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ABSTRACT

Koontz, Robert Philip. Ph.D., Purdue University, June 1971. A Political Analysis of the National Science Foundation. Major Professor: Michael Weinstein.

This research studied the organizational performance of the National Science Foundation (NSF) within the context of the Blau and Scott theory of formal organizations.

According to Blau and Scott, all formal organizations can be classified as one of the following types: commonweal, service, mutual benefit, and business. The classification is based upon who the prime beneficiary of the organization is. Also, each one of the four types of organizations has a central dilemma which is peculiar to that type of organization. This dilemma is pervasive; that is, evidence of the central dilemma can be found in the demands which surround the creation of the organization under investigation, in its official ideology and formal structure, and in the way the organization transforms demands into policies.

A key thesis in the Blau and Scott model is that formal organizations make policies dialectically. That is, organizations take into account both sides of their central dilemmas when they make policies.

The findings in this research indicate that NSF is a commonweal/service organization and that it possesses the central dilemma of both of these types of organizations. Evidence for this assertion was found in the demands surrounding the creation of NSF, in its official ideology and formal organization, and in the way NSF transforms demands into policies. It was also found that NSF resolves its two central dilemmas in its official ideology and formal structure and that NSF's normal decision making process is based upon the conclusion that its two central dilemmas are resolved.

The Blau and Scott thesis that formal organizations make policies dialectically was partially supported by the research. NSF officials took into account both sides of the commonweal dilemma in making policy on at least one occasion. In the case of the service dilemma, no evidence was found that NSF has been forced to consider both sides of this dilemma in making policy.

CHAPTER I

1. Introduction.

Thomas Jefferson brought to the White House an interest in science and a belief that government must provide for its healthy growth.[1] Despite Jefferson's keen interest in supporting science, his ideas had to wait a long time for development. It was not until 1950 that an agency, the National Science Foundation (NSF), was assigned the responsibility for the progress of science.[2]

In carrying out this responsibility, NSF currently distributes one-half billion dollars to scientific activities, 170.6 millions of which in 1968 went directly for basic research projects.[3] Because of the relatively short time span between publication of research findings and their transformation into tangible products with widespread social consequences, basic research is a very important activity.[4] By this standard, 170.6 millions dollars spent for scientific research by NSF in 1968 is more significant than the same and even much greater amounts spent for agricultural supports, new Army trucks, or better postal service.[5] NSF is not solely responsible for science and technology or even for the funding of all basic research, but it is a major element in the research and development (R & D) system.[6] Any attempt to understand the R & D system and its social consequences has to take into account those public agencies which supply the resources to carry out basic research.

NSF is what Talcott Parsons terms a formal organization. It has a membership, pursues purposeful activity, and endures.[7] Because of these characteristics, it is possible to analyze the conversion of demands placed upon NSF into policies (performance) in terms of formal organization theory. It is the purpose of this dissertation to consider one general formal organization theory (Blau and Scott), derive propositions from this theory, and test them against the performance of NSF. The dissertation seeks to explain the basic research policies of NSF within the Blau and Scott theory of general organizational behavior.

2. The Importance of the Blau and Scott Model of Organizational Behavior for Policy Research.

In this dissertation organizational behavior has two aspects. These aspects are organizational change and organizational performance. Organizational change refers to a drastic change in the fundamental values and structure of the organization.[8] Organizational performance, as was defined earlier, is the conversion of inputs (demands from the environment) into output policies. According to Blau and Scott, performance remains relatively stable as long as the fundamental structure and value orientations are unchanged.[9]

Changes in the structure and value orientation can occur only if there is a major change in the primary clientele groups which the organization serves.[10] If, for example, a mutual-benefit organization like the A.M.A. switches from its role of serving the medical profession to one of serving recipients of medical care, then major structural and value changes take place. These major changes cause the demands made upon the organization to be handled in a completely different way.

In this sense, Blau and Scott's theory is in Michael and Deena Weinstein's terms "post functional."[11] Functional theory, as articulated by Easton, Merton, Parsons, et. al., emphasized the continuing and evolving nature of an organization as it dealt with demands and supports from its environment. Functional analysis tells the researcher much about the environment of a given organization but little of the effects of the organization upon the demands placed upon it. What Blau and Scott are saying is that changes in demand and support patterns have little effect upon how the organizations handle demands (makes policies). The internal structure and values of the organization are relatively stable and change only when there is a change in the major client groups which the organization serves.

If Blau and Scott are correct, their model has considerable utility for researchers interested in organizational performance. Their theory permits the researcher to concentrate on one organization and its internal conversion process and how it changes demands into outputs. If the internal conversion process is relatively stable, as Blau and Scott suggest, then the policy researcher's job is much easier. The internal conversion process becomes an operator in mathematical terms and an operator of a more constant value than in the functional model.

The Blau and Scott model needs more testing, however. It is new and has been applied relatively few times. Blau and Scott have applied their model to a number of cases in their book Formal Organizations, but they took research results done by others using models other than Blau and Scott's.

This dissertation is an attempt to use the Blau and Scott typologies, assumptions, and propositions in order to furnish a limited test for the adequacy of the model of policy research.

3. Blau and Scott: Fundamental Assumptions.

Blau and Scott make a distinction between social and formal organizations. The latter is the subject of their theory, but in order to understand what a formal organization is, they believe one must understand what a social organization is.[12] Social organizations have two major characteristics: structure and values or value orientations. "'Social structure' refers to the ways in which human conduct becomes socially organized; that is, to the observed regularities in the behavior of people that are due to the social conditions in which they find themselves rather than their physiological and psychological characteristics as individuals."[13]

Structure is the pattern of interaction among individuals within the group under investigation. This pattern includes both the frequency and duration of contacts between members of the organization and the expressed sentiments accompanying these contacts. It is these contacts and the observed emotional responses which they invoke which provides the status system for the group.

> The differential distribution of social relations in a group, finally, defines its status structure. Each member's status in the group depends on his relations with the others--their sentiments toward and interaction with him. As a result, integrated members become differentiated from isolates, those who are widely respected from those who are not highly regarded, and leaders from followers.[14]

The status to which Blau and Scott refer develops naturally and is solely the result of the interaction pattern of the members of the group. Children's play groups furnish a clear cut example of this type of behavior. The children interact, sentiments and relationships develop, and a pattern of status starts to emerge.

The other dimension of social organization is the shared orientations or values of the group. Blau and Scott divide the shared orientations into two interrelated categories. First, shared values as to what is desirable develop, then there are certain approved means (norms) which develop for securing these desired ends. "If values define the ends of human conduct, norms distinguish behavior that is a legitimate means for achieving these ends from behavior that is illegitimate."[15]

Everyone in a social organization is supposed to observe its norms, but as the organization differentiates to accomplish specific tasks, observance of special sets of norms are expected of some individuals. These norm sets or roles develop the same way as the general norms of the organization, except that roles are observed by only certain individuals.

The two dimensions of social organizations, social structure and value orientations, are found in every social organization and mutually reinforce one another.

> As people conform more or less closely to the expectations of their fellows, and as the degree of their conformity in turn influences their relations with others and their social status, and as

> their status in further turn affects their inclinations to adhere to social norms and their chances to achieve valued objectives, their patterns of behavior become socially organized.[16]

What has just been described is Blau and Scott's conception of social organization and how it "naturally" develops. Formal organizations have the same dimensions as social organizations, namely structure and value orientations, but they differ in one important respect. Formal organizations are <u>explicit</u> in these characteristics. This is to say that the status in a formal organization is rationally conceived as in an organization chart. The social relations with respect to duration and frequency are also much more explicit. The line personnel see the president of the company less often than the assistant to the president, for example.

Values are also more explicit in a formal organization than in a social one. Objectives or goals are explicitly stated in what has become known as the organization's "official ideology." Generally, if the organization is very simple, a definitive statement of the offical goals will suffice. However, if the organization is large and complex there must be an official line or ideology which consistently links the goals with how they are to be accomplished. The official ideology serves to alert the membership and the interested groups to what the prevailing general norms of the organization are.

Norm sets or roles are again more explicit in a formal organization than in a social organization. Professionals are hired to do specific jobs and they bring their roles with them. They are employed to perform in a predictable manner. Bureaucrats, although they may or may not be professional administrators, can read what their roles are in the official regulations which pertain to their jobs.

Blau and Scott do not say that the non-explicit or informal side of a formal organization does not exist, but the informal aspect of the organization is defined in relation to the formal characteristics of the organization. As far as the Blau and Scott model is concerned, only those aspects of the organization which bear upon the behavior of the formal organization is of significance. "But to say that these informal structures are not completely determined by the formal institution is not to say that they are entirely independent from it. For informal organizations develop in response to the opportunities created and the problems posed by their environment, and the formal organization constitutes the immediate environment..."[17]

4. Blau and Scott's Theory of Formal Organizational Behavior.

What has been discussed in Section 3 applies to all formal organizations. In order to differentiate between types of formal organizations and to extend their theory, Blau and Scott use a typology based upon the criterion of who benefits the most from a given organization's existence.

Blau and Scott posit that all organizations come in contact with four client groups. These groups are the client-at-large or the general public, the clients-in-contact or the group which the organization directly serves, the owners or managers, and the rank and file membership of the organization. Which one of these groups is the prime beneficiary (who benefits?) determines what kind of an organization it is and how it will perform. For example, a formal organization which exists for the prime benefit of its owners or managers is classified as a business organization. A labor union which secures contracts primarily for the benefit of its membership is a mutual benefit organization. Blau and Scott list schools which serve students as examples of service organizations. The fourth and last type of organization is the commonweal organization. "The distinctive characteristic of commweal organizations is that the public-at-large is their prime beneficiary, often although not necessarily, to the exclusion of the very people who are the object of the organization's endeavor."[18] Examples of this type of organization are the Internal Revenue Service and the Post Office.

The application of the "who benefits?" criterion provides more than a discriminatory classification of organizations. The overriding purpose is to furnish the investigator a method of explaining organizational behavior or in the case of this dissertation, organizational performance.

Each of the above types of organization is faced with a central dilemma whose nature depends upon who the primary client group is. Every organization must continually deal with its central dilemma as it makes its policies. The central dilemma exists as soon as the organization is created and is evident in the creation process. The central dilemma disappears only if the organization undergoes a change in its primary client group. If this happens, another central dilemma appears. Even though organizations can never resolve their dilemmas, they always attempt to. The decision makers may make policy in favor of one side of the dilemma, but they will then justify the policy in terms of both sides.

Corresponding with each type of organization--business, mutual benefit, service, and commonweal--is a central dilemma peculiar to that type of organization. In the case of a business organization, for example, the central dilemma is one of making policy in favor of initiative or in favor of coordination and control. For a mutual benefit organization, the dilemma is one of democratic control versus "the effective accomplishment of objectives."[19] Service organizations are faced with maintaining professional standards versus serving the interest of their clients. "...the crucial problem posed by commonweal organizations is the development of democratic mechanisms whereby they can be externally controlled by the public", versus "...the maintenance of official bureaucratic mechanisms that effectively implement the objectives of the community."[20]

Dilemmas, like goals in the Simon means-ends model, are pervasive throughout the formal organization's behavior. Changes in an organization's prime beneficiary, in its central dilemma, and in its official ideology and social structure are concurrent. If the prime beneficiary changes, all the other changes occur at the same time. If the prime beneficiary remains constant, the other organizational characteristics remain relatively so.

Because the central dilemma of an organization is so pervasive, evidence of the central dilemma can be found in the demands from the client groups surrounding the creation of the organization under investigation, in the organization's ongoing official ideology, in the formal structure of the organization, and in how the organization makes policies. In addition, the researcher may be able to detect bias in the way the organization handles its dilemma. Should he be able to do this, he can predict roughly how the organization will handle every demand placed upon it and whether or not the organization is going to undergo a major change in its predominant client group. As Blau and Scott point out, if an organization continually makes policy in favor of one end of the dilemma over the other, a major change in the organization's client groups has occurred. If, for example, a union has an ideology and social structure which is biased toward the leadership, the investigator can predict a change in the prime beneficiary and a change in whose demands are acted upon favorably and whose demands are acted upon unfavorably.

The description of the Blau and Scott theory is complete. In order to summarize the main points of the theory and to offer a means of testing some of the more important aspects, the following propositions are offered. They were not stated specifically by Blau and Scott, but are given as implicit in their framework.

(1) The central dilemma is pervasive; that is, evidence of the central dilemma can be found in the demands which surrounded the creation of the organization under investigation, in its ideology and formal structure, and in the way it transforms demands into policies.

(2) The central dilemma of a formal organization is a function of the prime beneficiary of the organization.

(3) The central dilemma does not change unless its prime beneficiary is changed.

(4) Organizations make policies dialectically. This means that all policies must take into account both sides of the central dilemma and attempt to resolve this dilemma.

5. TVA and the Grass Roots, An Illustrative Case of How the Blau and Scott Model Could be Employed.

An example is used to restate the fundamental premises and hypotheses of the Blau and Scott model, to demonstrate how the model is applied to a real case, and to furnish some evidence of the model's general utility. An organization other than one investigated by Blau and Scott and other than the one investigated in this dissertation is chosen to demonstrate the model's general utility.

The thesis of the Blau and Scott model is that the central dilemma of an organization is determined by who the prime beneficiary is. Once the prime beneficiary is known, then the central dilemma of that organization can be hypothesized. The existence or non-existence of the central dilemma can be explained by studying the demands made within the process surrounding the creation of the agency and an examination of the organization's official ideology and formal administrative structure. In addition, if the existence of the central dilemma of the organization can be confirmed, this same evidence can be used to investigate whether or not the organization is biased toward one end of the dilemma or the other. The existence of a dilemma as hypothesized furnishes a crucial check between the model and the real world it purports to describe.[21]

If the central dilemma of the organization exists and organizational bias toward one end of the dilemma or the other can be detected, predictions as to the way the organization handles demands can be made.

Philip Selznick did not use dilemma analysis in his classic study of the TVA, but his work contains enough information to illustrate how such a study could be conducted. Because this example is used to illustrate rather than investigate, Selznick's conclusions are accepted as evidence. Using the Blau and Scott model, the TVA is classified and a central dilemma is hypothesized. Based upon Selznick's findings, an attempt is made to confirm or deny the existence of the hypothesized central dilemma. There is also an effort to detect bias within the TVA ideology and administrative structure should such a dilemma be judged to exist.

President Roosevelt requested (placed a demand upon the Congress) for an organization which would serve the residents of one geographic area and be autonomous from other government agencies and private organizations within that area. It was not a commonweal organization at least in the traditional sense. As envisioned by the President, the TVA would perform professional planning and services in the areas of "... flood control, soil erosion, reforestation, elimination from agricultural use of marginal lands, and distribution and diversification of industry."[22] According to Selznick the President wanted an agency which would provide services on a regional basis for those living in the Tennessee valley area. The President finally got an organization which provided services for the residents of the Tennessee valley but local client interests were to be protected as well as and even at the expense of regional interests. The final TVA formal organization reflected Roosevelt's interest in professional regional planning versus the concern for local client demands with a bias toward the latter.

> In the purchase of lands, in the distribution of fertilizer and power, in personnel policy -- in those functions which are a necessary part of the execution of its major and clearly delegated responsibilities -- the TVA has normally taken into account of the people of the area, with a view to adjusting immediate urgencies to long-term social policy. This, of course, is not the same as devising and executing a frontal plan for the reconstruction of the economy or institutions of an area.[23]

The TVA was to be a service organization in the Blau and Scott sense. It was to be an organization whose basic function is to serve clients. The clients in this case were the residents of the Tennessee valley. If the TVA can be so characterized, then its hypothesized dilemma would be that of a service organization. That is, the maintaining of professional standards of service versus the acceding to the demands of the clients the organization is serving. The central dilemma of a service organization is one of providing services <u>in the clients' best interests</u> versus following the <u>clients' desires</u>. The demand by the President and the initial organization as described by Selznick would seem to indicate that the dilemma described above was to be the dilemma of the TVA. It was charged with a mission of providing regional professional services, but had to place a high priority on the desires of the clients it served.

The official ideology of the TVA reflected its central dilemma, and the organizational structure demonstrated a definite bias toward the local interests as opposed to regional professional services. The official ideology, termed the "grass roots philosophy," was based on a principle called decentralized administration. Spokesman for this ideology viewed the growth of large centralized organizations as inevitable. Large government organizations, David Lilenthal, the first Director of the TVA, stated were necessary in order to compensate for the growth in labor unions, big business, and agriculture. Lilenthal argued that centralization need not be bad if its inherent dangers were recognized and dealt with.

> Absentee government is the quickest way to raise up the exploiting managerial class Mr. Burnham's book [The Managerial Revolution by James Burnham] predicts with such confidence. But these prophecies need not be fulfilled, we do have a choice, for the hazards of managerial exploitation can be diminished by skillful efforts in the direction of decentralized administration of centralized authority.[24]

The official ideology of the TVA juxtaposed the two positions of the central dilemma. Managerial excess in the name of rational regional development were to be checked by decentralized decision making close to and responsive to the group to be served. Lilenthal and the Board of Directors of the TVA might posit a goal of coordinated general development by decentralized administration but these were not complementary goals. This is not to say that one organization may not pursue two conflicting goals. It is to say that if there are such goals, they constitute a dilemma.

The difficulty of balancing these two conflicting goals was partially resolved by biasing the administrative structure in favor of the local interests over regional planning objectives. Selznick describes the TVA organization as one which has three administrative objectives. They were as follows:

> 1. The location of administrative control in the area of operation, with the Authority

> as a whole, in relation to the federal government, taken as an example.
> 2. The carrying on of operations with and through existing institutions already organized in the area of operation. The relation of the Authority to the agricultural extension services of the land-grant colleges is one of the important examples of this procedure.
> 3. The participation of local people at the end point of administration of the program, for example, through county soil improvement associations set up in connection with the TVA fertilizer test-demonstration program.[25]

Selznick explains that this bias of the TVA administrative structure toward existing local interests was necessary in order for the TVA to survive. "By adopting the grass-roots doctrine [and the administrative principles with which the TVA implemented it] the Authority was able to stand as the champion of local institutions and at the same time to devise a point of view which could be utilized in general justification of the managerial autonomy within the federal system."[26]

Not too surprisingly, the bias or championing of local organizations was reflected in the policy outputs of the TVA. In all of the cases which Selznick covers in his analysis of the operation of the TVA, its policies reflected bias toward the local clients' interests rather than to overall professional planning. For example, as a general policy, the TVA wanted to ensure the widest possible recreational use of land around the reservoirs which the TVA had created. The Farm Bureau was opposed to this policy and in conjunction with the state universities and the county extension services, forced the TVA to back down on this particular policy.[27]

Selznick did not use dilemma analysis, but his study provides enough evidence to make a strong case for the utility of such an analysis. The TVA appears quite clearly to be a service organization and the dilemma of this type of organization appears in the TVA's official ideology, in its administrative structure, and in its performance. The typology fits an ongoing organization and if the evidence which Selznick offers is correct the theory checks with the reality.

The focus of Selznick's study of the TVA is somewhat different than the focus of this dissertation. Selznick sought to examine how a new organization adapts to a potentially hostile environment. On the other hand, the environment in which NSF was created was on the whole friendly and has remained so without a great deal of effort on the part of NSF. There are similarities between the two organizations, however. Both were new organizations and not merely restructured older institutions. NSF and the TVA are both run respectively by a Director or Chairman and a Board of Directors. Neither must go through a Cabinet member for access to the President. Most important, the writer of this dissertation argues that both organizations can be analyzed fruitfully in terms of prime beneficiaries, central dilemmas, and organizational performance. Although Selznick did not choose to do so, his study provides evidence that an organization, other than one chosen by Blau and Scott or the one investigated in this dissertation, can be analyzed using the Blau and Scott theory of formal organizations.

6. Range and Scope of the Dissertation.

The range of this dissertation is based on the Blau and Scott theory of formal organizations. This means that the range of the dissertation is confined to the clients-in-contact, the owners and managers, the clients-at-large, and the rank and file of NSF.

The owners and managers of NSF are full time government employees and include the Director, the Assistant Director, and the NSF Division Heads. The rank and file are all full time employees of NSF other than those already mentioned. The clients-at-large, the general public, are represented by the appropriations and authorizations committees instrumental in the funding of NSF and all those congressional committees which have had as their witness, the Director of NSF. In addition, the clients-at-large's representatives include all those officials who have represented the President before the already named committees. Such representatives would include primarily officials from the Bureau of the Budget (BOB) or the President's Science Advisor when he is speaking for the administration. The clients-in-contact are those scientific groups which have had representatives speak before the above named committees.

The range of the study remains the same throughout. Congressional subcommittees, for example, move in and out of the NSF environment, but the criterion indicating whether they are in or out of the study remains the same.

The scope of the study has both a time and substantive dimension. The time bench mark is 1945, the year the famous report by Vannevar Bush, Science The Endless Frontier, proposed a science foundation. The terminal year of the study is 1969 since it is the last one for which data is available.

The substantive focus of the study is covered in the previous sections of this chapter. Briefly it is a focus upon how NSF makes policies in relation to the demands placed upon it. The study is done in order to furnish a limited test of the adequacy of the Blau and Scott model for policy research.

7. Summary of the Blau and Scott Theory.

As pointed out by Blau and Scott and illustrated by the TVA example, if the prime beneficiary of the organization can be identified, then the dilemma of the organization can be posited. Evidence as to the existence or non-existence of the dilemma depends upon the observable characteristics of the organization under investigation. As with any theory, Blau and Scott can guide the researcher in his search for facts but the verification of the theory is based upon how it fits the "real world."

Selznick identified the prime beneficiary of the TVA so it was relatively easy to apply and illustrate the theory. However, if the researcher starts with raw data, then he must look for evidence as to who the prime beneficiary is in the definition of the situation. This consists of the assigned goals of the organization at its founding and the demands made by those groups surrounding the creation of the organization. Evidence as to the existence of the posited dilemma and the way the organization attempts to resolve its dilemma (if one exists) can be found in the organization's official ideology (value orientations in Blau and Scott's terminology) and in the organization's formal structure. Although Blau and Scott give no definition of formal structure except to characterize it as the explicit side of the organization, in this dissertation the term means those formal avenues of legitimazation of policy decisions both internal and external to the organization.

FOOTNOTES

[1]A. Hunter Dupree. Science in the Federal Government. New York: Harper Torchbooks, 1957, p. 21.

[2]U. S. Public Law 81-507, Sec. 11.

[3]NSF, Annual Report-68. Washington: U. S. Government Printing Office, 1968, p. 31.

[4]David Bode. "Reflections on the Relation Between Science and Technology." Basic Research and National Goals, ed. NAS. Washington: U. S. Government Printing Office, 1965, pp. 41-76.

[5]U. S. Congress, House, Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, 91st Congress, First Session, on Technology Assessment, November 18, 14; December 2, 3, 4, 8, and 12, 1969. Washington: Government Printing Office, passim.

[6]In 1968 NSF distributed 12% of the total amount the Federal government spent for basic research. NSF, Federal Funds for Research, Development, and Other Scientific Activities. Washington: J. S. Government Printing Office, 1968, p. 11.

[7]Talcott Parsons. Structure and Process in Modern Societies. New York: The Free Press, 1965, pp. 16-19.

[8]Peter M. Blau and W. Richard Scott, Formal Organizations. San Francisco, Calif.: Chandler Publishing Co., 1962, p. 44.

[9]Ibid.

[10]Ibid.

[11]Michael and Deena Weinstein. "Blau's Dialectical Sociology." Unpublished paper to be presented at the Southern Sociological Society, April 9-11, 1970, p. 2.

[12]Blau and Scott, op. cit., p. 2.

[13]Ibid.

[14] *Ibid*., p. 3.

[15] *Ibid*., p. 4.

[16] *Ibid*., p. 5.

[17] *Ibid*., p. 6.

[18] *Ibid*., p. 54.

[19] *Ibid*., p. 48.

[20] *Ibid*., p. 55.

[21] Jacob Bronowski. "The Nature of Newton's Insight," *Science and Society*, eds. Alexander Vavoulis and A. Wayne Colver. San Francisco: Holden-Day, Inc., 1966, p. 21.

[22] Philip Selznick. *TVA and the Grass Roots*. Berkeley, Calif.: The University of California Press, 1953, p. 5.

[23] *Ibid*., p. 6.

[24] *Ibid*., p. 28.

[25] *Ibid*., p. 25.

[26] *Ibid*., p. 263.

[27] *Ibid*., p. 205.

CHAPTER II

1. Introduction.

What follows is an application of the Blau and Scott theory to the National Science Foundation. This chapter has several interrelated purposes. A theory is by definition an interrelationship of premises and hypotheses. The Blau and Scott formulation is an attempt to define this interrelationship in the context of formal organizations. It is the researcher's intention in this chapter to investigate the degree to which the operating structure of NSF conforms to the structure suggested in the Blau and Scott theory.

There are six primary purposes in the chapter. The first is to identify the prime beneficiary of NSF. Using the Blau and Scott categories, the second is to classify NSF as to type of formal organization. The third is to check the organizational-structural characteristics of NSF and compare these with those hypothesized in Blau and Scott's theory. The fourth is to posit what Blau and Scott state is the central dilemma of an organization like NSF. The fifth is to look for evidence of the central dilemma's existence or non-existence in the demands surrounding the creation of NSF, in its formal structure, and in its official ideology. The final purpose is to examine the same evidence for information as to how NSF resolves or deals with its central dilemma.

2. <u>The Bush Report: Who Should Benefit</u>.

According to Blau and Scott, the designation of any organization's prime beneficiary by the founders is the single most important fact about the organization. Although the prime beneficiary of an organization may be changed at any time after its creation due to external pressures, the initial choice of beneficiary is a value judgement made by its creators.[1] Based upon this assumption, the purpose here is to examine the creation of NSF to determine who were supposed to be its beneficiaries.

It is difficult to trace the idea for a government science founcation to any one person. A case could be made for its conception from any of Jefferson's early proposals for a national university to President Roosevelt's planning for the development of scientific resources during the early days of the New Deal.[2] However, Vannevar Bush's report, <u>Science the Endless Frontier</u>, was the source of the detailed proposals which culminated in the formation of NSF. Bush had been the wartime Director of the Office of Science, Research, and Development (OSRD). The report was in response to President Roosevelt's request for recommendations "... so that the continuing future of scientific research in this country may be assured on a level [equal] to what has been during the war.[3] This was to be accomplished, the President wrote, "... for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living."[4]

Bush's proposals for a federally financed science foundation became the basis for the first NSF bill introduced in Congress.[5] The Kilgore subcommittee of the Committee on Military Affairs in the Senate and the Priest subcommittee on Interstate and Foreign Commerce in the House held hearings on the Bush bill and other proposals for a science foundation.

There were obvious reasons why Bush was designated by President Roosevelt to furnish recommendations on how science should be encouraged after World War II. Bush had run OSRD with a great deal of success. OSRD projects included developing DDT, penicillin, time fuses, amphibious vehicles, and a host of other ventures. President Roosevelt stated that "Its [OSRD's] work has been conducted in the utmost secrecy and carried on without public recognition of any kind; but its tangible results can be found in the communiques coming in from the battlefronts all over the world. Someday the full story of its achievements can be told."[6]

Congressmen were also favorably disposed toward OSRD's accomplishments. Representative Priest of the

House subcommittee considering the NSF enabling legislation stated the following for the record:

> Representative Priest. Before you proceed, Dr. Bush, I should like to express what I believe is the nation-wide gratitude to you, sir, for the very great job you did during the war.[7]

John W. Kenny, the Assistant Secretary of the Navy, who was present when Congressman Priest paid this tribute to Bush, added, "I join with you [Congressman Priest] on behalf of the Navy Department, and I know Judge Patterson [Secretary of War] would join you on the part of the War Department if he were here."[8]

It was into this favorable atmosphere that the Bush report was received. Congressmen, scientists, and administrative officials all had been impressed by Bush's ability to bring to bear the talents of 5000 scientists and 10,000 technicians on national security problems during World War II.[9] He had done this and had preserved relative harmony among politicians, the military and the scientists. It was for these reasons that his report was received with a good deal of interest and attention by the Congress, the scientists and the Executive.

Bush left no doubt in his report as to who the prime beneficiary of NSF should be. It was the public-at-large, the commonweal. This was demonstrated by the goals which he felt NSF should serve. They were better health, national security, and an increase in prosperity.[10]

There was to be an instrument and a mechanism, however, to achieve progress toward these end goals. The instrument was to be progress in science and the mechanism was to be NSF. All of this was premised on Bush's strong belief that progress in science was essential to progress in the commonweal goals.

> Progress in the war against disease, depends upon a flow of new scientific knowledge. New products, new industries, and more jobs require continuous additions to knowledge of the laws of nature, and the application of the knowledge to practical purposes. Similarly, our defense against aggression demands new knowledge so that we can develop new and improved weapons. This essential, new knowledge can be obtained only through basic scientific research.[11]

In the first part of his report, Bush buttresses his case for the relationship between a healthy basic science community and beneficial results to the nation. His case rests mainly upon examples of science's contribution to military weaponry. Bush mentions radar and the V-2 as specific examples of how science provides the means toward the commonweal goal of national security. In addition, he cites a joint letter from the Secretaries of the Army and the Navy. In this letter, to the National Academy of Sciences, the Secretaries emphasize that

> (1) Powerful new tactics of defense and offense are developed around new weapons created by scientific and engineering research; (2) The competitive time element in developing those weapons and tactics may be decisive; (3) War is increasingly total war, in which the armed services

> must be supplemented by active participation of every element of civilian population.[12]

The next two areas which Bush believed had important basic science components were what he termed "the war against disease" and "the goal of full employment." In both these areas, Bush states there must be a strong ongoing basic research program. Bush argues that "Progress in the war against disease results from discoveries in remote and unexpected fields of medicine and the underlying sciences." Because of this fact, "Further progress requires that the entire front of medicine and the underlying sciences of chemistry, physics, anatomy, biochemistry, physiology, parasitology, etc., be broadly developed."[13] The other commonweal objective, full employment, is to be advanced in a similar way. Discoveries in science are unexpected but very fruitful in terms of economic benefits. For this reason, the government must aid science and can expect it to be a useful instrument in achieving the commonweal goal of a healthy economy.[14]

In accordance with the President's mandate and to further explain his case, Bush appointed four committees to answer specific questions based upon the initial premise that progress in science will mean progress toward commonweal goals. The committees' total membership was forty-eight. Included in their membership were Linus

Pauling; Isaiah Bowman, the President of Johns Hopkins University; Oliver Buckley, president of Bell Laboratories; Walter C. Coffey, president of the University of Minnesota; Edwin C. Land, president of Polaroid Corporation; J. Hugh O'Donnell, president of the University of Notre Dame; I. I. Rabi; Robert E. Wilson, chairman of the board, Standard Oil of Indiana; Henry A. Burton, director of the American Institute of Physics; J. B. Conant, president of Harvard University; Harlow Shapley; and Karl T. Compton, president of M.I.T.[15] The committees contained some of the most respected members of American science, education, and administration. While the reports of the committees differed in some minor points as to how NSF should be constituted,[16] all agreed that science could be instrumental in accomplishing the commonweal goals of better health, prosperity, and national security.

Typical of the reports was the one by the committee chaired by Dr. Isaiah Bowman. This committee was asked the question: "What can the Government do now and in the future to aid research activities by public and private organizations? The proper roles of public and of private research, and their interrelation should be carefully considered."[17] The Bowman committee linked the commonweal objectives with scientific research in the following way.

> By general consent the discoveries of pure science have for centuries been imme-

> diately consigned to the public domain and no valid precedent exists for restricting the advantages of knowledge of this sort to any individual, corporation, state or nation. All the people are the beneficiaries. Governments dedicated to the public welfare, therefore, have a responsibility for encouraging and supporting the production of new knowledge on the broadest possible basis. In the United States this responsibility has long been recognized.[18]

Along with his own prestige, Bush was able to add that of the forty-eight members of the committees working under the mandate of President Roosevelt. Bush and his committees were in agreement over what the goals of NSF should be; primarily they were to be commonweal, but service to science was to be the means. NSF, to be consistent with its goals, should be a commonweal service organization in the Blau and Scott typology.

3. NSF Enabling Act: Who Shall Benefit?

Concurrently, with the acceptance of the Bush report by the President and its distribution to the public, bills were introduced calling for the establishment of a federal science foundation. The most important of these were the Magnuson bill and the Kilgore bill. Neither differed as to what the goals of NSF should be, but there were differences in how NSF should be held accountable to the public. Hearings were held on those two bills and the testimony of the witnesses was similar in content to that of the Bush report. In order to advance toward the commonweal goals of health, prosperity, welfare, and national defense, the government should set up an agency to serve science. This is to say that they took as an article of faith that better funded science meant better health, welfare, prosperity, and national security. Dr. Isaiah Bowman, president of Johns Hopkins University, underlined the relationship between the establishment of a science foundation and national security.

> Dr. Bowman. The answer [to the problem of providing adequate national security], Congressman Brown, is that the formation of a national science foundation is basic to national security. The detailed answers, with respect to some of the questions that I have mentioned, must be found in the activities of a national science foundation once it is organized, using that wide network of scientific agencies both within and without the Government, that deal appropriately with these problems.[19]

What Bowman was saying was that to aid science was to aid national security. And so it went throughout the rest of the testimony offered by the two hundred witnesses. Dr. John P. Peters of the York School of Medicine stated that

> Experience in the last generation has shown that a single scientific advance in our knowledge of the causes and treatment of disease may do more to decrease morbidity, disability, and mortality from disease than indefinite multiplication of personnel and facilities. With all due credit to the organization of the military medical forces in the war just ended, the low disability and death rates can probably be attributed less to this organization than to a few notable scientific discoveries.[20]

This testimony seems somewhat overstated in the light of recent attacks by critics of the American system of health care. But in any case, Peters' belief that science is instrumental in providing commonweal benefits was not challenged by any of the Senators present at the hearing. Of the scientists called before the House and Senate Committees, only one testified against establishing NSF. Even he did not question the benefits which would accrue to the public as a result of an active scientific community.[21]

Whatever the field--chemists, biologists, physicists, and others--all advanced the notion that a strong basic research community aided by NSF would result in great benefits to American society. Those responsible for implementing commonweal goals, such as the Secretary of the Army and the Navy, agreed with the scientists' assessment of the worth of scientific research. Secretary of War Patterson and Secretary of Navy Forrestal both saw basic research as underwriting their security planning. Representatives from industry stressed the relationship between basic research and practical applications which would manifest itself in a variety of new products. Bruce K. Brown, vice-president in Charge of Development, Standard Oil of Indiana, was typical of those from industry in his belief in the causal link between strong science and a strong business establishment.

> Private industry is too diverse to be very articulate but, as a group, it well recognizes the direct connection between research, new processes and products, jobs, and profits. The National Research Council [NAS] recently made a survey of the postwar research plans of a number of industrial organizations. The results of its survey were reported in Industrial and Engineering Chemistry for August 1945, and while the specific numerical data cited are somewhat complex, the findings can be fairly summarized by saying that the companies approached, both large and small, intended, in the immediate postwar era, approximately to double their research programs. Thus a big upswing in privately financed industrial research and applied technology is indicated. Problems to be solved are already catalogued and venture money in the bank ready to be risked. However, these plans to enlarge industrial research programs will dry up and blow away unless they are fed by continuous streams of well trained technical personnel. Such personnel can be obtained and trained only by an increased tempo in scientific education and accumulation of basic scientific data.[22]

NSF, according to the Bush report and the testimony given to the Price and Kilgore committees, was to have two sets of goals--commonweal and service. However, the service goals were to be realized in order to make progress toward the commonweal goals. It would appear that Bush and his committees and those who testified in favor of NSF wanted a commonweal/service organization. The prime beneficiary was to be the clients-at-large, but benefits to the clients-at-large were to be achieved by aiding the clients-in-contact, the scientists.

Congress legitimized these desires and designated NSF to have two goals. They appear in the preamble of the NSF enabling act and it is the only place in the act where the commonweal goal is stated. The remainder of the act is concerned with how science is to be aided by NSF. The entire preamble of the act is reproduced below.

> An Act to promote the progress of science; to advance the national healty, prosperity, and welfare; to secure the national defense; and for other purposes.
>
> Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the National Science Foundation Act of 1950.[23]

If NSF was to be a commonweal/service organization, it is fair to ask the following question: Does NSF possess the characteristics of a commonweal organization and a service organization as enumerated by Blau and Scott? It is with this question that the next section of this chapter is concerned.

3. The Characteristics of NSF.

The authors of Formal Organizations posit two characteristics of a commonweal organization and one characteristic of a service organization. Although the enumerated characteristics are too general to constitute a proof of correct classification by themselves, they serve as an additional check on the assignment of a classification of "commonweal/service" to NSF.

Blau and Scott list the following two characteristics of a commonweal organization. First, the public through its representatives must possess some mechanism for the control of the ends served by these organizations.[24] This means that a commonweal organization is monitored in its yearly operation by selected officials. In Don Price's terms, the commonweal organization must be held responsible for its activities by the politicians.[25] More specifically, in this country a government agency is considered "controlled" by the commonweal to the degree its yearly budget, policies, and leadership choices are subject to Presidential and Congressional direction. The TVA, for example, does not depend on the Treasury for its yearly operating budget and is given considerable autonomy in the way it operates. As Wildavsky has pointed out, the making of a budget of an agency using public funds for its yearly operations entails a large amount of legislative and administrative supervision.[26] When a government agency like the TVA is required to compete in the private area, however, many of the factors affecting that budget are beyond the practical control of normal congressional and executive mechanisms. Such an agency as the TVA is at least once removed from responsible control by the politicians when compared with agencies which are dependent for their operating funds upon tax monies.

The second characteristic of a commonweal organization enumerated by Blau and Scott is as follows: If the client-in-contact is other than the client-at-large, benefits to the client-in-contact must be justified on how much they benefit the commonweal.[27] Blau and Scott give examples of commonweal organizations which include the State Department and the Bureau of Internal Revenue.

The State Department's budget, its top personnel, and its policies are reviewed by the Congress and the President. The bulk of State Department funds are general tax revenues and its performance or lack thereof is judged by what is good for the United States (the commonweal) rather than what is good for the clients-in-contact (other countries).

Both organizations stand in stark contrast with the TVA. Although Congress and the President review the budget of the TVA and exercise final authority as to who its top leaders are and what its overall policies will be, its performance is judged in relation to how well the TVA serves its clients-in-contact. The TVA is self-supporting. As long as it pleases its clients-in-contact, the degree of oversight and direction exercised by the President and the Congress is considerably less than is the case with the Internal Revenue Service or the State Department.

