Program Officers at the National Science Foundation:

A Case Study of the Biological Instrumentation Program

by

David M. Bott, Jr.

Thesis Submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Science and Technology Studies

APPROVED:

Ellsworth R. Fuhrman,
Chairperson

Gary L. Downey

Joseph C. Pitt

Robert A. Patterson,
Director of Graduate Studies

December, 1988

Blacksburg, Virginia

Program Officers at the National Science Foundation:
A Case Study of the Biological Instrumentation Program

by

David Matthias Bott, Jr.
Ellsworth R. Fuhrman, Chairman
Science and Technology Studies

(ABSTRACT)

This is a case study analyzing the program officers of the Biological Instrumentation Program at the National Science Foundation. It was conducted in order to fill a lacuna in the literature concerning the program officers of science funding agencies. The current literature places the program officer in a black box, implying an autonomous professional. In contrast this study portrays the Program Officer as embedded in a web of relationships extending within and without the Foundation. Constructivist and relativist approaches to science studies argue for the significance of the influence of these 'non-scientific' relationships on all contemporary scientific activity. The study describes the web of resource relationships surrounding the program officer and how the program officer wields power that may affect the content and submission of proposals for scientific research grants.

ACKNOWLEDGEMENTS

Thanks to all who helped me, kicked me, threatened me, supported me, and believed in me. Thanks to Skip, whose unfailing insistence that I already had written my thesis ten times over and "would you please put it in the proper format" was the academic support I needed. Thanks to Joe whose knowledge of my habits was part of my "growing banes." Thanks to Gary who got me into this program by telling me to stay in biology, and who got me out through cajoling, threats, and anything else he found proper. I would also like to thank the secretaries without whom this program could not exist. They turned administrative roadblocks into minor speedbumps.

I would like to remember the cast of characters at BIP who put up with my constant nosiness, pointless questions, and fumbling around as I learned how to be an observer. Especial thanks go to John and Sonja. Your friendship and interest in my project kept my enthusiasm from flagging, even after typing panel summaries for eight hours.

I must say to Andrea whose friendship made the last two years in education the most interesting: You're really Ace. Without her legwork and wonderful dinners this thesis would be a lost file forgotten by all. I must also mention Zac,

whose unfailing ability to discuss or argue with me at will, honed my ability to argue from any point of view with a smile.

Finally, I must somehow come up with words that can express my appreciation of the support and understanding of my family, especially my parents, whose love was my sustenance when all else was dry. I cannot forget their willingness to help, even when they had no idea what STS meant. I cannot remember how many times they supplied no interest loans to this supposedly independent student and then conveniently forgot them. And last but not least Rich, my brother, who would be at the other end of the phone at 3:00 a.m., listening to the ranting of an older brother when he should have been sleeping.

Table of Contents

I. Introduction

This thesis is an examination of the Biological Instrumentation Program (BIP) of the National Science Foundation (NSF) aimed at providing a better understanding of contemporary scientific funding agencies and, therefore, to understand contemporary scientific activity better. Federal funding agencies and contemporary scientific activity are interconnected. Many research articles in scientific journals acknowledge funding from Federal agencies. The National Science Foundation provided over $1.7 billion for scientific research.[1] Research upon the impact of funding on knowledge growth has been conducted (Cozzens: 1986). An understanding of funding agencies is necessary for determining its impact upon contemporary scientific activity.

The approach adopted for this study is informed by recent research under the rubric of 'laboratory studies' and uses it to gain an entry point for the study of funding agencies as a component of scientific activity. The literature of complex organization theory is also drawn upon because NSF, interconnected as it might be to science, is certainly a bounded organization with unique

---

[1] This is the total 1988 budget appropriations, excluding funds for scientific education, for NSF according to the FY 1989 Budget Summary.

characteristics. Finally, previous research of funding agencies, especially NSF, provides helpful insights and descriptions which orient and support this investigation.

The results of the investigation provide evidence that the program officer has potential power to influence the content, submission, and funding of proposals. However, the potential power must be realized through the management and negotiation of resources derived from relationships based upon the practices of the review process and upon the structure of NSF as a complex organization. These relationships exist within and without the agency.

II. Literature Review

There is a lacuna in research concerning science funding agencies, particularly of government agencies such as the National Science Foundation (NSF). In an issue of the Social Studies of Science devoted to the theme of funding and the growth of knowledge, Cozzens justifies the importance of policy-relevant research in science studies, "it focuses our attention in a powerful way on an important institutional context of contemporary science which is relatively neglected in our work" (1986: p.9-10). Though the theme in the Social Studies of Science volume is not on funding agencies but the connection between funding and knowledge growth, Cozzens mentions that the topic is only one in a range of themes that needs to be explored. She states that an important tool used to understand funding in light of the fact that coherent areas of scientific inquiry cross-cut the basic units of the funding system will be concepts "which picture scientists and funding officials as linked through networks of interaction" (1986: 14).

This thesis is designed to contribute to an understanding of the institutional context by providing a description of the Biological Instrumentation Program (BIP) at NSF and the links between the program officer and other actors involved in science funding.

A. Existing Research on the National Science Foundation

Descriptions of science funding agencies have often been of secondary importance to science studies researchers. Most research concerning funding has been designed either to deal with science funding in general, such as the Social Studies of Science issue mentioned above, or to answer policy questions, such as the concern for equitable distribution of government resources. Descriptive research on the National Science Foundation can be found in both the informal history by Lomask (1976) and the two part NAS study conducted by Cole, Rubin, and Cole (1979, 1981). Lomask is primarily interested in the creation of NSF up to the early 1970's. His book provides a "chronicle of some of the highlights of the first 25 years of a ... Federal organization" (1976: p.278). It is more of a resource than an analytical work and does not need to be examined here. On the other hand, the NAS study was more analytical. The focus was upon an evaluation of the peer review process at NSF with an emphasis on decision making by program directors. While it is designed to provide answers to a policy issue concerning equitable distribution of resources, the NAS study still provides the most complete description of an NSF program to date.

The NAS approach is policy oriented, focusing on an evaluation of peer review decision making. Cole et al. claim that "Review of the literature on peer review suggests that very little is known about how it works in governmental agencies [and that the NAS research] was directed toward increasing our knowledge in this area." They continue on the same page claiming that their "primary purpose is to determine as exactly as we can how peer review works in day-to-day operation of the Foundation" (1978: p.17). Their alleged concern for the day-to-day operation of the foundation is only partially conveyed in the rest of their reports which are mostly concerned with evaluations of the funding decision of the program director.

