on Federal Procurement," (unpublished background paper, Mimeographed), pp. 18-24.
[9]Cf. SCSD, op. cit.
[10]The large initial market and use of performance requirements provided several incentives: (a) for privately financed R and D (Cf. Letter from Robert Hosfer, Director of School Activities, Minneapolis-Honeywell Regulator Co., Jan. 10, 1963 and Letter from William Waeldner, Director of Engineering, Anemostat Corp., Jan. 24, 1964); and (b) to use the firm's or consulting engineers to design standardized components (Cf. Letter from Frank Platt, Manager, American Air Filter Co., Jan. 14, 1963) or to reduce the costs of existing components (Cf. Letter from F.C. Willington, Manager, Planning and Development Department, Monsanto Chemical Co., Jan. 11, 1963).
[11]Ezra Ehrenkrantz, "SCSD - Better Schools for the Money," American Institute of Architects Journal (Sept., 1964), p. 93.
[12]U.S. Executive Office, op. cit., p. 12.
[13]This information was drawn from the Office of the Secretary of Defense, Draft of Hospital Research Proposal (Dec., 1964), Mimeographed.
[14]Ibid., pp. 1-2.
[15]Ibid., p. 2.
[16]One estimate is that the ratio of R and D to weapons procurement is about 25%; the ratio in nonweapons programs is less than 1%. This estimate neglects, however, intra-mural R and D carried out by the DOD, which is about 11% of all R and D. See Emile Benoit, "Procurement Policies Facilitating Arms Control Adjustments," Study Prepared for Arms Control, OSD (Dec., 1964), (Mimeographed).
[17]Baker, op. cit., p. 107.
[18]See Joseph Kraft, "West Wing Story," Harpers (April, 1965), pp. 106-110.
[19]Cf. "Timing - the Test on Housing," Business Week (Mar. 3, 1965), pp. 46-47

[20]This conclusion is based also on the author's impression from discussions with representatives from defense firms during his brief summer work in the OSD in preparing the report of the Subcommittee on the Problems and Policies for Industrial Conversion in the summer of 1964.

[21]For an excellent discussion of the advantages of parallel R and D, see Burton Klien, "A Radical Proposal for R and D," Fortune (May, 1958), pp. 112-114.

[22]Burton Klien. "The Decision Making Problem in Development," The Rate and Direction of Inventive Activity, op. cit., p. 508.

[23]Ofiesh, op. cit., p. 64.

[24]See Table III, Appendix I, infra., p. 65.

[25]Cf. Ofiesh, op. cit.

[26]Gabriel Ofiesh, "Twilight Zone - Training for the Aerospace Age," in Focus on Public School Adult Education, ed. Virginia Warren, (New York: Nat'l Assoc. of Public Adult Education, 1964), p. 15.

[27]See Evan Herbert. "Programmed Learning," International Science and Technology (April, 1963), pp. 54-65.

[28]Last December Federal Electric of I.T.&T. was awarded a $11.5 million contract for operating the center at Camp Kilmer, New Jersey; Philco Corp., the center in Tongue Point, Oregon; and Litton Industries, a $13.4 million contract for establishing a center near San Francisco. See "Poverty Has a War of Its Own," Business Week (April 3, 1965), pp. 30-31; New York Times (April 18, 1965), p. 49; Wall Street Journal (Feb. 11, 1965), p. 1.

[29]Westinghouse is hoping to utilize its computer-classroom in the centers; Science Research Assoc. of I.B.M. looks upon the Job Corps as a means to expand existing sales of learning machines and programmed instruction material. See ibid., p. 1.

[30]The argument and supporting data were taken from the Institute of Applied Technology, op. cit., p. 12. The proposal stated:

> Less than half of the cities and towns in the United States with a population of 2,500 employ approved sanitary methods for their disposal system. . . . Federal government support of research to find a better way, and means of handling solid water, has amounted to an average of only about $70,000 per year during the past three years. . . . [I]f the DOD developed performance requirements for solid water disposal at military bases of sufficient magnitude to exclude present manual collection systems, . . . they would represent a sufficiently attractive market to generate new innovation in the field.

Ibid., p. 12.

[31]A study which will explore the substitutability between Federal and private R and D funds in a firm is being conducted by Evelyn Murphy, IAT.

[32]The need to demonstrate is based on Duesenberry's demonstration effect and Roger's studies; failure of the political mechanism or Down's argument and Galbraith's concept of countervailing powers; and the inefficiency of the market mechanism under uncertainty on Arrow's contentions.