If one looks quite superficially at the characteristics of NSF, it would appear to be a commonweal organization. It derives 99 percent of its monies from general tax funds, it frequently must defend itself before committees of the Congress, and its activities may be reviewed in the Executive by the BOB and the Office of Science and Technology (OST). The mechanism to ensure the operation of NSF in the commonweal interests as interpreted by the President and the Congress appears to be present. If one stops at the boundary line between NSF and the President/Congress, then the agency seems under every bit as much control of the politicians as any other government agency.

Blau and Scott list no other characteristics of a service organization than that its chief concern be the welfare of its clients. NSF would appear to have the capacity to exercise this concern. Congress gave to the Foundation authority "...within the limits of available appropriations to do all things necessary to carry out the provisions of this act."[28] Such authority included the power to make its own internal rules and regulations, to spend monies for the administration of the Foundation, and to enter contracts of "other operations" with U. S. citizens or citizens of foreign countries.[29]

The Director of NSF was to be a full time government appointee, responsible to the President and the

Congress. However, the members of the National Science Board, which was to "exercise the authority granted to the Foundation" were to be part-time. Although they were to be appointed by the President, appointment was to come from persons who "(1) shall be eminent in the fields of the basic sciences, medical science, engineering, agriculture, education or public affairs; (2) shall be selected solely on the basis of distinguished services; and (3) shall be so selected as to provide representation of the views of scientific leaders of the Nation."[30] Additionally, the President was to seek the advice of various national scientific and scholarly organizations in making his appointments to the Board. He was to give due consideration to "...any recommendation for nomination which may be submitted to him by the National Academy of Sciences, the Association of Land Grant Colleges and Universities, the National Association of State Universities, the Association of American Colleges, or by other scientific or educational organizations."[31]

Consideration for the interests of the clients-in-contact, the scientists, is reflected in the manner in which funds are appropriated to the Foundation. Wide latitude and discretion on the part of NSF characterizes the spending provision of the agency. Monies are appropriated in a category termed "no year" funds. Appropriations "...remain available for obligation and expenditure, for such period or periods as may be specified in the acts making such appropriations."[32] This privilege allows NSF a great deal of flexibility because it can defer spending of one year's appropriations to the following years. The rationale behind this rather unusual way of handling money is based upon what are stated to be the unique needs of science as opposed to other activities. The provision was explained and justified by Congressman Frank Keefe of Wisconsin during the House debate on the amendment to the original NSF legislation.

> Mr. Keefe. We ran against the situation [funding the training of scientists in the health fields] in the program carried on by the National Institutes of Health, and what did we find? We found that you could not induce a young man to go into a 6- or 7-year course of study necessary to become a trained scientist when he is constantly subjected to the annual whims or caprices of Congress as to whether funds will be provided to carry on that fellowship.[33]

The above statement refers specifically to the funding problems associated with training researchers. The same logic, however, would appear to be in the minds of the legislators concerning the other activities sponsored by the Foundation. That is, science in general needs a special type of financial management. In any case, the special "no year" funding provision applies to all the programs carried on by NSF.

Although the characteristics enumerated by Blau and Scott are general, they do appear to fit NSF. The agency is subject to responsible political control, but it has the means to serve the clients-in-contact, the scientific community.

4. The Demands Surrounding the Creation of NSF: Basis for a Dilemma.

If NSF is a commonweal/service organization, one would expect to find evidence of a central dilemma for both a commonweal and a service organization. Confirmation of the existence of such a set of dilemmas adds evidence to the hypothesis that NSF is in fact a commonweal/service organization.

The twin goals of NSF to be both a commonweal organization and a service organization were a result of the demand situation surrounding the creation of NSF. During the enabling hearings, scientists, industrialists, and politicians were all articulating their positions with regard to the establishment of a science foundation. Concurrent with the defining of the stated goals of NSF was the emergence of the central dilemma or dilemmas of NSF. They arise as soon as an organization is created and are for this reason a function of the creative process surrounding the formation of the organization. Specific dilemmas may disappear when organizations undergo changes in client groups, but old dilemmas are replaced by new ones. According to this formulation, all organizations have dilemmas.[34]

Public view of the creation of NSF took place before the Senate subcommittee chaired by Senator Kilgore and a House subcommittee chaired by Representative Priest. Hearings before these committees chronicled the appearance of over two hundred witnesses, the passage and Presidential veto of one NSF enactment bill, and the final creation of NSF. This last event occurred some five years after the distribution of the Bush report and the beginning of the first set of hearings. Because of all the activity before these two committees, it is possible to obtain a reasonably complete view of the creative process surrounding NSF. Spokesmen for organizations such as the American Association for the Advancement of Science (AAAS) were asking these two subcommittees to create a science foundation. The bases for possible dilemmas were being recorded as witnesses gave their positions.

Creation of new organizations generates many potential dilemmas which can be handled in several ways: a dilemma may be resolved by the demand being withdrawn or allowed to die by the spokesman who made it, a dilemma may be resolved by ruling the demands which create it as outside the province of the organization being created, a demand may become the basis for a dilemma within the new organization, or one demand may simply displace another demand.

The first three of the above four phenomena occurred at least once during the establishment of NSF. The first, allowing the demand to die, took place in connection with the Bush proposal for a Division of Military Affairs within NSF. He believed that "Placing the civilian military research function in the proposed agency would bring it into close relationship with a broad program of basic research in both the natural sciences and medicine. A balance between military and other research could thus readily be maintained."[35] "It should be the function of this Division to support long-range scientific research on military matters."[36]

The military, of course, backed the Bush Military Affairs Division proposal. The Kilgore subcommittee heard favorable testimony for it from the Secretary of the Navy, the Chief of Research and Invention of the Navy, the Secretary of War, and the Commanding General, Army Air Forces. This favorable testimony was repeated to the Priest subcommittee in the House. Typical of the testimony in both the House and Senate was that given to the Kilgore subcommittee by Secretary of War Patterson. The Secretary of War stated that

> The President in his message to Congress on September 6, 1945, has emphasized the need for research and has urged the early adoption of legislation for the establishment of a single Federal Research Agency which would, among other functions, promote and develop projects in all matters

> pertaining to the defense and security of the Nation. The War Department is in complete accord with the President's plan.[37]

By posing the inclusion of military needs in NSF, Bush and the spokesman for the services had submitted the basis for a dilemma. The dilemma had to do with the purposes and values of science and of the military. In objective terms it had to do with whether the NSF formal organization would be a service organization to the scientists or serve the specific commonweal objective of national security. The purpose of science in this case can be called crudely one which deals with the pursuit of truth for the sake of truth alone.[38] The purpose of the military in this context is the application of science in the furtherance of its mission of providing national security. To the scientists this meant the direction of his research by outsiders and the harassment of the communication channels of science in the name of security.[39]

The purpose of science, the pursuit of truth, implied to the military the avoidance by the scientists of finding answers to practical questions. Both sides of the issue were described by Secretary of the Navy Forrestal in testimony before the Kilgore subcommittee.

> I came back to what I said about the practical applicability of scientific research. Whether it is a business or war, the scientist is quite apt to want

> to get perfection before he permits it to be made. We had that in a notable example in the Navy in electronics and radar. We were trying to get perfection before putting it to use. The result was that I frankly think we were a little bit late in getting the full benefits of it. The same in business. The research fellow always wants to get the perfect radio before he puts it on the market. Somebody has to reach down and grab what is there in terms of abstract development and bring it into the field of practical use.[40]

The other side was described again by Secretary Forrestal as he commented on a proposal to form a scientific reserve corps, modeled after the Army and Navy reserves.

> I am a little bit dubious--I think it is possibly desirable, except that I go back again to the character of scientists. Mind you, I am not one, so I am speaking without very much warrant,but it seems to me that science is a good deal like art itself. It cannot come out of a decision to produce so much science and so much research so many particular resulting projects, any more than you can order Mr. Shelley to write a poem. I think that may be a farfetched analogy, but I think they have a good deal of the same curious manifestations of genius in the two fields.
>
> I wouldn't try to regiment this too much, because you may scare some of those lads off.[41]

The requirements of the military for practical application and a rigid security system were opposed to the free search for truth and the unrestricted communications system of science. As pointed out in Chapter I, opposing goals can be the objectives of the same organization. However, such a situation would lay the basis for a dilemma.

The question can logically be asked why the scientists did not oppose such a military division within NSF. There are two quite plausible answers to this question. The first is that even at this early date, the scientists were aware of the power of invoking the name of national security to obtain funds. World War II had demonstrated this to them. "During the war, the Government expanded its research budget from $69,000,000 in 1940 to $720,000,000 in 1944."[42] Much of this increase was due directly or indirectly to the military's need for weapons whose production required men with a high degree of scientific competence. The second answer is to be found in the increased sophistication with which the military treated the scientists. If the military would allow the scientist enough autonomy to do his work, a working relationship could exist. OSRD under wartime conditions had built a fruitful relationship between the military and the scientists and no doubt the scientists believed that it would be even easier to work with the military in peacetime. Daniel Greenberg in his book The Politics of Pure Science suggests that the Department of Defense (DOD) and the scientific community have had little difficulty over the funding of research in the name of national security.[43]

This basis for a dilemma, real or potential, did not become a part of NSF, however. During the five years it took to finally get an NSF bill through Congress which was acceptable to all parties, the military had grown tired of waiting and had developed their own methods for funding research. By the time NSF was finally created, the military was satisfied with their own procedures and the proposal for a Division of Military Affairs was allowed to die. The armed services were uninterested and no longer registered a demand that NSF be concerned with national security. A vestige did remain in the final bill which authorized and directed the Foundation

> ...at the request of the Secretary of Defense, to initiate and support specific scientific research activities in connection with matters relating to the national defense by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific research.[44]

This provision has remained unused.

Some demands do not become the bases for dilemmas because they are declared lying outside the proper concerns of the agency being created. This occurred in the discussion over patent rights. The situation arose from a demand by Senator Kilgore and backed by the President through his Budget Director. The demand was for the assignment of all patents which resulted from the spending of Federal research funds to the public domain. The demand in the original Kilgore Bill required that "...any invention, discovery, patent, patent right, or finding produced in the course of federally financed or development activities shall be the property of the United States and shall be freely dedicated to the public."[45] Not only was the Director to monitor patents that resulted from NSF research, but he was to watch all other Federal research and development for such results. In addition, the Director had the delicate job of determining how much of the patent belonged to the government and how much should be assigned to the researcher or the institution he represented.

If the Kilgore demand had been met, then the problems which rested with the Patent Office, the Congress, and other agencies would be transferred to the newly operated NSF. Vennevar Bush and others who supported the creation of a science foundation sought to have the House and Senate committees avoid these problems by not defining the public interest in terms of patent rights.[46]

This viewpoint was followed and the final NSF legislation allows the Director to make contracts at his discretion which are satisfactory to the public interest, protect the rights of the researcher, and are in accordance with current patent regulations. The public interest is not defined as placing patents which result from federally financed research in the public domain. In the final bill the public interest with respect to patents is not defined at all.[47] Any problems between federally financed researchers and the public interest are left to be settled with the Congress and the U. S. Patent Office.

The last two cases described involved demands which did not create the bases for dilemmas, but which illustrate an important point about dilemma formation. This is the fact that counter demands do not need to be made in order to create dilemmas. Counter demands, at least, do not need to be made formally. They may exist in the characteristics of the situation.

In the case of the military being represented in NSF, no counter demand was made by the scientists. The Bush report proposed a Division of Military Affairs and of the 200 witnesses before the Kilgore subcommittee, none testified against the formation of such a division. However, the tension between a profession whose goal is truth and one whose goal is preserving national security existed even though there was no debate.

The tension which arose over the Kilgore patent proposal existed from the minute the proposal was made. Public rights and private patent rights were at odds as soon as NSF was suggested to be the agency which would arbitrate between these interests. The basis for the dilemma only disappeared when the public interest was not defined in terms of patent rights.

The basis for the dilemma which is central to NSF was one which also did not provoke formal counter demands. The demand was made by the scientists and although there were arguments over the extent to which their demand should be met, no one in the traditional parliamentary sense rose to denounce it.

The scientists demanded that if there was to be a federal science foundation, then it should provide for the freedom of the scientists. It must include the freedom to choose one's own work according to one's interests and the judgements as to the merit of the work should reside with the scientist's peers. The desire for the freedom of science was made by all the scientists who appeared before the Kilgore and Priest subcommittees. The most detailed explanation and justification for such unusual freedom in using public funds was offered by Dr. Karl T. Compton, President of Massachusetts Institute of Technology, to the Kilgore subcommittee.

> The most important prerequisites for success in fundamental research involve such things as the following: choice of a field of research which appears rich in possibilities; selection of some specific project in that field which will open up a path into its unknown frontiers; availability of suitable laboratory facilities and equipment needed for the work; above all, research personnel of imagination, originality, analytical ability, and sound

> training and skill. Of the utmost importance in opening up a great new field of science, like nuclear physics, or electronics, or the understanding of physiological processes, is the greatest possible opportunity for exchange of ideas and information and mutual stimulation among all the workers in that field. This is the principal reason why discovery of fundamental facts of nature has never prospered under conditions which limit the free exchange of ideas--conditions such as patent commissions, trade secrets, and military security.[48]

No one disputed the desirability of preserving the right of the scientists for free thought. Nevertheless, the demand for such freedom at public expense laid the basis for a dilemma. Vannevar Bush described the problem while at the same time denying its existence. Under the heading of Five Fundamentals (for a science foundation), Bush wrote

> (5) While assuring <u>complete independence</u> and freedom for the nature, scope, and methodology of research carried on in the institutions receiving public funds, and while retaining discretion in the allocation of funds among such institutions, the Foundation proposed herein must be <u>responsible</u> to the President and Congress. Only through such responsibility can we maintain the proper relationship between science and other aspects of a democratic system. (Emphasis added).[49]

The basis for this dilemma has been described in several ways. Perhaps the most eloquent is by Don Price in <u>The Scientific Estate</u>. Science, Price notes, is concerned with the pursuit of truth. In order to pursue this concern, science must be free. Democratic politics, like all politics, is interested in purposes, but the agencies which pursue these purposes must be held accountable.[50] In this country, the agency head is held responsible to the politicians. This places the leader and managers of NSF in a dilemma. If one is an administrator of NSF, should he serve the desires of the scientific community or those of the politicians representing the commonweal?

5. <u>The Central Dilemmas of NSF</u>.

If one accepts the evidence of the proposed goals of NSF, the goals embodied in the enabling legislation, the demands made during the enabling hearings, and the description of the characteristics of NSF, then one may usefully classify NSF as a commonweal/service organization. If one accepts such a classification, there are three groups which one must consider in analyzing NSF. They are the public-at-large as represented by the politicians, the clients-in-contact or the scientists, and the staff of NSF. The latter named group serves as the focal point for the demands of the two prime beneficiaries: the politicians and the scientists. That the staff, owners or managers of an organization, is the group which must deal with the central dilemma of an organization is true in all of the four types of organizations discussed by Blau and Scott. In a commonweal organization, managers must provide a mechanism for control by the public and at the same time provide a means whereby the public objectives can be effectively implemented. In a service organization, the managers must pay attention to what the clients-in-contact want versus what is in the clients' best interests. If NSF is a commonweal/service organization, it is faced with both of these dilemmas. Attempts to deal with these dilemmas would rest in the hands of the Director of NSF, his personal staff, and the Heads of Divisions and their staffs. Figure I illustrates schematically the dilemmas of NSF. Beneath Figure I is a statement of the dilemma facing a commonweal organization and a service organization. Together they compose the central dilemmas of NSF.

The Politicians	NSF Staff	The Scientists

Figure 1.

The Central Dilemmas of NSF

1. "...the crucial problem posed by commonweal organizations is the development of democratic mechanisms whereby they can be externally controlled by the public," versus "...the maintenance of official bureaucratic mechanisms that effectively implement the objectives of the community."[51]

2. "Since one group in service organizations [the Staff] must decide what is in the best interests of another [the clients-in-contact], the basic problems here are to assure that the former serve the interest

> of the latter but that they do not let the latter determine how they are to be served."[52]

Adapted to the NSF case, the staff would have to maintain a mechanism which would be capable of receiving commonweal demands, but still be efficient enough to turn these demands into policy. As a service organization, NSF must not only serve the interests of the scientists but must also be concerned with the overall health of the scientific community. According to Blau and Scott, these dilemmas and attempts to resolve them would be pervasive throughout NSF. This is to say that official NSF ideology and formal structure would contain evidence of attempts to deal with them by NSF's leaders or its creators. How NSF's official ideology and formal structure take these dilemmas into account in turn affects how the organization performs (transforms demands into policies). The following sections examine the official ideology and formal structure of NSF in terms of its hypothesized central dilemmas.

6. The Official Ideology of NSF.

As described earlier in the section on the proposed goals of NSF, Vannevar Bush recognized the commonweal dilemma but used ideology to collapse or at least mute any concern over it. In The Endless Frontier, Bush stated that although the purpose of NSF was the betterment of the nation, this objective could best be achieved by aiding science. To Bush, aid to science meant allowing researchers to choose their own work, supplying them with a continuous and stable source of funds, and having scientific work judged by the investigator's peers.[53] If this were done, great commonweal benefits would result.[54]

> The publicly and privately supported colleges, universities, and research institutes are the centers of basic research. They are the well-springs of knowledge and understanding. As long as they are vigorous and healthy and their scientists are free to pursue the truth wherever it may lead, there will be a flow of new scientific knowledge to those who can apply it to practical problems in Government, in industry, or elsewhere.[55]

The committee assigned by Bush to write the "Report of the Committee on Science and the Public Welfare" and chaired by Dr. Isaiah Bowman, president of Johns Hopkins, agreed with Bush's philosophy. The report concluded "...that public health, higher standards of living, conservation of national resources, new jobs and investment opportunities--in short, the prosperity, well-being and progress of the American Nation--all require the continued flow of new scientific knowledge."[56] The committee also warned that only by allowing science to be "free" would these benefits of knowledge be had. They also reemphasized the need for scientists to have continuous and stable sources of support.

> This committee does not feel that it is desirable to supply these funds by a series of annual congressional

> appropriations for specific projects; the difficulties these have raised within the Government service testify to the evils that would be introduced into the university environment by this practice. The preservation of academic freedom requires that funds be allocated in a way that would minimize the possibility of external control and would encourage long-term projects.[57]

Of all the scientists who testified at the enabling hearings, none took exception to the relationship between basic research and broader national goals or the necessity for providing "freedom" for scientific research. William A. Higgenbotham, an experimental physicist and executive secretary for the newly formed Federation of American Scientists expressed what he believed to be the ideal relationship between science and government.

> Science depends on individual initiative even more than does private enterprise. Centralized planning and direction would stifle and smother it. Research is grass roots in the extreme. New laboratories of the Government is not what science legislation should provide. Government has laboratories, and good ones, but what is needed is a wide net of university and private laboratories, large and small, working on what they wish but assisted and encouraged by the Federal agency.[58]

If this advice were followed, Higgenbothem repeated, all areas of the national life would be benefited.[59]

The dilemma which faces all commonweal organizations of developing a sensitive system to hear the public's demands versus providing the means for efficient action on these demands was not approached by Bush or the scientific witnesses. Seemingly, no dilemma would exist if NSF would aid scientists and leave the judgements as to the aid's effectiveness to the investigator's scientific peers. Commonweal benefits would result and the public would realize the importance of these benefits. Therefore, the problem of handling traditional political demands would not exist.

The dilemma of the service organization was handled by Bush, his committees, and the scientific community by the same logic. Science was done by individuals. They should be free to choose their own work, provided with the means to do the job, and judged by fellow professionals actively working in the field. The Bowman Committee concluded in the Bush report that "We believe that it is possible to devise methods whereby great benefits to research may be achieved by such aid [provided by NSF] without sacrificing the freedom essential for scientific advance or the academic independence of our traditional institutions."[60] If science was at the "grass roots" as Higgenbothem inferred, then doing what was best for science meant doing what was best for individual scientists. Not surprisingly, the bias of the values expressed by the scientists was in favor of themselves. The people who would best judge what was "best for science were not to be in the proposed foundation, but were presumed to reside within the client-in-contact group, the scientific community.

Even those who opposed the Bush report's formal structure for NSF did not publicly question the value of the pursuit of science unencumbered by "political" interference. President Truman, although opposed to Bush's recommended structure, paid deference to the objective of a "free" scientific enterprise.

> I appreciate the interest taken in this subject by members of your Committee [Committee Supporting the Bush Report], and feel sure that their basic objectives of freedom of research, and non-partisan administration of a program of aid to scientific research and education, will be attained under such an organization as I have recommended.[61]

Fresh from their triumphs of World War II, the scientists who testified before the Priest and Kilgore committees spoke with a united voice on the values just enumerated, and had the backing of Bush and his prestigious committees. Scientists are by vocation interested in truth and much of this concern for truth could be drawn upon to support their desires for a government agency dedicated to helping those who pursued truth.

Although the scientists appeared to be united in the values which they felt the new organization should embrace, it was still necessary for the Director of NSF to synthesize these values into some type of coherent ideology. The logical place to look for such a synthesis is in the NSF Annual Report. These reports provide an opportunity over time for assessing statements of official ideology. They are submitted both to the Congress and the President and are official government documents whose preparation by NSF is required by law.

The 1957 year end report contains an especially complete statement of the NSF ideology by the then Director, Dr. Alan Waterman. He was the first head of NSF and served during its formative period from 1957 through 1963. The 1957 report is the most complete and authoritative statement of the NSF ideology during the Waterman tenure.

In this report, Waterman again stressed the link between basic research and the achievement of a variety of national goals. Accepting the assumption that basic research should be aided, he went on to describe how he thought NSF could best nurture basic research. It was Waterman's conclusion that NSF could best further science by adapting the agency to the ways of science.

> A national policy in pure science must, therefore, be an enlightened one--it must find out what scientists consider important to do and to see that they have the means to do it. This means wholehearted approval of providing support for competent basic research wherever needed, and in particular for the capital facilities which science needs in such fields as nuclear research, radio astronomy, and the scientific exploration of outer space.[62]

The ways of science were to Waterman relatively simple. In this sense, like Higgenbothem in testimony before the Priest subcommittee thirteen years earlier, Waterman believed science to be a "free enterprise" system. It is "democratic", Waterman continued, and "...any adequately trained research scientist may and does make his own contributions to science, which may be large or small." In his view, to tamper with such a productive and internally well run system would be unwise. "No scientific society would think of doing such a thing for its members. The scientists themselves know best what can be done and how to go about it."[63]

From an ideological standpoint, Waterman resolved the two dilemmas facing a commonweal/service organization. A mechanism within NSF to receive and act upon commonweal demands was unneeded if the scientific community did good research. Health, military security, and economic betterment would be attacked indirectly by aiding basic research. Because the scientists were the only ones competent to perform and judge basic research, commonweal demands on this subject were not relevant. Even more strongly than previous references, Waterman dealt with how NSF could best function for the good of science. The dilemma of the service organization did not exist because "...the scientists themselves know best what can be done and how to go about it."[64] NSF was to serve its clients' interests by doing what its clients wanted to do.

There was no apparent disagreement on ideological matters between Waterman and his successor, Dr. Leland Haworth. In 1965, before the Daddario committee, Dr. Haworth gave a more sophisticated statement of how basic research was linked to the public good.

> All three areas of activity are important. Applied research builds on the results of basic research. Development builds on both. The more complete our underlying knowledge, the easier the task of applied research and of development. In the broad sense, research is in this era the foundation upon which rests all technological development; such development is harvested from knowledge resulting from a great many experiments and the understanding derived from them. It would be a misconception of these activities if one sought to divide a 1-to-1 causal relationship between a specific development and a specific piece of basic research.[65]

In his argument, Haworth carried the previous concept of the difficulty of the evaluation of basic research by the untrained one step further. He advised it would be next to impossible to explain in specific cases how individual research projects aid the commonweal. He had reaffirmed, of course, in the above quote the belief that collectively basic, applied, and developmental research does aid the national welfare.

The best way to encourage basic research, which Haworth held to be along with science education the primary mission of NSF, was to rely heavily on qualified researchers. "In all the research programs, emphasis was placed on giving assistance to individual scientists of high creative ability. The technique of review of research proposals by panels of the proposing scientists' peers was established."[66] Haworth did not deviate from Waterman's earlier ideological outline of what NSF should be doing and how it should be done.

The evidence presented in this section indicates that the ideology of NSF takes into account the two central dilemmas predicted in the Blau and Scott model. NSF's ideology also resolves both dilemmas in favor of the clients-in-contact, the scientists. Good science contributes to commonweal objectives and the way to promote science is to fund quality research as judged by the professional peers of the investigator doing the research.

7. Formal Organization.

In section 3 of the first chapter, social organization was said to have two characteristics: value orientations and structure. These terms were discussed and their empirical manifestations were stated to be respectively, official ideology and formal organization. The first term was defined to be the values of the organization as publicly stated in official documents or by the organization's personnel before Congressional committees. The latter term refers to the explicit chain-of-responsibility. It asks the question, who is in charge or who is held responsible for the organization's performance (transforming demands into outputs)?

The official ideology of NSF was discussed in the preceding section and its formal organization is considered here.

The argument was made in the last section that the official ideology of NSF did not provoke much controversy at the enabling hearings. The disagreement which did take place was over the formal organization of NSF. As was the case with the official ideology, the Bush report provided the basis for the discussion of how NSF ought to be organized.

In The Endless Frontier, Bush described a very simple organizational scheme for NSF (See Figure 2). It was in accordance with Bush's ideological view that "freedom of inquiry must be preserved."[67] The organizational structure was to serve science by providing funds and allowing for the maximum amount of freedom within the scientific community.[68] If this were done, Bush believed, NSF would more than justify its existence by any conceivable set of commonweal criteria.[69]

In the Bush proposal, responsibility for the operation of NSF was to reside with a board selected by the President for their scientific and educational competence. They were to serve without pay, although the Board later called the National Science Board (NSB) was to appoint a full time Director of NSF. He was to be

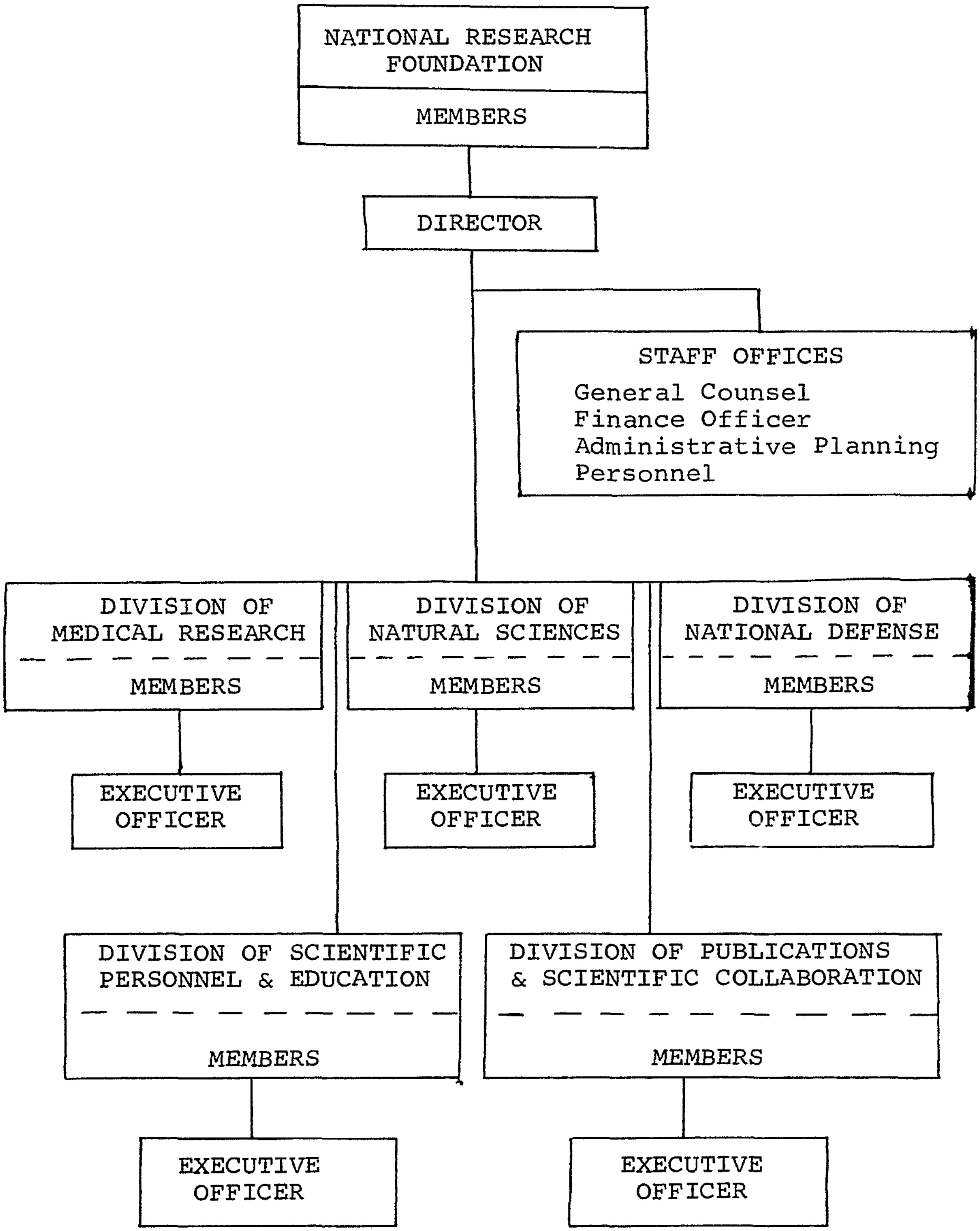

Figure 2.

Proposed Organization of National Research Foundation[70] "subject to the direction and supervision of the Foundation members (acting as a board), [and] the director should discharge all the fiscal, legal, and administrative functions of the Foundation."[71]

The NSB was also to appoint a Chairman and four other members for each one of the five operating divisions of the Foundation. All of these officials were to be part-time and were to be appointed after considering "...recommendations from the National Academy of Sciences."[72] The fifth division, the Division of National Defense was to "...include, in addition to, say, five civilian members, one representative of the Secretary of War, and one representative of the Secretary of the Navy, who should serve without additional compensation for this duty."[73]

The Board with advice from the appropriate Division Committees were to have the power to appoint advisory committees, "...enter contracts with or make grants to educational and nonprofit research institutions for the support of scientific research",[74] establish scholarships and fellowships, aid in the dissemination of scientific and technical information, promote international cooperation, and promote "methods of improving the transition between research and its practical application in industry."

The relationship between the scientific community and NSF was relatively explicit in comparison with Bush's ideas of what the relationship should be with the Executive and Legislative branches of the Federal government. This relationship is not covered in any detail except to state that the NSB should be appointed by the President. Bush's only other comment on the relationship between NSF and the rest of the government is contained in a list of conclusions he terms, "Five Fundamentals." In his fifth and final "principle", Bush states that

> (5) While assuring complete independence and freedom for the nature, scope, and methodology of research carried on in the institutions receiving public funds, and while retaining discretion in the allocation of funds among such institutions, the Foundation proposed herein must be responsible to the President and the Congress. Only through such responsibility can we maintain the proper relationship between science and other aspects of a democratic system. The usual controls of audits, reports, budgeting, and the like, should, of course, apply to the administrative and fiscal operations of the Foundation, subject, however, to such adjustments in procedure as are necessary to meet the special requirements of research.
>
> Basic research is a long-term process--it ceases to be basic if immediate results are expected on short-term support. Methods should be found which will permit the agency to make commitments of funds from current appropriations for programs of five years' duration or longer. Continuity and stability of the program and its support may be expected (a) from the growing realization by the Congress of the benefits to the public from scientific research, and (b) from the conviction which will grow among those who conduct

> research under the auspices of the agency that good quality work will be followed by continuing support.[76]

In reading the above statement, it is difficult to see what power Congress or the President would have over NSF, except to appropriate funds and then oversee and audit what NSF had done with them. The "Fifth Principle" is really a restatement of his ideology plus an explanation of the interrelatedness between this ideology and Bush's proposed structure. Science was to be as free as possible and aid to science if given freely would result in commonweal benefits. In this organizational plan, freedom was to be assured by making the Board and the Division heads part-time members of the Foundation, but full time representatives of the clients-in-contact, the scientists. The Director of NSF, although full time, was to be appointed by the NSB and responsible to it for the performance of NSF. Formal organization and official ideology appear to be congruent in the Bush scheme.

The Bush plan of organization was introduced in the Senate by Senator Magnuson and in the House by Representative Mills. The bills were identical and hearings on them began in the Seventy-ninth Congress.[77] While not opposing the basic purpose or ideologies expressed in these bills, the President through his Director of the

Bureau of the Budget and his Secretary of Commerce opposed certain organizational features in these bills.[78] Particularly odious to the President was the provision in the Mills/Magnuson (Bush) bills for choosing the Director of NSF and to whom he was to be responsible. The President wanted the power to appoint him and also wanted the Director to be directly responsible to the President and the Congress for NSF's performance. The Director of the BOB testified before the Priest subcommittee that

> One means of keeping an agency responsible is by control of its funds, and I am glad that both bills provide that the foundation shall receive its funds by the regular budgeting and appropriation process. [As already noted in Section 3, this process was modified to suit the special needs of NSF.]
>
> But there is another way in which a Government agency is held responsible--by the President's power of appointment and removal. S. 1285 [the Magnuson Bill] provides that the foundation be headed by a board composed of members none of whom is required to be a full time employee of the Federal Government. I know of no Federal agency charged with the administration of an extensive program of contracted relations with private institutions that has been headed by such a board.[79]

The Director of BOB concluded that "To make it possible for scientific advisors to make their contributions unhampered by administrative pressures, as well as to provide the most efficient and responsible type of structure, I believe that the foundation should be headed by a single administrator."[80] President Truman simply wanted a Director of NSF that the President could appoint and hold responsible for the performance of NSF. The NSB plus any others holding part-time positions should function in an advisory capacity only.[81]

The President's insistence on these points, split the scientists supporting the establishment of NSF. One group, the Inter-Society Committee was sponsored by the AAAS and was willing to barter with the Administration.[82] The other group, called the Committee Supporting the Bush Report, was in favor of a Director appointed by the NSB and directly responsible to it. The researcher found no evidence that these two groups were split over the desirability of establishing a foundation. The split was over the tactics of how best to meet the President's demands. The two groups compromised and backed a bill which retained most of the features of the Bush proposal except that the Director would be appointed and could be removed by the President. The bill called the Kilgore-Magnuson Bill (S 1850) passed the Senate 48 to 18, but died in the House during the last session of the Seventy-ninth Congress.[83]

The spirit of compromise between the Bush group and the scientists supporting proposals more favorable to the President's stand broke down with the advent of the 80th Congress. The Mills (Bush) Bill was reintroduced in the 80th Congress, and after passing both Houses, was pocket vetoed by the President. In his veto, the President repeated his opposition to the Bush scheme for a Director chosen and responsible to the NSB.[84] The President expressed his disappointment at not being able to approve the bill, but felt that "he would be deprived of effective means for discharging his constitutional responsibility."[85] He commented in his Memorandum of Disapproval of S. 526 that

> Full governmental authority and responsibility would be placed in 24 part-time officers whom the President could not effectively hold responsible for proper administration. Neither could the Director be held responsible by the President, for he would be the appointee of the Foundation and would be insulated from the President by two layers of part-time boards. In the case of the divisions and special commissions, the lack of accountability would be even more aggravated.
>
> The members of the Foundation would also be authorized to appoint a full time administrative head of an important agency in the executive branch of the Government, as well as more than 70 additional part-time officials in whom important governmental powers would be vested. This represents a substantial denial of the President's appointing power, as well as impairment of his ability to see that the laws are faithfully executed.[86]

The Inter-Society Committee was favorable to the President's views, and Howard A. Meyerhoff of the AAAS condemned the Bush Committee's support of the Mills Bill. Meyerhoff wrote that the Senate "...by passing S. 1850 in 1946 and S. 526 in 1947, demonstrated that it is trying to give scientists what they want. What it needs now is the advice of representatives of science rather than advocates of a partisan point of view."[87] Some supporters of the Bush proposal as embodied in the vetoed bill used the Chemical and Engineering News to express their position. This journal editoralized that "He [President Truman] has chosen to disregard the recommendations of the top science leaders of the country and in fact the opinions of the majority of the rank and file of the scientific professions. Thus, the extensive efforts and voluminous congressional hearings over the past few years have come to nought, at least for several months."[88]

After the President's veto was made, hearings were reconvened in the 81st Congress and S. 247 was finally passed by the Congress and approved by the President. It became law on May 10, 1950.[89] Like S. 1850 before it, the act represented a compromise between the Administration and those backing the Bush proposals.

As previously pointed out in this chapter, the enabling legislation for NSF specifies that the NSB is appointed by the President, but that he is requested "...to give due consideration to any recommendations for nomination which may be submitted to him by the National Academy of Sciences, the Association of Land Grant Colleges and Universities, the National Association of State Universities, the Association of American Colleges, or by other scientific or educational organizations."[90] They are appointed for six-year terms and these appointments are staggered every two years. This is to say that eight members of the NSB are appointed every two years. No legal means providing for their removal is in the Act. The Director is appointed by the President for a six-year term and is not to be appointed until the Board has had an opportunity to make recommendations for the Directorship.[91]

As was proposed in the Bush report, division committees are to be selected by the NSB and are to select their own division chairmen. New divisions can be added as the Board deems necessary. The NSB was also given authority to appoint any additional advisory committees from among its own membership or outside of it.[92]

In the original legislation, the Director is an ex-officio, non-voting member of the Board. He is responsible for operating the Foundation "...in accordance with the policies established by the Board", and in accordance with the provisions of the Act. According to S. 247 as passed, the Director is not to take any final actions unless they are specifically delegated to him by the NSB.[93]

There have been several significant changes in the organization of NSF since the original legislation was passed in 1950.[94] The Director is now a voting member of the NSB and chairs that body's executive committee. The Director may now appoint advisory committees and panels, and is required only to consult with the Board in making these appointments. In addition, the Director makes all appointments of NSF's permanent staff and is again required to merely consult with the Board on these appointments. Deputy Directors and four Assistant Directors have been added to the NSF internal organization. These are Presidential appointees, but the President is asked to afford an opportunity for the Director and NSB to make recommendations for these posts.