The major questions addressed by Cole et al. were clearly outlined:

> 1. What is the role of the program director in determining who gets NSF funds?
>
> 2. Do eminent reviewers give favorable treatment to the proposals of eminent colleagues?
>
> 3. To what extent do eminent scientists receive higher ratings on their proposals than non-eminent scientists?
>
> 4. To what extent do eminent scientists have a better chance of receiving NSF grants than do non-eminent scientists?
>
> (1978: pp.17-18)

These questions do not substantively nor descriptively focus upon the day-to-day operations of the program director. Their description of the program director's activities focuses only on decision making. For example, the titles of the chapters in Phase I (1978) include: Section 1/ Program Director Activity prior to decision making, Section 2/ Relation between reviewer and applicant characteristics as an influence on ratings, Section 3/ Influence of characteristics of applicants on reviewer ratings, Section 4/ Interpretations of reviews by program directors, Section 5/ Influence on decision, and Section 6/ Post-decision-making activities of the program director. The second phase of their research (Cole and Cole: 1981), in lieu of enhancing the description, consists of an evaluation of the selection of reviewers by the program officer. Their inquiry deals with the efficiency and accountability of the federal agency's decision makers. The study was directed towards meeting policy aims rather than describing the day-to-day activities of the program officer or peer review process.

The NAS study conducted by Cole et al. provides a description of NSF centered around the funding decisions made, and whether these decisions were optimal for science. Cole et al.'s description of program directors depicts them

as autonomous professionals with reliance only upon the proposal for input into the decision making process. From this viewpoint the program officer only reacts to completed proposals and plays no part in their creation or submission. This narrow view is strengthened by the focus upon the program director as purely a decision maker. The focus restricts the usefulness of this approach for understanding NSF programs and their personnel as part of the institutional context of science. Such an impoverished concept of the program officer as an isolated autonomous decision maker must be enhanced.

It may be possible to better understand the activities of program officers if the program officer is also thought of as a bureaucrat and a liaison between science and government. We will examine the context, the relationships, and the practices of a program officer to find if they involve more than just decision making.

B. Other Funding Agency Research

In opposition to the narrow focus of the NAS study, Gustafson (1975), in a general examination of peer review funding processes focussing on NIH and NSF, hints at the complexity of the funding process by pointing out that even in its purest form peer review combines the intrinsic

criteria of scientists with the extrinsic criteria of governmental agencies (1975: 1060). He also notes that in at least one case the advisory panel at NSF was very influential in the funding decisions (1975: 1065). Gustafson also hypothesizes that there are various relationships between actors in the peer review funding process. Questions about other actors besides the program officer and the scientist were not regarded important in Cole et al. Gustafson leads one to believe that there may be more to intra-agency relationships than the NAS study recognized.

Morrison's (1975) analysis of private funding organizations, such as the Rockefeller and Ford Foundations, describes some complexities in the funding process. He found that sensitivity to the foundation's context, demands other than those that brought the foundation into existence, and the reciprocal relation between the funding organization and the researchers they support were all important concepts in understanding the funding organizations' activities. He claims that private foundations, though not directly accountable to the public like federal agencies, were sensitive to the social context in which they were situated. Legitimacy as funding agencies was a prime concern for these foundations (1975: pp.378, 387).

Morrison also calls attention to problems of a bureaucratic nature that may be important for research funding organizations and their personnel. He posited that the reduction of administrative headaches is an explanation for large grants to research organizations such as universities (rather than grants to individuals): "The money has been given from one bureaucracy to another with all the empathy of confidence that this implies" (1975: p.395). The third point made by Morrison is that "the relationship [between the foundations and the researchers they support] is a reciprocal one ... for just as the organization of empirical research required the financial support of the foundations so the foundations needed such organized research to help dispense their funds" (1975: p.395). These three points will be considered in describing the activities of an NSF program officer.

C. Constructivist and Relativist Contributions

Recent work in the sociology, philosophy, and history of science provides an important resource for developing a comprehensive description of the program officer at NSF. One important issue raised by this work is a questioning of the **a priori** distinction between cognitive and social elements. One approach termed loosely the relativist or

constructivist approach, with Bloor (1976) as perhaps the most extreme position, argues that the distinction is inappropriate. Whether these researchers have succeeded or not in providing grounds for the removal of this distinction is debatable. However, they have expanded the arena in which questions concerning the content of science and epistemology can be raised. The approach has produced some very interesting research which indirectly helps frame this research. Constructivists and relativists argue for the significance of the context or environment of scientists for understanding contemporary scientific activity.

The problems with the distinction and the importance of the context is based on historical work such as Kuhn (1970), Forman (1971), and Shapin (1979). Their research has resulted in "something markedly divergent from the general drift of the numerous commentaries by philosophers and historians" (Barnes: 1982). The empirical research on contemporary science inspired by such work deals with an expanded arena for knowledge questions compared to work by most philosophers and historians. Barnes (1982: ix-x) also notes that this does not imply that the new research is superior, only that it is divergent. The empirical literature based upon the expansion of the arena falls within my interests and will consequently be the focus of

this discussion.

Some researchers on contemporary scientific activity have attempted to remove the **a priori** distinction between scientific and non-scientific elements in the domain of laboratories, scientific controversies, and scientific theories. Whether one accepts that their research has supported their arguments concerning the distinction, powerful and meaningful portraits of scientists and scientific activity have resulted. Therefore, the distinction will not be adopted **a priori** in this research.

A thrust in the sociology of science towards qualitative research such as ethnographies has been noted in the past fifteen years (Woolgar: 1982). Qualitative methods have been adopted to reduce assumptions concerning the actors and environments being studied. In essence, there is a call to Cartesian skepticism in which nothing is taken for granted. Latour and Woolgar's (1986) argument for 'apprehending as strange' those aspects of the object of study which are readily taken for granted is an example. While such an ideal cannot actually be attained, the spirit of the argument that observers should not uncritically accept the terms and explanations used in the past or used by those observed is valid. Approaches pretending to know nothing of the object of study must be avoided as well

(Downey: 1988).

In this vein, Rip claims that "we are in need of ethnographies about funding agencies (1986: 98). He argues that funding agencies entail a much different audience for a grant application than a scientific audience for a published paper. "Funding agencies and their review panels and assessors judge a funding application in terms of agency goals and criteria. The text builds a bridge between a branch of scientific inquiry on the one hand, and the concerns of the agency on the other...a bridge of 'interests' between science and politics, worlds that are generally held to be separate" (1986: 85,91). One should know both banks of a chasm before a bridge is built between them. Bridge building and interweaved relationships are absent from existing accounts of NSF, though they would seem to be important even for a narrow focus upon decision making. These links, according to Rip should be described and explored from a vantage point inside the agency.