[33]Arthur Barber, Deputy Assistant Secretary of Defense. "Some Thoughts on Diversification." Speech delivered Jan. 26, 1965, before Arms Control Seminar, Ann Arbor, Michigan (Mimeographed).
[34]Ibid.
[35]Meyerson, et al., op. cit., pp. 131-132.
[36]Barber, op. cit.
[37]Gardner Ackley. "American Economic Policies - The Goals and Priorities." Speech delivered before the New England Conf. on Opportunities and Problems of Defense Conversion, Boston, Mass., Sept. 21, 1964 (Mimeographed).
[38]Michaelis, op. cit., p. 45.
[39]See Robert C. Weaver, The Urban Complex (New York: McGraw-Hill), pp. 172-178.
[40]Lawrence Lessing. "The 400 M-P-H Passenger Train," Fortune (April, 1965), p. 218.
[41]Wall Street Journal, op. cit., p. 1.
[42]Supra., p. 35

Chapter VI

[1]Cf. "Computers to Solve Marketing Puzzle," Business Week (Apr. 17, 1965), pp. 114-138.
[2]Baker, op. cit., p. 97.
[3]Don. Oberdorfer. "Where the Cutback Cuts Deep," Saturday Evening Post (Sept. 12, 1964), p. 21.
[4]One could argue that diversification into new defense programs is the next best alternative use on the grounds that maintaining the systems-oriented teams as a unit is more "productive" than the atomistic sum of individuals' efforts, which would be the case if the firm released them.
[5]See John H. Rubel, "How to Use Private Industry for Providing Major Services for the Job Corps and Why," Memorandum to Sargent Shriver, April 14, 1964 (Mimeographed copies, Science and Public Policy Seminar, Littauer Center, Harvard Univ.), pp. 1-12.
[6]Cf. "Changing Liabilities to Assets," Business Week (March 20, 1965), pp. 155-162. Litton's Economic Development Division has also received a $130,000 contract to assist the Applachian Regional Commission in establishing priority projects for the $1.1 billion Federal Applachian program. (See "Applachia - A New Greenery," Business Week (April 24, 1965), pp. 32-34. Earlier during the year, Litton received a $13.5 million contract to operate a Job Corps center in the San Francisco area. See New York Times (April 18, 1965), p. 49.
[7]A proposal which was discussed during the author's work in preparing the subcommittee report on industrial conversion was the use of U.S. firms in corsortia with national governments in U.S. foreign aid and investment programs. The proposal was similar in nature and political rationale to the approach being followed by the OEO in letting contracts for urban Job Corps centers.

[8]See "Charging Liabilities to Assets," op. cit., p. 162. Having some of the contractor firms find jobs for graduates was one of the suggestions made by Rubel, "Further Discussion of the Systems Approach and the Use of Private Industry for the Job Corps," Memorandum to Sargent Shriver, May 11, 1964 (op. cit.), p. 3.

[9]Rubel, "How to Use Private Industry for Providing Major Services for the Job Corps and Why," op. cit., p. 12.

[10]Lawrence Lessing. "The 400-M-P-H Passenger Train," Fortune (April, 1965), p. 218.

[11]See Carl Kaysen and Donald F. Turner, Antitrust Policy: An Economic and Legal Analysis (Cambridge: Harvard Press, 1959), p. 13.

[12]For a discussion of alternative patent policies, see Lee Preston, "Patent Rights Under Federal R and D Contracts," Harv. Bus. Rev., Vol. 41, No. 5 (Sept/Oct., 1963), pp. 6-12.

SCIENCE AND PUBLIC POLICY PROGRAM

Author: Blaschke, Charles L.

Title: Federal Procurement: An Instrument to Increase the Rate of Innovation

Comments:

This paper is somewhat rambling and skims over the surfact of its subject. Perhaps the subject is such that more cannot be done, but that in itself is a relevant limitation of the author's achievement.

* * * * *

This paper is a long and rambling discussion of a prospective role to be played by the Federal Government in promoting innovation. While a government sponsored demonstration effect presents some interesting possibilities, this paper stops short of a thorough analysis. It relies excessively on concepts such as "the demand for innovation" which are insufficiently examined.

While there are some errors in the paper, it does show considerable industry. It would benefit a good deal from a tightening of the argument and the elimination of much which is not directly germane.