Division Committees and their Chairmen have been abolished and replaced with advisory committees appointed as the Director and the NSB see fit.[95]

Most of these changes have strengthened the position of the Director vis-a-vis the NSB. The NSB still retains coequal power in broad policy making matters of NSF, but serves mainly as a consultant in matters of appointment, awarding of grants, and the day to day operation of the Foundation. The Director has lost some power in only one respect. He may now be removed by the President; NSB members, however, are still insulated from legal termination of their respective eight-year terms.

The most important and perhaps most subtle organizational feature of NSF is the way it is internally divided into its operating parts. This type of internal structure has the support of the Senate and House subcommittees which handle NSF authorization matters and has important policy ramifications.

> The committee believes that organization along functional lines--much as NSF operates today in actual practice--represents a sound procedure. Such categories as basic research, education, scientific and technical manpower development, institutional development, science information, and the like, would seem desirable to the NSF organization. Structuring along these lines has the advantage of requiring identification of program and budget elements that would permit clearer definition of their scope and relative balance. Further, it facilitates congressional and Presidential review.
>
> The committee notes that the Director, in organizing the Foundation's internal structure, is obliged to consult with the Board. However, his is the controlling voice since the management of NSF operations is his responsibility.[96]

All of these categories are service to science designations. Basic research, which receives the major portion of NSF funds (52% in 1969), is the most obvious example.[97] However, even science education programs in the grade schools provide aid to American institutional science. Not only does such education make the general public aware of how science fits into our society, but it plays a role in seeking out and developing future scientists.

NSF is organized not only to serve science, but also to hear the scientist's demands and respond to them. Formerly the NSB, and now the Director in conjunction with the NSB, can appoint committees from the scientific community to advise each one of the full time staffs.

An example illustrates how NSF's organizational structure complements the way science itself is organized. Internally and at the permanent staff level there is an Assistant Director for Research. He and the three other Assistant Directors are located hierarchically and directly below the Director and Deputy Director of NSF. Next in line to the Assistant Director of Research are the various NSF Divisions of Research. In the life sciences, for example, there is a Division of Biological and Medical Sciences and this division is further divided into sections, i.e. the Cellular Biology Section, the Molecular Biology Section, etc. Parallel to the permanent staff are the advisory committees and panels which advise the Divisions and Sections. In the case of biology, there is an Advisory Committee for Biological and Medical Sciences, and advisory panels for the various sections of the divisions. NSF is a dual organization from the Director/ Board level to the section/panel level. In addition, the Director and the Board occasionally appoint ad hoc committees to consider particular problems confronting the scientific community as a whole or, more typically, particular disciplines. Currently there is a Special Commission on the Social Sciences which is supposed to report to the NSB and to the Director on the problems and opportunities of that field.[98] NSF has numerous ways, formal and informal, whereby science as a collective or as separate disciplines may pass information on to the NSF permanent staff.

NSF has the capacity, like science itself, to grow organizationally as pressure for new disciplines and sub-disciplines are generated within the academic community. This "spin off" of new fields is considered by scientists and historians of science to be one of the necessary conditions for a vigorous scientific community.[99] NSF has the ability to complement and parallel this growth from a formal organization standpoint.

Bush did not get everything he wanted. The Director is a Presidential appointee and may be removed by the President. Bush had wanted the Director to be chosen by the NSB and responsible to it for the operation of the NSF. However, even on this point, President Truman had yielded somewhat to Bush and his supporters both inside and outside the Congress. The President is still obligated to consult with the Board in making his selection and the scientific community apparently has an unwritten approval power over appointees to the Directorship of NSF. The recent offer, withdrawal of offer, and then re-offer to Franklin Long, vice-president of Cornell University, by President Nixon in 1969 indicates a rough estimate of the power which schientific community may exert with respect to this post.[101] All of the names considered by President Nixon for the Directorship nomination were secured and checked by the NSB.[102]

> Long was tentatively chosen, had accepted the job, and was about to be named publicly when he was blocked by White House advisors who were apparently responding to pressure from Congressional Republicans who opposed Long's views on the ABM and other issues (Science, 18 and 25 April and 2 May [1969]). After the scientific community protested that the nominee's views were irrelevant to the "non-political" NSF job, Nixon had his special assistants, Henry Kissinger and Du Bridge, again offer the post to Long. Nixon also pledged to consider only scientific and administrative competence, not political views, in choosing a new NSF head.[103]

Nor is the Director entirely responsible to the President. To be sure, in a showdown of strength, he could be removed by the Executive, but NSF is not run by such confrontations. There is some evidence that Alan Waterman departed under a slight amount of pressure due to the Mohole fiasco but he was seventy-one years old at the time and could have been expected to step down from the post shortly anyway.[104] It can be said more accurately that the President shares authority over the Director of NSF with Congress, the NSB, and the scientists on the various NSF committees and advisory panels, along with the scientific professionals who carry on a constant dialogue with NSF.[105]

What Bush and his supporters did achieve was an agency organized along lines which complement the way science itself is organized. At every point in the NSF hierarchy there are opportunities to hear demands from the part-time advisors who are full time members of either the scientific or scientific administration community.

One of Emmette S. Redford's conclusions in his book Ideal and Practice in Public Administration is that "Constitutionalization, or institutionalization of ideal, is the supreme task of political science.[106] Judging by this criteria, Bush was a good political scientist. He posited an ideology and then engineered a structure which was quite compatible with the ideology. According to this way of thinking, commonweal demands are best met by serving the needs of science. A mechanism for transmitting commonweal demands exists, but an equally effective method for translating these demands into effective policies does not. Like most government agencies, NSF is overseen by four Congressional Committees and the President. Any of these bodies may transmit commonweal demands to NSF. However, the Foundation is organized to respond to service or clients-in-contact demands. Parallel with all the levels of NSF's full time chain of command, there exists bodies of scientists whose duty it is to transmit to NSF the demands from the clients-in-contact. If as the official ideology suggests, there is no difference between the interests of science and the public welfare, the outputs will indirectly service all commonweal demands.

The dilemma of the organization of the traditional service type does not seem to exist in the formal structure of NSF or is at least ignored. A service organization is supposed to be faced with the dilemma of acting in the clients' interests versus doing what is best for the clients. Because the clients, as part-time advisors, are legally positioned to be in such close contact to the decision making bodies within NSF, machinery not only exists for hearing the clients demands, but for also allowing them to tell NSF officials how these demands should be answered. Because of the formal structure of NSF, the Director would seem to be constrained from an organizational standpoint of acting solely in science's interests. And because the constraint is structurally build into the organization, it would be present whenever the Director chose to act against the scientist's interests in the concern for science or for that matter for the commonweal concern. Such actions would be difficult for an executive who is responsible to the President and Congress. It would seem to be almost impossible to an executive who must also listen to so many outside boards and panels.

8. Conclusion.

At this point it is necessary to summarize the findings of this chapter since they provide direction for the remainder of the dissertation. These findings are as follows:

1. NSF is a commonweal/service organization.
2. As such it possesses two dilemmas:
    a. "...the crucial problem posed by commonweal organizations is the development of democratic mechanisms whereby they can be externally controlled by the public," versus "...the maintenance of official bureaucratic mechanisms that effectively implement the objectives of the community."[107]
    b. "Since one group in service organizations [the Staff] must decide what is in the best interests of another [the clients-in-contact], the basic problems here are to assure that the former serve the interest of the latter but that they do not let the latter determine how they are to be served."[108]
3. The official ideology of NSF has attempted to resolve both of the above dilemmas by positing that
    a. In the aggregate, commonweal demands will be served best if NSF serves science first.
    b. Doing what is best for science is to do what the scientists themselves believe is best.
4. The formal organization of NSF is designed to be receptive and responsive to the demands made by scientists. At the same time, it is designed to receive, but be unresponsive to or dampen political demands. In short, the formal organization of NSF is in accordance with its official ideology.

The method of analysis used in this chapter was to go from theory to the real world, and from the real world back to theory. Blau and Scott's model was described and then matched with NSF as it was manifested in the goals of its creators, the dynamic process surrounding NSF's founding, the client groups it is purported to serve, NSF's characteristics, and lastly its official ideology and formal organization. The Blau and Scott theory proved to be remarkably well fitting, not only in terms of typology, but in terms of predicting central dilemmas which NSF gave evidence of possessing and having to deal with in its official ideology and formal organization.

The veracity of the conclusions stated in this chapter rests on the evidence presented earlier, but the utility of these conclusions is decided by how well they explain the behavior (performance) of NSF. Just how well they do this is the subject of the succeeding chapters.

FOOTNOTES

[1] Gaetano Mosca. *The Ruling Class*, edited and revised, translated by Hannah D. Kahn. New York: McGraw-Hill, 1939, p. 71.

[2] A. Hunter Dupree, *op. cit.*, pp. 350-68.

[3] Franklin Roosevelt. "Letter to Vannevar Bush, November 17, 1945," in *Science The Endless Frontier*, ed. Vannevar Bush. Washington: Government Printing Office, 1945, p. vii.

[4] *Ibid.*

[5] U. S. Congress, House, Subcommittee of the Committee on Interstate Commerce, 81st Congress, 1st Session, on H.R. 12, S. 247, and H.R. 539. Washington: Government Printing Office, 1949, p. 44.

[6] Roosevelt, *op. cit.*

[7] U. S. Congress, House, Subcommittee of the Committee on Interstate Commerce, 81st Congress, 1st Session, on H.R. 12, S. 247, and H.R. 539, *op. cit.*, p. 44.

[8] *Ibid.*

[9] U. S. Congress, House, Subcommittee of the Committee on Interstate and Foreign Commerce, 80th Congress, 1st Session, on H.R. 942, H.R. 1815, H.R. 1830, H.R. 1834, and H.R. 2027. Washington: Government Printing Office, 1947, p. 1.

[10] Vannevar Bush. *Science The Endless Frontier*, *op. cit.*, p. 5.

[11] *Ibid.*, p. 1.

[12] *Ibid.*, p. 12.

[13] *Ibid.*, p. 9.

[14] *Ibid.*, p. 13.

[15]*Ibid.*, pp. 37-39.

[16]The Committee on medical research recommended that an independent Federal agency be set up to support basic research in the medical sciences. *Ibid.*, p. 59.

[17]*Ibid.*, p. 37.

[18]*Ibid.*, p. 76.

[19]U. S. Congress, House, Subcommittee of the Committee on Interstate Commerce, 79th Congress, 2nd Session, on H.R. 6448 (Washington: Government Printing Office, 1946), p. 8.

[20]U. S. Congress, Senate, Subcommittee of the Committee on Military Affairs, 79th Congress, 1st Session, on S. Res. 107 and S. Res. 146 (Washington: Government Printing Office, 1945), p. 478.

[21]The testimony of Dr. Frank B. Jewett, president, National Academy of Sciences, before the Committee on Military Affairs does not disagree that basic research pays off, but questioned whether a Federal agency is the best method of funding such research. *Ibid.*, pp. 426-47.

[22]*Ibid.*, p. 415.

[23]U. S. *Public Law* 81-507, Sec. 1.

[24]Blau and Scott, *op. cit.*, p. 55.

[25]Don K. Price, *The Scientific Estate* (Cambridge, Mass.: Harvard University Press, 1946), p. 137.

[26]Aaron Wildavsky, *The Politics of the Budgetary Process* (Boston: Little, Brown, and Company, 1964), p. 4.

[27]Blau and Scott, *op. cit.*, p. 54.

[28]U. S. Public Law, *op. cit.*, Sec. 11.

[29]*Ibid.*, Sec. 11 (c).

[30]*Ibid.*, Sec. 4 (a).

[31]*Ibid.*

[32]U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, 89th Cong., 2nd Session, 1966, p. 29.

[33]U. S. Congressional _Record_, 81st Congress, 1950, Vol. 96, p. 2524.

[34]Blau and Scott, _op_. _cit_., p. 222.

[35]Bush, _op_. _cit_., p. 60.

[36]_Ibid_., p. 29.

[37]U. S. Congress, House, Subcommittee of the Committee on Interstate and Foreign Commerce, 79th Congress, 2nd Session, on H.R. 6448, _op_. _cit_., p. 26.

[38]Price, _op_. _cit_., p. 125.

[39]"The Great Science Debate, _Fortune_, Vol. 33 (June, 1946), p. 236.

[40]U. S. Congress, Senate, Subcommittee of the Committee on Military Affairs, 79th Congress, 1st Session, on S. Res. 107, _op_. _cit_., p. 247.

[41]_Ibid_., p. 249.

[42]Bush, _op_. _cit_., p. 80.

[43]Daniel Greenberg, _The Politics of Pure Science_ (New York: The New American Library, 1967), p. 122.

[44]U. S. _Public Law_, _op_. _cit_., Sec. 3.

[45]U. S. Congress, Senate, Subcommittee of the Committee on Military Affairs, 79th Congress, 1st Session, on S. Res. 107 and S. Res. 146, _op_. _cit_., p. 6.

[46]U. S. Congress, House, Subcommittee of theCommittee on Interstate and Foreign Commerce, 80th Congress, 1st Session, on H.R. 942, H.R. 1815, H.R. 1830, H.R. 1834, and H.R. 1017, _op_. _cit_., p. 234.

[47]U. S. _Public Law_, _op_. _cit_., Sec. 12.

[48]U. S. Congress, Senate, Subcommittee of the Committee on Military Affairs, 79th Congress, 1st Session, on S. Res. 107 and S. Res. 146, _op_. _cit_., p. 624.

[49]Bush, _op_. _cit_., p. 27.

[50]Harry S. Truman, "President Truman's Memorandum of Disapproval of S. 526, dtd. August 6, 1947," _Science_, Vol. 106, (September 12, 1947), pp. 237-39.

[51]Blau and Scott, *op. cit.*, p. 20.

[52]*Ibid.*, p. 52.

[53]Bush, *op. cit.*, pp. 26-27.

[54]*Ibid.*

[55]*Ibid.*, p. 7.

[56]*Ibid.*, p. 71.

[57]*Ibid.*, p. 87.

[58]U. S. Congress, House, Subcommittee of the Committee on Interstate and Foreign Commerce, 80th Congress, 1st Session, on H.R. 942, H.R. 1815, H.R. 1830, H.R. 1834, and H.R. 2027, *op. cit.*, p. 114.

[59]*Ibid.*

[60]Bush, *op. cit.*, p. 68.

[61]Harry S. Truman, "Letter to Dr. Isaiah Bowman on Federal Assistance for Scientific Research," *Public Papers of Presidents, Harry S. Truman* (Washington: Government Printing Office, 1961), p. 570.

[62]National Science Foundation, *National Science Foundation Annual Report* 1957 (Washington: Government Printing Office, 1958), p. x.

[63]*Ibid.*, p. x.

[64]*Ibid.*, p. x.

[65]U. S. Congress, House, Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, 89th Congress, 1st Session, on Review of the National Science Foundation (Washington: Government Printing Office, 1965), p. 6.

[66]*Ibid.*, p. 7.

[67]Bush, *op. cit.*, p. 7.

[68]*Ibid.*, pp. 26-27.

[69]*Ibid.*, pp. 12-15.

[70]*Ibid.*, p. 30.

[71]*Ibid*., p. 29.

[72]*Ibid*.

[73]*Ibid*.

[74]*Ibid*., p. 31.

[75]*Ibid*.

[76]*Ibid*., p. 27.

[77]U. S. Congress, House, Subcommittee of the Committee on Interstate Commerce, 81st Congress, 1st Session, on H.R. 12, S. 247, and H.R. 539, *op. cit*.

[78]Harry S. Truman, "Letter to Dr. Isaiah Bowman on Federal Assistance for Scientific Research," *op. cit*.

[79]U. S. Congress, Senate, Subcommittee of the Committee on Military Affairs, 79th Congress, 1st Session, on S. Res. 107 and S. Res. 146, *op. cit*., p. 100.

[80]*Ibid*., p. 101.

[81]*Ibid*., p. 109.

[82]Howard Meyerhoff, "The Truman Veto," *Science*, Vol. 106 (September 12, 1947), p. 237.

[83]U. S. Congress, House, Subcommittee of the Committee on Interstate Commerce, 81st Congress, 1st Session, on H.R. 12, S. 247, and H.R. 539, *op. cit*., p. 45.

[84]*Ibid*., p. 45.

[85]Harry S. Truman, "President Truman's Memorandum of Disapproval of S. 526, dtd. August 6, 1947," *op. cit*., p. 238.

[86]*Ibid*., p. 238.

[87]Howard Meyerhoff, *op. cit*., p. 237.

[88]Walter J. Murphy, Editor, "Science Foundation Delayed by Truman Veto," *Chemical and Engineering News*, Vol. 25, (August 18, 1947), p. 2355.

[89]U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, *op. cit*., p. 2.

[90]U. S. *Public Law*, *op*. *cit*., Sec. 4 (a).

[91]*Ibid*., Sec. 5 (a).

[92]*Ibid*., Sec. 6 (c).

[93]*Ibid*., Sec. 5 (b). Original Enabling Act of 1950.

[94]U. S. *Public Law*, 90-407.

[95]U. S. *Public Law*, 90-407, Sec. 15 (a) and Sec. 4 (i).

[96]U. S. Congress, Senate, Committee on Labor and Public Welfare, 90th Congress, 2nd Session, on H.R. 5404, (Washington: Government Printing Office, 1968), p. 19.

[97]National Science Foundation, *National Science Foundation Annual Report 1969* (Washington: Government Printing Office, 1969), p. 5.

[98]*Ibid*., p. 114.

[99]Joseph Ben-David, "Scientific Productivity and Academic Organization in Nineteenth-Century Medicine," *The Sociology of Science*, eds. Bernard Barber and Walter Hirsch (New York, N. Y.: The Free Press of Glencoe, 1962), p. 326.

[100]U. S. *Public Law*, 90-407, Sec. 8.

[101]Philip M. Boffey, "McElroy Proposed to Head NSF; Branscomb, Bureau of Standards," *Science*, Vol. 164, No. 3887, June 27, 1969, pp. 1504-06.

[102]*Ibid*., pp. 1504-06.

[103]*Ibid*., p. 1505.

[104]Daniel Greenberg, *op*. *cit*., p. 196.

[105]U. S. Congress, Senate, Committee on Labor and Public Welfare, 90th Congress, 1st Session on S. 2598 and H.R. 5404 (Washington, D. C.: Government Printing Office, 1968), p. 105.

[106]Emmettee S. Redford, *Ideal and Practice in Public Administration* (Birmingham, Ala.: University of Alabama Press, 1958), p. 141.

[107] Blau and Scott, *op. cit.*, p. 20.

[108] *Ibid.*, p. 52.

CHAPTER III

1. Introduction

Chapter II concludes that NSF is a commonweal/ service organization and as such, must deal with two central dilemmas. The first comes from NSF's being in an environment whereby it can be presented with commonweal demands versus the capacity of NSF to effectively perform in accordance with these demands. The second comes from the fulfilling of the demands of the clients-in-contact, the scientists, versus the maintaining and improving the overall health of the scientific community. Evidence is presented that the central dilemmas of a commonweal organization and of a service organization exist within NSF.

NSF attempts to resolve its two central dilemmas by positing an ideology based upon the following assertion: by fulfilling the demands of the scientists, NSF advances the commonweal interests in the aggregate and the health of science is maintained and furthered. In Chapter II, it is found that the formal organization of NSF is consistent with the official ideology.

The above findings are made a basis for further argument, but it is not yet known whether NSF can give affirmative responses to the scientists' demands when these demands are in conflict with demands made by the politicians (commonweal demands). It is also not known whether NSF officials can give affirmative responses to the scientists' demands when their demands are in conflict with what NSF officials believe should be done for the good of science.

Before addressing the above questions, the characteristics of NSF's normal decision making process are examined. This topic is broken down into three questions. They are: What does NSF do? How does NSF do what it does? and finally, How does NSF decide to do what it does? The purpose in answering these three questions is to ascertain whether NSF normally performs in accordance with its official ideology. The answers to these three questions constitute the subject of Chapter III. The discussion of the relationship between the performance of NSF and the demands of the politicians, the scientists, and those who speak for the good of science is the focus of Chapter IV.

2. What NSF Does.

Stated most simply, what NSF does is give money to individuals or institutions in order to support scientific research and to educate those who may later do research.

> The broad overall charge of this Act [the National Science Foundation Act of 1950, as amended] assigns to the Foundation the responsibility to strengthen basic research and education in the sciences throughout the United States.[1]

Aside from doing a limited amount of data gathering and making some reports based on this data, NSF has no other activities. By law, NSF is prohibited from actually operating any research installations: "The foundation shall not, itself, operate any laboratories or pilot plants."[2] In all cases, except those just noted, NSF gives the money to a parent organization which then gives it to its researcher or the individual who is in charge of the project. This generalization is true even in the case where the researcher is the initiator of the project and the primary user of the money. For example, in NSF's largest program, the Scientific Research Project Program, the grant is given indirectly to the researcher through his college or university.

> Support [in the Project Program] is provided primarily through grants to colleges and universities for individual projects initiated by scientists who would carry out investigation.[3]

The same procedure is followed in the rest of NSF's performance programs. Money is given to an organization for the work of one individual or a group of individuals.

The general rule is that NSF is twice removed from any particular project which NSF sponsors.

Because NSF's primary activity is the distribution of funds and because NSF is in all cases far removed from the planning and execution of the actual projects, the NSF fiscal year financial reports furnish an excellent set of categories listing what NSF does. These reports not only include the names of NSF's major activities, but they also indicate how much NSF spends on them.

Because NSF seldom drops a program once it is begun, the 1969 financial report furnishes a list of not only the programs NSF is doing now, but also a list of the programs NSF has done in the past. NSF's largest program, for example, the Project Program, has been an NSF program from 1952 on.

NSF lists thirty-one programs in its "Financial Report for Fiscal Year 1969."[4] Table I names these programs and the 1969 obligations to them.

TABLE I

NSF PROGRAMS FOR FISCAL YEAR 1969[5]

Name of Program	1969 Obligations (millions of dollars)
1. Scientific Research Project Support	176.0
2. Fellowships and Traineeships	39.8
3. Pre-College Institutes and College Teacher Programs	33.9
4. National Research Centers	25.6
5. University Science Development	23.1
6. Computing Activities	17.0
7. Program Development and Management (Non performance program)	16.5
8. National Research Programs	13.5
9. Science Information Activities (Non performance program)	10.7
10. College Science Improvement	8.8
11. Departmental Science Development	8.6
12. Undergraduate Instructional Programs	8.2
13. Course Content Improvement (Pre-College)	7.7
14. National Sea Grant Program	6.0
15. Graduate Science Facilities	6.0
16. Science Curriculum Improvement (Undergraduate)	5.0
17. Cooperative College-School Program	4.8
18. Physical Sciences Facilities	4.6

TABLE I (cont.)

Name of Program	1969 Obligations (millions of dollars)
19. Planning and Policy Studies (Non performance program)	2.4
20. Science Education for Students	1.9
21. International Scientific Activities (Non performance program)	1.8
22. Biological Research Facilities	1.6
23. Advanced Training Projects (Graduate)	1.3
24. Special Projects (Graduate)	1.2
25. Environmental Sciences Research Facilities	1.0
26. Special Projects (Undergraduate)	.7
27. Pre Service Teacher Education (Undergraduate)	.7
28. Special Projects (Pre-college)	.311
29. Public Understanding of Science (Non performance program)	.186
30. Institutional Grants for Science	0
31. Research Participation for Teachers (Pre-college)	0

Five of the above 31 programs are not covered under the topic of "What NSF does" or under the category of NSF's performance budget. Two of the five, the Planning and Policy Study and the Program Development and

Management Programs are not considered performance programs, but management programs. As such they are covered in this chapter under the heading, "How NSF Decides to Do What It Does." Three of the five are not covered, the International Cooperative Scientific Activities, the Science Information Services, and the Public Understanding of Science Programs because they are beyond the scope of this dissertation and therefore are not included under the topic "What NSF Does." These programs cover activities of sufficient complexity to warrant separate research.[6] None of this research is done in this dissertation.

In 1969, the International Cooperative Scientific Activities, the Science Information Services, the Planning and Policy Studies, the Program and Development, and the Public Understanding of Science Programs are obligated 1.8, 10.7, 2.4, 16.5 and .2 million dollars respectively.[7] If one subtracts these five program allocations from the total number of program allocations, twenty-six remain with a 1969 obligation of 401 million out of a total obligation of 432 million dollars. For the purposes of this dissertation, these twenty-six programs constitute "what NSF does" or the performance budget of NSF.

Of the twenty-six programs characterized as performance programs, nine account for 341 million or eighty-five percent of the 401 million of the 1969 obligation for performance programs. Table II lists these top nine programs and the monies obligated for them during the past five years. Table III lists the same programs, but the figures are in percentages rather than in millions of dollars.

In 1969, two programs, Scientific Project Support and Fellowship and Traineeships, accounted for 54 percent of the performance budget. If the next two programs listed in Table III are included, the amount accounted for in the performance budget increases to 62 percent. Table IV illustrates how these first nine programs cumulatively contribute to the 1969 performance budget. The pattern demonstrated in Table IV is much the same for the other years. This pattern is that a few programs account for the majority of the funds in the NSF performance budget. Stated another way, the Project Program accounts for the greatest proportion of obligated monies and each succeeding program (succession measured in terms of financial magnitude) counts for less and less of the total performance obligation. In the dissertation, unless otherwise specified, the findings about performance programs are inferred from observations of these nine large programs.

TABLE II

YEARLY OBLIGATIONS TO NSF's LARGEST PROGRAMS

Name of Program	Money Obligated (Millions of dollars)					
	Year 64	65	66	67	68	69
1. Scientific Research Project Program	112.4	119.5	157.8	167.9	170.6	176.0
2. Fellowships and Traineeships Program	30.1	40.2	44.5	45.9	46.0	39.8
3. Pre-College Institutes and College Teacher Programs	43.2	43.2	40.5	37.9	38.3	33.4
4. National Research Centers	19.2	19.5	23.0	24.5	31.5	28.6
5. University Science Development	--	27.4	36.4	33.2	14.6	23.1
6. Computing Activities	4.5	4.5	8.9	12.7	22.0	17.0
7. National Research Programs	29.9	45.2	36.0	11.9	15.5	13.5
8. College Science Improvement	--	--	--	.5	2.0	2.2
9. Institutional Grants for Science	3.4	2.9	3.3	3.2	3.0	0
Total	330	347	438	474	472	401

TABLE III

PERCENTAGES OF NSF PERFORMANCE APPROPRIATION SPENT ON NSF's LARGEST PROGRAMS

Name of Program	Money Obligated (Percentages of Total Performance Budget)					
	Year 64	65	66	67	68	69
1. Scientific Research Project Program	33.9	30.2	36.1	35.4	36.2	43.9
2. Fellowship and Traineeship Program	9.1	10.1	10.2	9.7	9.7	9.9
3. Pre-College Institutes and College Teacher Programs	13.1	10.9	9.2	8.0	8.1	8.4
4. National Research Centers	5.8	4.9	5.2	5.2	6.6	7.1
5. University Science Development	--	6.9	8.3	7.0	6.3	5.8
6. Computing Activities	1.4	1.1	2.0	2.7	4.7	4.2
7. National Research Programs	9.1	11.4	8.2	2.5	3.3	3.4
8. College Science Improvement	--	--	--	.5	2.0	2.2
9. Institutional Grants for Science	3.4	2.9	3.3	3.2	3.0	0
Totals	76	78	83	74	80	85

TABLE IV

CUMULATIVE PERCENTAGES OF FISCAL YEAR 1969 APPROPRIATION SPENT ON NSF's LARGEST PROGRAMS

Name of Program	% of 1969 Budget	Cumulative % of 1969 Budget
1. Scientific Research Project Program	43.9	43.9
2. Fellowship and Traineeships	9.9	53.8
3. Pre-College Institutes and College Teacher Programs	8.5	62.3
4. National Research Centers	7.1	69.4
5. University Science Development	5.8	75.2
6. Computing Activities	4.2	79.4
7. National Research Programs	3.4	82.8
8. College Science Improvement	2.2	84.9
9. Institutional Grants for Science	0	84.9

3. <u>How Does NSF Do What It Does: The Grant and the Contract</u>

NSF distributes its monies by means of two accounting devices: the grant and the contract.[11] For the purposes of the dissertation both are treated under a single heading, the general grant system. The actual difference between the two is a technical one and not a difference involving how they are awarded. For example, in the Project Program the normal procedure is to use grants to support research projects of merit.[12] However, if the work is being done by someone in a private research laboratory, then a contract is issued.[13] Proposals for research projects whether they ultimately lead to a grant or a contract are judged and processed in the same manner. If they are for similar types of research, the two are judged and processed in competition with one another.

> In practice, distinctions between grant and contract instruments by various Federal agencies for support of basic research has been lost; both have been adjusted to meet needs.[14]

4. <u>How NSF Does What It Does: The Grant System</u>

President Truman approved the NSF Act on May 10, 1950.[15] The National Science Board (NSB) was appointed on November 2, 1950, and the first Director of NSF, Alan Waterman, was appointed on April 6, 1951.[16] Despite Waterman's late appointment, he was able to report that by June 30, 1952, slightly more than a year after he became Director of NSF, NSF had made 96 project grants and had awarded 624 graduate fellowships.[17] Waterman was able to move this quickly because he made use of a procedure with which he was familiar, the grant system. Waterman had used the system before coming to NSF when he was deputy chief and chief scientist of the Office of Naval Research.[18] He merely instituted a similar grant system for NSF.

During its first full year of active operations, 1952, NSF was able to support research projects, finance fellowships, and enlist other organizations to operate programs.[19] The NSF grant system retains these same capabilities today.[20]

The earliest complete description of the grant system is found in the 1952 NSF Annual Report. This description is presented in the form of a chart and appears in Figure I, below.

One of the more complete public descriptions of the early grant system is given by NSF's first Director, Dr. Alan Waterman. The account is contained in an exchange between Waterman and the Chairman of the House Subcommittee on Independent Offices, Congressman Albert Thomas of Texas. The testimony took place during that subcommittee's review of NSF's 1956 budget.[22] It is summarized, in paraphrase, as follows:

1. Proposals for scientific research[23] are received by NSF with the endorsement of the scientist's parent institution.[24] These proposals are then sent to panels of outside reviewers who make judgements for NSF as to the scientific worth of the proposals. The panels

NATIONAL SCIENCE FOUNDATION

MAJOR STEPS IN THE SELECTION OF GRANTS FOR BASIC RESEARCH

INSTITUTION			NATIONAL SCIENCE FOUNDATION					
Scientist	Head of Dept.	Officer of the Institution	Scientific Div.	Panel of Scientific Consultants	Divisional Committee	Foundation Staff	National Science Board	Director
Originates proposal for basic research	Determines whether proposal conforms with department policy & program	Determines whether proposal conforms with institution policy	Determines whether proposal is within scope of NSF program & division budget	Reviews proposal for scientific merit Duplication of effort Reasonableness of budget Relation to the national research effort	Reviews research program of the division Recommends policy	Reviews proposal for policy Legality Availability of funds Relation to the national and federal research effort	Reviews and approves proposal prior to final action by the director	Takes final action Forwards Grant to institution

Proposals Declined and Withdrawn

Grants for Basic Research

Figure 3. 1952 NSF Grant System[21]

are composed of scientists working in the specific field of the scientist who submitted the proposal.[25]

2. Proposals recommended by the outside reviewers are submitted to the divisional committees. These committees are appointed by the NSB and their members are not full time NSF employees. The duty of these committees is to review the proposals submitted for scientific excellence. The membership of these committees is broader with respect to scientific disciplines than the review panels.[26]

3. After receiving the recommendations of the divisional committees, the proposals are sent to the full time staff of the Director of NSF. The staff reviews the proposals "...from the standpoint of Government interest and budget requirements, legal and administrative, fiscal matters and so on, and these are then recommended, the selected number to our Board [the NSB]."[27] Final approval of the grant is made by the NSB on the recommendation of the Director of NSF.

4. NSF maintains only a minimum of supervision of the grant recipient's activities. His parent institution is required to send NSF an audit of funds once every 6 months and a report summarizing the scientist's activities after each year.[28]

The only changes from the grant system just described and the present system is the abolition of the

Divisional Committees and the necessity that the NSB review every grant. The 1968 Amendment to the NSF Enabling Act provides that the NSB must only review those grants and contracts in excess of $500,000.[29] Prior to this amendment, the NSB was required to approve every grant and contract NSF made. Divisional Committees are abolished by the 1968 Amendment. The Director may now appoint advisory committees and review panels as he and the NSB see fit.[30]

The present grant system as it operates under the 1968 Amendment is presented in a report by the NSF staff to the House Subcommittee on Science, Research and Development. The report is contained in the 1970 Authorization Hearings. The procedures outlined in this report with the exceptions already noted are the same as those portrayed in Figure I and described by Waterman to Congressman Thomas.

In the report for the 1970 Authorization Hearings, the grant process is separated into five steps. These steps are program announcement, proposal submission, proposal evaluation, and grant recommendation, administrative review and grant award, and grant management.[31] Program announcement is accomplished by sending brochures directly to institutions of higher learning and others who might be interested in the program. The brochures contain the requirements for submitting a proposal and the rules and regulations of the Foundation pertaining to the program.[32]

The proposal submission stage is left entirely in the hands of the individual scientist. He may contact the respective program directors for "informed discussions," but they must take place before his proposal is submitted.[33] All proposals must contain certain information.

> Although the contents of proposals vary to satisfy the specific requirements of various programs, in general all consist of a summary, a work statement, and a budget. The work statement must describe the nature of the project, the proposed means of achieving the stated aims, and the personnel who will be engaged in the project, including information relating to the prior experience and scientific accomplishments of the principal investigator. The proposal must also contain assurances that the proper facilities and equipment will be available, an estimate of the cost of the project broken down into categories of expenditures, a statement of other anticipated sources of funds, and an estimation of the time period for which support is requested.[34]

These proposals are then evaluated by outside review panels. In the entire grant process, these panels make the most important decision: whether or not the proposal under consideration is meritorious and deserving of support or is non-meritorious and not worthy of NSF support.[35] Because of the importance of these panels in the grant process, some knowledge of their characteristics is needed.

In Chapter II, NSF is described as an organization with a dual structure. On the one hand, there are the Director of NSF, the Associate Directors, and the various Division (Program) Directors. (See Figure 2) These are all full time employees of NSF. On the other hand, there are the National Science Board (NSB), the Division (Program) Advisory Committees, the ad hoc committees, and the outside review panels. None of the members of these groups are full time NSF employees, and as such, are paid on a per diem basis only. They are expected to represent the interests of the scientific and science education community. The NSB is appointed by the President of the United States with the advice of various bodies in the scientific community. The other advisory bodies are appointed by the Director of NSF with the concurrence of the NSB and in consultation with the National Academy of Sciences and/or specific professional societies.[36] The NSB, the Division Advisory Committees, and the special ad hoc committees are to advise NSF officials on policy matters and play no direct part in the grant process. The outside review panels differ from these other outside advisory groups in this respect. The outside review panels are not to advise NSF on policy matters, but to meet to make specific decisions on the merit of concrete proposals submitted to NSF.

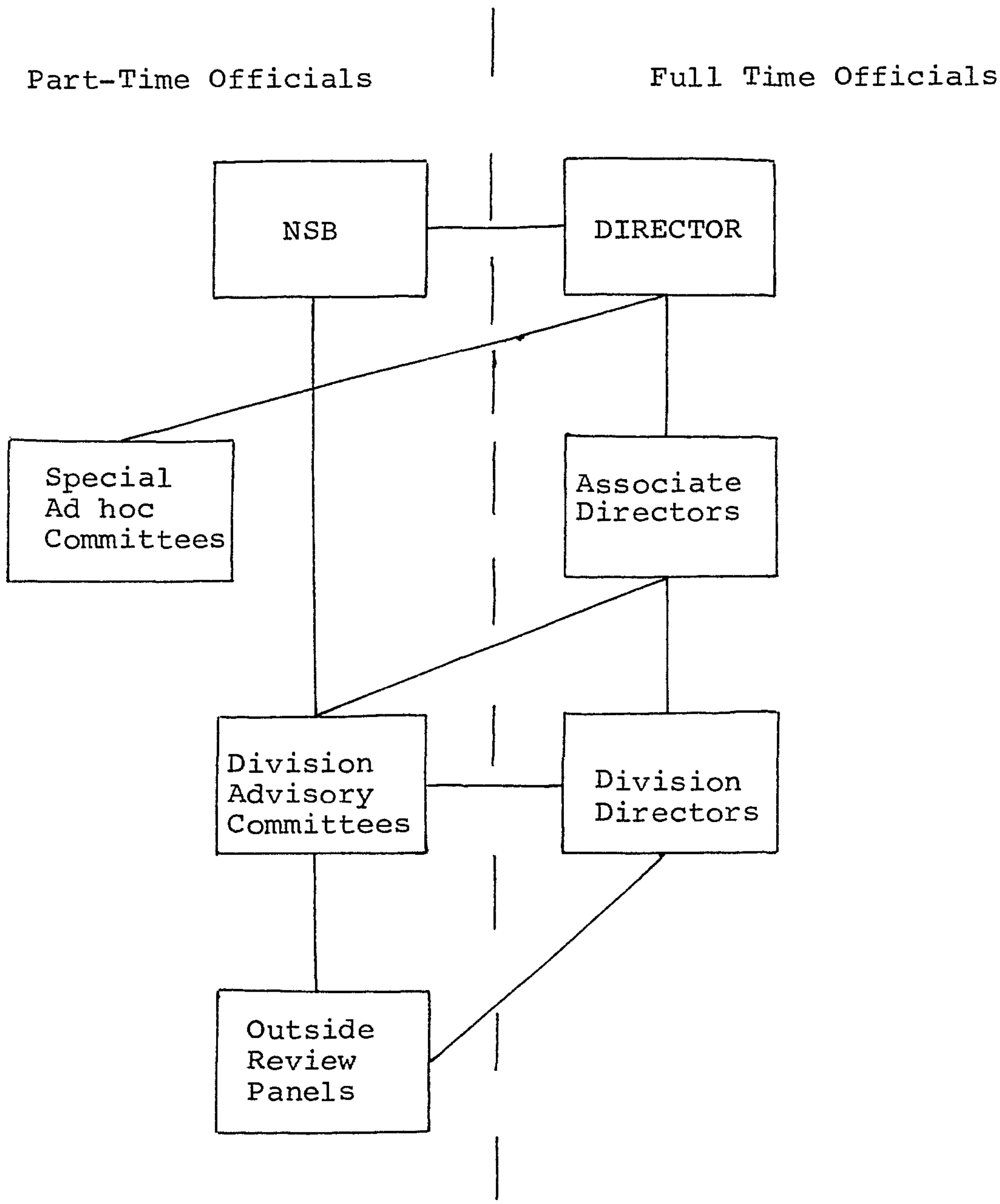

Figure 4

Dual Structure of NSF

Based upon the evidence given by the review panels, the proposals are reviewed by the Division (Program) Director,[37] a full time employee of NSF. The proposals which he recommends are then forwarded to the appropriate Associate Director for concurrence.[38] If a grant is recommended by the outside review panels and these two officers, it is sent on to the Grants Office for administrative review.[39]

> The Grants Office examines all recommended grant awards for conformance to Federal regulatory requirements, to Foundation grant policies, and for allowability of proposed grant budget items. This office seeks to resolve problems in consultation with interested Foundation offices and with grantee institutions. It then prepares for the Office of the Director individual award instruments--the grants letter with appropriate attachments. When an award is made, the Grants Office assures that it is accepted under conditions specified in the grant instrument.[40]

It should be emphasized that during the entire proposal evaluation process, the emphasis is to leave the decision as to who actually gets a grant to the scientific community, i.e., the outside review panels. According to NSF official statements, NSF decisions concerning who is to receive grants are based upon the excellence of the perspective grantee's proposal and his reputation in the field.[41] Dr. Leland Haworth, Waterman's successor as Director of NSF, commented on where he believed the responsibility for evaluation of research project proposals should lie.