Cozzens, though she could not be called a relativist or constructivist, recognizes claims that funding agencies comprise an element of the relevant institutional context of science. Knorr-Cetina (1982) and Latour (1987) argue that the relevant context of scientific activity extends beyond the site of knowledge construction to include trans-

scientific arenas and non-scientific actors, such as funding agents. Laboratory studies by Knorr-Cetina (1980a) and Latour and Woolgar (1986) exhibit the emphasis on context and a rejection of the **a priori** distinction between scientific and non-scientific elements of the laboratory.

Knorr-Cetina (1980a) claims that decisions made in the laboratory are context dependent and contingent upon the immediate environment. She conceives of the actor as making decisions based upon contingent factors in the laboratory. In a later paper she declares that "investigations which are now available all confirm the local, situationally contingent nature of research production... [and that] laboratory selections situated in a locally circumscribed space appear to be simultaneously situated in a field of social relations" (1982: p.102). Knorr-Cetina suggests the concept of transepistemic arenas, in which scientific and non-scientific factors are intertwined in laboratory decision making as a framework for analyzing the laboratory as a component of scientific activity. She demonstrates the superiority of transepistemic arenas as an explanatory framework over the concept of scientific communities, which presupposes the significance of scientific relationships in the laboratory. In essence Knorr-Cetina has shifted from a scientific community, narrowly defined by criteria such as

those possessing a PhD, to a 'community' broadly defined as those actors which play a role in scientific activity. These actors can be funding agents.

Latour and Woolgar state that "the extent to which the distinction between "social" and "intellectual" is accepted as unproblematic by observers of science may have significant consequences for the reports about science which they produce." and that they "regard the use of such concepts as a phenomenon to be explained. More significantly, [they] view it as important that [their] explanation of scientific activity should not depend in any significant way on the uncritical use of the very concepts and terminology which feature as part of that activity" (1986: pp. 23, 27). They reject the adoption of distinctions used by actors as explanations in favor of using the distinctions as a framework for analysis.

Latour and Woolgar acknowledge a valid criticism of their research, a narrow focus upon the laboratory as an isolated unit, in their postscript: "although it was originally both necessary and desirable, the laboratory should not be studied as an isolated unit; it is only one part of a wider story" (1986: p.281). The picture that develops from Latour and Woolgar's claims is that the scientific laboratory must first be empirically examined

with a focus upon what activities occur and what distinctions are used by the actors. Then, one must connect these site specific studies to 'the wider story.'

Downey (1988) through an examination of the controversy over emergency core cooling of nuclear reactors declares that the distinction between cognitive and social phenomena is "a significant distinction framing action in Western culture" (p. 231, emphasis added). Downey, like Latour and Woolgar above, does not adopt the distinction **a priori**, but considers it a resource used by actors.

Results of other research on scientific controversies such as Callon (1980 a,b) show that other elements of the cultural context can play a role similar to that of scientific facts. Callon (1980a) describes the controversy surrounding research and development of electric vehicles in France. He shows that concern over the consumer market, the development of fuel cells, and the interaction between government and industry were important elements surrounding the controversy. When discussing which actor (scientific, government, or industrial) is **a priori** most important Callon argues that "analysis must look at all those involved from the same viewpoint, noting their interests and their conceptions, the problems they formulate, the distinctive restrictions which impede their activities, the strategies

they develop" (1980a: p. 358). None of the factors/elements are analytically prior nor more significant until the empirical work shows the importance of the distinction.

A review of the science studies literature with regard to relativist and constructivist related empirical research reveals a warning concerning the adoption of distinctions used by the subjects of research. One can neither accept them as explanations of the observed, nor can one ignore them. A need to study components of contemporary scientific activity like funding agencies is also revealed. Because the debates in science studies are often over cognitive accounts of science, there is a difficulty in finding empirical research and analyses of such important components of science as the laboratory (until the late 1970's) and the funding agency (still a wide-open field). The research concerning the funding agencies has been policy oriented and does not provide adequate descriptions of funding activity. In order to understand a funding agency, one must turn to analyses of organizations where empirical as well as theoretical issues can be brought to bear on this study.

D. Contributions from the Study of Complex Organizations

Complex organization theories offer some valuable insights for understanding the National Science Foundation.

As an independent government funding agency the Foundation must have characteristics similar to the entities studied under complex organization theories. Perrow's (1986) critical essay discusses the current state of the field of bureaucratic and organizational theory. He provides a framework based on power from which to discuss various works on complex organizations relevant to an analysis of the Biological Instrumentation Program.

Perrow's theme of organizations as tools of power is compatible with the theories of scientific activity previously discussed, especially Latour and Callon's work. Power for Perrow is the ability to extract valued outputs from a system in which other persons or groups either seek the same outputs for themselves or would prefer to expend their effort toward other outputs (1986: 259). This is the central theme of Callon's (1980a) analysis of the development of the electric vehicle in France. Latour deals with this in his broad concept of "action at a distance" which includes power (1987: 219-232).

There is also agreement concerning an awareness of social factors involved in the construction of theories. Perrow is concerned with what theories are and how they are produced. For example he claims that:

> "we are increasingly nervous in and reflexive about our theorizing, trying to grasp our own social construction of organizations. The

> fourfold tables now concern theorists, rather than organizational types. There is always a threat of either self-indulgence or retreat from our subject matter in this, but I think we are becoming more aware that theorizing is not a "neutral" activity, but one guided by strong interests and values that need to be explicated." (1986: 146).

Here Perrow reveals a sensitivity to assumptions that smooth the combined use of theories of organizations and scientific activity. He addresses ethnomethodological theories throughout the book; and his sympathy to studies of organizational contexts further reveals this compatibility. This section will use Perrow's framework of power in organizations to incorporate insights by various organizational researchers into a framework for understanding the BIP.

Perrow argues that organizations have "become a means, both in capitalist and noncapitalist countries, of centralizing power in society and legitimating or disguising that centralization" (1986: 5). If we are to follow Perrow's definition in the case of NSF, the power would be equated with the ability to allocate research funds, to set the premises of decision making for funding (at least within the bounds of NSF's goal of fostering basic research), and to disguise the exercise of these abilities. The important questions for Perrow involve who gains and wields power. Cole et al.'s conclusion that the program officer wields a

great deal of power supports the adoption of Perrow's framework for understanding the program officer. The question remains as to how the power is wielded and whether it is wielded solely by the program officer, especially in light of the fact that the NAS study claims that the choice of reviewers did not seem to satisfactorily answer where the program officers' power was derived (Cole et al.: 1981).