> The Foundation is an instrument, created by Congress, through which scientists compete on the basis of quality for the resources to conduct basic research of their own choosing. The overriding consideration is the quality of the research to be performed and this is judged by the investigator's peers within each field [the outside review panels]. In this competition the whole range of scientific inquiry is eligible for support, without the restrictions and priorities which must be imposed when the purpose is to achieve a specialized practical objective.[42]

The autonomy of not only the Research Project Program outside review panels, but of all NSF outside advisory panels is defended by NSF officials. The panels are to be free from outside interference including that from NSF officials. Outside review panel members are to judge proposals on their merits alone, and the exchange which took place between Chairman Albert Thomas of the House Appropriations Committee and Dr. Henry Riechen, Jr., the Associate Director of NSF, is illustrative of this qualification.

> Dr. Riecken. We contract with the National Academy of Sciences to select scientists and engineers to man the panels, who review these applications and rank-order the candidates on ability.
>
> Mr. Thomas. They do exactly what you instruct them to do. What about putting a limitation in here [the 1966 Appropriations Bill] that no more than ten

> percent of the number [of fellowship recipients] you select should come from any one State?
>
> Dr. Riechen. I simply don't know how to answer that, except to repeat what the National Science Foundation Act provides; namely awarding fellowships on the basis of ability only.[43]

Riechen's testimony is remarkably similar to Waterman's on the autonomy of review panels given before the same House Committee in 1955.

> Mr. Thomas. These are agents of the Foundation [members of outside review panels]. Call them whatever you want to, consultants, friends or paid employees, they are still your agents, are they not?
>
> Dr. Waterman. They are employed because we want their independent scientific judgement.[44]

NSF seeks to lessen the burden of even making decisions concerning which grants should be funded and which should not because of budgetary limitations. When funds are inadequate to cover all the meritorious grants in one field of science in the Project Program, for example, the outside review panel is asked to arrange meritorious grants in order of excellence.[45] Also, NSF officials often trim each request by a certain percentage in a particular field so that a greater proportion of the meritorious projects may be funded.[46]

The last stage of the grant process is grants management. This step is merely to insure that the money is being spent in accordance with government regulations and to record the progress the researcher is making on his project.[47] This stage makes no attempt to evaluate the scientific worth of the project. Evaluation as to scientific value is left again to the scientific community and is only indirectly reported to NSF. That is, if a scientist has gained the reputation for being a poor researcher or science education director, his peers do not rank his proposals very high.[48]

> No post facto review is undertaken because the research is subject to critical review by the investigators' peers when submitted for publication in professional journals. Such publication is never, however, made a condition of support. Also, the Foundation maintains no register of papers from research it has sponsored.[49]

Besides the Project Program which is described by Waterman, the Fellowship Subprogram of the Fellowship and Traineeships Program is another example of the general grant system. In the Fellowship Subprogram, however, only people are judged, not people and their proposals as in the other NSF programs. Dr. Henry W. Riechen, Associate Director of NSF, presents it to Chairman Thomas of the Appropriations Committee in the following way.

> Dr. Riechen. We announce that the competition for fellowships will be open on a certain date. It is widely advertised by direct mail to the institutions and in magazines and journals. The applicants file supporting material; that is, statements of their academic record and the grades they have had, and letters

> of evaluation from professors who know their work.
> We contract with the National Academy of Sciences to select scientists and engineers to man the panels, the selection panels, who review these applications and rank-order the candidates on ability.[50]

What has just been described and illustrated is the general grant system of NSF, the dominant characteristic of which is the selection of meritorious recipients by groups of persons outside NSF. Of the nine programs which constitute eighty-five percent of the 1969 obligation, seven use award systems similar to the one presented in the 1970 Authorization Hearings and described in this Chapter.[51] (See Footnote)

The two exceptions are the National Research Centers Program and the Institutional Grants for Science Program. In the latter program, the selection of the grantees is based upon a percentage formulae of federal funds for research obligations by Federal agencies.

> As in earlier years, the grants will be calculated by applying a graduated arithmetical formula to the total amount of an institution's appropriate awards. The formula will provide 100 percent of the first $10,000 of an institution's base figure, and lesser percentages thereafter; it is expected that the largest institutional grant will be approximately $150,000.[52]

Although Institutional Grants for Science are not judged by outside review panels, it can be argued that the net result is again to place the decision of who gets what within a program outside the NSF structure. Which university obtains a grant under this program is not an NSF decision, but of how much money the university has been able to obtain through other grants. Although NSF is responsible for the administration of the Institutional Grants for Science Program, NSF has an outside advisory committee to advise it on administration of the program. NSF has little more to say about who gets these grants than it does in the seven programs which use the general grant system.

The National Research Centers Program does not rely on outside review panels to judge and rank proposals. Proposals which come under this program are judged to be meritorious by the very fact that they are submitted. The National Center for Atmospheric Research of the National Research Center Program, for example, was established in 1960 upon the recommendation of the Committee on Atmospheric Sciences of the National Academy of Sciences.[53] This recommendation which was later formulated into a proposal included the provision that the Atmospheric Center be owned, built, and supported by the government.[54] It was to be operated by a consortium of universities.[55] All National Research Centers (there are presently four) have followed this pattern.[56] They are proposed by NAS or an eminent group of scientists or both, and then built by NSF, which also owns and supports them, and run by a consortium of universities. Merit and competition are not factors within the National Research Centers evaluation process because those people initiating the proposals are recognized as meritorious by their colleagues before the proposals are submitted.

The Fellowship and Traineeship Program, the Precollege Institutes and College Teacher Programs, the University Science Development Program, the Computing Activities Program, the Science Information Program, and the National Research Programs all judge their proposals by a process similar to the one presented as the general grant system. Within these seven programs, proposals are judged in competition with one another by outside review panels.

All nine of the major NSF programs leave the decision of who gets grants within each separate program to those outside NSF. In the case of seven of the nine, outside review panels of advisors are used. In the National Research Centers Program no outside reviewers are used, but the evaluation of a proposal is left to those outside NSF. The Institutional Grants for Science relies on a formula to award its grants, but again the result is to leave the evaluation to those outside NSF.

The answer to the question of how NSF does what it does, or how NSF distributes its money is to let the potential recipients determine from among themselves who is the most and who is the least worthy. In addition, it is found that the judgement as to the worth of the completed project is left in the hands of the grant recipient's peers or, in the case of a scientific education project, in the hands of the science education community. This means that pre- and post evaluation of the projects is done outside the National Science Foundation.

5. How Does NSF Decide to Do What It Does: The Determination of Program Size

The previous section, which discusses how NSF does what it does, also gives information on how NSF decides to do what it does. It is found that NSF assigns exclusive authority over project design, execution, and final evaluation of the finished project's worth to the clients-in-contact, the scientists. In addition, NSF assigns extensive authority to the scientists over the decision as to who gets grants under the various programs. NSF deals with the above decisions by assigning extensive authority over them to the scientists.

There are other important sets of decisions, however, with which NSF must deal in order to operate. They include the determination of the size of various NSF programs, the initiation of new programs, and the cancellation of old ones. This section is concerned with how NSF handles these sets of decisions. As already noted in a previous section, NSF does not normally drop a program. For this reason, this last decision set is eliminated from the discussion.

Because both pre-and post evaluation of NSF sponsored projects rests in the hands of the scientists, NSF could theoretically remain passive in the decision of how large the various programs should be. All that NSF would need to do is allocate its resources in accordance with the requirements as already articulated and rated by the scientific community. The system would be compatible with the official ideology of NSF. The scientists would regulate the size of the various NSF programs by submitting meritorious proposals and the number of these proposals would establish the size of the NSF programs. According to statements of the past two Directors of NSF, Alan Waterman and Leland Haworth, such a self-regulating decision mechanism is the goal of NSF. In testimony cited earlier, Haworth describes this system. In addition, he describes the link between the system and the official ideology of NSF.

> The Foundation is an instrument, created by Congress, through which scientists compete on the basis of quality for the resources to conduct basic research of their own choosing. The overriding consideration is the quality of the research to be performed and this is judged by the investigator's peers within each field. In this competition the whole range of scientific inquiry is eligible for support, without restrictions and priorities

> which must be imposed when the purpose is the achieve a specialized practical objective.[57]

Haworth's statement is made in Hearings before the House Subcommittee on Independent Offices of the House Appropriations Committee in 1966. In 1958 Haworth's predecessor, Alan Waterman, expressed a similar desire to the same Subcommittee. According to Waterman, the size of NSF programs would be limited only by the supply of talented men and the projects they propose.

> Mr. Thomas [Chairman of the Subcommittee]. The only question I have now is: What is the financial limit of this program [Thomas is referring here to all NSF programs]?
>
> Dr. Waterman. The number of competent people available with good problems to work on. It comes right down to that, sir.
>
> Mr. Thomas. Your financial expenditures is limited only by the number of competent people you have?
>
> Dr. Waterman. In the last analysis that is the best criterion for supporting research.[58]

Although Haworth and Waterman seem to be speaking mainly about research programs, the same criterion of basing the size of NSF programs on the supply of deserving recipients can be found in the justifications of NSF scientific education programs.[59]

> In April 1952 the Foundation awarded 569 predoctoral and 55 postdoctoral fellowships to individuals selected from 2,977 applicants. In April of this year, 515 predoctoral and 42 postdoctoral awards were made to persons selected from 3,298 applicants. In addition

> 1,274 candidates were awarded honorable mention; with sufficient funds all of these would have received fellowships.[60]

NSF officials realize that a decision system which establishes program limits only on the needs of the scientific community is practically and politically impossible.[61] Nevertheless, such a system should be the goal which NSF should strive for.

In another exchange with Chairman Thomas of the Appropriations Subcommittee on Independent Offices, Alan Waterman explains how a program's fiscal limits are set. In this exchange, Waterman also acknowledges that not all meritorious proposals should be funded. However, this remains the limit toward which NSF should work.

> Dr. Waterman. Our present request for support of basic research is approximately $30 million, and that will take care of 50 percent of the dollar value of applications which we expect to receive.
>
> Mr. Thomas. You want to increase about one-third more?
>
> Dr. Waterman. Not this year, sir.
>
> Mr. Thomas. I mean that is your ultimate goal?
>
> Dr. Waterman. Yes, sir; our ultimate goal would be to take about two-thirds of the value of meritorious applications, which I think would be a good leveling off point.
>
> Mr. Thomas. Certainly the word you use, "meritorious", is going to increase by virtue of this program. So, your ceiling will go up, will it not?

> Dr. Waterman. Yes, sir. There still will be a limit in the number of competent people, and that is what we have to bank on.[62]

In Chapter II, NSF is found to possess a formal structure which can expand as the number of scientific disciplines increase. By basing program budgetary limits upon the number of meritorious proposals received, NSF would also seem to have the ability to parallel the growth of the scientific community in yet another way. As new disciplines are added and the number of competent researchers increase within these disciplines, NSF would be able to expand its program budgets to underwrite these new activities. The only remaining limits on NSF expansion would be the willingness of Congress and the Bureau of the Budget to go along with the above system and the decisions by NSF on whether or not to start new programs. Theoretically, there are no limits set by the official ideology, the formal organization, or the decision criterion for setting program size.

The preceding discussion offers further insight into the relationship of NSF to its two central dilemmas. In order to follow the official ideology and operationally resolve its service dilemma, NSF hands most of its decision making powers to the scientists. However, the politicians make a complete transfer of the decision process impossible. The politicians' presence insures that NSF will always be conscious that it can only do for science what the politicians permit it to do. The politicians can always ask that NSF consider commonweal demands over the demands of the scientists.

Because NSF can never grant complete control of its decisions to the scientists, it also has the potential to insert itself into the decisions as to what is best for science. In addition, the politicians not only force NSF to publicly state how answering the scientists' demands helps the commonweal but also how NSF activities help science.

Thus, NSF can never resolve its two central dilemmas. They are inactive only as long as the politicians allow NSF to answer only the demands of the scientists.

6. How Does NSF Decide to Do What It Does: The Initiation of New Programs

Although it is difficult to establish the precise origin of any program, there is considerable evidence indicating that NSF plays a passive role *vis-a-vis* the scientific community in the initiation of new programs. This evidence points to initiative on the part of the scientific community over and above any initiative carried on by the NSB. Evidence for the inference that the scientific community exercises such innovative power can be found by examining all of the seven new programs and one new sub-program among those nine large NSF programs which are cited earlier as accounting for 85 percent of the 1969 obligation for performance activities. One of the nine programs, the Project Support Program and one of the subprograms, the Fellowship Subprogram are not new NSF activities. Both are provided for in the original NSF legislation. Of the seven remaining programs and one subprogram, there exists evidence that those outside NSF played a major role in the initiation or preliminary planning or both in all but two of these new activities. The exceptions are the Institutional Grants for Science Program and the Pre-College Institutes Program. There is no evidence to indicate scientific educational groups other than the NSB played any great role in the initiation of these two programs.

There is evidence, however, to indicate that non-NSF scientists and educators other than the NSB played a key role in establishing the National Research Centers Program, the National Research Programs, and the Computing Activities Program; recommended the initiation of the Traineeship Subprogram; and were heavily involved in the planning of the University Science Development Program and College Science Improvement Program.

The National Research Centers Program and the National Research Programs are the result of formal proposals submitted by eminent scientists outside of NSF.

> National research programs usually originate in the scientific community, not in the Federal Government. Only after a consensus is reached as to their desirability is a request for support submitted to the Government. Frequently such requests are transmitted through the National Academy of Sciences, which not only acts for the scientific community in its representations to the Government but is for the most part also the vehicle through which U. S. scientists adhere formally to international scientific organizations.[63]

The 1964 NSF Annual Report assigns the origins of National Research Centers Programs to a similar source, i.e. the scientific and academic community.

> As is the case for national research programs, the stimulus for the establishment of a national center comes from the scientific and academic community when its numbers are in agreement that a new major facility is needed to expedite progress or to remove deficiencies in some specialized field of science. The National Academy of Science--National Research Council, the appropriate scientific soci-eties, as well as key Government officials have all, at times, participated in the discussion with the Foundation which led to the initial establishment of these centers.[64]

In the case of both the National Research Programs and the National Research Centers, the pattern was to designate the activities programs after the first one was established. This is to say that the National Research Program was not announced as a new program and the proposals invited. The process was the opposite. A proposal arrived which was endorsed by the National Academy of Sciences, was then taken to the BOB and the Congress by NSF, and then funded by NSF after the authorization by Congress.

The first National Research Program was the International Geophysical Year. The idea for U. S. Government sponsorship grew out of a meeting of the International Council of Scientific Unions (ICSU). The United States was represented at the meeting by scientists chosen by the NAS.

> The proposal for the present international geophysical research effort originated in the International Council of Scientific Unions (ICSU), the central organization representing the several specialized international scientific unions. Toward the end of 1952, ICSU began planning for the IGY program. ICSU established a special committee for planning at an international level, and associated scientific groups in various nations were asked to call up national committees for planning and undertaking their national programs. The affiliated body in the United States is the National Academy of Sciences-National Research Council, which established a national committee for the preparation of the United States program. In response to the request of the United States National Committee [the Committee was selected by the NAS-NRC]. The National Science Foundation has undertaken to coordinate various Federal interests.[65]

A similar type of genesis for the first National Research Center is described by Richard M. Emberson in a Science article, "National Radio Astronomy Observatory."[66]

The proposal originated within the radio astronomy community and not within NSF. After the National Radio Observatory was established and proposals started coming in for other "big science" projects (big science projects are those such as the Radio Astronomy Laboratory which require large installations and accompanying hosts of technicians), a program was begun in NSF and given the name of National Research Centers Program.

As pointed out in the last section, the process of initiation and authorization of National Research Centers is a variation from the standard grant system. In this system, proposals are submitted under an existing program and judged by merit in competition with one another. In the National Research Centers Program there is only one proposal and it is meritorious simply because it is recommended and formulated by the leaders of the specialty to which the program applies. In these programs, initiation and judgement as to merit are all from outside NSF and are not distinct steps as were those described in the depiction of the standard grant system.

The initiation of the Computing Activities Program did not start as the result of any one single large appropriation such as the National Research Centers Program or the National Research Programs. However, as with these two programs, outside scientists played a key role in its establishment. The Computing Activities Program became a separate program because it could no longer fit comfortably in the Basic Research Project Program. Research Scientists began using so many computers in their work that NSF felt it advisable to set up a separate program.[67] Had NSF not devised a separate program, the alternative might have been that computer activities would have claimed a disproportionate share of the existing Research Project Program. In the 1958 House Appropriations Hearings, Alan Waterman explained how the Computing Activities Program was begun.

> Dr. Waterman. Previous computers have been associated with research projects. This item in the budget applies to the provision of a computer to a university to use for any purpose. Previous grants have been made in connection with a particular grant for a particular piece of research for which a computer was needed.
>
> Mr. Thomas. What did you justify last year [fiscal year 1957] for this [Computing Activities Programs], $400,000?
>
> Dr. Waterman. There was no special justification because they needed the services of a computer for a particular research grant. We did have an item for computing facilities in the budget last year. [A line item sum but no separate program designation or justification.]
>
> Mr. Thomas. Don't you know we like to keep up with you? We like you and we expect you to use the money for the purpose for which we give it to you, and not divert it for something else?

> Dr. Waterman. These are much more modest in cost, sir.
>
> Mr. Thomas. That has nothing to do with it.
>
> Dr. Waterman. We treat these just as we provide an electronic microscope or a low temperature piece of equipment for the sake of research.[68]

In the 1957 NSF Annual Report there is no mention of computer facilities. This report appeared one month before the testimony just cited and supports Waterman's assertion that computer activities were "bootlegged" under existing NSF programs. In the 1958 NSF Annual Report, computer activities are listed as a subprogram under the Facilities for Research in the Mathematical, Physical, and Engineering Science Program. In 1960, Computer Activities obligations had grown to 1.7 million dollars and are listed in the 1960 NSF Annual Report's Financial Report as a separate item for the first time. The above listings indicate a gradual evolution of a bootlegged item into a full grown program worthy of Congressional and BOB interest. The initiative for the development of the Computer Activities Program seems to be again largely in the hands of those outside NSF. The scientists needed more and more computer facilities and NSF responded by first allowing the scientists to include computer facilities in their research project proposals, then established a subprogram under the Scientific

Facilities Program, and finally created a separate program for computer facilities.

NSF demonstrates more initiative in the creation of the University Science Development Program and the College Science Improvement Program. However, outside scientists and educators still were heavily involved in the initial planning of these two programs.

The University Science Development Program is designed "...to assist in increasing the number of universities capable of conducting programs of education and research in the sciences."[69] The College Science Improvement Program is analogous to the University Science Development Program, but takes care of those smaller institutions which could not qualify under other programs.[70]

The University Sciences Improvement Program came out of discussions between NSF officials and the administrators and faculty of "several institutions of different kinds including 4-year undergraduate colleges and large universities."[71] Haworth commented on how NSF worked with the colleges and universities in order to formulate plans to aid the institutions rather than individual researchers.

> We sent a group of people around to several institutions of different kinds including 4-year undergraduate colleges and large universities. They discussed

> the problems and needs of their institutions with the administrators and the faculties as examples to see what kind of programs would be most effective.[72]

The University Science Development Program began in 1965 and the College Science Improvement Program began two years later. Both accept proposals which are judged according to their merit by outside review panels. In these programs, NSF did broach the idea of aiding colleges and universities on an institutional wide basis, but the prospective recipients were used in the initial planning of the programs.

The last activity which bears evidence of outside initiative is the Traineeship Subprogram of the Fellowship and Traineeship Program. As noted earlier, the Fellowship activity of the Program was created in the initial organization. However, the Traineeship Subprogram did not appear as an NSF activity until 1964.[73] The formal initiation of this subprogram rests with President Kennedy through his Director of the Office of Science and Technology, Dr. Jerome B. Wiesner. The testimony below was given by Wiesner to the Senate Appropriations Subcommittee for Independent Offices.

> Dr. Wiesner. The large increase for education which appears this year [in the 1964 fiscal year NSF budget request] was included at the recommendation of the President to the Science Foundation after we made the study of the availability of technical manpower, and of our ability to do graduate

> training. We observed a lack of graduate academic institutions in certain parts of the country, where it was thought they were desirable, and the President requested the Science Foundation to augment their budget to make a greater effort in education.[74]

The study of which Wiesner speaks is a President's Science Advisory Committee (PSAC) report: Meeting Manpower Needs In Science and Technology (The Gilliland Report). One of the recommendations of the Gilliland Report was that Graduate Traineeships should be increased relative to fellowships.

> Place the major emphasis in the expansion of graduate education on training grants relative to competitive fellowships, but continue the latter at a level that will serve to maintain the standard of quality of all graduate students.[75]

NSF had no traineeship program to increase, but the request to start such a program is included in the 1964 fiscal year budget request. Congress approved the request and the Traineeship Subprogram has been a part of the NSF activities ever since.

The Gilliland Report carries an endorsement by the President that "immediate consideration be given to this report in developing legislative and budget proposals which I shall submit to the Congress in January 1963."[76] The formal initiative for the NSF Traineeship Subprogram was clearly with the President, but the

Gilliland Report was written by a committee chosen by PSAC. Both the members of PSAC and the members chosen to sit on the Gilliland Committee were not NSF administrators. Only two out of seventeen members of PSAC and two out of thirteen members of the Gilliland Committee were full time government employees.[77] The initiative for the Traineeship Program was largely from outside government and by NSF's own admission outside NSF.[78]

Of the seven programs and one subprogram investigated, evidence indicates that NSF played a relatively passive role in the establishment of all but two of these activities. The origins of the two exceptions, the Institutional Grants for Science Program and the Pre-College Institutes Program, are unclear. There is no evidence to indicate whether NSF of those outside NSF originated the Institutional Grants for Science Program and the Pre-College Institutes Program. What is clear is that NSF played a passive role in the initiation of six activities which constituted 77 percent of the 1969 NSF performance budget.

7. <u>How Does NSF Decide to Do What It Does: Conclusion</u>

Other investigators support the finding that NSF remains passive with respect to setting program budgetary limits and the initiation of new programs. After hearing forty witnesses and reviewing a study of NSF by the

Library of Congress' Science Policy Research Division of the Legislative Reference Service, the House Committee on Science and Astronautics concluded the following:

> Fundamentally it may be said that the Foundation has functioned, and still does, in a manner that is largely passive. It has not itself put a sustained effort into developing substance, form, and direction of the programs it supports. Once granted its annual budget, NSF has to a large extent followed a practice of waiting for talented outsiders to suggest appropriate projects on which to spend it.[79]

In The Politics of Pure Science, Daniel Greenberg concluded that "Thus, two decades after Bush and his colleagues had brought the penurious scientific community to the war-time service of government, American science had become affluent, highly productive, and the *de facto* sovereign of its own vital affairs."[80] Although Greenberg is characterizing the entire basic research community, part of his evidence for the above assertion is based upon two of his own case studies of NSF. The subjects of these two case studies are the Mohole Project and the Westheimer Report on Chemistry. The former involves the initiation and funding of a new NSF program and the latter involves the adjustment of an NSF intra-program budget. According to Greenberg, NSF played a passive role in both of these situations.

In the Mohole Project, scientists outside NSF proposed that a deep hole be drilled "...into the ocean floor for the purpose of studying the composition of the earth's interior."[81] The project was sanctioned by a study by a Committee of the National Research Council of the National Academy of Sciences. NSF accepted the recommendations of this committee and agreed to fund the project. NSF continued to underwrite Project Mohole's costs until Congress ordered the project terminated. Although NSF did make the decision as to who would be the prime contractor, NSF did not initiate the project nor did it attempt to set any limits on Mohole's spiraling costs. According to Greenberg, the initiative and the determination of the final costs of Project Mohole were clearly outside of NSF.[82]

The Westheimer Report on Chemistry was a report sponsored by the National Academy of Science's Committee on Science and Public Policy. The report concluded that chemistry was underfunded in comparison with the other physical sciences. Greenberg notes that NSF responded to this report by raising chemistry's share in the NSF budget.[83] "A direct consequence of this [the Westheimer Report] was that NSF, whose financial decisions regarding chemistry had inspired the report, agreed that it would be desirable to make greater sums available for chemistry."[84]

Greenberg presents no evidence to demonstrate that NSF is any more than an agency which reacts to the proposals and recommendations of others. In the two cases Greenberg examines, the initiative for setting up a new program, the management of this program's budget, and the initiative for the determination of another program's budget priorities lie outside NSF.

In Science and the Federal Patron, Michael D. Reagan concurs with the view that the academic scientists are dominant in the scientists, politicians, NSF administrators triad. Commenting on NSF's all but defunct policy advisory role, Reagan writes:

> In 1953, the Chairman of NSB, Chester J. Barnard, wrote in NSF's annual report that 'Except for certain specified operating functions, the Foundation is essentially an authoritative advisory body' for national policy formation. That was wishful thinking: what NSF essentially became was an operating agency to transfer funds from the federal treasury to academic scientists.[85]

At a very crude level of generalization, NSF is an organization which bases its decisions on the state of the scientific enterprise as this state is defined by the scientists. The extensive analysis in this chapter and the judgement expressed by other scholars writing on the subject of how NSF arrives at its decisions support this generalization. Decisions with respect to the initiation and execution of research and science education projects, the size of NSF programs, and the impetus for new programs and subprograms rest largely with those outside NSF.

8. Conclusion

The primary finding of this chapter is that NSF normally operates according to its official ideology. This ideology as espoused by Dr. Alan Waterman, NSF's first Director, posits that "...the scientists themselves know best what can be done and how to go about it."[86] The evidence indicates that scientists play a major role in the initiation of new programs, the determination of program size, and the pre- and post evaluation of these programs' projects.

As a broad generalization, NSF can be classified as an open system with a very low internal energy level. This is to say that NSF officials rely little on feedback to determine the outputs.[87] Programs are funded and because they are evaluated by those inside the scientific and education community, NSF is without firsthand knowledge as to the effects of these programs. In addition, NSF seems to have ruled out even the collection of second hand knowledge of the effects of these programs. Although quantitative records are kept inside NSF as to project size and location, all qualitative post evaluation is left within the scientific community. There is no formal mechanism for the transfer of these judgements.

Even though NSF can resolve its two central dilemmas ideologically and is shown to normally operate in accordance with this ideology, the presence of the politicians makes a complete transfer of responsibility for NSF decisions to the scientists impossible. The politicians can always ask NSF to operate in accordance with their demands as opposed to the demands of the scientists. Also, because the presence of the politicians makes the transfer of responsibility to the scientists impossible, NSF has the potential to make decisions for the good of science rather than merely giving the scientists what they want. In short, NSF may ignore its two central dilemmas only as long as there are no strong demands for it to do otherwise.

The next chapter is concerned with how NSF performs when strong demands contrary to the desires of the scientists are made.

Footnotes

[1]National Science Foundation, National Science Foundation Annual Report 1967 (Washington: Government Printing Office, 1967), p. 3.

[2]U. S. Public Law 81-507, Sec. 15C.

[3]National Science Foundation, National Science Foundation Annual Report 1963 (Washington: Government Printing Office, 1964), p. 3.

[4]National Science Foundation, National Science Foundation Annual Report 1969 (Washington: Government Printing Office, 1969), p. 127.

[5]Table I is prepared from data taken from the National Science Foundation Annual Report 1969, op. cit.

[6]For examples of broad treatments of the two subjects, international science cooperation and science information problems, see Eugene Skolnikoff, "Scientific Advice in the State Department," The Politics of Science, ed. William R. Nelson (New York: Oxford University Press, 1968), pp. 384-96, and Walter Hirsch, Scientists in American Society (New York: Random House, 1969), respectively.

[7]National Science Foundation, National Science Foundation Annual Report 1969, op. cit.

[8]Table II is prepared from National Science Foundation Annual Reports 1964 through 1969.

[9]Ibid.

[10]Table IV is prepared from data taken from the National Science Foundation Report 1969, op. cit.

[11]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, 1970 National Science Foundation Authorization (Washington: Government Printing Office, 1969), pp. 24-30.

[12]Ibid. p. 24.

[13]Ibid., p. 29.

[14]U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, 89th Congress, 2nd Session, 1966, p. 44.

[15]National Science Foundation, National Science Foundation Annual Report 1950-51 (Washington: Government Printing Office, 1951), p. 1.

[16]*Ibid*.

[17]National Science Foundation, National Science Foundation Annual Report 1952 (Washington: Government Printing Office, 1952), p. 13.

[18]National Science Foundation, National Science Foundation Annual Report 1950-51, *op. cit.*

[19]National Science Foundation, National Science Foundation Annual Report, 1952, p. 13, *op. cit.*

[20]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, 1970 National Science Foundation Authorization, *op. cit.*, p. 60.

[21]National Science Foundation, National Science Foundation Annual Report 1952, *op. cit.*, p. 14.

[22]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 84th Congress, 1st Session, Independent Offices Appropriations for 1956 (Washington: Government Printing Office, 1955), pp. 235-37.

[23]As is discussed later, the same procedure is followed in other programs such as fellowships. That is, a person seeking a fellowship initiates the request and NSF through the use of the NRC of the NAS rules upon whether or not the initiator is to receive the fellowship.

[24]As already noted, the researcher may be connected with a private laboratory. Also, collections of universities may band together in seeking a grant or contract. This occurs in National Research Programs such as the International Geophysical Year (IGY).

[25]The panels of which Waterman speaks are composed of scientists employed to work for NSF on a part-time basis. The purpose of these panels is to do special tasks such as rank the proposals in order of merit.

[26]The divisional committees have been abolished. In their place have been substituted permanent and ad hoc advisory panels. The permanent panels are composed along disciplinary and sub-disciplinary lines, and their purpose is to advise NSF of distribution of funds within a field and between programs which affect a field. The ad hoc panels advise NSF on certain large programs for which there exists no permanent panel.

[27]The NSB is no longer required to review every grant. U. S. *Public Law* 90-407, Sec. 5c.

[28]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 84th Congress, 1st Session, Independent Offices Appropriations for 1956, *op. cit.*, p. 237.

[29]U. S. *Public Law* 90-407, Sec. 5c.

[30]U. S. *Public Law*, 90-407, Sec. 15(a) and Sec. 4(i).

[31]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, 1970 National Science Foundation Authorization, *op. cit.*, p. 24.

[32]*Ibid.*, p. 25.

[33]*Ibid.*, p. 26.

[34]*Ibid.*, p. 27.

[35]Leland J. Haworth, "Directors Statement," National Science Foundation, *National Science Foundation Annual Report, 1964* (Washington: Government Printing Office, 1965), p. xxii.

[36]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 87th Congress, 2nd Session, 1963, Independent Offices Appropriations (Washington: Government Printing Office, 1962), p. 733.

Also, U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, 89th Congress, 2nd Session, *op. cit.*, pp. 22-25.

[37]*Ibid.*, p. 27.

[38]*Ibid.*

[39] *Ibid*.

[40] *Ibid*., p. 28.

[41] *Ibid*., p. 27.

[42] U. S. Congress, House, Subcommittee of the Committee on Appropriations, 89th Congress, 1st Session, 1966 Appropriation for the National Science Foundation (Washington: Government Printing Office, 1965), p. 570.

[43] *Ibid*., p. 722.

[44] U. S. Congress, Subcommittee of the Committee on Appropriations, House, 84th Congress, 1st Session, Independent Offices Appropriations for 1956, *op*. *cit*., p. 236.

[45] Dr. Charles Falk, Assistant Director, NSF 1969, in an address to the Political Science Department of Purdue University, Lafayette, Indiana, April 22, 1969.

[46] Dr. Louis Levin, Acting Director, NSF 1969, in an address to the Science and Public Policy Studies Group, Washington, D. C., July 17, 1969.

[47] U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, *op*. *cit*., p. 28.

[48] *Ibid*., p. 27.

[49] U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, *op*. *cit*., p. 47.

[50] U. S. Congress, House, Subcommittee of the Committee on Appropriations for the National Science Foundation, 89th Congress, 1st Session, *op*. *cit*., p. 722.

[51] U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, *op*. *cit*., p. 26.

The above citation lists all nine of NSF's major programs as using the general grant system. In a broad sense this is correct, but in a review of the *NSF Annual Reports* and the Appropriations Hearings, two programs deviate sufficiently in their selection of grantee's to warrant their exclusion from the general grant system category. These two programs are the National Research Centers Program and the Institutional Grants for Science Program.

[52]National Science Foundation, _National Science Foundation Annual Report 1969_, _op_. _cit_., p. 84.

[53]U. S. Congress, House, Committee on Science and Astronautics, The National Science Foundation: A General Review of Its First 15 Years, 89th Congress, 2nd Session, _op_. _cit_., p. 123.

[54]National Science Foundation, _National Science Foundation Annual Report 1969_, _op_. _cit_., p. 41.

[55]_Ibid_.

[56]_Ibid_., p. 23.

[57]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 89th Congress, 1st Session, _op_. _cit_., p. 570.

[58]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 85th Congress, 1st Session, Independent Offices for Appropriations for 1958 (Washington: Government Printing Office, 1957), p. 1287.

[59]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, 1970 National Science Foundation Authorization, _op_. _cit_., p. 187.

[60]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 83rd Congress, 1st Session, Independent Offices Appropriations for 1954 (Washington: Government Printing Office, 1953), p. 319.

[61]Dr. Louis Levin, _op_. _cit_.

[62]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 85th Congress, 1st Session, _op_. _cit_., p. 1280.

[63]National Science Foundation, _National Science Foundation Annual Report, 1964_, _op_. _cit_., p. 48.

[64]_Ibid_., p. 39.

[65]National Science Foundation, _National Science Foundation Annual Report 1954_ (Washington: Government Printing Office, 1954), p. 14.

[66]Richard M. Emberson, "National Radio Astronomy Observatory," _Science_, Vol. 130, No. 3385, November 13, 1959, pp. 1307-18.

[67]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 85th Congress, 1st Session, *op. cit.*, p. 1362.

[68]*Ibid.*, p. 1362.

[69]National Science Foundation, *National Science Foundation Annual Report 1967* (Washington: Government Printing Office, 1967), p. 262.

[70]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 89th Congress, 2nd Session, Independent Offices Appropriations for 1967 (Washington: Government Printing Office, 1966), p. 262.

[71]U. S. Congress, House, Subcommittee on Appropriations of the Committee on Appropriations, 88th Congress, 1st Session (Washington: Government Printing Office, 1964), p. 752.

[72]*Ibid.*

[73]National Science Foundation, *National Science Foundation Annual Report 1965* (Washington: Government Printing Office, 1966), p. 10.

[74]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 88th Congress, 1st Session, Independent Offices Appropriations for 1964 (Washington: Government Printing Office, 1963), p. 544.

[75]President's Science Advisor Committee, *Meeting Manpower Needs In Science and Technology* (Washington: Government Printing Office, 1963), p. 12.

[76]*Ibid.*, p. v.

[77]*Ibid.*

[78]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 88th Congress, 1st Session, *op. cit.*, p. 550.

[79]U. S. Congress, House, The National Science Foundation Its Present and Future (Washington: Government Printing Office, 1966), p. xiv.

[80]Daniel Greenberg, *The Politics of Pure Science* (New York: The New American Library, 1967), p. 272.

[81]*Ibid.*, p. 171.

[82]*Ibid*., pp. 171-207.

[83]*Ibid*., p. 68.

[84]*Ibid*., p. 169.

[85]Michael D. Reagan, *Science and the Federal Patron* (New York: Oxford University Press, 1969), p. 201.

[86]National Science Foundation, *National Science Foundation Annual Report 1957* (Washington: Government Printing Office, 1958), p. x.

[87]The definition of "open system" is lifted from DiStefano, Joseph J.; Allen R. Stubberud; and Ivan J. Williams, *Theory and Problems of Feedback and Control Systems* (New York: McGraw-Hill Company, 1967), p. 3 and p. 15.

CHAPTER IV

1. Introduction

The most important findings in the preceding chapters are the following: (1) NSF is a commonweal/service organization and as such possesses the respective central dilemma of each one of these formal organizations, (2) NSF has resolved its two central dilemmas in its official ideology and has designed a formal structure and decision making mechanism based on this ideology, and (3) NSF normally performs in a manner best described as one of responding affirmatively to the demands made by the clients-in-contact, the scientists.

The question still remains as to whether NSF can give affirmative responses to the scientists' demands when these demands are in conflict with demands made by the politicians (commonweal demands). It is also not known whether NSF officials can give affirmative responses to the scientists' demands when these demands are in conflict with what is good for science. The investigation of the first question is the subject of this chapter. The second question is the subject of the next chapter.

2. The Commonweal Dilemma of NSF

According to Blau and Scott the dilemma of a commonweal organization is that it must maintain a mechanism for receiving commonweal demands from the public, but at the same time be able to effectively implement policies which satisfy these demands.[1]

Because NSF is a federal agency it is provided with a mechanism to hear commonweal demands. These demands can be made to NSF by the Congress and/or the President. Presently, four congressional committees review NSF's policies and budget.[2] Along with the potential demands made by the Congress, the President also may present a commonweal demand to NSF. He can deal directly with NSF or transmit his wishes via the Office of Science and Technology (OST) or the Office of Management and Budget (OMB).[3]

The formal ideology of NSF holds that the demands of the scientists represent not only what is best for science, but what is best for the commonweal. As long as the politicians accept this ideology or make no demand contrary to the demands of the scientists, the commonweal dilemma of NSF is quiescent. However, as soon as the politicians place a strong demand on NSF which is radically different from NSF's existing performance, NSF is faced with a dilemma. If NSF acts upon the demands of the politicians and this action significantly changes NSF's performance, it is acting in opposition to the tenents of the official ideology and risks alienating the elaborate client-in-contact decision making mechanism upon which NSF relies. If such a course of action is taken, NSF could lose the confidence of the scientific community. Conversely, if NSF ignores the demands of the politicians, it risks the sanctions which the President and the Congress can bring to bear upon misbehaving agencies.

Such a dilemma would be expected to arise only when the politicians make a strong demand upon NSF which is not in accordance with the performance chosen for NSF by the clients-in-contact, the scientists.

3. Selection of a Commonweal Demand

In order to observe NSF's performance under conditions where the commonweal dilemma might be activated, it is necessary to identify a strong political demand which could be expected to run counter to the performance of NSF desired by the scientists. Work done by students of Congress, of science and public policy, and others indicates that the desire on the part of politicians for federal spending in their respective geographic areas (geographic distribution) may represent such a demand. Political scientists who study Congress indicate that such demands have traditionally been strong ones. Students of science and public policy argue that federal agencies which fund science are not exempt from this type of demand. There is also some evidence that representatives of the scientific community differ from the representatives of the people on how research and development funds should be geographically distributed. If geographical distribution is traditionally a strong political demand, if federal science awards are subject to this demand, if the politicians are critical of how these funds are distributed, and if the scientists are opposed to a new scheme of distribution based on geography; then this claim by the politicians would be an excellent one to investigate with regard to NSF and its performance budget. A dilemma for NSF officials would arise if the politicians insisted that the funds be distributed in a different manner from the way the spokesmen for the scientific community have recommended that NSF funds be distributed. The purpose of this first part of the chapter is to investigate whether or not the above conditions exist and if they do to observe how NSF reacts to them.

Before investigating whether NSF is faced with a dilemma of geographic distribution versus placing the funds where the scientists want them placed, work by other political scientists and students of science and public policy is reviewed. This review is done in order to establish that geographic distribution of federal funds is a major concern of the politicians and to see if conflict between scientists and politicians ever arises over this issue.

4. A Potential Commonweal Dilemma: Geographic Distribution

In The Congressman, Charles L. Clapp concludes that "...congressmen seek to impress their constituents with tangible evidence of their influence by seeking new installations and special contracts for their districts."[4] According to Clapp, congressmen are more sympathetic to requests from their colleagues for federally financed projects than any other set of demands. Congressmen realize that political futures are tied to the number of federal dollars a legislator can return to his district.[5]

Clapp supports the case he makes by extensive interviewing of congressmen. He bases his conclusion on fifty personal interviews with forty congressmen and ten legislative assistants.[6] In addition to these interviews, he presides over eight round table discussions with twenty Democratic and seventeen Republican congressmen.[7] Clapp selects his interviewees and discussants from what he states is a wide ideological and geographic range.[8] These interviews and round table discussions cover other questions besides the importance of the personal requests of congressmen. Frequently, the participating congressmen disagree with one another. However, Clapp cites no disagreement on the importance his interviewees and discussants attach to the securing of federal funds and projects for their respective districts.

Using a similarly constructed interview sample, Donald Matthews finds that the Senate behaves in somewhat the same fashion as the House. Matthews argues that senators seek favors from one another and expect to repay these favors.[9] Favors and repayments often involve tangible projects in the senators' respective states. The following is one senator's appraisal of the process. It is cited by Matthews as representative of the opinions of all senators.

> A man gets elected to the Senate on some kind of platform. He has made some promises or pledges that he will get this or that thing done. Then he gets down here and finds that nobody else gives a damn about his projects. What can he do? He either must back down on his promises or begin log-rolling. At first, I was pretty cynical when I found this was necessary. But then I realized that this was the kind of compromise necessary to govern a nation like this.[10]

Matthews concludes on the basis of his interviews and an extensive review of the public record that "Indeed, it is no exaggeration to say that reciprocity is a way of life in the Senate..."[11]

All of this mutual help plus the legislators orientation toward his constituency results in what William Keefe and Morris Ogul call log-rolling and localism. They conclude after examining a number of studies of Congress that

> The legislator's orientation toward his locality--the constituency comes first--is a major fact about Congress and the state legislatures. Localism and log-rolling are joined when decisions are made to build highways, hospitals, post offices, flood control projects, airports and to locate military installations. Few policy questions are more likely to alert the typical legislator than the allocation of funds for public works projects.[12]

One of the studies which Keefe and Ogul cite frequently in their book is Stephen K. Bailey and Howard D. Samuel's Congress at Work. In this book the authors undertake an extensive study of the Rivers and Harbors and Flood Control Act of 1950.[13] By investigating the progress and final outcome of this bill, Bailey and Samuel document Congress' use of the legislative process to apportion federal tax funds on a wide geographic basis. The final bill which was passed and reluctantly signed by the President authorized "...ninety-four rivers and harbors and fifty-eight flood control projects..."[14] Representative H. Rees (R., Kansas) is quoted as stating that this bill was "a real 'pork barrel' bill. There was something in it for almost every area and every section of the country...you will find them--East, West, North, South, Middle States and all."[15] According to Bailey and Samuels, the final House vote was 210-137 and the Senate passed it without debate 44 to 24. All this was in spite of the opposition of the President of the United States and several federal department heads.[16]

This case study also documents what the other researchers hint at. Namely, localism finally results in wide geographic dispersion of the federal resources available. Each legislator wants a project for his area, but to get this project he must support those in other areas.

Although studies by some political scientists reveal that legislators have considerable leeway in the way they vote because their constituencies are often uninformed,[17] no students of Congress have refuted the finding that there is a strong desire by congressmen to have federal money spent within their districts. Such spending is tangible evidence that the politician is doing something for his area.

5. Research and Development Funds and the Demand for Geographic Distribution

Because legislators demonstrate a strong desire for federal monies in their districts, it is not unreasonable to assume that they would be interested in knowing how the government geographically distributes 15 billion dollars for research and development.[18] Observers of science politics support this view. Donald K. Fleeming in an article, "Big Money and High Politics of Science", sees federal science funds as a logical extension of pork barrel activities.

> Pork barrel, though the only recognizable name for the phenomenon in question, is an unnecessarily invidious term for the inevitable process of deciding how the economy is going to be energized by federal projects. If there is little reason to despise the general process, there is still less occasion for assuming that the particular projects are unworthy. The improvement of rivers and harbors and the construction of dams were socially useful under the old dispensation. The seeding of the country with scientific installations is nothing to be ashamed of today.[19]

Don Price argues that politicians demonstrate an even greater interest in R & D spending than in the more conventional types of projects. This is so, Price states, because the politicians believe that science installations are "the lever of rising living standards and economic growth."[20] Research means new products and new products mean growth and jobs. Although this causal chain is not documented by social scientists, congressmen accept it. According to Price, if the politicians fight for regular pork barrel projects, they can be expected to fight even harder for scientific pork barrel projects.

As the Rivers and Harbors Bill serves to document and illustrate legislative concern with traditional pork barrel politics, a study by Daniel Greenberg documents and illustrates the same concern over equitable geographic dispersion of federally supported science installations.[21] In addition, the Greenberg study demonstrates how those selected to represent the scientific community differ with the politicians.

The Greenberg study concerns the bid and ultimate rejection of a proposal by MURA (the Midwest University Research Association, a non-government group of Midwest physicists) for the location of a high energy accelerator in the Midwest. Like the Rivers and Harbors Bill, the MURA case involved large sums of money and ultimately placed the President and powerful elements of Congress against one another. In the Rivers and Harbors Act, President Truman finally acceded to the overwhelming congressional pressure. In the MURA bid, President Johnson overruled the Midwest congressmen and senators who supported the location of a high energy accelerator in their area. The President's position was in favor of an advisory study made by scientists chosen to represent the U. S. high energy physics community. President Johnson did not take this action, however, before he had devoted much presidential time and energy in an attempt to pacify the politicians in favor of MURA's position. He wrote to Senator Hubert Humphrey, "I devoted more personal time to this problem than to any non-defense question that came up during the budget process."[22]

The controversy over the building of a high energy accelerator in the Midwest started as a result of the findings of the Ramsey report. Members of a panel of scientists headed by Norman F. Ramsey of Harvard University were assigned by NSF the task of representing the views of the nation's nuclear physicists on the subject of high energy accelerator construction in the mid and late 1960's.[23] The panel's report released on May 20, 1963, recommended that the Midwest accelerator be assigned a lower priority in the construction schedule than the accelerators planned on the west and east coasts.[24] The BOB, the AEC, and the President used this report to deny funds for the MURA accelerator in the 1965 budget.[25] Although President Johnson did not back down on this decision, he came under severe pressure to do so from Midwest newspapers, the area's university presidents and ultimately from a delegation of Midwest senators and congressmen headed by Hubert Humphrey. Greenberg points out that although the initial MURA proposal was unsuccessful in securing funding in 1965, the President did authorize the building of a much larger accelerator at Weston, Illinois.[26] This accelerator was not of the design proposed by MURA, but it finally brings a large high energy research accelerator to the Midwest.

Although the AEC was able to follow the recommendations of the Ramsey panel in the MURA case, this decision did not satisfy the Midwest politicians. They were critical of the way the scientists on the panel proposed to set the priorities for the construction of high energy accelerators. The recommendations of the Ramsey panel prevailed, but the power of the Presidency was needed to back these recommendations against the wishes of the Mid-west politicians.[27]

There are other R & D projects which document the same strong desire on the part of politicians for these types of projects to be located in their areas. Among these are the award of the Mohole contract,[28] the location of the NASA Electronics Center in Cambridge, Massachusetts,[29] and the location of the Manned Spacecraft Center in Houston, Texas.[30] All these cases support Price's point that politicians are acutely interested in the way the federal government geographically distributes its R & D funds.

The politicians' perceptions of inequitable distribution of research and development funds and the desire for the federal government to correct these perceived imbalances are especially intense during 1965 and 1966. The editor of Science magazine, Dr. Philip H. Abelson, writes in his editorial of July 2, 1965, that "Distribution of research and development funds is becoming a major political issue."[31] Abelson notes that local politicians with the support of their area's educators are applying pressure to the federal government for greater distribution of research and development funds.[32]

Based on the work of other political scientists and observers of science and public policy, geographical distribution of federal funds has been a traditionally strong political demand, federal science awards are subject to this demand, and politicians have been critical of how these funds have been distributed. Also, conflict between scientists and politicians has arisen over this issue.

It can be documented that NSF has been subject to strong criticism for its geographic distribution patterns by the politicians.

6. <u>Congressional and Presidential Dissatisfaction with and Demands for Change of NSF's Geographic Distribution Policies</u>

During the 1965-66 time period dissatisfaction with and demands for change of NSF's geographic distribution policies came from four sources. These included the Senate Subcommittee on Government Research (the Harris subcommittee), the House Subcommittee on Appropriations for Independent Offices, the House Subcommittee on Science, Research, and Development (the Daddario subcommittee), and the President of the United States. Criticisms from the Harris subcommittee, the Daddario subcommittee, and the President all occurred during the same time period, 1965-67.[33] Criticisms by the House Appropriations subcommittee were also made before this time period. This subcommittee has been interested in NSF's geographic distribution policies from 1955 on.[34]

The Harris subcommittee held hearings for two years on the general subject of "Equitable Distribution of R & D Funds by Government Agencies."[35,36] Although the Harris subcommittee issued no formal recommendations to NSF on the subject, the senators taking part in the hearings expressed their strong dissatisfaction with the way particular government agencies including NSF distribute their funds. The House Appropriations Subcommittee on Independent Offices was also a platform for members of that important subcommittee to express critical views on NSF distribution policies. In addition to being generally critical of the way NSF geographically distributes its funds, this subcommittee criticized specific NSF programs.

Both the President and the Daddario subcommittee in the House issued statements which recommended that NSF change its geographic distribution policies. The President's memorandum applied to all government agencies,[37] but the Daddario subcommittee report was specifically pointed at NSF.[38]

Collectively, the above criticisms and directives would clearly constitute a demand for change in NSF's geographic distribution policies. It is the purpose of the following sections to substantiate and review these criticisms and directives, investigate how NSF was geographically distributing its funds, and evaluate how NSF reacted to this commonweal demand for "equitable geographic distribution."

The central question of all of these separate investigations still remains the same. How does NSF react to a strong commonweal demand when this demand is in conflict with NSF's prior performance? That is, how does NSF react when the politicians want NSF to perform differently from the way scientists have had the agency perform?

7. General Criticisms: The Harris Subcommittee on Government Research

In 1965, Senator Fred Harris began hearings under the title, "Equitable Distribution of R & D Funds by Government Agencies."[39] The Harris subcommittee investigated all government agencies which allocate research and development funds and NSF was one of the agencies investigated.

The Harris hearings furnish evidence that there were strong feelings among some members of the Senate that many states were unjustly deprived of research funds by the existing system of awarding grants and contracts. The basis for this inference rests on two characteristics of the hearings. Firstly, several senators present at the hearings noted that their opinions were widely held throughout the rest of the Senate. Secondly, no senator chose to testify in favor of the opposite position.

The primary political bond which the critical senators had in common was their region. All were from the Midwest. Critical testimony was offered by Senators Harris of Oklahoma, Mondale of Minnesota, and Pearson of Kansas. In addition to these, Senators Karl Mundt of South Dakota, Carl Curtis of Nebraska, and Roman Hruska of Nebraska and Frank Lansche of Ohio were critical of the way the government geographically distributed its funds for research and development. Senators Curtis and Mundt asserted that the majority of the Senate shared their opinions, however. Senator Mundt stated,

> The uneasiness that our colleagues in the Senate share over this problem in [sic] such that we could make some kind of rough house approaches with speeches and ask the Senate to pass a reform for this whole area [geographic imbalance of distribution of research and development funds], which in my opinion would be exactly the wrong way to approach it.[40]

In order to avoid what Senator Mundt termed "a rough house approach", Senator Curtis had introduced a resolution which called for NSF to make recommendations to the Senate on what could be done about the problem.[41] Although this resolution was never brought to the floor for a vote, it furnished the formal initiative for the Harris hearings.[42] The Senate appropriated money so that

Senator Harris could conduct a wide ranging set of hearings into the problem. After the Harris hearings began, Senator Curtis did not seek the wide support for his resolution which he had before the hearings began. Senator Curtis expressed the following sentiment to the Harris subcommittee.

> I did not seek the wide cosponsorship which was given this resolution a year ago because the hearings last year established the deep interest of the Senate in its subject matter. A review of the record of last year's hearings would find me remiss were I to fail to express my high esteem for the chairman of this committee and to applaud the thorough and incisive manner in which he went to the heart of this problem. Its solution has never been believed to be an easy one but I know the hearings today show the full determination of the chairman and this committee to find that solution.[43]

In addition to Senator Harris' critical remarks, five senators offered testimony which criticized the present geographic distribution system of research and development funds. The viewpoints of Harris and the five critical senators were remarkably consistent. No senator appeared at the hearings to defend the geographic distribution system under attack. The senators collectively made the following arguments in their criticism of what they termed the then present system of geographic imbalance of research and development funding. Although different points were made by different senators, they did not disagree with one another and their separate viewpoints were consistent. Firstly, research and development funds were not distributed on an equitable basis and individual senators were aware of what their states were getting in relation to other states. Secondly, maldistribution of research and development funds have had and would continue to have bad effects on the deprived areas' economic and educational sectors. Thirdly, the problem was one which feeds upon itself. That is, the rich research and development states would become richer and the poor states would become poorer. Fourthly, the senators who testified were hesitant about applying a fixed geographic distribution formula. Lastly, while a fixed formula was considered an extreme last resort, the Senate had the power to make the offending federal agencies redress the imbalance which they stood accused of creating.

All the senators who looked at the printed hearings could become knowledgeable about how their own states faired by the existing system of funds distribution. Numerous charts and graphs are printed in the record of the Harris hearings revealing the amount of research and development funds each state gets. One of the senators who testified used his own state as an example of the inequity in the distribution system. Senator James Pearson of Kansas illustrated the plight of his own state by citing per capita R & D expenditures. According to

Pearson, Kansas received $11.70 per person, while California received $287.00 per person.[44] The figures he used were for 1965 and he did not believe the situation would improve unless the agencies dispensing the funds took steps to change these figures.[45]

Senator Curtis emphasized what he believed to be the economic and educational effects of imbalanced distribution policies. Senator Curtis stated that,

> But, were we to ignore the trend, we will see the educative and creative skills of this Nation located in a few complexes which will dominate both educational and industrial patterns of rising generations.[46]

Senator Curtis' remark was typical of similar statements included in all the testifying senators' remarks. Senator Laushe, for example, stressed the importance of quick remedial action by the agencies involved because even states with strong economic and educational systems would be eroded if the imbalance continued.[47]

Senator Hruska agreed with Senator Laushe that the imbalance was serious and would continue because institutions getting large sums of federal research dollars could use this fact to attract more talent in order to get even more funds.

> If things continue as they have been, the problem of inequitable distribution of R & D funds will solve itself. But it will be a far from happy solution, for it would mean that because of inadequate organization, facilities, and talent, the present big 20 schools had no competition in perpetuating their dominance.[48]

Senators Mundt and Curtis both noted that solution to the problem would not be easy. Senator Curtis, who had introduced the resolution which initiated the hearings, specifically rejected a simple legislative formula to redress the balance. "We cannot achieve an equitable and responsible distribution of funds by allocating dollars on a per capita basis."[49] Senator Curtis warned, however, that unless this imbalanced was redressed "...the entire country may someday get weary of this load it is carrying, which does not affect, so far as productive activity is concerned, so much of the United States."[50] This was a threat to the agencies involved because it would be the politicians who would translate the people's weariness into punitive actions. Curtis hoped that this threat would prove to be sufficient motivation for the agencies to change their practices.

Senator Mundt agreed with Senator Curtis, but made a different kind of threat to the agencies. Speaking as a member of the Senate Appropriations Committee, he stated that this committee could take simple and direct actions if no progress on the problem's solution was made by the agencies.

> And as a member of the Appropriations Committee, I know how adamant we can become in suggesting that it be done appropriations wise.[51]

Senator Mundt also agreed with Senator Curtis that corrective legislation could be passed if it were needed to make the agencies change their distribution policies.[52]

It is difficult to document exactly why Senators Mundt and Pearson were hesitant about imposing a final geographic formula on the offending agencies. The evidence seems to indicate that the two senators saw such an imposition as a rough and powerful last resort. They wanted to give the agencies a chance to take corrective action before imposing a fixed formula.

The statements made by the senators criticizing the geographic distribution of research funds are consistent with Price's argument that politicians consider research and development important because it adds to the economic prosperity of a given geographic area. The senators believed a geographic imbalance in the distribution of research and development funds existed and that this imbalance would cause the deprived areas to fall behind in future economic development. Although they were hesitant to impose rigid standards on the agencies to redress the imbalance they believed existed, the senators testifying expected the agencies to respond with some type of corrective actions. The senators who spoke at the Harris hearings were critical of the government's research and development funding agencies and hoped that the hearings' record would convey this dissatisfaction to the agencies concerned.

8. Criticisms of NSF: The House Appropriations Subcommittee on Independent Offices

The criticisms of NSF geographic distribution policies made by members of the House Appropriations Subcommittee are best described as terse when compared with the lengthy criticisms made by senators participating in the Harris hearings. There is an explanation for this difference. The Harris Subcommittee was charged by the Senate to focus on only one topic, the geographic distribution policies of government agencies. In addition, the Senate allowed the Harris subcommittee to pursue its investigation during two sessions of the Congress. In contrast, the Appropriations subcommittee has had neither the specific focus of the Harris subcommittee nor the time to investigate this topic to such lengths.

As an appropriations subcommittee, it must consider the total range of NSF activities. This range includes yearly increases in NSF's budget requests, new programs, and the general effects of NSF programs. These topics must be dealt with in a short time period. Hearings before this subcommittee generally last less than two working days. However, in spite of the broad range of topics which the subcommittee on Appropriations for Independent Offices considers and the short time available, the subcommittee has addressed itself to the subject of geographic distribution. Accomplishments in this area include the establishment of quantitative oversight of, the direction of criticisms at, and the attempt to modify some of NSF's geographic distribution policies.

The standard pattern of the NSF appropriations hearings is to permit opening statements by the Director of NSF and the Chairman of the National Science Board.[53] The Appropriations subcommittee chairman and members of the subcommittee then ask questions concerning these opening statements and any other questions which the members of the subcommittee have in mind. After the opening statements, questions and responses, the NSF program directors are permitted to read statements for the record on their particular programs. Individual program directors are asked questions on facets of their programs. New programs and program increases are given more attention by the subcommittee than old ones. Often old programs' descriptions are simply placed in the record and accepted by the subcommittee without comment. This pattern of statements, questions after the statements, and the severe review of new programs and increases in the budgets for old programs is in accordance with the general pattern outlined by Aaron Wildavsky in The Politics of the Budgetary Process.[54]

It is within the general pattern described above that the establishment of quantitative oversight of, the direction of criticisms at, and an attempt to modify one of NSF's geographic distribution policies were made.

Quantitative oversight of the geographic distribution policies of NSF has consisted of requiring NSF to furnish lists of what states receive NSF funds. These requests have asked for the total NSF funds received by each state and the sums received by each state for separate programs. As to whether the cumulative geographic totals for all NSF programs appears in the record depends upon the appropriations subcommittee's questions during the hearings. That is, the subcommittee focuses on different facets of NSF during each fiscal year's hearings and this focus may include total NSF geographic spending and/or the geographic spending done under one or more particular programs.

The first request for the total geographic spending was made by the subcommittee chairman, Albert Thomas, in 1955. He asked NSF's first director, Dr. Alan Waterman, to give the names and locations of all institutions receiving NSF funds and the state of residence of all the recipients of NSF fellowships.[55] During the time period 1959 through 1965, similar cumulative listings have been requested and have appeared in the 1961[56] and 1963[57] fiscal year budget hearings.

During some fiscal year appropriation hearings, NSF officials have been asked to list the geographic distribution of funds of particular performance programs or even of parts of various programs. During the time period 1959 to 1965, the geographic dispersion of at least one NSF program and/or part of one NSF program appeared. For example, in the 1964 hearings, NSF officials listed the geographic disposition of funds under the following headings: Basic Research Grants in Biological and Medical Sciences,[58] Institutional Grants for Science,[59] Undergraduate Instructional Equipment,[60] University Nuclear Research Facilities, Grants for Oceanographic Facilities,[61] Grants for Atmospheric Research Programs,[62] and Teacher Institutes.[63]

There was no regular pattern indicating when a particular program's geographic distribution of funds would be examined in the hearings. As previously stated, the appearance of either a cumulative listing of all the programs' geographic distribution or of a particular activity seemed to be the function of one of the subcommittee member's interest in that particular year. If a program came under the critical eye of the subcommittee for some reason, then the NSF official describing the program might be asked to supply a list of states and institutions in which funds for the program had been spent. For example, the Instructional Equipment for Undergraduate Education activity came to the attention of Representative Joe L. Evins of Tennessee because the program's estimate for fiscal year 1964 was 14 million more than the previous year's allocation.

> Mr. Evins. You had $8 million last year. Why do you need an additional $22 million increase for the next year? Why such a substantial increase?[64]

Waterman responded that "These are items very badly need- by practically all colleges and universities."[65] Representative Charles O. Jones of North Carolina then asked the following question:

> Mr. Jones. Do you make any effort to determine the institutions that have the greatest need for this equipment or are you paying most of your attention and do most of these grants go to institutions that are already wealthy and are well supplied with equipment?[66]

Representative Jones did not allow a response and went on to ask for "...the list of institutions that these grants."[67] Such a disorganized method of inquiry is typical of how the remaining geographic disposition lists come to appear in the record of the hearings. Questions having nothing to do with geographic disposition of funds are asked and then quite suddenly a demand for a list of where the funds go under a particular program is made. Not much information results from such a system of questioning. With respect to the criterion of measuring programs toward greater geographic distribution, it would be better to require NSF to supply quantitative geographic information both cumulatively and listed by separate programs every year. Because of a lack of time and the varied questions from the subcommittee members, the subcommittee does not collectively operate in this fashion. What the record does show is the continuing interest by members of the subcommittee in quantitative information on the geographic disposition of NSF funds. This continuing interest has been classified as "quantitative geographic oversight" by the writer of the dissertation.

In addition to making the quantitative geographic oversight of NSF's programs, members of the subcommittee have made critical comments about and have attempted to modify the geographic distribution policies of some of NSF's activities. In the time period 1959 through 1965, one of the above situations occurred on nine separate occasions. During three of the nine occasions, a member of the subcommittee severely criticized three different NSF activities. On a fourth occasion the geographic disposition of one activity was criticized and ordered to be changed. On a fifth occasion, a member commented positively on the dispersion characteristics of an NSF subprogram. The four remaining occasions of the nine discovered and noted by the researcher involved relatively minor criticisms of NSF geographic dispersion practices. During none of the nine occasions noted did any subcommittee member counter a fellow member's expressed judgement.

The three activities which drew the most severe criticism were the Fellowship Subprogram of the Fellowships and Traineeships Programs, the Scientific Project Support Program, and the Institutional Grants for Science Program. The subcommittee chairman, Representative Thomas, ordered NSF officials to change the distribution practices of the Fellowship Subprogram. The only activity which a member of the subcommittee praised for its geographic dispersion practices was the Pre-College Institutes Subprogram of the Pre-College Institutes and College Teacher Improvement Program. All these activities are included in those listed under the nine programs cited in Chapter II of the dissertation as constituting the ten largest NSF performance programs.

The critical comments, the attempt to modify, arose in the same manner that the lists for geographic disposition came into being. A subcommittee member would express interest in a particular activity, this member or another would comment on that particular activity, and the subcommittee would move on to another topic.

The subcommittee chairman, Representative Thomas, for example, followed this pattern in his criticism of the NSF Fellowship Subprogram. Dr. Katherine F. McBride, President of Bryn Mawr College and member of the National Science Board, had just completed a statement describing the positive benefits of the NSF Fellowship Subprogram.

She noted that fellowship holders were distributed throughout the fifty states. After her favorable opening statement about the subprogram, Representative Thomas made the following comment:

> Mr. Thomas. If you will turn to your tables you will note the budget people have set out some very interesting tables by States. To some degree it bears out the point you have just made but, in my own judgement, there is still certainly lots to be gained by wider distribution. The table speaks for itself. It shows that 40 or 50 students would take an examination in one State and maybe out of the 40 or 50, 10, 11 or 12 made it. I don't know what the Science Foundation can do about, it but certainly there is still a glaring lack of distribution. I just don't think that the intelligence of the various States in the Union varies that much where 15 or 20 percent finally are accepted in one State and maybe 33 1/3 percent are accepted in another.[68]

After Representative Thomas' statement, Dr. Waterman and Dr. McBride defended NSF's geographic distribution of fellowships. Thomas did not comment in a negative way on their responses and the subcommittee proceeded to take up the next topic.

NSF's largest program, the Research Project Grant Program, received a similar short but intense criticism in the 1961 fiscal year authorization hearings. The charge was again leveled by Thomas and was essentially the same as the one directed at the fellowship program.

That is, a small number of states were getting a disproportionate share of the funds distributed under the program.

> In looking over your breakdown for 'Science,' I find that about four or five States are getting about 40 or 50 percent of your total amount of money, which was $69 million for this year, or was it $86 million?[69]

After Thomas' comment, the discussion shifted to the method by which funds are awarded under the grant projects program.[70] NSF officials defended the program, the way the grants were distributed under it, and the geographic effects of this distribution.[71]

The Institutional Grants for Science Program, which is tied to the amount of research funds a university receives, was attacked by the subcommittee chairman during the 1963 Fiscal Year Appropriations Year Hearings. Representative Thomas asked Dr. Howard E. Page, the Program Director for Institutional Programs, to name the schools which got the largest grants under this program.[72] Page responded that Harvard, MIT, Cal Tech, University of California, and the University of Chicago were the institutions receiving the largest grants under the program.[73] Thomas responded by repeating his conviction that the Basic Research Grants Program and the Fellowships Subprograms had the same weaknesses.

> Mr. Thomas. You have already said enough. You are going right back to the bigger and richer institutions. Those which

> need it most are not included. That is one of the weaknesses in fellowships [NSF]. It is one of the weaknesses in your basic grant programs for research.[73]

After a defense of the program given by Drs. Page and Waterman, the discussion moved on to the next program item in the budget. Thomas nor none of the other members of the subcommittee commented favorably on the NSF officials' defense of the Institutional Grants geographic distribution program.

Members of the House Appropriations Subcommittee have praised one particular subprogram, the Pre-College Institutes portion of the Pre-College Institutes and College Teacher Programs. During the 1966 fiscal year hearings, Representative Charles Jonas of North Carolina and Chairman Thomas accused NSF of not treating this one activity favorably enough. Representative Jonas commented favorably on the subprogram and then asked Dr. Leland Haworth, the Director of NSF in 1966, the following question:

> Mr. Jonas. If the committee wanted to put another $10 or $12 million in the program, which other program would you want us to take it from?[74]

Dr. Haworth responded "That is a difficult question, Mr. Jonas."[75] After asking questions on the administration of the program, Mr. Jonas wanted to know if the distribution was better than the fellowship program.[76] He was assured by Dr. Riechen, the Pre-College Institutes and

College Teacher Programs Director, that this program's distribution was better than the fellowship program's.[77] Representative Thomas expressed the opinion to Dr. Haworth during the above discussion that "...the committee thinks more of this program than the Foundation does."[78] The implication seems clear. The relatively wide geographic distribution patterns under this program were popular with the members of the subcommittee.

The Appropriations subcommittee has not confined itself to commenting favorably and unfavorably on the geographic characteristics of the various activities. The subcommittee on at least one occasion has threatened to change the geographic distribution patterns of the various programs by legislation if the distribution patterms practiced were not changed by the Foundation.

The threat was made in connection with the examination of the Fellowship Subprogram during the 1966 fiscal year hearings. Representative Thomas requested from the program director, Dr. Reichen, a list of the states showing the "Distribution of Fellowship Applicants and Awardees by State of Permanent Residence."[79] The list was furnished and Representative Thomas examined and placed it in the record.[80] Thomas repeated his criticism which he made in the 1963 hearings that NSF picks fellows "...from half a dozen universities to the exclusion of everybody else."[81] Thomas expressed the opinion that this distribution could be improved.[82] Reichen defended the Fellowship Subprogram and the way the awards were distributed;[83] however, Thomas was not impressed and threatened:

> Mr. Thomas. I do not want to argue with you. I hope you change it. If you do not change it, we will change it for you.[84]

After this warning Reichen was allowed to finish his opening statement.[85]

Criticisms of NSF made by the Appropriations subcommittee were not as lengthy as the ones expressed in the Harris hearings. They are nonetheless judged to be important by the researcher. Firstly, these hearings were directed at specific NSF programs and even at activities under these programs. The Harris committee criticisms were directed at overall agency distribution policies and did not deal with specific agency activities. Secondly, the House Appropriations subcommittee is a very crucial institution in NSF's organizational life, because it is the first to receive all NSF money bills. Because NSF is primarily an agency which hands out funds rather than regulates how funds are spent, this subcommittee has a great deal of power over the Foundation. It is for these reasons that the short criticisms made by the subcommittee are offered as evidence supporting the assertion that the politicians did make a commonweal demand upon NSF for a change in its geographic distribution policies.

9. Criticisms of NSF: The House Subcommittee on Research and Development (The Daddario Subcommittee)

The Harris subcommittee and the House Appropriations subcommittee approached the examination of NSF with different emphases. The former examined all government research and development funding agencies, but confined itself to only one topic--the geographic distribution of these funds. The latter concentrated solely upon NSF, but covered a wide range of topics of which geographic distribution was one.

With respect to subject matter, hearings of the House Subcommittee on Research and Development, headed by Representative Daddario, were similar to those held by the Appropriations subcommittee. The Daddario subcommittee focused upon NSF and looked at many topics including geographic distribution. Other than the Appropriations subcommittees in the House and Senate, the Daddario subcommittee was the only congressional body to examine exclusively NSF. Its stated purpose was "...a critical review of the operations and functions of the National Science Foundation."[86] The hearings were marked by extensive preparation, thoroughness, and a detailed and critical report of NSF and its activities. In 1964 the Subcommittee had "...arranged with the newly formed Science Policy Research Division of the Library of Congress for a complete background report on the Foundation."[87] This was the first government report on NSF made by someone outside the Foundation. "The report was completed and submitted to the subcommittee in May 1965."[88] The hearings began the following June and lasted through the middle of August. The subcommittee heard testimony from over forty witnesses, submitted questions to these and other witnesses for written and researched answers, and requested and received numerous tables and other quantitative data from NSF for analysis by the subcommittee and its staff.[89] From the Library of Congress' Science Policy Research Division's report and the testimony and data obtained in connection with the hearings, the subcommittee wrote a formal report which was unanimously adopted by the full Committee on Science and Astronautics.[90]

The background report or review prepared by the Library of Congress' Science Policy Research Division was not intended to be a critical review of the Foundation. According to its writers, it attempted to chronicle NSF's legislative origins, formal organization, and major programs.[91] In addition, the report contained a list of issues gleaned from the public record which the authors "...deemed deserving of congressional examination."[92] For the purposes of this section of the dissertation, this list of issues is of interest. It is the only part of the report which could be called in any way controversial.

The list was included at the beginning of the report and was described as a set of "...new circumstances [which] now have been manifested which are bound to exercise a critical influence on the course, direction, and rate of future growth of the Foundation, and for which policy planning is essential."[93] Included in this list of nine policy issues was the topic of geographic distribution.[94] It was treated much the same way as it was by the senators before the Harris subcommittee. Research and development was something which contributed to regional economic growth and was therefore something to be encouraged throughout the country.

> 4. The potential of science to contribute to economic and social needs has illuminated the heavy localization of Federal support both in universities and in industry, and has brought about a sharper inquiry by the Congress on the manner in which science and technology contribute to local and regional activities and how, in combination with special local attributes, a different geographic distribution of Federal support would contribute increasingly to the national welfare.[95]

The similarity in thought expressed was probably intentional.

In addition to describing the obvious characteristics of the Foundation and its activities, the authors of the report wanted to summarize previous criticisms which had been voiced in the Congress.[96] The bibliography included with the report cites the House Appropriations hearings as a reference.[97] As noted, this body was one of NSF's principle critics on the subject of geographic distribution. The Harris hearings are not listed because they began seven months after the Library of Congress' report was submitted to the Congress. The Daddario subcommittee used this Library of Congress report in preparing their hearings.

The record of the actual hearings before the Daddario subcommittee contains several questions posed by subcommittee members making reference to the subject of geographic distribution; however, they lack the critical tone of questions on the same subject asked by members of either the Harris subcommittee or the House Appropriations subcommittee. Members of the Daddario subcommittee seemed quite content to let the NSF officials and their supporters do the talking. A typical exchange before the subcommittee on the subject of geographical distribution might include a member's broaching the topic, the asking for detailed responses, and then moving on to another item. For example, when NSF Director Haworth outlined the fellowship program, he was asked by Representative Daddario to comment on a plan to impose geographic quotas on particular states which received the majority of NSF fellowships.[98] Haworth responded that although he was in favor of having good universities spread throughout the country, he did not believe such a quota plan was a good idea.[99] Haworth argued that to do otherwise would "... lose the usefulness, the maximum usefulness of the very best people and the very best institutions."[100] The subcommittee accepted Haworth's statement without comment, and he began his prepared statement describing the Traineeship Subprogram of the Fellowship and Traineeship Program.[101] In his description of this subprogram, Haworth stated that it had a good record in achieving equitable geographic distribution.[102] After his formal statement, Haworth was asked to furnish for the record a listing of states which received the Traineeship monies.[103] The testimony then continued with a description of another NSF activity.[104]

In this manner the Daddario subcommittee compiled its data on NSF's geographic distribution of funds. NSF officials described their programs, subcommittee members asked questions about the programs, and this information was furnished for the record. This pattern was similar to the one followed in the appropriations hearings, except the Daddario subcommittee members refrained from critical comment on NSF's geographic distribution record. Their withholding critical comment did not, however, affect the thoroughness with which they treated the subject. The hearings contain tables showing the geographic distribution records for the Traineeship Subprogram, of the Fellowship and Traineeship Program,[105] total NSF support for all

NSF programs excluding facilities,[106] the Fellowship Sub-program of the Fellowship and Traineeship Program,[107] the total NSF support for science in the elementary and secondary schools,[108] and total funds contributed with joint fundings from NSF and the National Institutes of Health for health research facilities.[109] This information was in addition to the data gathered by the Library of Congress for the preparatory report on NSF.

Although the hearings were thorough and the preparation for them extensive, the issue of geographic distribution was not examined as systematically as it might have been. In looking at the various programs, one year's funds distribution was not compared with succeeding years' distributions and entire subprograms and activities were not considered by the subcommittee. The abundant charts, graphs, tables, and commentary do show, however, a keen interest on the part of the subcommittee in this issue.

This interest was demonstrated most specifically in the final report prepared by the subcommittee and unanimously adopted by the parent committee, the Committee on Science and Astronautics.[110] In this report, critical statements and recommendations were made concerning NSF's geographic distribution policies. In Chapter III of the report, under a section entitled, "Specific Problem Areas," critical comments are made about NSF's past geographic distribution record. The paragraph below is a good synopsis of the conclusions reached by the subcommittee with respect to geographic distribution of NSF funds.

> The problem now to be faced is the balancing of programs for project research with those for institutional support among the Federal departments and agencies so that leading scientists and institutions can continue their quest for excellence in science while at the same time other institutions with the initiative and energy to seek after such excellence can be encouraged and helped to develop their resources.[111]

Based on the above quoted conclusion, the background report prepared by the Library of Congress, and the hearings, the subcommittee formally recommended in its Conclusions and Recommendations Section of the Committee Report that "additional emphasis [be placed by NSF] on institutional and development grants, traineeships, etc."[112] Under this recommendation, the subcommittee held that present science capabilities should be maintained and furthered, but that a larger number of institutions should be included in NSF programs.[113]

The final recommendation was not as threatening in tone as some of the comments made before the Harris subcommittee and the House Appropriations subcommittee, but it was a formal recommendation and it had the unanimous support of the Committee on Science and Astronautics. For this reason it should be accorded at least equal weight with the critical remarks emanating from the other two committees. Whatever its weight, it is another congressional source of criticism of NSF's geographic distribution policies prior to 1965.