Power is tied to legitimacy at the level of the individual in Kanter's study of the Industrial Supply Corporation (1977: 164-97). She argues that power is closely allied with legitimacy. Obtaining power and legitimacy depend upon visibility, relevance to the context, and extraordinary activities. A description of the program officer from a power perspective would involve these three factors and would necessarily include more than just decision making as a part of the program officers' important activities.

Perrow expresses a concern about the levels of analysis (1986: 262-5). This is also important to science studies researchers. Aldrich (1978) claims that the level of analysis makes a big difference in the results of research. In his paper on human service delivery systems the three different levels of social services systems, clients, organizations and the inter-organizational field, show

marked differences in their vulnerability to outside interventions. Science funding has been examined at the inter-organizational level in science studies research considering the impact of funding on knowledge growth for example (Cozzens: 1986). The NAS study examined the organizational or agency level by conflating their observations of a variety of programs into an overall picture of peer review at NSF. The individual program or program officer has yet to be researched in the same manner, as evidenced by Rip's (1986) call for ethnographies of funding agencies.

Another interesting and relevant issue is that of the centralization or decentralization of power in organizations. The NAS study described NSF as a decentralized organization, in that the authority to make decisions is in the hands of the program officer. Robert E. Cole (1979) in his case study on a Japanese automaker warns that decentralized authority does not necessarily imply decentralized power.[2] Although Japanese workers are given authority to make decisions concerning their immediate job, Cole claims that the company still determines the job structure and the issues upon which decisions can be made

---

[2] It should be noted that Cole uses the case study to provide and test hypotheses rather than as a simple exploratory tool for preliminary analysis.

(1979: 499-504). Perrow (basing his argument on March and Simon (1958)) coincides with this view by arguing that unobtrusive control or the ability to set the premises of a decision may disguise who wields the power in an organization. This also coincides with the Callon (1980a) analysis of the struggle to define what is problematic in fuel cells. It must be discovered whether the program officer primarily or independently sets the premises of the funding decision or whether this ability is beyond his control.

Perrow's concern with how control is gained is addressed by Pfeffer (1978). Pfeffer furthers the discussion of power in an organization by distinguishing between controlling an organization to produce more and controlling the organization as an end in itself. This distinction comes about when the analytical problem is not about how to reorganize to be most efficient at producing an output, but who dictates the reorganization or if there will even be a reorganization. The NAS study of NSF was concerned primarily with the organization's effects on the output. Thus, a description of who has power to dictate the uses and nature of that output or who becomes an obligatory passage point (Latour: 1987, 120) is needed to enhance the NAS description of NSF.

Finally, Hall et al. (1977) discuss the nature of the interaction between organizations. They are interested in the basis of interaction, stating that the traditional view considers exchange theory as the basis of interaction. They agree that exchange theory works for voluntary interaction, but argue that their findings indicate that exchange theory does not explain mandated or legal interaction as well. A formal agreement between two organizations resolves issues of "competence of personnel, performance, and compatibility of operating philosophy ... although power is still operative." When legal agreement is in force "the power issue is apparently resolved to the extent that it does not become part of the pattern", that is to say the power differences are no longer an issue (1977: 492). This contrast between voluntary, formal, and legal bases of interaction could help explain the different relationships of the program officer with regard to reviewers, authors of proposals, and the research organization that receives the awarded grant money. Power is operative until the legal agreement is reached according to Hall et al. Afterward it is still an analytical concept, however its usefulness in explaining interaction is limited to the existing power differences.

Hall et al. also observed that formal and/or contractual (legal) interaction often has its origin in voluntary interaction. The status of the BIP as a relatively new program, its consistent growth, and the fact that it became part of a new division during the observation period makes it a good candidate for observing changes from voluntary to formal interactions.

A description of the program officer on the basis of the literature review would consist of a delineation of the relationships between the program officer and relevant actors that involve the ability to influence the allocation of research funds, to set the premises of funding decisions, and/or influence the submission and content of proposals for scientific research (and possibly the research itself). Consideration would be given to relationships within NSF that may not be directly connected to the funding decision, but that have a bearing upon the context within which those decisions are made. Thus, attention should be given to regulations or practices related to agency needs such as administrative and budget limitations, legitimacy, and political manipulation. Finally, the reviewer and the PI relationship with the program officer would be regarded.

The relationships would be characterized once they are outlined. These relationships should be bi-directional.

The character of resources exchanged within these relationships should be noted. The relationship between the proposal review process and the links between the program officer and other actors should be considered. The result would be a picture of a program officer within a complex organization managing resources in response to agency needs and external relationships, all of which motivate the funding decisions. The extent to which the program officer can modify both the relationships and the context in which the relationships exist becomes an indicator of the amount of power he or she possesses with regard to the funding decisions.

III. Methods

Research methods used to study NSF have included the informal history (Lomax: 1976), quantitative analysis of peer review funding (Cole et al.: 1978, 1981, Small: 1974, Hensler: 1976, Groeneveld et al.: 1975), and interagency comparison (Gustafson: 1975). The most comprehensive analysis of NSF in the research literature today is Cole et al. (1978) where a description of the funding process was based on in-depth interviews of seventy scientists and/or program officers involved in the NSF peer review system. The most important descriptive question asked, however, was "What is the role of the program director in determining who gets NSF funds?" (1978: 17). Other questions were aimed at determining the fairness of funding decisions. The focus on equitable funding distribution is a policy issue and results in an inadequate description of the funding agent.

An expanded analysis picturing NSF as an organization is needed. Even if one accepts the Cole et al. study as sufficiently comprehensive, it is ten years old and many of the recommendations made by the National Academy of Science as a result of the research, have been implemented. There has been increasing attention and funding for interdisciplinary research (Budget Summary: 1989, NSF Annual Report: 1976). At the very least, these changes warrant

additions to the observations of Cole et al. An analysis of the program officer as a member of an complex organization also adds to an understanding an important component of science. An analysis of the emphasis on interdisciplinary research and an extension of the description of program officers to include intraorganizational relationships requires a contemporary, internal analysis. The case study is the best method for research with a contemporary focus, limited control over conditions, and a primary concern for description of 'real-life' conditions (Yin: 1984).