10. <u>Criticism of NSF; The President of the United States</u>

The strongest criticism to be made of the geographic distribution policies practiced by the government's research and development funding agencies came from the President of the United States. This criticism is rated strong because it was made by the President, it stated the problem clearly, and it specified policies by which the President believed geographic imbalance could be corrected.

In a "Statement by the President to the Cabinet and Memorandum on Strengthening Academic Capability for Science," dated September 14, 1965, the President made the following points. He stated his belief that "a strong and vital education system is an essential part of the Great Society."[114] The President included in his definition of a strong and vital education system the necessity for institutions with research capabilities.[115] Not only must all children have equal opportunities for education, but all regions should have access to excellence in research.

> We must, I believe, devote ourselves purposefully to developing and diffusing--

> throughout the Nation--a strong and solid scientific capability, especially in our many centers of advanced education. Our future must rest upon diversity of inquiry as well as the universality of capability.[116]

At the time of his statement, President Johnson did not believe that federal research policies were accomplishing this goal. The President noted that "At present, one-half of the Federal expenditures for research go to twenty major institutions, most of which were strong before the advent of Federal research funds."[117] While the President wanted the "outstanding quality" in science maintained at these major centers of excellence, he wanted universities of strong potential developed in other regions of the country.[118]

The President also recognized NSF's special responsibility in the development of science at the universities and urged NSF to encourage such development over a wider geographic area.[119] All federal agencies including NSF were to:

> Contribute to the improvement of potentially strong universities through such measures as--Giving consideration, where research capability of comparable quality exists, to awarding grants and contracts to institutions not now heavily engaged in Federal research programs;
> --Assisting such institutions or parts of institutions in strengthening themselves while performing research relevant to agency mission, by such means as establishing university-administered programs in specialized areas relevant to the missions of the agencies.[120]

Because NSF had the special responsibility of maintaining the health of and developing the scientific capacity of the nation,[121] the Presidential directives apply with special force. However, both of the points outlined above are in slight conflict with NSF official ideology which does not consider geographic distribution equal in importance with quality as a criterion for choice of recipients of science grants and awards. Institutional development was to be given added emphasis with the clear objective of developing additional centers capable of doing high quality science. According to the President's directive, NSF administrators were not supposed to assume science would best develop if it were left in the hands of the scientists. The President even suggested that agencies might have to rearrange their spending priorities in order to carry out the intent of his directive.

> Departments and agencies should carefully assess the degree to which and the manner in which their existing programs support this policy, and when indicated, should use a large proportion of their research funds in accordance with the intent of the policy.[122]

To give added emphasis to his directive, the President requested that his Special Assistant for Science and Technology, Donald Hornig, follow the progress of the agencies toward the President's announced goals.[123] Agencies were to turn in monthly progress reports to Hornig so that he would have some basis for evaluating this progress or lack thereof.[124]

It is well to keep in mind that President Johnson did not advocate the cut-off of support of the already established scientific centers. The President wanted federal agencies to support these centers so that they would continue to develop their capacities. However, the agencies were already supporting these centers handsomely relative to the other universities in the country. To reaffirm the importance of the existing centers of science was no departure from the present policy of the government. To direct the agencies to distribute their increases in research and development funds more widely was a departure from present policy. This was particularly true in light of the projected growth of the present research producing institution. According to a National Academy of Science study, these universities would need a 15 percent increase in their funding during the 1966-70 time period.[125] Funds desired for geographic redistribution would have to compete against the already stated claim in the NAS study for increases in funds. To direct the agencies to distribute the <u>increases</u> in research and development funds more widely would require NSF to place itself in opposition to the projected demands of the established research producing universities.

The President, in any case, had made it clear that he was not happy with the present geographic distribution policies of the research and development funding agencies and had therefore assigned NSF special responsibility in broadening this distribution.

11. Geographic Redistribution: A Commonweal Demand

Although some of the critics of NSF's geographic distribution were less vehement than others, all the public statements of the politicians cited seemed to be in agreement on the following point. A few states were getting the majority of research and development funds, an inequity further compounded by the existing geographic spending practices of the federal agencies supporting research and development. If the situation was to change, these same government agencies, including NSF, would have to change their geographic distribution policies.

The criticisms and assertions made during the 1965 through 1967 time period constitute a demand by the politicians for NSF to change its geographic distribution practices. The politicians did not tell NSF how greater distribution was to be achieved, but did make it clear they wanted wider distribution of the agency's funds.

As noted earlier, criticisms made by members of the Appropriations Subcommittee on Independent Offices were voiced earlier than 1965. However, the criticisms made by members of this subcommittee after 1965 were as strong as those made prior to that year. This is to say that the members of this subcommittee seemed to be as unhappy with NSF's performance patterns after 1964 as they had been prior to that time. If there had been a response to the subcommittee's pre-1965 criticisms on the part of NSF, the subcommittee still was not satisfied. Whatever NSF's response to the Appropriations subcommittee's earlier criticisms, the collective criticisms and recommendations of the Harris, Daddario, House Appropriations subcommittees, and the memorandum by the President constituted a relatively stronger demand for NSF to change than the Appropriations subcommittee's singular criticisms prior to 1965.

12. Political Demands and Scientific Demands

As stated in this chapter's introduction, one of the writer's main purposes is to make an investigation of the organizational responses of NSF to a strong political demand. Once such a demand is identified, a series of important questions regarding NSF's responses can be raised. Among these questions are, what were the responses of NSF to the demand placed upon it?, did NSF's performance change after the demand was made?, and finally, if NSF did respond affirmatively and effectively to the politicians' demand, did this response indicate a shift in control of NSF's performance from the scientists to the politicians?

Based on the analysis of NSF in Chapters II and III, one would not expect to find radical changes in NSF's performance. To answer a demand from the politicians at the expense of the scientists would be difficult for NSF to accomplish. Although NSF has the authority to answer political demands when they conflict with demands made by the scientists, using this power would be incongruent with the official ideology, formal organization, and established decision making process of NSF.

Despite any difficulties NSF might have because of its official ideology, formal organization, and decision making process, NSF could not ignore the politicians' demand for greater geographic distribution of funds; it had to respond to a demand which was supported by the President, two subcommittees of the House, and a subcommittee of the Senate.

Response came in a variety of ways, all of which can be grouped under four headings: firstly, a description and analysis by NSF officials of the causes of the problem; secondly, an outline of what NSF had done and would do in order to improve the situation; thirdly, a defense of the admitted geographic imbalance practiced under certain NSF programs; and lastly, the assignment of some of the responsibility for a satisfactory solution to the problem to the Congress and to the local political and educational leaders of the deprived areas.

The documentation of these responses can be found in NSF Director Leland Haworth's statements to the already mentioned Harris subcommittee.[126]

13. The Harris Subcommittee

The Harris subcommittee's investigation of "Equitable Distribution of R & D Funds by Government Agencies" spans a twelve month period.[127] Hearings were held on July 25, 26, and 27, 1966; May 10, 11, 17, and 18, 1967; and again on July 11, 17, and 18, 1967.[128] Haworth appeared before the subcommittee on July 25, 1966, and on July 18, 1967.[129] In both these appearances and the latter especially, Haworth gives a detailed description of NSF's responses to the problem of funds distribution.

Haworth had a sufficient amount of time to prepare a detailed response because both of his appearances occurred after the problem had been reviewed by interested subcommittees of the House and by the President. Haworth's 1966 and 1967 testimony to the Harris subcommittee took place after his appearance before the Daddario subcommittee (August 1965), the release of the President's Memorandum on Strengthening Academic Capability for Science (September 1965), and his appearance in support of NSF 1967 Fiscal Year Budget before the Appropriations Subcommittee on Independent Offices (March 1966).

In testimony before the Harris subcommittee, Director Haworth attempted to downgrade the interrelationship between federal distribution of research and development funds and a region's ability to compete for these awards. Haworth asserted that there was a combination of causes for geographic imbalance rather than a mere lack of federal funds.[130] He admitted that federal funds helped a region's scientific development, but felt that the amounts it got were closely tied to other factors.[131] These factors included the number of Ph.D.'s the various regions produced (an index of scientific power) and the amount of support the respective universities got from local politicians, educational leaders, and alumni.[132]

In order to support his assertion that amounts of federal research and development funds received were linked to the number of Ph.D.'s in the region, Haworth produced charts which compared the percentage of the nation's Ph.D's which a state produced versus the amount of federal monies for research and development a particular state received.[133] Taking note that California got more money than it might be expected to on the basis of the number of science Ph.D's it produced (14.2 percent of the federal research and development monies versus 9.3 percent of the science Ph.D's produced), he explained this exception in terms of California's peculiar capacity to do academic research.

> Significant exceptions to this rule occur in the case of California and Massachusetts, however, where the percentage of

> support for academic science is considerably higher than the percentages [sic] of population or of degrees granted. The principal reason for this can be traced to the presence in these States of a number of large, very high-quality universities having faculties containing an unusual number of people of extraordinary research ability. Such people compete successfully for research support and in many cases are the principal investigators on major research endeavors which require large supporting staffs and expensive facilities.[134]

The special excellence which California and Massachusetts and other more favored states possessed was due to "The support which these institutions have received from interested local citizens and alumni, local and State Government, and private foundations as well as from the Federal Government." This combined support has produced "...an extraordinary fertile environment for research."[135]

Haworth's arguments are consistent with NSF's official ideology. According to the official ideology, NSF is to play a largely passive role with respect to the social institution of science. Haworth argued that proper geographic distribution was more dependent on the institutions where science was done than on how NSF allocated its funds to the different states.[136] Therefore, if the government wanted more widespread geographic distribution, it would have to help more universities strengthen themselves.[137] Haworth warned, however, that this strengthening of deprived universities must not be done at the expense of the existing centers of excellence. These had to be maintained so that they could train scientists for the underdeveloped universities and colleges.[138]

According to Haworth, NSF would strengthen institutions of lesser rank and science generally throughout the country.[139] At the same time, existing centers of excellence would be maintained. NSF had been pursuing these twin goals in the past but would give them added emphasis in the future.[140]

More specifically, Haworth described the relationship of NSF's largest programs to the solution which he had prescribed. In testimony to the Harris subcommittee, Haworth discussed six out of the nine programs listed in Chapter III as NSF's largest programs. The six large NSF programs mentioned by Haworth as being relevant to the problem of geographic distribution were the Research Project, the Fellowship and Traineeship, the University Science Development, the College Science Improvement, the Computing Activities, and the Department Science Development Programs. In addition to these six, he discussed a seventh program not listed in Chapter III as one of NSF's nine largest programs. All of these seven programs according to Haworth were related in particular ways to the problem and the solution of geographic imbalance. For example, in the strengthening of institutions of lesser rank, Haworth mentioned four NSF programs as being particularly worthwhile. These programs are the University Science Development Program, the College Science Improvement Program, the Computing Activities Program, and the Department Science Development Program.[141] This last program is NSF's tenth largest and was not classified in Chapter III as one of NSF's "nine largest programs." According to Haworth, these four programs are supposed to aid in the establishment of additional areas of scientific excellence.[142]

The NSF Annual Reports also describe three of the above four programs as being beneficial to the goal of a more widely dispersed scientific establishment. The 1964 Report, for example, characterizes the University Science Development Program in the following manner:

> In March 1964, the Foundation began a program designed to assist selected academic institutions in strengthening significantly their activities in science and engineering. The major objective of the Science Development Program is to increase the number of institutions of recognized excellence in research and education in the sciences. It is not intended to replace existing programs or to consolidate grants for administrative convenience. Rather, this program's primary purpose is to accelerate improvement in science by providing funds to be expanded in accordance with carefully developed plans. Such plans must be designed to produce significant upgrading in the quality of the institution's science activities. Grants will be made to colleges and universities judged to have the greatest potential for moving upward to a higher level of scientific quality and for maintaining this quality.[143]

The College Science Improvement Program was announced in May of 1966 and is described in the 1968 Annual Report as being similar to the University Science Development Program except that it applies to colleges. The goal is to improve science education "...of predominantly undergraduate educational institutions in a comprehensive way."[144]

According to the 1967 Annual Report, the Departmental Science Development Program is designed to help departments which have potential of becoming first rank scientific enterprises. "Open to institutions offering master's or doctor's degrees in science or engineering, the program offers the possibility of substantial support for development in institutions not yet having strength in a sufficient number of departments to qualify for grants under the University Development Program."[145] The Departmental Science Development grants run for a period of three years and like the University Department grants require extensive preparation of proposals by the grantee.[146]

With the exception of Haworth's testimony to the Harris subcommittee that the Computer Activities Program was "...a broad Federal program of support for the use of computers", there were no claims in NSF Annual Reports or other documents that the computer program would help NSF to achieve greater geographic distribution. However, because Haworth specifically listed it as one of the NSF programs which was supposed to alleviate the problem of geographic imbalance. It is listed as one of NSF's responses to the demand.

In addition to the above four programs which Haworth states are designed to encourage universities and colleges to achieve excellence, he notes that two other major NSF activities help spread the agency's funds more widely. Haworth testified to the Harris subcommittee that the Traineeship Subprogram of the Fellowship and Traineeship Program and the Pre-College Institutes and College Teacher Program contribute to the strengthening of a nation-wide scientific capability.[147] Haworth stated that the Traineeship Subprogram achieves a much wider distribution than the Fellowship Subprogram.

> And in distribution among institutions is much wider, and includes a large majority of the Ph.D. granting institutions. That was part of the objective because students selected on an individual basis and free to go tend to concentrate on a few places such as MIT. The traineeships are spread across the fifty states. This program is, in a sense, a kind of development program, too.[148]

Haworth points out to the subcommittee that the mission of the Pre-College Institutes and College Teacher Program was also directed toward developing science throughout the country. "These institutes have, of course, benefited teachers in every State, in every town of any size. Hundreds of thousands of teachers have now attended such institutes."[149] The House Appropriations subcommittee has shared Haworth's opinion that this particular program distributes money widely. It is NSF's second largest program and it is the only program which the Appropriations subcommittee specifically directs NSF officials to spend the amount allocated to it.[150]

Haworth makes no mention of the National Research Centers Program and the National Research Programs and their connection to the problem of geographic imbalance. This seems to be a reasonable omission. The National Research Centers Program locates its centers in places where they will be near the particular problem being studied. There are only four centers and they are located in the following states: the National Radio Astronomy Observatory in West Virginia, the Kitt Peak National Observatory in Colorado, the Cerro Tololo Observatory in Chile, and the National Center for Atmospheric Research in Colorado. The researcher found no Congressional criticisms of the location of these centers. It would appear that Congress has accepted the justification for these locations.

There has been no detectable criticism by the Congress or administration of NSF's geographic distribution of funds practiced under the National Research Programs.[151] Director Haworth makes no mention of these programs in his discussion of what NSF is doing to achieve a better balance in the distribution of research and development funds.

For the reasons cited above, neither the National Research Centers Program nor the National Research Programs are considered by the researcher to be particularly relevant to the problem of geographic distribution.

The Scientific Research Project Support Program and the Fellowship Subprogram of the Fellowship and Traineeship Program occupy no such neutral position in either Haworth's testimony before the Harris subcommittee or in the dissertation. Both programs were admittedly biased toward certain states, but NSF takes the position that neither of these programs should be adjusted in favor of greater geographic equity.[152] If institutions are upgraded, then the funds administered under these two programs will naturally seek a more balanced distribution.[153] Haworth is quite clear on these points.

> The oldest part of our education programs is the support of graduate fellowships in which, by the terms of our act--and I think properly so--the selection of the individual is to be based solely on merit and the fellow is free to go to any institution he selects and can gain admittance to. Since the beginning the foundation has had fellowships of this sort. Most of those granted fellowships select one of a small number of institutions.[154]

In testimony before the Daddario subcommittee in 1965, Haworth was even more explicit about the relationship of the fellowship program and geographic distribution.

> Mr. Daddario. As I understand your comment, you indicated it was not a good thing to have this residence limitation because it would affect your ability to support the highest quality people.
>
> Dr. Haworth. Yes. Mr. Chairman, I am in favor of having good universities and colleges in all parts of the country, all regions of the country; I am also in favor of giving opportunity to every individual to develop himself as far as he can. But I think in the national interest we must have some programs, be they for research or for fellowships, that must be administered purely on the quality basis. We must keep them separate; we must not fuzz up the quality programs by other considerations such as geography. Let's achieve such goals with programs that are designed to develop better institutions.[155]

As far as Haworth was concerned, scientific quality would be the main criterion in the award of fellowships. If institutions desired more NSF fellows they would have to improve their overall quality.

Haworth defended the awarding of grants made under the Research Project Support Program on the basis of quality and quality alone. By using the criterion of quality, Haworth believed that the Nation would benefit "...from the most significant possible advances in scientific knowledge."[156] To introduce other criteria into this program would be detrimental to scientific progress.[157] Haworth admitted to the subcommittee that these two programs were biased toward certain states, but defended this bias.

The last response to the demand for greater geographic distribution which Haworth presented to the Harris subcommittee sought to remove some of the responsibility from NSF. He told the subcommittee that the rate at which the deprived states improved their universities was also dependent on how much these institutions did for themselves and how generously Congress funded those NSF programs which were supposed to aid in this improvement. To emphasize this last point Haworth made the following statement to the Harris subcommittee:

> Let me conclude by saying that any major extension of geographic distribution will depend on whether additional funds can be made available from all sources--private and public, local and Federal. The goal of raising less favored institutions in every region of the country to higher standards of excellence cannot be achieved on the scale we would like at the present level of expenditures. What we need is time to allow our present and planned programs to take effect and on [sic] objective evaluation of our regional requirements and the funds needed to meet them.[158]

NSF's response to the problem of geographic imbalance consisted of four elements. These were an analysis of the problem, a proposed solution to this problem based on the analysis, a defense of existing NSF programs, and the displacement of some of the responsibility for a satisfactory solution to the Congress and the deprived regions themselves.

14. Quantitative Analysis of NSF's Performance with Regard to the Demand for Greater Geographic Distribution

It is concluded in previous sections of this paper that the politicians placed a demand on NSF to achieve greater geographic distribution of funds. The politicians did not tell NSF how to achieve this goal but left little doubt that they wanted it accomplished. It was also concluded that although NSF did respond to the politicians' demand, it would be difficult for NSF to change its performance because of its official ideology, formal structure, and decision making process.

The purpose of the following analysis is to determine whether or not NSF's performance did change after the demand was placed on NSF to do so. The analysis is done in a way consistent with Haworth's testimony to the Harris subcommittee. That is, the programs which Haworth described as relevant to the problem are the focus of the analysis.

The seven programs Haworth cited to the Harris subcommittee in this connection were the Scientific Research Project Support Program, the Fellowship and Traineeship Program, the University Science Development Program, the College Science Improvement Program, the Computing Activities Program, the Department Science Development Program, and the Pre-College Institutes and

College Teacher Program. These programs are examined in the way Haworth presented them. After the overall distribution of all seven programs is considered, NSF's two admittedly "biased" activities are reviewed. Finally, the other activities which Haworth cited as helping distribute NSF funds more widely are considered.

To measure any change that might have taken place, the seven programs are compared in two fiscal years. The fiscal year 1964 is selected because it is the year before most of the criticism of NSF's geographic pattern began. Fiscal year 1969 is the other year selected because it is the last one for which complete data is available. Also, the choice of 1969 allows NSF the maximum time to react to the demand placed on it. Many of NSF's grants are made for three year periods and most of the grants made under the research Project Program are renewals.[159] For these reasons, NSF would need time to effect change in its geographic distribution practices.

The selection of the seven programs described by Haworth to the Harris subcommittee is consistent with the focus of Chapter III of the dissertation. In Chapter III, the analysis of NSF programs is confined to NSF's nine largest programs. In the present chapter, six out of these nine programs are examined. The three programs examined in Chapter III but not considered here are the National Research Centers Program, the National Research

Programs, and the Institutional Grants for Science Program. The National Research Centers Program and the National Research Programs are not treated in the present chapter because Haworth did not describe them to the Harris subcommittee as being relevant to the problem of geographic distribution. Also, these two programs have not been criticized by the politicians with regard to geographic imbalance. The Institutional Grants for Science Program is not included for analysis because no funds were spent under it during fiscal year 1969.

As noted in the last section, NSF's tenth largest program, Department Development, is included by Haworth as part of NSF's response to the demand for greater geographic distribution. For this reason, it is also included in the analysis of NSF's performance response.

The three programs discussed in Chapter III but not examined in this chapter accounted for 11 percent of NSF's 1969 performance budget. The seven programs examined in this chapter accounted for 77 percent of the total NSF 1969 performance budget. Because Haworth mentioned these seven activities in the context of geographic distribution, because they make up 77 percent of NSF's 1969 performance budget, and in order to keep the dissertation manageable in size, they are used as the subjects for analysis of NSF's performance reaction to the demand for greater geographic distribution.

15. Geographic Distribution By States Versus State Per Capita Distribution

The analysis of NSF's response to the demand placed upon it for greater geographic distribution of its funds is done on the basis of state units rather than on a state per capita basis. The primary reason for this choice is because the criticisms directed at NSF by the politicians are primarily in terms of maldistribution between states rather than in terms of per capita distribution. The Harris subcommittee, the House Appropriations subcommittee, the Daddario subcommittee, and most importantly the President all underlined that maldistribution occurred in absolute terms with respect to the states or regions. Except for Senator Pearson's testimony, states like California and Massachusetts were not mentioned as getting too much per capita but as getting too much *vis-a-vis* the other states. For example, in the Harris hearings, Senator Mundt said to Director Haworth that

> We cannot quarrel with the fact we have fine universities in California and Massachusetts. But if we are going to try to do something to keep people from shifting in vast numbers to those economic and educational areas we are going to have to crank into our distribution of these Federal funds and contracts at every level of activity, something else besides this gravitation to point of excellency.[160]

The displeasure of Chairman Thomas of the House Appropriations subcommittee at NSF's distribution of large sums of its monies to the scientifically affluent states has already been noted. Although the Daddario subcommittee report did not criticize NSF's geographic distribution pattern as strongly as Representative Thomas did, the criticisms in the Daddario report were aimed at overconcentration of funds in certain states or regions.[161] Per capita overconcentration was not mentioned in this report.

Most importantly, the President in his memorandum noted that

> ...the funds are still concentrated in too few institutions in too few areas of the country. We want to find excellence and build it up wherever it is found so that creative centers of excellence may grow in every part of the nation.[162]

The President's remarks indicate that his criticism is of geographic concentration rather than geographic per capita concentration.

16. NSF's Overall Geographic Performance Pattern

Table V compares the percentages of the funds spent under the seven selected programs in the top ten states for fiscal years 1964 and 1969.[163] The research is directed at the question of whether there is an overall change in the geographic spending patterns practiced under these seven large NSF programs. More specifically, the question is whether or not there are different states in the 1969 listing compared with those in the 1964 listing, and whether or not the order of these listings has changed. It is also of interest to see if the percentage of funds obtained by these ten states both individually and collectively rose or fell in 1969 as compared with 1964.

The figures in Table V indicate that there is little change in the states included in the top ten states in 1964 and 1969. Of the ten states in the 1964 list, nine are on the 1969 list. New Jersey replaces Wisconsin in the 1969 listings.

TABLE V

GEOGRAPHIC DISTRIBUTION OF SEVEN OF NSF's PROGRAMS.[164] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
California	12.6	California	15.1
New York	9.8	New York	11.9
Illinois	7.7	Massachusetts	7.0
Massachusetts	7.3	Pennsylvania	6.7
Pennsylvania	5.3	Illinois	5.5
Michigan	3.7	Michigan	4.2
Texas	3.1	Indiana	3.3
Ohio	3.1	Texas	3.1
Indiana	2.9	New Jersey	2.8
Wisconsin	2.8	Ohio	2.8
Total	58.3	Total	62.4

The rank order in 1969 is similar to the rank order in 1964. In the top five states, California and New York are numbers one and two, respectively. In 1969, Massachusetts moves from fifth to fourth place. Illinois is the only state in the top five to lose its 1964 position, as it moves from number three to five.

In the next five states, Michigan remains in the sixth place and the other states change their positions slightly. Indiana moves from ninth place to sixth, and Texas drops from sixth to seventh place. New Jersey replaces Wisconsin in the top ten and ranks ninth in 1969. Ohio drops from eighth to tenth place in 1969.

Five states of the top ten increase their share of total funds in 1969 as compared to 1964. California and New York make substantial gains. California jumps from 12.6 percent to 15.1 percent and New York moves from 9.8 percent to 11.9 percent. Pennsylvania increases its share of the total from 5.3 percent in 1964 to 6.7 percent in 1969. Michigan goes from 3.7 percent to 4.2 percent. The other four states which are in the top ten in 1964 and 1969 lose percentages of the total, but this loss was less than 1 percent per state.

Collectively, the top ten states did better in 1969 than in 1964. One would not expect this to happen if NSF were trying to geographically redistribute its funds. The top ten had 62 percent of the total budget in 1969 compared with 58 percent in 1964. Also, the percentages are even more concentrated among the top five states in 1969 than they are in 1964. In 1964 the top five account for 43 percent of the total, but in 1969 these top five states account for 47 percent of the total funds for the seven selected programs.

The data in Table V indicate that the states which received the most funds in 1964 are almost the same states which received the greatest proportion of funds in 1969. The rank order of these states is similar in 1964 to the rank order in 1969. Individually, about half of these top ten states increased their share of NSF funds over 1964, and half of the states dropped slightly below the percentages they achieved then. Collectively, the top ten and especially the top five substantially increased their share of NSF funds for the seven programs highlighted in the Haworth testimony. In conclusion, NSF increased the concentration of its funds in a few states.

17. Geographic Performance Patterns Practiced under the Research Project Support Program and the Fellowship Subprogram

According to Director Haworth's testimony, two NSF activities are biased toward certain states. The Research Project Support Program and the Fellowship Subprogram give their awards to institutions and fellows whom the scientific community feels are the most competent. Haworth believed no criterion other than scientific excellence should govern these awards. He did think, however, that as other NSF programs aided the states to increase their scientific excellence, awards made under the Research Project and Fellowship Subprogram would be spread among a greater number of states.

The geographic patterns of these two activities for fiscal years 1964 and 1969 are similar to the patterns of the overall geographic pattern discussed in the last section. States in the top ten in 1964 remain the top ten in 1969, the rank orderings of the states remain similar in the two years, and the percentages achieved by the top ten rises in 1969 over 1964.

Table VI gives information about the geographic distribution under NSF's largest program, the Research Project Program. In this program, nine of the top ten states in 1964 are included in the top ten states for 1969. Indiana replaces Washington in 1969. The rank order of the top ten is similar for these two years. The top five states in 1964 remain the top five states in 1969, and they are in the same order for 1969 as 1964. In the bottom five states the order of states changes only slightly between 1964 and 1969.

In terms of percentages, the top ten states increase their percentages of the total funds available under this program in 1969 as compared with 1964. In 1964 the top ten received 66 percent and in 1969 they received 68 percent.

TABLE VI

GEOGRAPHIC DISTRIBUTION OF RESEARCH PROJECT PROGRAM[165] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
California	16.2	California	17.3
New York	10.2	New York	13.0
Massachusetts	10.1	Massachusetts	8.5
Illinois	8.9	Illinois	7.0
Pennsylvania	5.1	Pennsylvania	5.9
Wisconsin	3.8	Indiana	3.9
Michigan	3.6	Michigan	3.8
Connecticut	3.0	New Jersey	3.5
New Jersey	2.8	Connecticut	2.7
Washington	2.6	Wisconsin	2.7
Total	66.3	Total	68.3

Table VII gives information about NSF's other "biased" activity, the Fellowship Subprogram of the Fellowship and Traineeship Program. The geographic distribution pattern established under this subprogram is similar to the geographic patterns already discussed. Almost the same states appear in the top ten for 1969 as 1964, their rank orderings are similar in the two years, and collectively the percentages received by these top ten increased in 1969 in comparison to 1964.

In the top ten states, the only state appearing in 1969 that did not appear in 1964 is Connecticut. It replaces Texas in the top ten for 1969. The rank ordering of the top ten is similar for 1969 when compared with 1964, but is not as stable an ordering as was the case for

TABLE VII

GEOGRAPHIC DISTRIBUTION OF FELLOWSHIP SUBPROGRAM[166] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
New York	14.5	California	24.6
California	11.8	Massachusetts	22.2
Pennsylvania	6.2	New York	9.8
Illinois	6.2	Illinois	6.6
Massachusetts	4.2	New Jersey	5.2
New Jersey	4.1	Michigan	3.7
Texas	3.9	Wisconsin	3.5
Ohio	3.8	Connecticut	3.2
Michigan	3.7	Pennsylvania	2.5
Wisconsin	2.6	Texas	1.5
Total	61.0	Total	82.8

the Research Project Grant Program. In the top five, only Illinois remains in the same spot for both years. New York drops from first place in 1964 to third place in 1969, California rises from second place in 1964 to first in 1969, and Pennsylvania goes from third place in 1964 to ninth in 1969. Massachusetts rises from fifth place in 1964 to second place in 1969. A similar rearranging occurs in the bottom five states of the top ten in 1969 as compared with 1964. Still, almost the same states which appear in the top five in 1964 appear in the top five in 1969 and similarly with the bottom five.

Collectively, the top ten states received a greater share of the funds from the Fellowship Subprogram in 1969 than they did in 1964. In 1964, the top ten received 61 percent and in 1969 they received 83 percent of the total.

Haworth is correct in saying the Research Project Program and the Fellowship Subprogram are biased toward certain states. Under the two programs, almost the same states appear in the top ten in the two fiscal years. Only Connecticut, Texas, Ohio, and Washington fail to appear both times among the top ten in both programs. Haworth is not correct in his believe that other states would increase their share of awards made from these programs. The states in the top ten are almost the same for both years, and the total percentage achieved by these states increased under both programs in 1969 as compared with 1964.

18. <u>NSF's Geographic Distribution Practices under the University Science Development Program, the College Science Improvement Program, the Computing Activities Program, and the Department Science Development Program</u>

The University Science Development Program, the College Science Improvement Program, the Computing Activities Program, and the Department Science Development Program were singled out by Director Haworth as being especially helpful to the problem of geographic imbalance in NSF's spending patterns. Haworth described these programs as ones which could help state universities of lesser rank improve themselves.

The researcher is interested in finding whether these programs had a better geographic distribution record in 1969 than in 1964. More importantly, the researcher is interested in knowing whether these four programs spread money among more states than do the "biased" Research Projects Program and Fellowship Subprogram.

In the analysis of the four programs which Haworth asserted would help strengthen less developed universities there is a complicating factor. Only one of these programs, the Computer Activities Program, was operating in 1964. The other three programs began to distribute their funds after 1964. Comparison of spending patterns of years after 1964 with those of 1969 of these three programs was not possible because of the short time period between the years. Also, the most important consideration in terms of Haworth's testimony is whether or not any or all of the four programs helped to distribute funds more widely than other NSF programs. The important question is, did these programs differ significantly from the way funds are distributed under the two "biased" activities?

19. <u>NSF's Geographic Distribution Practices under the Computer Activities Program</u>

As mentioned, only of the four programs described by Haworth as being particularly helpful in distributing NSF funds over a wider geographic area was operating in 1964--the Computer Activities Program. This program's geographic distribution record <u>seems</u> better in 1969 than in 1964. In 1969, the top ten states receiving funds in this program obtained 72 percent of the total amount compared with 91 percent in 1964. Also, eight of the top ten states listed in 1964 were replaced by new states in the 1969 top ten. As a generalization, it can be stated there was a rotation of states in 1969 compared with the situation in 1964, and the top ten states received less funds in 1969 than in 1964.

The mere rotation of states between 1964 and 1969 does not tell the complete story, however, for it is not yet known whether the money in 1964 or 1969 went to the scientifically deprived states or to the scientifically affluent states.

Because the Research Project Support Program and the Fellowship Subprogram were admitted to be "biased" toward the already scientifically affluent states, those states which appear in both of the top ten of these programs in 1964 are classified by the researcher as scientifically affluent states. Eight states so appear--

TABLE VIII

GEOGRAPHIC DISTRIBUTION OF THE COMPUTER ACTIVITIES PROGRAM[167] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
Pennsylvania	17.4	California	19.8
Illinois	13.5	Michigan	14.3
Indiana	11.2	Texas	8.7
Virginia	9.0	Pennsylvania	8.2
New York	8.6	North Carolina	5.3
Hawaii	7.8	New York	5.0
New Hampshire	6.7	Louisiana	2.8
Georgia	5.8	Illinois	2.8
Massachusetts	5.6	Kansas	2.6
Utah	5.6	Alabama	2.6
Total	91.2	Total	72.3

California, New York, Massachusetts, Illinois, Pennsylvania, Michigan, Wisconsin, and New Jersey. By comparing the records achieved by these states in the Research Project Program and the Fellowship Program with the Computers Activities Program, information can be gained as to how widely the Computer Activities Program spreads it money. Table IX is designed to illustrate this comparison. In contrast with the two "biased" activities, the Computer Activities Program awarded less money to the scientifically affluent states in both 1964 and 1969. In 1964 these states received 50 percent of the Computer Activities funds compared with 61 percent and 53 percent received by the Research Project and Fellowship Subprogram, respectively. In 1969, the scientifically affluent states received 54 percent of the Computer Activities Program funds as compared with 62 percent and 78 percent, respectively for the Research Project Program and the Fellowship Subprogram.

TABLE IX

COMPARISON OF GEOGRAPHIC DISTRIBUTION OF COMPUTER ACTIVITIES PROGRAM, RESEARCH PROJECTS PROGRAM, AND FELLOWSHIP SUBPROGRAM[168]
(FIGURES IN PERCENTAGES)

	1964% Name of Activity			1969% Name of Activity		
State	Computer	Research Project	Fellowship	Computer	Research Project	Fellowship
Calif.	4.5	16.2	11.8	19.8	17.3	24.6
N. Y.	8.6	10.2	14.5	5.0	13.0	9.8
Mass.	5.6	10.1	4.2	1.9	8.5	22.2
Ill.	13.5	8.9	6.2	2.8	7.0	6.6
Penn.	17.4	5.1	6.2	8.2	5.9	2.5
Wisc.	0	3.8	2.6	1.5	2.7	3.5
Mich.	0	3.6	3.7	14.3	3.8	3.7
N. J.	0	2.8	4.1	.4	3.5	5.2
Totals	49.6	60.7	53.3	53.9	61.7	78.1

The Computer Activities Program did achieve greater geographic distribution than did either the Research Project Program or the Fellowship Subprogram. Still, it is difficult to argue that the Computer Activities Program is one which radically differs in its geographic distribution policies. More accurately, it is a program which distributes its monies relatively more widely than do the Research Project Program or the Fellowship Subprogram.

20. <u>NSF's Geographic Distribution Practices under the College Science Improvement Program</u>

Table X lists the top ten states for the College Science Improvement Program. The total percentage achieved by these ten states was 48 for 1969. Because this percentage cannot be compared with a 1964 total, it does not by itself mean a great deal.

TABLE X

GEOGRAPHIC DISTRIBUTION OF THE COLLEGE SCIENCE IMPROVEMENT PROGRAM[169] (FIGURES IN PERCENTAGES)

Name of State	1969 %
Pennsylvania	7.4
Ohio	7.3
Minnesota	6.2
Illinois	4.8
California	4.3
Wisconsin	4.2
Tennessee	3.9
New York	3.7
Colorado	3.7
New Jersey	2.7
Total	48.2

Table XI is directed at the question of whether the College Science Improvement Program has a better geographic distribution record than do the "biased" Research Project Program and the Fellowship Subprogram. As in the last section, only the scientifically affluent states are listed in Table XI. The figures indicate that the College

TABLE XI

COMPARISON OF GEOGRAPHIC DISTRIBUTION OF COLLEGE SCIENCE IMPROVEMENT PROGRAM, RESEARCH PROJECTS PROGRAM, AND THE FELLOWSHIP SUBPROGRAM[170]
(FIGURES IN PERCENTAGES)

	1969% Name of Activity		
Name of State	College Science Improvement	Research Project	Fellowship
California	4.3	16.2	11.8
New York	3.7	10.2	14.5
Massachusetts	0	10.1	4.2
Illinois	4.8	8.9	6.2
Pennsylvania	7.4	5.1	6.2
Wisconsin	4.2	3.8	2.6
Michigan	0	3.6	3.7
New Jersey	2.7	2.8	4.1
Total	27.1	60.7	53.3

Science Improvement Program has a markedly better record than either the Research Project Program or the Fellowship Subprogram with regard to greater geographic distribution of its funds. The College Science Improvement Program awarded only 27 percent of its funds to the scientifically affluent states in 1969 as compared with 62 percent by the Research Project Program and 78 percent by the Fellowship Program to these states. The College Science Improvement Program can be classified as one which achieves wide geographic distribution.

The finding that the College Science Improvement Program has a wider distribution than the more "biased" programs also increases confidence in the analysis. The analysis has revealed a case where a program did not achieve a markedly different geographic pattern and a program which did achieve such a distribution.

21. NSF's Geographic Distribution Practices under the Departmental Development Grants

The University Science Development Program and the Departmental Science Development Program are designed so that universities and departments of "lesser rank" can improve themselves. By such improvement, Haworth argued, a larger number of excellent universities would be developed and this would increase the number of states which could compete for funds under NSF's "biased" programs. As has been established already, such a chain of events has not yet taken place. It is the purpose of this section to see if the University Science Development Program and the Departmental Development Program have a better geographic distribution record than the Research Project Program or the Fellowship Program.

Tables XII and XIII are included in this section for descriptive purposes and completeness. They list the top ten states under both of these programs for fiscal year 1969. It should be noted that there are only eight states which received awards in 1969 under the University Science Development Program. There are only nine states which received awards in 1969 under the Departmental Development Grants Program. Because awards were not made under these programs in fiscal year 1964 and because less than ten states received awards under these programs in 1969, Tables XII and XIII tell little more than which states got how much of each program's totals.

TABLE XII

GEOGRAPHIC DISTRIBUTION OF UNIVERSITY SCIENCE DEVELOPMENT GRANTS[171]
(FIGURES IN PERCENTAGES)

Name of State	1969 %
New York	25.0
Pennsylvania	15.8
Arizona	13.7
Missouri	13.4
California	13.0
Virginia	8.2
Florida	7.3
Kansas	3.5
Total	99.9

TABLE XIII

GEOGRAPHIC DISTRIBUTION OF DEPARTMENTAL DEVELOPMENT GRANTS[172]
(FIGURES IN PERCENTAGES)

Name of State	1969 %
Illinois	14.5
Nevada	13.0
Oklahoma	12.1
Arizona	11.8
California	10.9
New York	10.7
Massachusetts	9.9
Ohio	9.7
Pennsylvania	7.3
Total	99.9

As was the case with the Computer Activities Program and the College Science Improvement Program, the next set of Tables are more revealing. Table XIV compares the percentages of awards achieved by the most favored states under NSF's two biased programs with the percentages of awards achieved by the most favored states under the University Science Development Program. Similarly, Table XV makes the same comparison for the Departmental Development Program.

TABLE XIV

COMPARISON OF GEOGRAPHIC DISTRIBUTION OF UNIVERSITY SCIENCE DEVELOPMENT GRANT PROGRAM, RESEARCH PROJECT PROGRAM, AND THE FELLOWSHIP SUBPROGRAM[173] (FIGURES IN PERCENTAGES)

	1969% Name of Activity		
State	University Science Development	Research Project	Fellowship
California	13.0	17.3	24.6
New York	25.0	13.0	9.8
Massachusetts	0	8.5	22.2
Illinois	0	7.0	6.6
Pennsylvania	15.8	5.9	2.5
Wisconsin	0	2.7	3.5
Michigan	0	3.8	3.7
New Jersey	0	3.5	5.2
Totals	53.8	61.7	78.1

The University Science Development Program has a wider geographic distribution record than the Research Project Program or the Fellowship Subprogram. In 1969, the University Science Development Program awarded 54 percent of its total funds for that year to the eight most favored states. This compares with 62 percent and 78 percent for the Research Project Program and the Fellowship Subprogram, respectively.

Table XV demonstrates that the Departmental Development Program also has a better geographic distribution record in 1969 than either the Research Project Program or the Fellowship Subprogram.

TABLE XV

COMPARISON OF GEOGRAPHIC DISTRIBUTION OF DEPARTMENT DEVELOPMENT PROGRAM, RESEARCH PROJECT PROGRAM, AND THE FELLOWSHIP SUBPROGRAM.[174] (FIGURES IN PERCENTAGES)

	1969% Name of Activity		
State	Department Development	Research Project	Fellowship
California	10.9	17.3	24.6
New York	10.7	13.0	9.8
Massachusetts	9.9	8.5	22.2
Illinois	14.5	7.0	6.6
Pennsylvania	7.3	5.9	2.5
Wisconsin	0	2.7	3.5
Michigan	0	3.8	3.7
New Jersey	0	3.5	5.2
Totals	53.3	61.7	78.1

In 1969, the Department Development Program awarded 54 percent of its funds to the most favored states. Again, this 54 percent compares with the 62 percent and 78 percent achieved under NSF's two "biased" activities.

As was argued earlier in the case of the Computer Activities Program, the geographic distribution record achieved in 1969 under the University Development Program and the Department Development Program is relatively better than the records achieved under either the Research Project Program or the Fellowship Subprogram. However, 54 percent of the funds from the University Development Program and 54 percent from the funds of the Departmental Development Program going to the ten most favored states is not a radical redistribution of NSF funds.

22. <u>Geographic Performance Patterns Practiced under the Pre-College Institutes and College Teacher Program</u>

The four activities explained above were described by Director Haworth as being especially applicable in solving the problem of geographic imbalance. In addition to these four activities, Haworth told the Harris subcommittee that NSF had two activities which had also helped and would continue to help develop a broader geographic scientific base. These activities were the Pre-College Institutes and College Teacher Program and the Traineeship Subprogram. The researcher is interested in seeing what the distribution patterns are for these activities in fiscal years 1964 and 1969. As was the case with the four activities just examined, the researcher is also interested in comparing their geographic distribution patterns with NSF's two "biased" activities. This last comparison is of interest and special import because of the distinction which Haworth made. Namely, the Research Project Program and Fellowship Subprogram are biased toward certain states, but the Pre-College Institutes and College Teacher Program and the Traineeship Subprogram are supposed to spread their funds over a wider geographic area. This section examines the Pre-College Institutes and College Teacher Program, and the next examines the Traineeship Subprogram.

Table XVI illustrates the geographic distribution of the Pre-College Institutes and College Teachers Program for fiscal years 1964 and 1969. The geographic distribution record of this program seems to be slightly better in 1969 than in 1964. In 1969 the top ten states receive 44 percent of the total funds spent under this program as compared with 46 percent for 1964. The states appearing in the top ten for 1969 are almost the same states which appeared in the 1964 listing. Colorado and North Carolina drop from the 1969 list, and Massachusetts and Oregon join the list. Also, the states rotate in their orderings in 1969 as compared with 1964. Only California and Illinois appear in the top five in both 1969 and 1964. In the bottom five, no state which is in this category in 1969 was in that category in 1964.

TABLE XVI

GEOGRAPHIC DISTRIBUTION OF PRE-COLLEGE INSTITUTES AND COLLEGE TEACHER PROGRAMS[175] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
New York	6.8	California	5.8
California	5.9	Illinois	5.5
Ohio	5.6	Michigan	5.1
Illinois	5.2	Indiana	5.0
Texas	4.7	Pennsylvania	4.7
Pennsylvania	4.2	New York	4.7
Michigan	3.9	Texas	4.7
Indiana	3.4	Ohio	4.4
Colorado	3.1	Massachusetts	3.3
North Carolina	2.1	Oregon	3.0
Total	45.7	Total	44.2

As was the case with the Computer Activities Program, mere rotation and percentage of the total tell us very little. The important question is whether the awards in 1964 or 1969 went to the scientifically deprived states or the scientifically affluent states. That is, did the eight states which appear in the 1964 top ten of NSF's two "biased" activities achieve a high percentage of the total funds from the Pre-College Institutes and College Teacher Programs? Table XVII compares this program with the Research Project Program and the Fellowship Program for 1964 and 1969 in order to answer the above stated question. The data in Table XVII indicate that the Pre-College Institutes and College Teacher Program

TABLE XVII

GEOGRAPHIC DISTRIBUTION OF PRE-COLLEGE INSTITUTES AND COLLEGE TEACHER PROGRAM, RESEARCH PROJECT PROGRAM, AND FELLOWSHIP SUBPROGRAM[176] (FIGURES IN PERCENTAGES)

State	1964% Name of Activity Insti-tutes	Research Project	Fellow-ship	1969% Name of Activity Insti-tutes	Research Project	Fellow-ship
Calif.	5.9	16.2	11.8	5.8	17.3	24.6
N. Y.	6.8	10.2	14.5	4.7	13.0	9.8
Mass.	2.6	10.1	4.2	3.3	8.5	22.2
Ill.	5.2	8.9	6.2	5.5	7.0	6.6
Penn.	4.2	5.1	6.2	4.7	5.9	2.5
Wisc.	1.1	3.8	2.6	2.5	2.7	3.5
Mich.	3.4	3.6	3.7	5.1	3.8	3.7
N. J.	2.0	2.8	4.1	2.1	3.5	5.2
Totals	31.7	60.7	53.3	33.7	61.7	78.1

have a much better geographic distribution record than NSF's two "biased" activities. In 1964 the eight scientifically affluent states received 61 percent of the funds from the Research Project Program and 53 percent of the funds from the Fellowship Subprogram. This compares with 32 percent achieved in 1964 by these eight states under the Pre-College Institutes and College Teacher Program. The data is similar for 1964. In that year, the two "biased" activities award 62 percent and 78 percent of their funds, respectively, to the eight favored states. The Pre-College Institutes and College Teacher Program award only 34 percent of its funds to these eight states. Haworth is correct in praising this program for its ability to achieve relatively wide geographic distribution of its funds.

23. Geographic Performance Patterns Practiced under the Traineeship Subprogram of the Fellowship and Traineeship Program

Table XVIII contains information about the geographic distribution of the Traineeship Subprogram. This activity gives awards to universities who in turn make awards to graduate students of the universities' choosing. This is in contrast to the Fellowship Subprogram which gives the awards directly to the graduate students, who then choose the university they wish to attend. Because of this difference, Haworth argued it was possible for a greater number of less developed universities to participate under the Traineeship Subprogram than the Fellowship Subprogram. This greater participation in turn leads to a broader geographic distribution of funds.

Table XVIII seems to indicate that the geographic distribution record of the Traineeship Subprogram is improved in 1969 over how it was in 1964. In 1964 the top ten states under this activity were awarded 70 percent of its funds, but in 1969 they receive only 61 percent of the total. There is little change in the states which appear in the top ten for both years, however. Florida and Illinois are the only states which appeared

TABLE XVIII

GEOGRAPHIC DISTRIBUTION OF TRAINEESHIP SUBPROGRAM[177] (FIGURES IN PERCENTAGES)

Name of State	1964 %	Name of State	1969 %
California	12.4	California	11.9
New York	11.0	New York	10.9
Florida	8.9	Idaho	6.7
Massachusetts	8.7	Massachusetts	6.2
Illinois	7.7	Pennsylvania	6.1
Michigan	5.8	Michigan	5.0
Pennsylvania	5.3	Texas	3.9
Indiana	4.9	Indiana	3.9
Texas	3.6	Ohio	3.9
Ohio	3.0	Wisconsin	2.5
Total	70.1		61.0

in the 1964 top ten but do not appear in the 1969 top ten.

As in the case with the last NSF activity discussed, Table XVIII tells us little about whether the funds under this Traineeship Subprogram went to the scientifically deprived states or the affluent states. Table XIX contains information on this topic.

It appears that geographic distribution did widen under this program between 1964 and 1969. In 1964, the Research Project Program and the Fellowship Subprogram awarded 61 percent and 53 percent, respectively, to the eight most favored states. These figures compare with 54 percent awarded to the most favored states under the Traineeship Subprogram. In 1964 the Traineeship Subprogram did no better from the standpoint of geographic

TABLE XIX

GEOGRAPHIC DISTRIBUTION OF TRAINEESHIP SUB-PROGRAM, RESEARCH PROJECT PROGRAM, AND FELLOWSHIP SUBPROGRAM[178]
(FIGURES IN PERCENTAGES)

	1964%			1969%		
	Name of Activity			Name of Activity		
State	Trainee-ship	Research Project	Fellow-ship	Trainee-ship	Research Project	Fellow-ship
Calif.	12.4	16.2	11.8	11.9	17.3	24.6
N. Y.	11.0	10.2	14.5	10.9	13.0	9.8
Mass.	8.7	10.1	4.2	6.2	8.5	22.2
Ill.	7.7	8.9	6.2	0	7.0	6.6
Penn.	5.3	5.1	6.2	6.1	5.9	2.5
Wisc.	.2	3.8	2.6	2.5	2.7	3.5
Mich.	5.8	3.6	3.7	5.0	3.8	3.7
N. J.	2.6	2.8	4.1	2.4	3.5	5.2
Totals	53.7	60.7	53.3	45.0	61.7	78.1

distribution than the Fellowship Subprogram. In 1969 the Research Project Program and the Fellowship Subprogram award 62 percent and 78 percent of their funds, respectively, to the most favored states. For 1969, the Traineeship Subprogram awarded 45 percent of its funds to these states. The Traineeship Subprogram awarded 8 percent less of its funds to the most favored states in 1969 than it did in 1964. At the same time, the Fellowship Subprogram increased its percentage of funds to these states from 53 percent in 1964 to 78 percent in 1969. The Traineeship Subprogram does not concentrate its funds in the eight most favored states to the extent that the Research Project Program or the Fellowship Subprogram does. However, the Traineeship Subprogram's geographic distribution record is not as good as the Pre-College Institutes' and College Teacher Program's.

24. NSF's Performance Reaction to the Politicians' Demand for Geographic Distribution

There is little evidence to indicate that NSF performed in accordance with the political demand for greater geographic distribution of NSF funds. If one examines the total funds awarded to the top ten states in 1964 and 1969 under the seven programs studies, it seems clear that geographic concentration of funds increased. That is, the top ten states received more of the funds from the total funds spent under these seven programs in 1969 than they did in 1964. In 1969 the top ten states received 62 percent of the total funds awarded under the seven programs, and in 1964 the top ten received 58 percent of these funds. Also, the states which appeared in the top ten in 1964 did not change greatly from the ones which appeared in 1969. Nine of the states which appeared in the top ten in 1964 appeared in the top ten in 1964.

There was no improvement in terms of geographic distribution in either the Research Project Program or the Fellowship Subprogram. Director Haworth had admitted that both of these activities were biased toward certain states and the Appropriations Subcommittee had been especially critical of the geographic distribution of the fellowships. Under the Research Project Program, the top ten states received 66 percent of the funds available in 1964 and 68 percent of these funds in 1969. There was an even more dramatic concentration of funds in the top states under the Fellowship Subprogram. Under this program, the top ten states received 83 percent of the funds in 1969 and in 1964 they received 61 percent. The states appearing in the top ten under these two activities tended to be the same states. In 1964 and 1969 the same eight states appear in the top ten under the Research Project Program and the Fellowship Subprogram.

The four programs which Haworth described to the Harris subcommittee as being most relevant to a solution to the problem of geographic distribution did have a better geographic distribution record than the Research Project Program or the Fellowship Subprogram. These four programs were the College Science Improvement Program, the Science Development Program, the Computer Activities Program, and the Department Science Development Program. The College Science Improvement Program achieved the best geographic distribution record of any of the seven programs investigated. This program gave only 27 percent of its total funds in 1969 to the states classified as scientifically affluent. For the same year, the University

Science Development Program, the Computer Activities Program, and the Department Science Development Program awarded 54 percent, 53 percent, and 54 percent of their funds, respectively, to these states. These three percentages and the 27 percent recorded under the College Science Improvement Program are all better than the 62 percent and 78 percent achieved in 1969 by the eight scientifically affluent states under the Research Project Program and Fellowship Subprogram. However, the College Science Improvement Program, the University Science Development Program, the Department Development Program, and the Computer Activities Program are all much smaller programs than the admittedly biased Research Project Program. The Research Project Program accounted for 43.9 percent of the performance budget in 1969. Together these four programs with the better geographic distribution record received only 16.7 percent of the 1969 performance budget. Three of these four programs--the Department Development Program, the Computer Activities Program, and the College Science Improvement Program--were all smaller in 1969 than the Fellowship Subprogram.

The two activities which Haworth cited as being helpful in distributing NSF funds more widely also had a better geographic record than the biased activities. The Pre-College Institutes Program awarded 32 percent of its funds to the scientifically affluent states in 1969 and the Traineeship Subprogram gave 45 percent of its 1969 funds to these states. Again, however, these two activities are much smaller than the biased Research Project Program. The Pre-College Institutes and College Teacher Program, and the Traineeship Subprogram received 8.4 percent and 1.5 percent, respectively, of the 1969 performance budget. The Traineeship Subprogram's 1.5 percent is smaller than the Fellowship Subprogram's 5.7 percent of the 1969 performance budget.

NSF did respond to the politicians' demand for a wider geographic distribution. This response, however, was more verbal and symbolic than in terms of actual performance changes. New programs were described as being directed toward the solution of the problem and old ones were defended in terms of their past contributions to the solution. In addition, NSF officials sought to fix some of the responsibility for the resolution of the problem on the Congress and the local officials and educational leaders.

In terms of performance, NSF increased its concentration of funds in a few states and the programs which did have relatively better geographic distribution records were not large enough to have a significant impact on the problem.

Footnotes

[1]Peter M. Blau and W. Richard Scott, Formal Organizations (San Francisco, California: Chandler Publishing Co., 1962), p. 55.

[2]Presently, NSF must go before two authorization committees and two appropriations committees. The two authorization committees are the House Committee on Science and Astronautics and the Senate Committee on Labor and Public Welfare. The appropriations committees are the House Appropriations Committee and the Senate Appropriations Committee. These latter two committees have held hearings on NSF since its inception (1951). The former two committees held their first authorization hearings in 1969. Prior to this a number of committees have had NSF employees testify before them.

[3]For the purposes of this dissertation, demands made upon NSF by either the President or the Congress are considered "commonweal demands." They are made in the greater public interest as the U.S. political system provides for the representation of this interest. Whether or not these demands are in accordance with some normative scheme of what the public interest is is not within the purview of this chapter.

[4]Charles L. Clapp, The Congressman (Garden City, N. Y.: Anchor Books, Doubleday and Co., 1964), p. 205.

[5]Ibid.

[6]Ibid., p. 5.

[7]Ibid., p. 2.

[8]Ibid., p

[9]Donald Matthews, "The Folkways of the United States Senate: Conformity to Group Norms and Legislative Effectiveness," The American Political Science Review, December, 1959, p. 1071.

[10]Ibid., p. 1071.

[11]Ibid., p. 1072.

[12]William J. Keefe and Morris S. Ogul, The American Legislative Process (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 469.

[13]Stephen K. Bailey and Howard D. Samuel, Congress at Work (New York: Henry Holt and Co., 1952).

[14]Ibid., p. 193.

[15]Ibid., p. 192.

[16]Ibid., p. 193.

[17]Warren E. Miller and Donald E. Stokes, "Constituency Influence in Congress," New Perspectives on the House of Representatives, eds. Robert L. Peabody and Nelson W. Polsby, 2 ed. (Chicago: Rand McNally and Co., 1968), pp. 31-53.

[18]Michael S. March, Federal Budget Priorities for Research and Development (Chicago, Ill.: The University of Chicago Press, 1970), p. 4.

[19]Donald K. Fleeming, "Big Money and High Politics of Science," The Politics of Science, ed. William R. Nelson (New York: Oxford University Press, 1968), p. 299.

[20]Don Price, The Scientific Estate (Cambridge, Mass.: Harvard University Press, 1965), p. 21.

[21]Daniel Greenberg, The Politics of Pure Science (New York: New American Library, 1967), pp. 209-68.

[22]Ibid., p. 209.

[23]Ibid., p. 240.

[24]Ibid., p. 242.

[25]Ibid., p. 267.

[26]Ibid., p. 268.

[27]Ibid., p. 267.

[28]Ibid., p. 191.

[29]Donald R. Fleming, "The Big Money and High Politics of Science," in The Politics of Science, ed. William R. Nelson (New York: Oxford University Press, 1968), p. 299.

[30]Greenberg, op. cit., p. 249.

[31]Philip H. Abelson, "The Research and Development Pork Barrel," _Science_, July 2, 1965, editorial page.

[32]_Ibid_.

[33]Representative Emilio Q. Daddario's subcommittee on Science, Research, and Development held hearings on NSF in June, July, and August of 1965. Geographic distribution was one of the topics covered in these hearings. President Johnson issued a memorandum on the subject on September 14, 1965. Senator Harris chaired a special subcommittee which investigated the geographic distribution of research and development funds by federal agencies. These hearings began in July 1965 and ended in July 1967.

[34]See U. S. Congress, House, Subcommittee of the Committee on Appropriations, 84th Congress, 1st Session, Independent Offices Appropriations for 1956 (Washington: Government Printing Office, 1955), pp. 294-307 for an example of the subcommittee's early interest in NSF's geographic distribution policies.

[35]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, Equitable Distribution of R & D Funds by Government Agencies (Washington, D. C.: Government Printing Office, 1967).

[36]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, Equitable Distribution of R & D Funds by Government Agencies (Washington: Government Printing Office, 1967).

[37]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, The National Science Foundation, Its Present and Future (Washington: Government Printing Office, 1966), p. 105.

[38]Lyndon B. Johnson, "Statement by the President to the Cabinet and Memorandum on Strengthening Academic Capability for Science," _Public Papers of the Presidents of the United States, Lyndon B. Johnson, 1965_ (Washington: Government Printing Office, 1966), p. 997.

[39]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, _op. cit._, p. 1.

[40]_Ibid_., p. 9.

[41]*Ibid.*, p. 1.

[42]*Ibid.*

[43]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, *op. cit.*, p. 306.

[44]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, *op. cit.*, p. 671.

[45]*Ibid.*, p. 673.

[46]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, *op. cit.*, p. 4.

[47]*Ibid.*, p. 161.

[48]*Ibid.*, p. 135.

[49]*Ibid.*, p. 4.

[50]*Ibid.*, p. 2.

[51]*Ibid.*, p. 9.

[52]*Ibid.*, p. 10.

[53]See U. S. Congress, House, Subcommittee of the Committee on Appropriations, 87th Congress, 1st Session, Independent Offices Appropriations for 1962 (Washington: Government Printing Office, 1961. See pp. 374-548 for a typical example of this pattern.

[54]Aaron Wildavsky, *The Politics of the Budgetary Process* (Boston: Little, Brown and Company, 1964).

[55]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 84th Congress, 1st Session, *op. cit.*, p. 294.

[56]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 86th Congress, 2nd Session, Independent Offices Appropriations for 1961 (Washington: Government Printing Office, 1960), p. 27.

[57]U. S. Congress, House, 87th Congress, 2nd Session, Independent Offices Appropriations for 1963 (Washington: Government Printing Office, 1962), p. 777.

[58]U. S. Congress, House, Independent Offices Appropriations for 1964 (Washington: Government Printing Office, 1963), p. 419.

[59]*Ibid.*, p. 429.

[60]*Ibid.*, p. 437.

[61]*Ibid.*, p. 459.

[62]*Ibid.*, p. 469.

[63]*Ibid.*, p. 526.

[64]*Ibid.*, p. 436.

[65]*Ibid.*

[66]*Ibid.*, p. 436.

[67]*Ibid.*, p. 436.

[68]*Ibid.*, p. 314.

[69]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 86th Congress, 2nd Session, Independent Offices Appropriations for 1961 (Washington: Government Printing Office, 1960), p. 158.

[70]U. S. Congress, House, Independent Offices Appropriations for 1963 (Washington: Government Printing Office, 1962), p. 832.

[71]*Ibid.*

[72]*Ibid.*

[73]*Ibid.*

[74]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 89th Congress, 1st Session, *op. cit.*, p. 766.

[75]*Ibid.*

[76]*Ibid.*, p. 767.

[77]*Ibid.*

[78]*Ibid.*

[79]*Ibid.*, p. 716.

[80] *Ibid*.

[81] *Ibid*., p. 717.

[82] *Ibid*.

[83] *Ibid*.

[84] *Ibid*.

[85] *Ibid*., p. 719.

[86] U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, *The National Science Foundation, Its Present and Future*, *op*. *cit*., p. XI.

[87] *Ibid*., p. XII.

[88] *Ibid*., p. XII.

[89] *Ibid*., p. XI-XVII.

[90] *Ibid*., p. IV.

[91] U. S. Congress, House, Committee on Science and Astronautics, 91st Congress, 1st Session, *The National Science Foundation, Its Present and Future*, *op*. *cit*., p. XI.

[92] *Ibid*.

[93] *Ibid*., p. 10.

[94] *Ibid*.

[95] *Ibid*.

[96] *Ibid*., p. XI.

[97] *Ibid*., pp. 280-84.

[98] U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 89th Congress, 1st Session, Review of the National Science Foundation (Washington: Government Printing Office, 1965), p. 55.

[99] *Ibid*., p. 55.

[100] *Ibid*.,

[101]*Ibid*., p. 56.

[102]*Ibid*.

[103]*Ibid*., p. 57.

[104]*Ibid*., p. 69.

[105]*Ibid*., p. 58.

[106]*Ibid*., p. 71.

[107]*Ibid*., p. 303.

[108]*Ibid*., p. 79.

[109]*Ibid*., p. 381.

[110]U. S. Congress, House, Committee on Science and Astronautics, 89th Congress, 1st Session, The National Science Foundation, Its Present and Future, *op. cit*.

[111]*Ibid*., p. 56.

[112]*Ibid*., p. 115.

[113]*Ibid*.

[114]Lyndon B. Johnson, *op. cit*, p. 997.

[115]*Ibid*.

[116]*Ibid*., p. 996.

[117]*Ibid*.

[118]*Ibid*., p. 997.

[119]*Ibid*., p. 998.

[120]*Ibid*.

[121]*Ibid*., p. 997.

[122]*Ibid*., p. 998.

[123]*Ibid*.

[124]*Ibid*.

[125]National Academy of Science, _Basic Research and National Goals_ (Washington: Government Printing Office, 1965), p. 10.

[126]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, _op. cit._, and U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op. cit._

[127]_Ibid_.

[128]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op_. _cit_.

[129]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, _op_. _cit_.

[130]U. S. Congress, Senate, Subcommittee of the Committee on Operations, 90th Congress, 1st Session, _op_. _cit_., p. 631.

[131]_Ibid_.

[132]_Ibid_.

[133]This table will appear in final copy as an Appendix.

[134]Ibid., p. 631.

[135]_Ibid_.

[136]_Ibid_., p. 640.

[137]_Ibid_., pp. 641-42.

[138]_Ibid_., p. 631.

[139]_Ibid_., p. 635.

[140]_Ibid_., p. 642.

[141]_Ibid_., p. 635.

[142]_Ibid_.

[143]National Science Foundation, _National Science Foundation Annual Report 1964_ (Washington: Government Printing Office, 1965), p. 3.

[144]National Science Foundation, _National Science Foundation Annual Report 1968_ (Washington: Government Printing Office, 1968), p. 191.

[145]National Science Foundation, _National Science Foundation Annual Report 1967_ (Washington: Government Printing Office, 1967), p. 150.

[146]_Ibid_.

[147]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op_. _cit_., pp. 660-61.

[148]_Ibid_., p. 660.

[149]_Ibid_., p. 661.

[150]U. S. _Public Law_ 89-128.

[151]Geographic distribution questions were raised concerning one National Research Program. Senator Thomas Kuchel of California questioned why the Brown and Root Corporation of Houston, Texas, was awarded the contract to build the program's deep drilling platform. This has been the only instance in this program where the question of geographic distribution has been raised. Daniel Greenberg, _op_. _cit_., pp. 171-208.

[152]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op_. _cit_., p. 659.

[153]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, _op_. _cit_., p. 37.

[154]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op. cit_., p. 660.

[155]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 89th Congress, 1st Session, _op_. _cit_., p. 55.

[156]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 90th Congress, 1st Session, _op_. _cit_., p. 635.

[157]_Ibid_.

[158]U. S. Congress, Senate, Subcommittee of the Committee on Government Operations, 89th Congress, 2nd Session, *op. cit.*, p. 45.

[159]U. S. Congress, House, Subcommittee of the Committee on Appropriations, 87th Congress, 2nd Session, *op. cit.*, p. 766.

[160]*Ibid.*, p. 659.

[161]U. S. Congress, House, Subcommittee of the Committee on Science and Astronautics, 91st Congress, 1st Session, The National Science Foundation, Its Present and Future, *op. cit.*, p. 105.

[162]Lyndon B. Johnson, *op. cit.*, p. 997.

[163]These tables are prepared from data obtained from the following documents: National Science Foundation, *National Science Foundation Grants and Awards Fiscal Year 1964* (Washington: Government Printing Office, 1965), *passim*, and National Science Foundation, *National Science Foundation Grants and Awards 1969* (Washington: Government Printing Office, 1970), *passim*.

[164]*Ibid.*

[165]*Ibid.*

[166]*Ibid.*

[167]*Ibid.*

[168]*Ibid.*

[169]*Ibid.*

[170]*Ibid.*

[171]*Ibid.*

[172]*Ibid.*

[173]*Ibid.*

[174]*Ibid.*

[175]*Ibid.*

[176]*Ibid.*

[177]*Ibid*.

[178]*Ibid*.

CHAPTER V

1. Introduction: The Service Dilemma of NSF

The previous chapter deals with whether NSF could perform in accordance with the scientists' demands when these demands conflict with what the politicians want. This chapter deals with whether NSF officials can give affirmative responses to the scientists' demands when they are in conflict with what is best for the overall good of science.

Before proceeding with the investigation it is necessary to point out an important difference with respect to NSF and its two central dilemmas. The argument is made in Chapter II that NSF resolves both dilemmas within its official ideology. More importantly, NSF has a formal organization and has established decision making patterns based on the premise that its two central dilemmas are resolved. Commonweal interests may be provided for in the official ideology, but this does not mean NSF officials are entirely free to pursue the official ideology. The politicians are not communicants of this ideology and can demand that NSF officials take action contrary to what the scientists want. Congress has the power to cut NSF appropriations and even change its formal organization. At the same time, NSF cannot ignore the demands of its clients-in-contact, the scientists. To do so would destroy the decision making apparatus upon which NSF relies. NSF's commonweal dilemma rests on two strong supports--one being the scientists and the other the politicians.

The situation is different with respect to the service dilemma. There is no organized outside group to put pressure on NSF officials to place the health of science over demands of the scientists. NSF officials seem to be free to follow the official ideology and are in fact encouraged to do so by the NSB, the NAS, the outside advisory panels, and by members of the different scientific disciplines.

In the case of both the commonweal dilemma and the service dilemma, the official ideology tells NSF officials what to do. If NSF complies with what the scientists want, the commonweal and the health of science will be served. In the case of the commonweal dilemma the President and the Congress can ask NSF to deviate from its official ideology to better serve the commonweal. In the case of the service dilemma, however, there are no extra-NSF groups to make NSF deviate from the official ideology. That is, there are no organized and recognized professional science policy makers to decide what is best for science.

2. NSF and Service to Science Demands

There has been at least one demand from a well known member of the scientific community that NSF base its decisions as to what the various scientific fields receive on something else besides what the scientists want. In Reflections on Big Science[1] and in testimony before the Daddario subcommittee,[2] Dr. Alvin Weinberg, the Director of Oak Ridge National Laboratory, prescribes an alternative to NSF's method of deciding how much different scientific fields should receive. Instead of relying on proposal pressure and what experts in the field think their own field should receive, Weinberg suggests that experts from neighboring fields and unrelated fields make these judgements.[3] To aid them in their judgement, he proposes two sets of criteria for judging different scientific fields.[4] The first set of criteria Weinberg labels "internal criteria." They pose the following questions: "Is the field ready for exploration?" and "Are the scientists in the field really competent?"[5] The second set is labeled "external criteria." These criteria are to be used to compare the different fields in terms of their "...technological merit, scientific merit, and social merit."[6] Technological merit is based on how much a particular field would help advance technology. Scientific merit means how much the outside judges believe advances in a field would help neighboring scientific disciplines. Social merit refers to the fields potential for contributing to the betterment of society. Weinberg uses examples to explain his two sets of criteria, but makes no attempts to operationalize them.

Although Weinberg's ideas have generated interest and discussion among observers of science policy, NSF has made no official acknowledgement that the Weinberg scheme even exists. With the exception of Weinberg all the other scientists which testified before the Daddario subcommittee supported NSF's decision making methods as outlined in Chapter III of this dissertation.

The researcher did find a political demand, however, which was presented in terms of service to science, was responded to by NSF officials, and required NSF to take a positive role in the allocation of funds to the various scientific areas. Because of these points and because the researcher found no other evidence more relevant to the NSF's service demand, this political demand is selected by the researcher for further investigation.

The political demand for NSF to assert itself more positively in the funding of science arose as a result of the 1965 Daddario subcommittee's investigation of NSF. The demand was that NSF serve as the balance wheel for the federal funding of basic research. The clearest explanation of what this role entailed is contained in the subcommittee's final report to the Committee on Science and Astronautics. This report was unanimously adopted by the full Committee on Science and Astronautics on February 1, 1966.[7] This same report was mentioned in previous sections of this chapter in connection with Congress' demand for wider geographic distribution of NSF funds.

According to the report, there were three requirements which NSF must fulfill in order to become a balance wheel--determine national needs in science, gather information about what other government agencies intended to do for science, and make sure that disparities between the different fields were compensated for.

> This responsibility is that of becoming the Federal balance wheel, for scientific research. That is to say the Foundation, having identified national needs for science and the intention of other agencies, <u>has a responsibility to compensate for any disparity in level of support or allocations among different fields of science</u>.[8] (Emphasis added)

3. <u>NSF's Response to the Balance Wheel Demand</u>

The Daddario Report instructed NSF to formulate what the nation's needs are with respect to science and gather information on what other agencies intended to do with regard to science. According to the NSF 1966 <u>Annual Report</u>, NSF was already gathering and would continue to gather information on what the nation's science needs were.[9] NSF had been financing representatives of the various scientific fields to supply information on the nation's scientific needs. NSF planned to continue the funding of similar studies for all of the various scientific fields.[10]

As to the requirement for information on what the other government agencies were doing for science, the 1966 report points out that NSF had been and would continue to gather information on this subject.[11] This information is published in a series under the title Federal Funds for Research, Development, and Other Scientific Activities. These reports have been published since 1952.[12] In addition to stating what each agency has spent in each of the scientific areas in the past, the report tells how much each agency is asking for in the next two budget years. If NSF did want to balance its spending in the various scientific areas against what other agencies were spending, the information had been and would be available to make it possible.

Neither the asking of outside committees or groups to gather information on science's needs nor the gathering of information on how much other government agencies are spending or are going to spend on science would violate the NSF official ideology. In the first case, NSF is again asking the scientists what they want and in the second case, it is only gathering information on other agencies' spending for science. As noted, NSF had been performing both these tasks before the Daddario subcommittee's demand for balance had been made and has continued to do so since the publication of the 1966 Daddario subcommittee report. It is the requirement of NSF "...to compensate for any disparity in level of support or allocations among different fields of science,"[13] which would require NSF to assume a more positive role in its service to science mission. In fulfilling this requirement, NSF would have to make decisions as to how much money it would provide different scientific fields in relation to what other agencies were providing. Such a role would require NSF to deviate from the formal ideology which states that NSF need only rely on the demands of the scientists in order to serve science.

NSF apparently accepted the role of balance wheel with the requirement that it assume this positive role in the federal science establishment. In the 1966 report, NSF announced that it saw itself performing as a balance wheel in the funding of basic research.

> In recognition of the importance of basic research, the Foundation last year secured an increase of about one-third (from approximately $120 million to $160 million) in funds available for the support of basic research projects, almost entirely at educational institutions. This increase, approved by the executive branch and the Congress during a period

> of stringen [sic] budgetary economy demonstrates the importance by all parts of Government to science in general and to the need for a growing basic research effort in particular. That it was the vehicle for this increase is tangible evidence of the Foundation's importance as a "balance wheel" in Federal support for science, particularly in periods when defense and other considerations may cause leveling-off in funds available to other agencies for support of basic research.[14]

The Daddario subcommittee expected NSF to act as a balance wheel and outlined three requirements which NSF must fulfill in order to be a balance wheel. NSF responded to the first two requirements by continuing activities it was already doing. NSF had already been gathering information from outside panels of scientists as to what the United States needed in science. As to what other agencies intend to spend for science, NSF had collected data on this subject since 1952. However, NSF would have to assert itself with a new force if the third requirement to "...compensate for any disparity in level of support or allocations among different fields of science," was to be accomplished.[15] In announcing that NSF did see itself as a basic research balance wheel, NSF presumably announced that it intended to fulfill this role.

4. NSF's Performance Reactions to the Balance Wheel Role: Introduction

NSF did respond to the demand that it fulfill the role of a balance wheel. It recognized the demand as legitimate and stated that it intended to perform in accordance with the precepts laid down by the Congress.

As was the case with the demand for geographic distribution, the researcher is interested in seeing if there is evidence that NSF performed in accordance with the demand. Specifically, the researcher is interested in seeing if NSF took a positive role in balancing its funding with respect to what the other government agencies were spending for basic research.

It is the purpose of the following sections to investigate this topic. The investigation is confined to fiscal years 1964 through 1969 and to the Research Projects Program. 1964 is selected because this year ended before the 1966 demand for balance was made and 1969 is selected because this is the last year for which information is available. The investigation is confined to the Research Project Program since this is the activity with which NSF saw itself performing the balance wheel function.

The methodology followed in this dissertation has been to go from the general to the particular and to keep the focus of the research within manageable bounds.

This methodology is followed with respect to NSF's balance wheel role.

According to the 1969 NSF Federal Funds for Research, there are seven major basic research areas which NSF and other government agencies fund. These are the physical, life, social, psychological, environmental, mathematical, and engineering sciences.[16] The researcher examines three of the above general areas and one of these general areas in detail for evidence as to whether or not NSF did positively assert itself as a balance wheel. The three general areas examined are the physical sciences, the life sciences, and the social sciences. After these three areas are investigated for their performance as balance wheels, the area of the physical sciences is examined by discipline. The physical sciences is broken down into its three disciplines and each discipline is then examined as to its performance as a balance wheel. The physical sciences and the life sciences are the Research Project Program's largest activities. In 1969, they accounted for 31 percent and 22 percent, respectively, of this program's funds.[17] The social sciences accounted for 9 percent of the program's funds in that year and is NSF's smallest Research Project Program activity.[18] The NSF 1969 combined percentage of these three areas account for 62 percent of the Research Project Program's funds.

The test performed on the general areas and the separate disciplines of the physical sciences is a simple one. NSF's funding in these various instances is compared with the total funding by all other governmental agencies. The researcher is looking to see whether or not NSF funding went up when the combined total of all other federal agencies went down and vice versa. That is, did NSF act as a balance wheel and attempt to level out disparities created by other government agencies in the funding of basic research?

5. NSF and the General Area of the Physical Sciences

As was mentioned earlier, money spent for the physical sciences accounted for 38 percent of the total amount spent under the Research Project Program. It is and has been the largest major area in terms of funds spent under the Research Project Program. The same statement is true with respect to total federal funding of basic research. The physical sciences account for the largest share in fiscal year 1969 and this has been the case prior to 1969 as well. In this dissertation the area of the physical sciences includes those disciplines classified as the physical sciences in NSF's Federal Funds for Research, Development, and Other Scientific Activities: Fiscal Years 1968, 1969, and 1970. These are astronomy, chemistry, and physics.[19]

Figure 5 compares the total funds allocated to these three disciplines by all federal agencies excluding NSF with what NSF spent on these fields in fiscal years 1964 through 1969. On the basis of the data presented in Figure 5, it is difficult to argue that NSF played the role of balance wheel for the general area of the physical sciences. In four instances when total spending dropped off for the physical sciences, NSF spending also dropped off. The only time NSF acted as a balance wheel was between 1968 and 1969. In this instance NSF funding for physics went down as total federal funding went up. With regard to the physical sciences, then, there is little evidence to indicate that NSF asserted itself as a balance wheel.

6. NSF and the Life Sciences

The next largest area funded by the Research Project Program in 1969 by NSF is the life sciences. They accounted for 22 percent of the total funds spent under the program in 1969.