A. The Case Study

According to Yin (1984) the case study approach is one of the most valuable and misused methodologies in the social sciences. He offers a systematic outline of methodological rules designed to strengthen the validity and promote the critical use of case studies. This study adopts his framework for the analysis of the program officer.

The case study approach is most useful for studies of contemporary subjects in which the primary questions involve how and why, essential questions for a description of program officers (Yin, 1984: 15-20). Experimental and historical strategies are also effective methods for these types of questions (1984: 16). Experimental methods are not

appropriate for this research, however, because the researcher lacked the necessary control over events. A contemporary description of NSF cannot be based upon historical methods.[3] The changes instituted at NSF since the congressional controversy over peer review funding in the 1970's need to be incorporated in new studies of NSF.

The BIP will be the focus of a single case study by virtue of the investigator's limited access to NSF. The focus on BIP does not allow a comparison of different programs in various divisions or directorates, which may be useful. However, the BIP, as an interdisciplinary program created after the NAS study was conducted, is unique and an analysis of this program can offer insights into the peer review funding system not gained in a general examination of NSF. Single case studies may be justified because of possible revelations gained owing to the uniqueness of and/or special access to the subject under scrutiny (Yin: 1984, 43-47). The BIP is distinctive and, by virtue of being an NSF program, difficult to access. Therefore, it is an excellent choice as the subject of a single case study.

The focus of this research is a description of the program officer and the program. This description will

---

[3] Contemporary historical methods excepted, but these are subsumed to an extent under the case study method.

include inter- and intra-organizational interaction at the individual level. The intra-organizational level will require that the boundary be either NSF or the program depending upon the activity. The inter-organizational level will focus upon individuals, but will extend beyond NSF boundaries. The number of levels involved requires the use of an embedded case study with various units of analysis (Yin: 1984 42-47).

The BIP as the primary unit of analysis is considered only as an analytical not a natural boundary. An artificial focus is both necessary and desirable when investigating a previously unresearched topic (Latour and Woolgar: 1986, postscript). Once the program has been understood within the artificial boundary it will be possible to extend the analysis beyond the limits of the program.

The program officer is one sub-unit. The initial sub-units to be investigated were the relationships of the program officer with 1) organizational superiors, 2)peers such as program officers in the same program and other programs, 3) reviewers, and 4) the scientists applying for grants (termed PI's). An attempt to determine the relative importance of these relationships to the program officer and to funding decisions will follow.

An objection may be raised concerning the adoption of terms used by others studying scientific research for the analysis of the program officer and the BIP. The objection can be overcome for two reasons. First, the program officers at NSF are almost always competent and important research scientists. The methods employed for following their daily actions should not be so different that the terms are useless. The program officers usually serve for only one to three years. They are active scientists, familiar with the latest research in their fields. In this sense, they are the same individuals found in the laboratory. Second, the program at NSF, like the laboratory, is an important component of contemporary scientific activity. Although the output of a program is mostly funding decisions and that of a laboratory is papers and theories, both are outputs produced by scientists. The laboratory produces data and articles which are resources used to determine the importance of future research. The program officer may also participate in determining the relative importance of particular types of research by the wording of program announcements or by regarding certain research proposals as not relevant for review by the program. This research should provide interesting results for comparison with laboratory studies.

B. The Research Site

The BIP was originally conceived to fund the purchase of instrumentation that had been the responsibility of individual research programs. These programs dropped the priority of instrumentation proposals because of budget limitations and the interdisciplinary nature of the requests that made it difficult to determine under which program's jurisdiction the proposal fell. BIP filled the role by funding and coordinating funding of interdisciplinary and instrumentation requests.

According to the Budget Summary 1989 the BIP was one of the largest programs at NSF spending over $15 million in Fiscal year 1987. An increase of a half million dollars is expected for 1988, and the request for 1989 is increased by another $1.5 million. According to the latest NSF annual report the "program has emerged as one of the Foundation's leading activities" (NSF Annual Report: 1986, 55). As a leading activity with a focus upon interdisciplinary research the BIP is unique and relevant to an up-dated understanding of the program officer at NSF.

The BIP deals with proposal requests for a single instrument worth between $35,000 and $400,000. In contrast to usual research program proposals that focus on the

experiments as the object of funding the BIP proposals allow less space for discussion of the experiments being performed by the PI, usually three to four pages of an average fifty page proposal. Another difference between BIP and research programs is that partial funding for an instrument, unlike for a particular research strategy, is very difficult. The only mitigating factors are cost-sharing with the institution and other funding sources or funding for a less expensive instrument. Still, the total funding from all sources at the time of the award must equal the purchase price of the instrument or the funding is wasted.

The interdisciplinary nature of proposals to the BIP also distinguishes the program from the usual research program. The competition is often between what the program officers term 'apples and oranges.' That is the proposals competing in a particular Panel may deal with wildly varying topics in diverse fields. Reviewers in a usual research program, such as genetics, have a lot less variety to deal with when comparing proposals for ranking. This difference between the usual research programs and the BIP must be taken into account if the analysis is to be extended beyond BIP. I believe that the BIP's uniqueness in terms of content, and yet its similarity in process to programs funding projects can shed light on the question of how to

approach an agency that funds such a broad spectrum of research as denoted by the expression 'basic science.'

Another facet to BIP personnel was their involvement with the Facilities Centers initiative and the Biological Facilities program. The Biological Facilities Program is distinguished from BIP because it provides funds for more than one instrument, but less funds than the Facilities Centers initiative. It is a mid-range program. The Biological Facilities Program was in the planning stage and no observations concerning the review cycle were made. The Facilities Centers initiative was conceived as a short term competition for large research facilities that would be sites for increasing interdisciplinary research thus fulfilling NSF's goal of fostering basic science. Although limited in duration (about two years of competition with 3-5 cycles of submission, review, and funding) the initiative was conducted in the same manner as a regular program. The initiative for the BBS directorate was run by BIP personnel however the funding decision was the responsibility of the NSF Assistant Director heading the BBS directorate. The Facilities Centers program was interdisciplinary, and like the BIP required the BIP program officers to deal with officers from other programs. The similarities between the BIP and the Facilities Centers initiative allow a comparison

to be made that will provide a means to better understand the review cycle itself and the program officer's role in it.

C. Analytical Distinctions and Categories of Data Collected

The aim of this research is a description of the program officer at NSF. This analysis will focus upon the relationships and practices of the program officer as the units of analysis (Lofland and Lofland: 1984). The "background" against which these units will be contrasted is the organization (BIP/NSF). In this analysis certain encounters, such as the Advisory Panel meeting, will be described to understand better the relationships and practices of the program officer.

The term 'program officer' includes both program directors and program associates who are primarily considered 'extra hands' of the program director. Cole et al. (1978) do not make this distinction; however, a perusal of the latest phone directory available to the observer reveals that there is a significant proportion of program officers listed as associate program directors (23 associates out of 53 officers including vacancies). Though there is no formal difference between the program director and the associate program director in terms of ability to

sign the award recommendation (Proposal and Award Manual: I-10), there could be a difference in the relative responsibilities and relationships when an associate program director exists in the program. Hence the distinction should be considered in the analysis.

The decision making boundary for the program officer is the program, especially for funding. Although in this study we recognize the extreme permeability of boundaries in terms of the influence of resource relationships (Knorr-Cetina: 1982, Latour and Woolgar: 1986) it is still useful and desireable to bracket this phenomenon during analysis (Garfinkel: 1967, Latour and Woolgar: 1986). The program boundary is significant to the NSF staff and is adopted to provide a framework for analysis (Downey: 1988, Lofland and Lofland: 1984).

The major focus of the description is upon the program officers and the relationships and practices that comprise their activity. Three types of relationships can be postulated before the analysis. (1) The program officer may have intra-organizational relationships with superiors, peers, or subordinates. (2) Inter-organizational relationships may occur with reviewers, principle investigators, other funding agents. (3) In the particular case of program officers in instrumentation there may also

be relationships with industrial representatives. Each of these relationships could involve conflict, coordination, or a mixture of both. The conflict approach would be basic to a power orientation, whether power is a means or an ends (see page 21).

The direct/indirect contrast is important for analyzing relationships. Although the number of direct contacts between an individual and a program officer may be few, indirect influence may play an important role in that program officer's activity. Indirect influence is difficult at best to measure (Blau: 1977), but rough judgments across a spectrum from "there was no impact" to "there was a strong influence" can be made.

Another level of the direct/indirect contrast can be made based upon encounters between individuals. In order to avoid confusion we will speak of the contrast between immediate/oblique encounters. At this level an immediate contact would be a face-to-face meeting, or the equivalent such as speaking with the person on the telephone. An oblique contact would be any contact through an intermediate, such as a letter, a phone message, or another individual. This is an important contrast when discussing the control of actor accessibility.

The other important unit of analysis, practices, can best be discussed in terms of the proposal review cycle (Cole et al.: 1978). However, intra-organizational demands upon the program officer must also be considered. The phases of the review cycle for the BIP and Facilities Centers are the program announcement/proposal solicitation, reviewer selection, advisory panel meeting, and funding decision negotiation. Each phase can be examined in terms of the relationships and practices involved. Intra-organization practices, such as soliciting lists of reviewers from other programs or getting involved in non-required projects, can also be examined.

Another important contrast is that of cognitive/ noncognitive. The contrast is necessary for trying to sort out issues in proposal evaluation. While it is true that factors other than cognitive, such as material and social resources, play a role in the construction of scientific theories and beliefs (Latour: 1987), there has been no convincing argument in the literature that no cognitive factors are involved. As with the direct/indirect contrast the cognitive/noncognitive contrast does not allow fine-grained analysis. A rough spectrum rather than a distinction will have to suffice, where nothing better can be produced.

The interdisciplinary nature of the BIP is also of concern. Although it provides an excellent revelatory case study, distinctive elements of the interdisciplinary BIP environment cannot be used in agency-wide generalizations about research program officers. Interdisciplinary elements must be distinguished from other elements as well as possible, without the availability of direct comparison. Accurate distinctions can only be made after research on non-interdisciplinary research programs are completed. Some factors, such as the increased number of phone calls, seem readily distinguishable. Others, such as the difficulty of comparing competing proposals with radically different contents and finding relevant reviewers for complex proposals, do not. This issue must be dealt with in further attempts to analyze program officer activities.

D. Data Collection and Procedures

Access to NSF was originally gained through the summer intern program. The research was conducted in 1987 during the second summer internship. The first was held in the Division of Biotic Systems and Resources in the summer of 1986. The second internship lasted from early July until mid September, 1987. It was continued through the academic year with an additional intermittent appointment beginning

in September, 1987 and not to have exceeded one year. The appointment was terminated in July, 1988 due to funding cuts. The total time of employment was just over three months.

From the very beginning, the program director was informed that research for a Master's thesis would be conducted while I was employed at NSF. There was no attempt to be covert. This was an advantage in that the people associated with the BIP were extremely interested and helpful, though few were directly aware of the exact nature of the research.

A thorough description of the program officer requires more than one source of evidence. An ethnographic basis for research was supplemented by analysis of documents and interviews of relevant actors. Finally, a perusal of the research literature, especially Cole et al. (1978) was used as an additional source of data. Unobtrusive data were difficult to obtain, though examination of offices, notes and files were conducted when possible.[4] Telephone messages recorded by BIP staff were gathered for a one month period as an additional source. Interviews, direct observation,

---

[4] Opportunities to examine and record memoranda and official letters occurred during the performance of employment duties. Permission was granted by supervisors to take advantage of these opportunities for gathering data.

and unobtrusive evidence collection were the best methods for obtaining data when the researcher was simultaneously an employee and a researcher.

Obtaining evidence for a description of the program officer was hindered by the duties of employment. However, without employment, access to most of the files and discussions concerning funding decisions would have been extremely difficult. The program director allowed observation of Panel meetings and daily office activities when the workload was light and during unpaid visits. These supplementary observations were conducted for approximately one week. Supplementary evidence was collected to provide a better foundation for analysis.

Seven in depth interviews were conducted. Three of these were conducted with the two BIP program officers, Dr. Wooley (Interviews 1a, 1b) and the Associate Program officer (Interview 4). One was conducted with the Director of Division of Molecular Biosciences which included BIP (Interview 2). One was conducted with a former BIP program director who is currently a research program director (Interview 5). Another interview was conducted with a program officer from a different research program, involved with the Facilities Centers initiative during reviewer selection and as an advisory panel discussion leader

(Interview 3). The remaining interview was conducted with a program assistant whose position was neither that of a program officer nor clerical in nature (Interview 6). The interviews ranged from 1/2 to 1 $^{1}/_{2}$ hours duration. They were conducted in September 1987 and in June/July 1988.

All of the interviews were non-standard and non-scheduled. This provides a flexible format. Preparation for an interview consists of a "list of things to be sure to ask about when talking to the person being interviewed" (Lofland and Lofland: 1984, 58-9). This also allows interviewees to speak freely and in their own terms. The perception of the subjects was considered an important source of data.