Neither the NSF 1969 Annual Report nor the latest Federal Funds for Research, Development, and other Scientific Activities breaks down the life sciences into separate scientific fields. The latter document differentiates between biological sciences and clinical medical sciences under the general area of life sciences, but

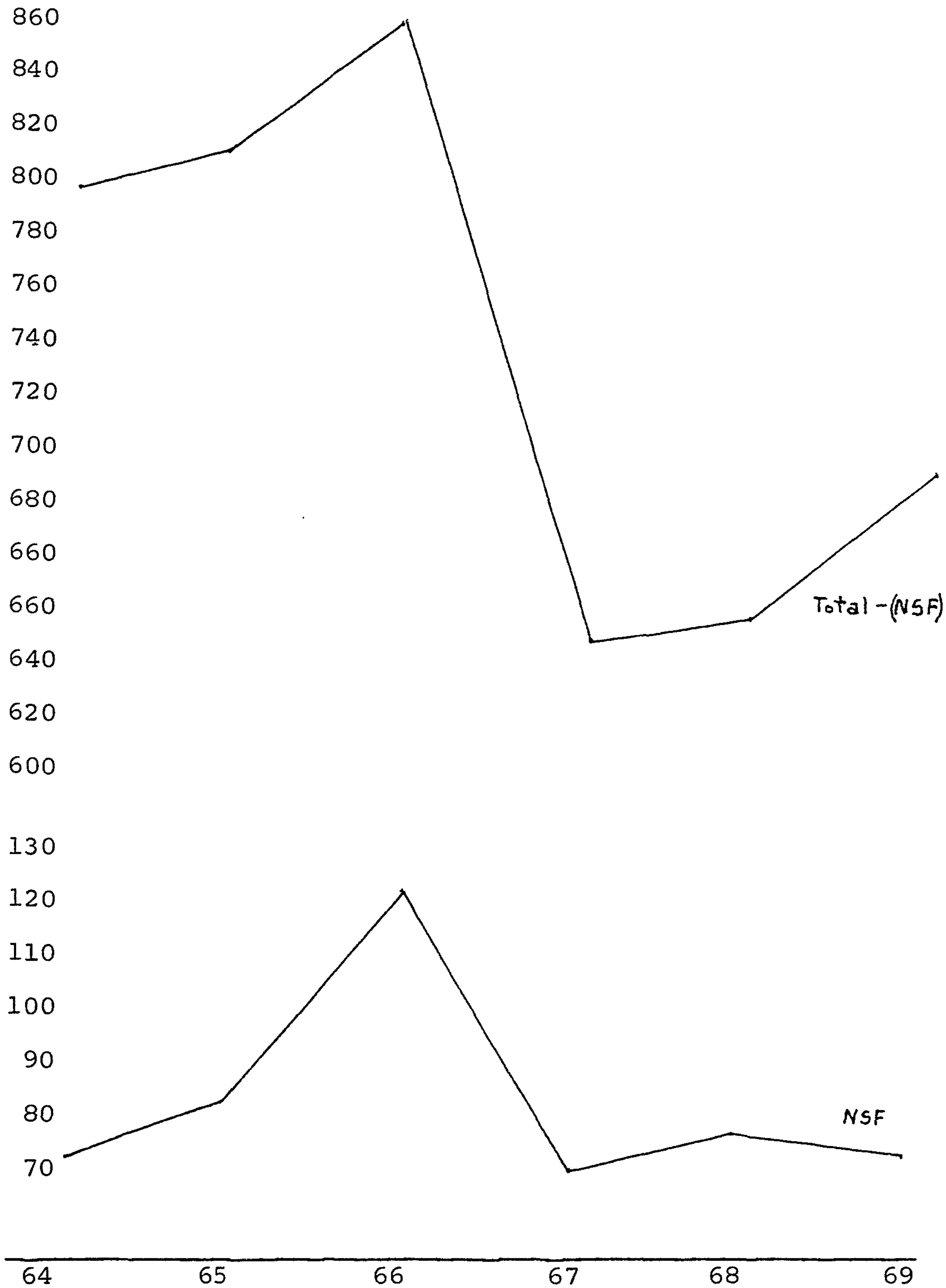

Figure 5. Funds for the physical sciences from all government agencies excluding NSF compared with funds allocated by NSF to the physical sciences.[20] (Figures in millions of dollars.)

NSF has only one category under the life sciences--biological sciences.[21] For this reason, the life sciences for NSF and for all the other government agencies excluding NSF include only those funds spent for the biological sciences for the figures used in this dissertation. Figure 6 graphs NSF's record and the rest of the federal agencies' record with respect to the biological sciences. Although NSF does not parallel the growth of the biological sciences, it is difficult to argue that NSF acted as a balance wheel here either. In the fiscal years 1965 through 1969 the biological sciences increased their total funds from all government agencies excluding NSF in every year compared with the previous year. NSF increased its funds to the biological sciences in three out of five of these years. These increases were not great, but the fact that they were made casts doubt that NSF was much of a balance wheel for the biological sciences.

7. <u>NSF and the Social Sciences</u>

Over the years NSF has increased its spending in the social sciences at a rapid rate. In 1958, NSF spent .4 million dollars[23] and in 1969 spent 15.2 million for this activity.[24] It is still, however, the smallest major area in the Basic Research Program. In 1969, the

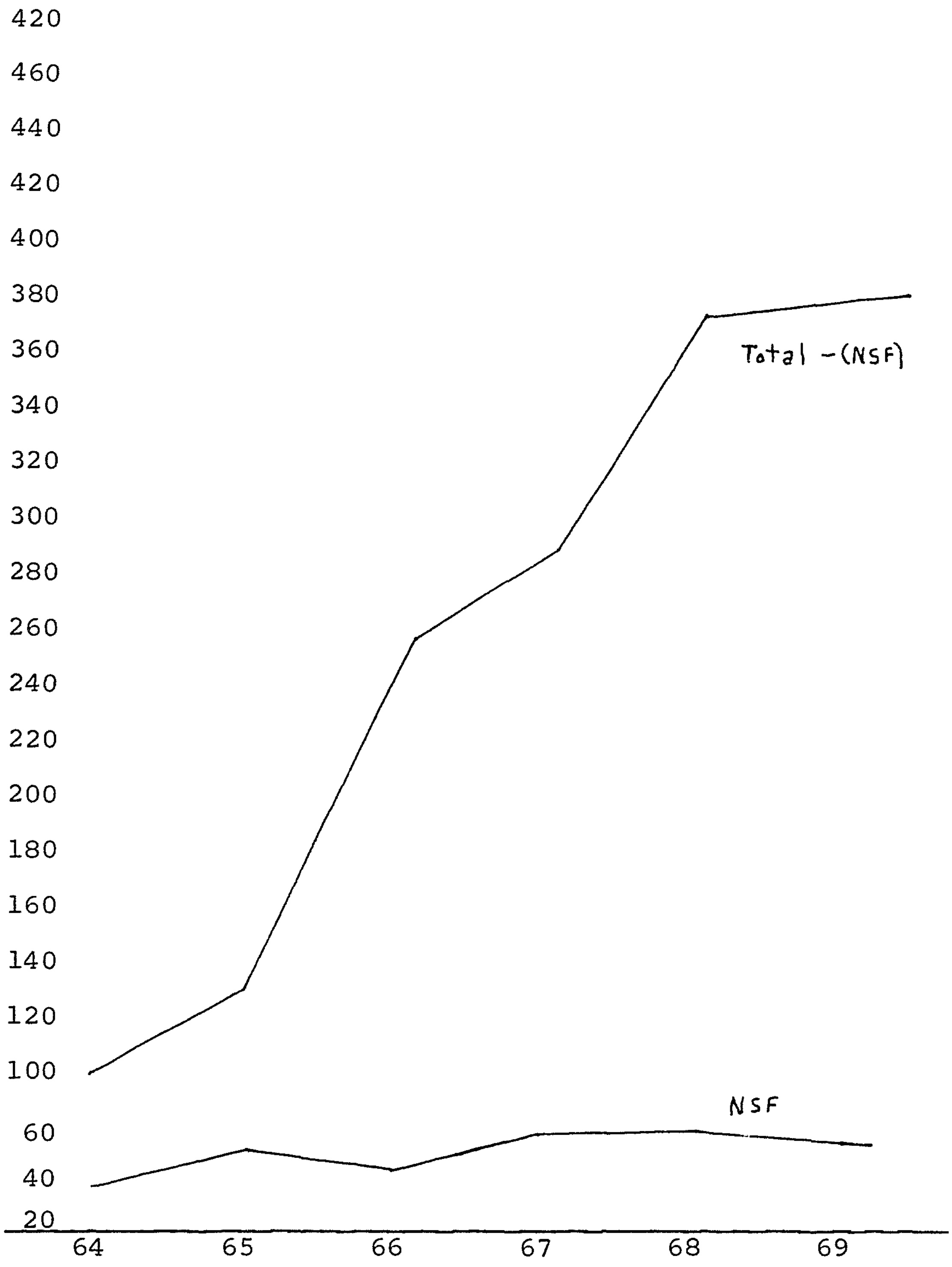

Figure 6. Funds for the life or biological sciences from all government agencies excluding NSF compared with funds allocated by NSF to the biological sciences.[22] (Figures in millions of dollars.)

social sciences accounted for 9 percent of the program's appropriations.[25]

The data graphed in Figure 7 indicate a pattern similar to the one for the biological sciences. That is, the funds granted to the social sciences by NSF do not parallel the growth of the total funds granted by the other government agencies. However, the graph does not indicate that NSF played the role of balance wheel. In only two instances did NSF funds for the social sciences fall when total funds rose. In the other three instances covered by the graph, NSF funds for basic research in the social sciences rose, although not rising as rapidly as the total funds from all other federal sources. With respect to funds for basic research in the social sciences there is no evidence that NSF played a balance wheel role for the area as a whole.

8. <u>NSF and the Physical Sciences: Physics</u>

The physical sciences have always been the Research Project Program's most expensive activity. As was pointed out earlier, this general area accounted for 31 percent of the funds of the Research Project Program. Because this area is such a large one in terms of NSF funding, the following sections investigate the balance wheel performance of each of the physical sciences: physics, chemistry, and astronomy.

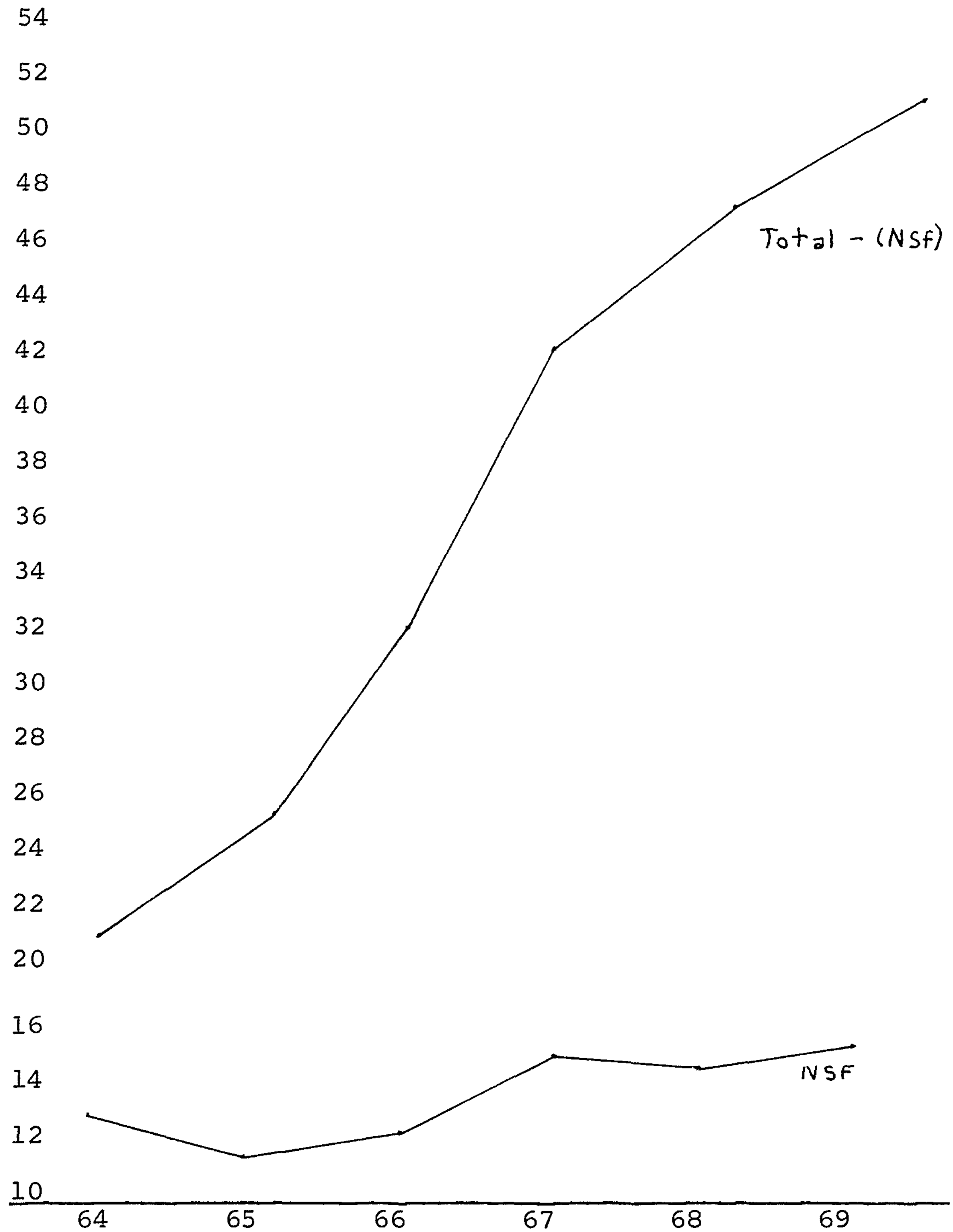

Figure 7. Funds for the social sciences from all government agencies excluding NSF compared with funds allocated by NSF to the social sciences.[26] (Figures in millions of dollars.)

Physics receives the largest amount of NSF funds of any field in the basic Research Project Program. This statement is also true with respect to the total funds from all other government agencies. In 1968, physics received 26 million dollars from NSF[27] and 362 million dollars from all other government agencies.[28] In terms of percentages, physics received 15 percent of the 1968 NSF funds spent under the Research Project Program[29] and 19 percent of the total funds excluding NSF of all federal funds available for basic research.[30]

The graph in Figure 8 does not indicate that NSF played any balance wheel function to this large federal activity. Total federal funds for physics increased every year from 1964 through 1969.[31] Likewise funds made available under the Research Project Program for basic research in physics increased in every year from 1964 through 1969.[33] As with the physical sciences as a whole, the increases made by NSF for physics were less sharp than those made by the government as a whole, but this hardly constitutes evidence that NSF played a balance wheel role with respect to physics funding during this time period.

9. NSF and the Physical Sciences: Chemistry

In 1968 chemistry received 19 percent of NSF's Research Project Program's funds[34] and in that same year chemistry received 5 percent of the total federal funds

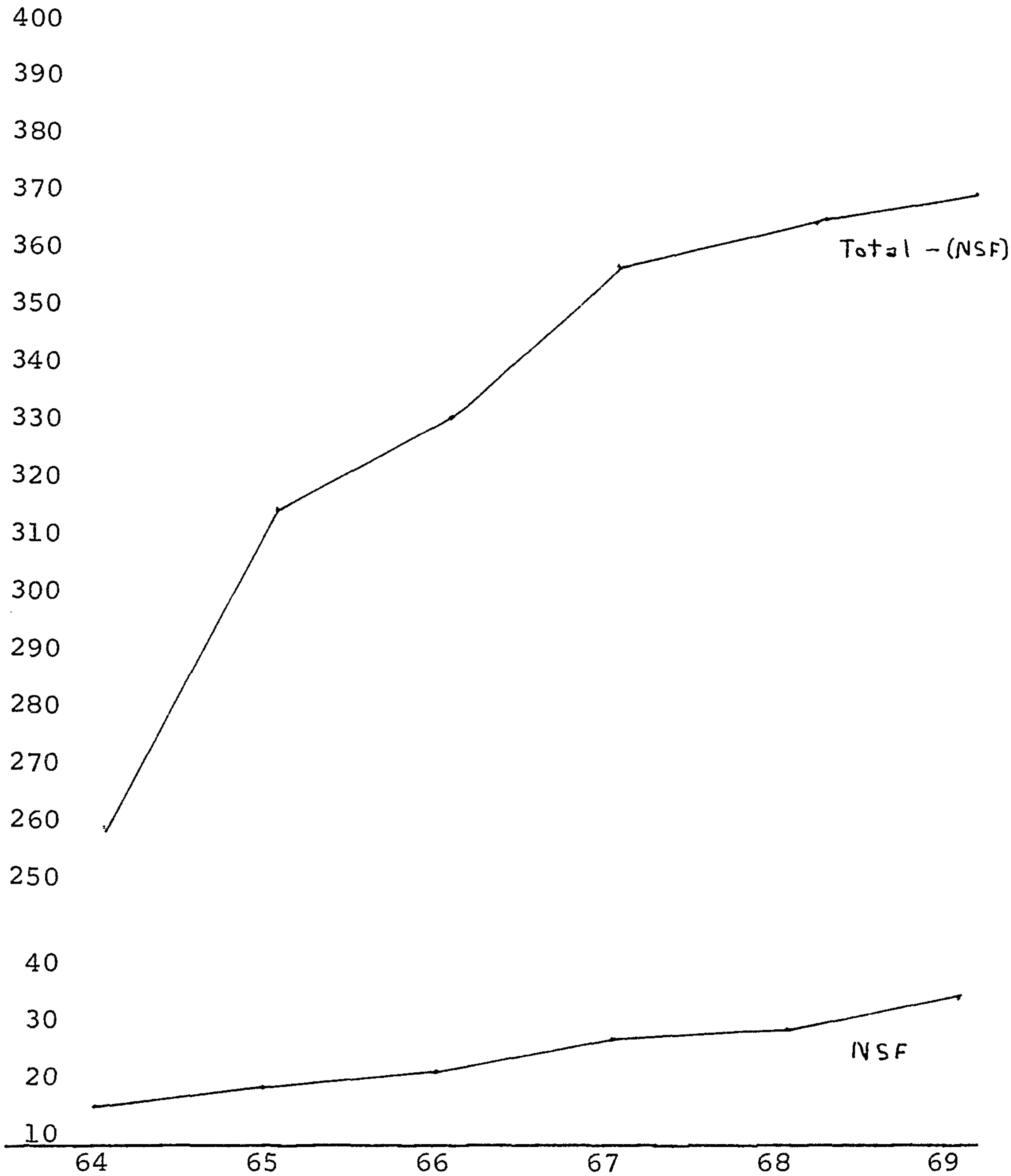

Figure 8. Funds for the field of physics from all government agencies excluding NSF compared with funds allocated by NSF to the field of physics.[32] (Figures in millions of dollars.)

from all other government agencies.[35]

As with physics, NSF funds for chemistry did not parallel the spending for chemistry by the other federal agencies. In only two instances did NSF parallel the change which the agencies other than NSF effected. Between 1965 and 1966, and 1966 and 1967, total federal funding of chemistry excluding NSF increased. NSF also increased its funding of chemistry for these years. In the other three instances, NSF did not parallel what the other agencies did. Between 1964 and 1965 and between 1968 and 1969, the other agencies increased their funds for chemistry. During these time periods, NSF allocations to chemistry remained constant. In only one instance, however, did NSF act as a balance wheel. Between 1967 and 1968, total federal spending for chemistry went down. NSF increased its funds for chemistry in 1968 as compared with 1969. In this instance only did NSF act as a balance wheel.

As with all the other major areas and as with physics, there is little evidence that NSF acted as a balance wheel for federal funding of basic research in chemistry.

10. NSF and the Physical Sciences: Astronomy

Although one might not think that agencies other than NSF would spend money on such an esoteric field as

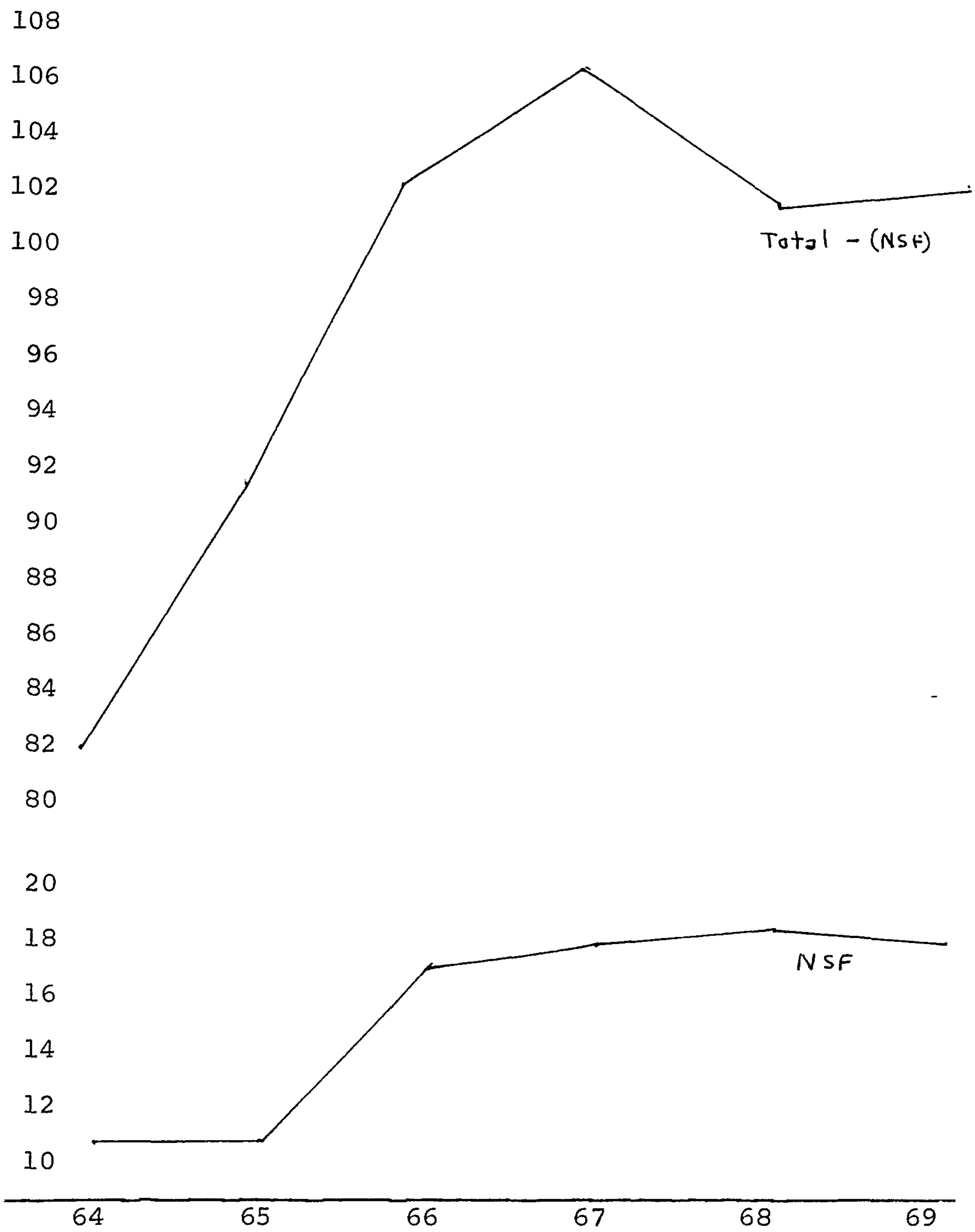

Figure 9. Funds for the field of chemistry from all government agencies excluding NSF compared with funds allocated by NSF to the field of chemistry.[36] (Figures in millions of dollars.)

astronomy, there are several which spend considerable amounts on this activity. In 1968, total spending for astronomy excluding NSF accounted for 199 million dollars.[37] NSF spent 6 million dollars for this activity.[38]

The data in Figure 10, however, do not reveal that NSF has acted as a balance wheel with respect to astronomy. In two instances NSF increased its funding for astronomy when the other agencies increased their funds for this activity. In another instance, NSF funds remained constant when the other agencies increased their funds from one year to the next. In the other two instances of the five between fiscal years 1964 and 1965, NSF did function as a balance wheel. Between 1965 and 1966, the other agencies decreased their spending for astronomy, but NSF increased its spending. Between 1966 and 1967 the other agencies increased their funding for astronomy and NSF decreased its spending. In these last two instances it can be said that NSF did act as a balance wheel for the field of astronomy. However, in three of the five funding instances between 1964 and 1969, NSF did not fulfill this function.

11. <u>NSF and Its Balance Wheel Function</u>

The request for NSF to be the balance wheel of the federal science establishment was a political demand. For this reason NSF had to respond to the demand. It responded by acknowledging the demand's existence in the

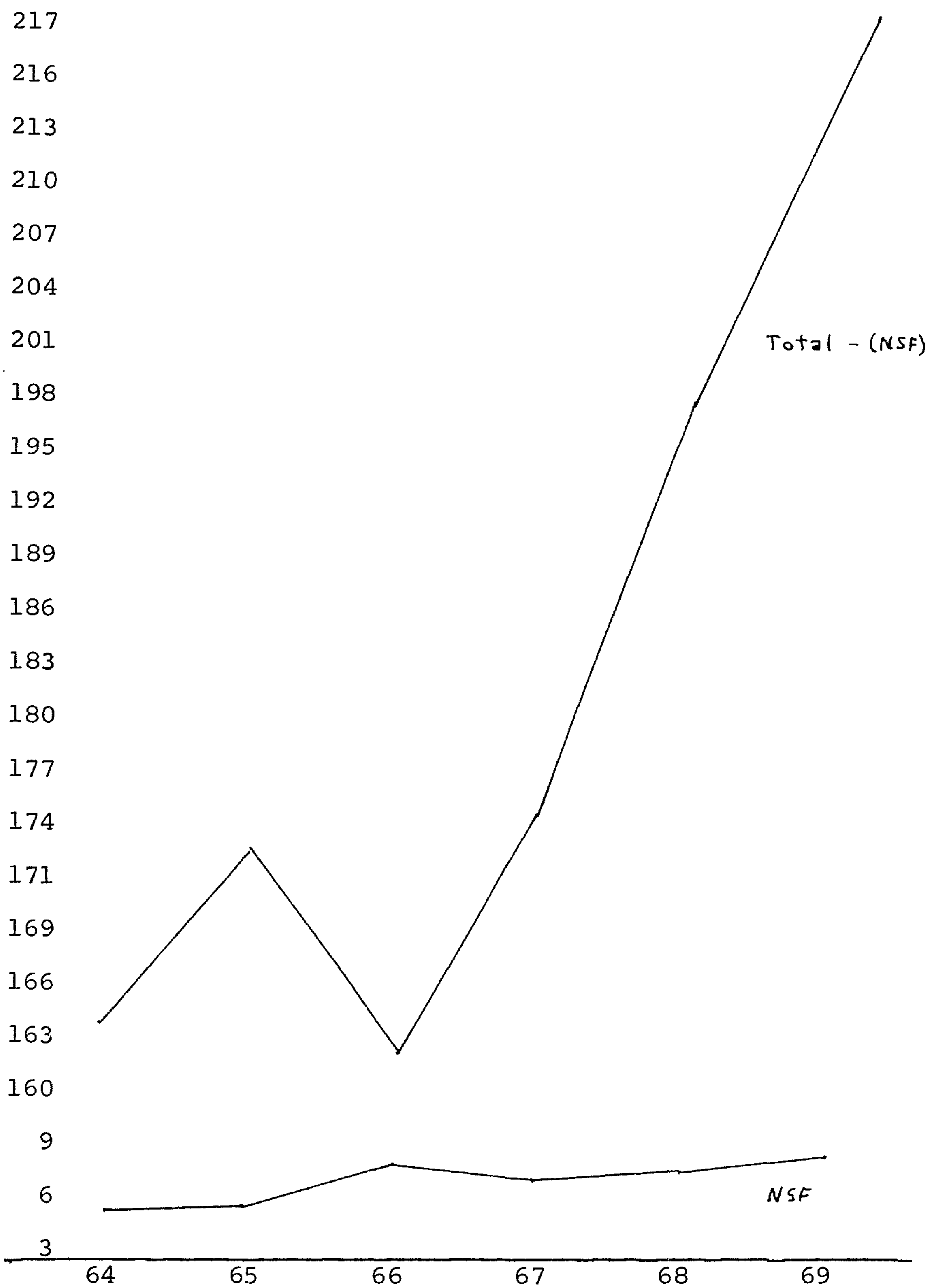

Figure 10. Funds for the field of astronomy from all government agencies excluding NSF compared with funds allocated by NSF to the field of astronomy.[39] (Figures in millions of dollars.)

1966 Annual Report. In addition, NSF emphasized in this same report that it was complying with two requirements of the balance wheel concept. NSF had been and would continue to ascertain the needs of the United States with regard to science. Also, the 1966 Annual Report pointed out that NSF collects information on what other agencies spend for science. It is the third requirement which is of interest from a service to science standpoint. This requirement asked that NSF take into account what other government agencies were spending for science when NSF made up its budget. NSF was to balance the spending patterns of the other agencies. Such action would require that NSF rely on not just what the scientists wanted, but upon what other federal agencies were doing for science. If NSF did provide a balance wheel function, such performance would be an indication that NSF was moving away from its official ideology with respect to service to science. It was for this reason that any indications that NSF was acting as a balance wheel would be of interest to the researcher.

Although NSF did respond to the demand that it act as a balance wheel, the researcher found little evidence that NSF had actually performed as one. In the three major areas examined and the one major area examined by disciplines, NSF did not act as a balance wheel for the federal science establishment.

Footnotes

[1]Alvin Weinberg, Reflections on Big Science (Cambridge, Mass.: The MIT Press, 1967).

[2]U. S. Congress, House, 89th Congress, 1st Session, Review of the National Science Foundation (Washington: Government Printing Office, 1965), pp. 261-79.

[3]Alvin Weinberg, *op. cit.*, p. 69.

[4]*Ibid.*, pp. 72-77.

[5]*Ibid.*, p. 71.

[6]*Ibid.*

[7]U. S. Congress, Committee on Science and Astronautics, 89th Congress, 1st Session, The National Science Foundation, Its Present and Future, (Washington: Government Printing Office), p. iii.

[8]*Ibid.*, p. 80.

[9]National Science Foundation, National Science Foundation Annual Report, 1966 (Washington: Government Printing Office, 1967), pp. xvi-xviii.

[10]*Ibid.*, p. xviii.

[11]*Ibid.*, pp. 127-28.

[12]National Science Foundation, Federal Funds for Research, Development, and other Scientific Activities (Washington: Government Printing Office, 1967), p. iii.

[13]U. S. Congress, Committee on Science and Astronautics, 89th Congress, 1st Session, The National Science Foundation, Its Present and Future, *op. cit.*, p. 80.

[14]National Science Foundation, National Science Foundation Annual Report, 1966, *op. cit.*, p. xxii.

[15]U. S. Congress, Committee on Science and Astronautics, 89th Congress, 1st Session, The National Science Foundation, Its Present and Future, *op. cit.*

[16]National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities (Washington: Government Printing Office, 1969), p. 168.

[17]National Science Foundation, National Science Foundation Annual Report, 1969 (Washington: Government Printing Office, 1969), p. 127.

[18]*Ibid.*

[19]National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, *op. cit.*, p. 170.

[20]The data to construct this figure are from the following documents: National Science Foundation, Federal Funds for Research, Development and Other Scientific Activities, Volumes XIV thru XVIII, *op. cit.*, *passim* and National Science Foundation, NSF Annual Report Years 1964 thru 1969, *op. cit.*, *passim*.

[21]National Science Foundation, National Science Foundation Annual Report, 1969, *op. cit.*

[22]See footnote 20.

[23]National Science Foundation, National Science Foundation Annual Report, 1958 (Washington: Government Printing Office, 1959).

[24]National Science Foundation, National Science Foundation Annual Report, 1969, *op. cit.*

[25] *Ibid.*

[26]See footnote 20.

[27]National Science Foundation, National Science Foundation Annual Report, 1968 (Washington: Government Printing Office, 1968), p. 253.

[28]National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, *op. cit.*

[29]National Science Foundation, National Science Foundation Annual Report, 1968, *op. cit.*

[30]National Science Foundation, Federal Funds for Research, Development, and Other Scientific Activities, *op. cit.*

[31]See footnote 20.

[32]*Ibid*.

[33]*Ibid*.

[34]National Science Foundation, *National Science Foundation Annual Report, 1968*, *op*. *cit*.

[35]National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, *op*. *cit*.

[36]See footnote 20.

[37]National Science Foundation, *Federal Funds for Research, Development, and Other Scientific Activities*, *op*. *cit*.

[38]*Ibid*.

[39]See footnote 20.

CHAPTER VI

The purpose of this dissertation is to explain the behavior of NSF in terms of the Blau and Scott model of organizational behavior. In Chapter I of the dissertation, the major propositions of this model are listed as follows:

(1) The central dilemma of an organization is pervasive; that is, evidence of the central dilemma can be found in the demands which surround the creation of the organization under investigation, in its official ideology and formal structure, and in the way the organization transforms demands into policies.

(2) The central dilemmas of a formal organization are a function of the prime beneficiary of the organization.

(3) The central dilemma does not change unless its prime beneficiary is changed.

(4) Organizations make policies dilectically. This means that all policies must take into account both sides of the central dilemma and attempt to resolve this dilemma.

The first two propositions listed are considered in Chapters II and III. The fourth proposition is considered in Chapters IV and V. The third proposition while not considered in any one particular chapter, is supported by evidence cited throughout the study. That is, during the time period of the study no evidence is found to suggest that NSF's primary beneficiaries or central dilemmas have changed.

In Chapter II evidence is presented that the founders of NSF designated it as an agency with two prime beneficiaries--the clients-at-large or the common-weal, and the clients-in-contact or the scientists. Because NSF has these two prime beneficiaries, it was hypothesized that NSF would have the respective central dilemma of a commonweal organization and a service organization. In order to support this hypothesis and to investigate whether the theorized central dilemmas are pervasive throughout NSF, evidence of the dilemmas' existence was assembled in Chapters II and III under the following set of categories: the goals of the creators, the process surrounding the founding, the organizational characteristics, the official ideology, the formal organization, and the way NSF normally performs.

The evidence gathered under the above set of categories supports the proposition that NSF possesses the two central dilemmas predicted and that these dilemmas are pervasive throughout the organization.

Two additional conclusions are supported by the evidence assembled in Chapters II and III: (1) that NSF has resolved its two central dilemmas in its official ideology and has designed a formal structure and decision making mechanism based on this ideology, and (2) NSF normally performs in a manner best described as responding affirmatively to the demands made by the clients-in-contact, the scientists.

The last proposition of the Blau and Scott model states that formal organizations make their policies or transform demands into policies dialectically. This means that the owners or the managers must take into account both sides of their organization's central dilemma as they make policies.

In the case of NSF, the full time officials normally would not be expected to consider both sides of the organization's two central dilemmas unless strong demands were made for it to do so. The reason for this expectation is that the two dilemmas are resolved in the official ideology. As long as the politicians and those interested in the good of science go along with the official ideology of NSF, the full time officials of NSF would not be faced with either central dilemma.

The evidence in Chapter III supports the assertion that NSF normally performs as if its two central dilemmas are resolved. The dilemmas are present, but NSF officials can usually make their decisions without being faced with conflicting choices.

It was for these reasons that Chapters IV and V of the dissertation are concerned with situations whereby NSF is faced with conflicting choices. The central question being: How does NSF perform when the demands of the politicians or those who speak for the good of science conflict with what the scientists want? The findings in Chapters IV and V indicate that NSF does acknowledge the demands of the politicians, but that its performance is relatively unchanged by these demands. NSF makes symbolic gestures or initiates low cost programs, but continues to serve the interests of the scientists rather than the interests of the politicians or those who speak for the good of science. There is a dialectical process operating. NSF takes into account the demands of those who offer alternatives to what the scientists want, but does so symbolically or at a low cost. Performance remains attuned to what the scientists want. That is, NSF's symbolic or low cost responses reflect the dialectical operation of the dilemma but NSF's actual performance does not.

The primary emphasis of this dissertation has been upon NSF. Discussions of the Congress, the President, other executive agencies, and the scientific community have been limited to those occasions when these groups interact with NSF. However, because NSF is found to be so responsive to the scientific community, some additional overall comments on this relationship seem warranted.

In Murray Edleman's The Symbolic Uses of Politics, he writes that:

> Backing up all of these organizational supports of accepted roles are the agency's constituencies. We may take it as the key feature of any constituency that it can cripple or kill an agency.[1]

If there is any major theme underlined by the evidence cited in this dissertation it is the overwhelming loyalty of the scientists to NSF. As far as the public record goes, NSF is seldom criticized by the scientists. With the exception of Alvin Weinberg's suggestions that basic research might be funded on another basis besides what workers in the various disciplines want to do, criticism of NSF's official ideology, formal structure, and decision making process is not undertaken by the scientists. The politicians' hostile comments about NSF to members of the scientific community are seldom if ever publically reinforced by the scientists. This unanimity on the part of NSF's clients-in-contact supports NSF in its effort to remain true to its official ideology.

The lack of dissenters in the scientific community noted in this dissertation is consistent with the work done by other scholars. In The Scientific Community, Warren Hagstrom sums up his work in the following manner:

> The thesis presented here is that the solidarity of this community and the conformity of its members is secured through intensive socialization and a complementary system of social control.[2]

The evidence for Hagstrom's thesis is based on interviews "...of seventy-nine professional scientists."[3]

In Public Knowledge, John Ziman emphasizes the norm of consensus practiced by members of the scientific community.

> The whole subject of the conduct of scientific disputes is discussed at length in a perceptive chapter by Hagstrom, who shows the strength of the social procedures used to isolate, neutralize or settle them. All I would add to this admirable account is the general point of this book [Ziman's book]--that the creation and preservation of a free consensus is the overriding aim of Science, and not a by-product of some other social or intellectual goal.[4]

Hagstrom and Ziman suggest an explanation for the ability of the scientists to present a united front to both the politicians and the NSF officials. Although Hagstrom and Ziman were writing about scientists and their work, the consensus principle could reasonably be expected to carry over into the scientists' relations with other institutions. The evidence in this research strongly suggests that the norm of consensus does carry

over to the scientists' relations with NSF and the poli-
ticians concerned with NSF.

Footnotes

[1]Murry Edleman, The Symbolic Uses of Politics, (Urbana, Ill.: University of Illinois Press, 1964,) p. 54.

[2]Warren D. Hagstrom, The Scientific Community (New York: Basic Books, 1965), p. 292.

[3]*Ibid*., p. 3.

[4]John Ziman, Public Knowledge (London, England: Cambridge University Press, 1968), p. 135.

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