The setting for all of the interviews was the interviewee's office. In each case, the interviewee was approached at least a day in advance in order to request an appointment. Most of the subjects knew about the study before the request. The former Program director and the program officer associated with the Facilities Centers were the only two who stated that they were not aware of the nature of the research.

In all cases it was explained that the research was a Master's thesis involving a case study of the BIP intended to produce a description of the program officer. Permission

to tape record the interview was requested. The former Program Director who claimed that tape recorders made him nervous refused. Notes were taken in place of tape recording for that interview. During all interviews a note pad was kept ready and key names or concepts were jotted down in case the tape recorder failed.

They were encouraged to ask questions concerning the research or to raise any questions or objections they had during the course of the interview. A sheet listing the important topics to be covered was brought to every interview by the researcher. Each item was checked off as it was covered so as not to miss any. After the interview, immediately if possible, a post-interview note was written, describing the interview, as well as noting the time and place.

Documents and archival materials were examined and/or copied for examination for the duration of the research period. Documents include personal notes, letters, phone messages and correspondence of the personnel associated with the BIP, including the researcher. Access to the archives concerning budgets was gained while working on a cost sharing evaluation project and through the Budget Summary: Fiscal Year 1989. Past proposals, both awards and declines, from 1986 to 1988 were routinely accessible because these

were stored in the immediate office files. Proposals dated earlier than 1986 were sent to a permanent storage facility in the building and had to be requisitioned. Due to the focus on a contemporary description, the difficulty of access, and the limited use of these data the earlier proposals were not examined.

Archival sources included the jackets (files containing proposals, past and present) dated from 1986, some funding records for 1986-8, procedures and policies manuals, and various reports and flyers produced by NSF. Many contained information not subject to release by the Privacy Act. Although examined, under advisement by the NSF Office of General Counsel, most of this information is not explicitly described. Other archival sources such as regular reports, flyers, and policy manuals were gathered by the same means as personal documents. Personal copies were obtained by permission, by commandeering an extra copy , or by photocopy when a document could not be retained. These documents were located by inquiry, chance, and the aid of BIP personnel. Any available documents that were linked to the BIP, the program director, or other associated personnel were gathered when possible.

A link was considered to be the mention of the name, BIP, or that of personnel associated with the program.

Also, any document that dealt with a PI or reviewer that could be verified as associated with the program was included. A number of documents that were believed to be linked had been gathered initially yet turned out to be of no use. It was considered better to obtain more than needed than to miss a useful one.

An official chron file, containing official correspondence of the program officers, was not available. Correspondence concerning particular proposals was kept in the jacket for that proposal. This and the use of electronic mail eliminated the need for a chron file. Because the communication between program officers is most often by telephone, and because the correspondence between the program officer, reviewers and PI's are filed within the particular jacket, the absence of a chron file is not critical for an understanding of program officer activities. In fact, the absence of a permanent record of the program officer's activity, except for that directly relevant to the evaluation of a particular proposal, is interesting in itself.

Seventy-five phone messages were gathered over a two month period as another documentary source. The Program Director preserved on a standard phone message pad issued by the U.S. government (standard form 63, revised 8-81) any

phone messages he received. These messages were gathered by the Program Director for two months (May and June, 1988). Although the pool of messages cannot be considered fully complete as it did not include calls directly answered by Dr. Wooley and is not large enough to be significant in a quantitative examination, they are roughly representative of phone calls received by a BIP program director. They are not reliable regarding the content of the contact, but they are useful in identifying the types of callers (PI, Reviewer, Industrial, NSF, Professional Other, Personal). The interview and personal observation were used to supplement this method of establishing who contacted the program officer.

Documents and archives were considered non-interactive sources of data. Non-interactive methods are a necessary complement to more interactive methods of interviewing and personal observation. The primary forms of data gathering by virtue of their specificity, were the more interactive forms such as personal observation and interviewing.

Personal direct observation was conducted at all times. This involved quickly jotted words or phrases on scraps of paper, writing on lunch hour and breaks, and waiting until after employment hours to fully transcribe observations because of the requirements of employment.

Although there were three sources of data, the objection could be raised that most of the data were collected during a relatively short period of observations. The objection can be overcome for two reasons. First, the collection from each source of data, particularly the interviews, was conducted to make up for deficiencies that would be derived from only one source of data. Second and most importantly, the fact that there were two different programs being administered by BIP personnel, allowed observation of every phase of the cycle. While the workload of the BIP staff was more constant than other program staffs because when one cycle was nearing completion the other cycle was in a different phase, the character of the work was typical.[5]

E. The Nature of STS Inquiry

Science and technology as a human activity has been understudied. Although there are histories of ideas, epistemological essays, empirical studies of scientists and the research they perform, there is little work done with the express intent of creating a comprehensive picture of

---

[5] This is assumed base upon the researcher's previous experience in a research program the year before this research was conducted, informal discussions with NSF staff outside of the BIP, and a reading of Cole et al (1978).

science and technology as both a successful activity for acquiring knowledge and as an activity in and of itself. Research that expands the arena in which relevant questions and research concerning science and technology as a human activity can be asked is needed. Such research includes social factors within questions concerning epistemology. Such a view diverges from those who believe that one key to understanding science exists. The divergent view is set apart from research aimed at discovering the social character of scientific activities which explain why scientific knowledge is superior as well as it is set apart from research aimed at discovering characteristics of rationality which explain why scientific knowledge is superior.

The attraction of some constructivist and relativist approaches to science is that they do not assume that there is one key to understanding scientific activity. They expand the domain for relevant questions concerning knowledge acquisition to include the social character of scientific activity but not to the exclusion of other factors. Science becomes a method of knowledge acquisition integrated within human activity.

A short-hand method of explanation such as describing science as a purely rational activity is powerful but

limited in the same way as describing human reproduction with biological principles. Much can be accomplished in terms of modifying the process, but the limitations of excluding social characteristics of scientific activity are similar to excluding social characteristics in an explanation of sex. Useful explanatory resources are eliminated when relying upon a single concept. Thus, while it is useful to pursue explanatory keys whether they are social or cognitive, it is also useful to provide integrative descriptions.

This thesis is designed to enhance the existing understanding of funding agencies that attempt to find a single explanatory key in decision making. While such attempts are useful for achievine policy goals, they do not consider the full range of possible concepts that provide an understanding of funding agencies. For example, the possibility of influencing the content of proposals or science cannot be as readily evaluated if relationships between the program officer and intra-organizational actors are ignored. Because the description of the program officer's practices and context may provide insights into the influence of knowledge production and contributes to a more comprehensive understanding of a component of scientific activity this research falls within the sphere of science and technology studies.

IV. Results

A description of the program officer within the BIP at NSF will begin at the smallest structural unit the program.[6] Once some understanding of the relationships between the personnel of the BIP has been gained, the focus will shift to the relationships of the program officer with other NSF personnel. Finally, the inter-organizational relationships will be examined. These include agents from other funding agencies, reviewers, and finally those scientists who submit proposals, the potential PI's. Finally, a comprehensive picture of the program officer will be presented.

An important issue is the 'inside out' order in which the relationships are examined. While those most affected by the funding decision are examined last is partly due to this 'inside out' approach of the analysis, from the standpoint of the observer this order of appearance is roughly similar to the relative importance of the relationships to the program officers under study. This is no doubt influenced by the 'inside' position of the observer, but the program officer is also located on the 'inside' looking 'out.'

---

[6] The focus of the description is upon the program director of BIP, Dr. Wooley. As the Program director he is the nucleus of this study. The questions concerning program officer relationships revolved about him because the program revolves about him.

A. Intra-organizational Relationships

1. The Biological Instrumentation Program

The program officer is the central figure in a program (7/21/87).[7] The staff personnel are considered supportive resources to aid the program officer in the completion of the review cycles. The program director is the principal program officer. The director has ultimate responsibility for the output of the program. A description of Dr. Wooley in the latest NSF Annual Report describes him as "an unusually capable supervisor and has provided notable leadership for both support and program staff." (1986: 55).

Dr. Wooley's work habits did not promote a large amount of daily contact between himself and the staff (7/21/87). Wooley's day to day activity appeared separated from that of the rest of the program personnel. While most of the BIP staff remained at or near their desks, Wooley was rarely observed to remain within the vicinity of the program. The separation from the staff was also enhanced by the program officers' possession of an office versus the open modular desks of administrative personnel.

---

[7] Dates in parentheses refer to field notes. Other references, to documents or interviews, are also in parentheses.

Answering phone calls for Dr. Wooley by the program assistants is a good example of the 'barrier' between the staff and Dr. Wooley. The observer usually had to physically check Wooley's office to determine if he was present. Originally, the observer attempted to jot down where the program director indicated he would be to better answer the phones. The practice was quickly abandoned after referring callers to the indicated office only to be informed later that Dr. Wooley was not in the vicinity he had indicated. The ultimate strategy adopted by the observer to contact Wooley was to write down a list of topics to be discussed, wait until we met or go and seek him out if the list was urgent and long enough. The permanent program staff created a phone message board during the summer so that the program officers, primarily Wooley, would not have to seek out the person who received the call to obtain a message. A memo from Dr. Wooley to the staff furnishes evidence that he is aware of the difficulty: "I do not ask you to know my schedule: simply if you happen to know I am not in, or will be in meetings all day, it is a good idea to try to minimize the number of yellow messages to include only "critical" calls that need immediate response." (Memo: 7/5/87).

The program associates and other program directors also had the same difficulty of access to Wooley. Nearly all intentional personal contact with Wooley initiated by NSF personnel was oblique. Those determined to meet with him personally either left a message for an appointment or followed clues from others as to his last known whereabouts.

There was a time and space barrier for personal contact between Dr. Wooley and BIP staff (extending to the NSF staff in general). Whether this barrier was created by Wooley because of the large number of people demanding his time, or whether the demand necessitated the barrier could not be determined. BIP personnel did receive a large number of calls concerning the status of particular proposals during and after panel meetings for both review cycles. As mentioned in the previous section, Wooley was involved in two review cycles, and planning a third. Although he mentioned a number of officers from other programs (Biophysics and Prokaryotic Genetics) that "volunteered to help again with Centers this month" (Memo: 7/5/87), the phone calls were either transferred to Dr. Sperlich, the BIP associate program director, or messages were taken to await Wooley's attention. The 7/5/87 memo suggests that Wooley had more demands than time. He specifically mentions negotiations "with investigators from the 'spring panel'", a

panel meeting within two days, and a new proposal deadline for the Facilities Centers initiative as claims upon his time.

Another facet of interaction between the BIP staff and Dr. Wooley was work assignment. Routine work for the BIP staff was either tacitly understood as necessary or delegated by the associate program officer, Dr. Sperlich.[8] Non-routine or high priority tasks were delegated by Wooley immediately by request, and obliquely either by personal note or through Dr. Sperlich. Except for these non-routine task requests, most interaction between the BIP staff with Dr. Wooley was of an informative or conversational nature (Dr. Sperlich excepted). The result was an atmosphere of equals consisting of address by first name and personal conversation. The impression of the observer was a willingness to work harder to complete the non-routine tasks assigned directly by Dr. Wooley, because the non-routine nature and the direct request by the program director meant those tasks were important (7/9, 7/21, 8/12, 8/14/87).

The willingness of the staff to work for him, and his separation from routine administrative tasks provided the

---

[8] The tacitly understood tasks were explained to new staff (including the observer) only a few times, with disappointed reminders following the discovery that the tasks were not completed in time.

program director with a great deal of freedom, which was evident form his absence from the BIP offices. The freedom was not 'free time' (3/2/88). The observer's impression was that Dr. Wooley's power to avoid routine work was provided in part by what appeared to be the importance of his activities. The importance of the activity was established by such tactics as visibly and audibly negotiating with organizational superiors and PI's in view of the BIP staff (7/28/87). Rather than escorting superiors to his office, Dr. Wooley would often speak to them in the open general office space. The observer watched numerous of these discussions between him and the head of the Biological, Behavioral, and Social Sciences Directorate, noting once their plans to draw up a budget over the weekend. These meetings were based upon the involvement of Dr. Wooley with the directorate-wide Facilities Centers initiative. The program director could be understood as 'cosmopolitan' in the framework of the BIP (Gouldner: 1958). Dr. Wooley possessed the power to work on extra-program activities by delegating routine work to the staff and his associate program director.

2. Foundation-Wide Peer Relationships

The BIP director's cosmopolitan nature was primarily directed to Foundation-wide activities rather than activities transcending NSF boundaries. Wooley was involved with the directorate-wide Facilities Centers Initiative and is director of a program that requires interaction and negotiation with other program officers. He was also active with the NSF Office of Advanced Scientific Computing (Annual Report: 1986). Wooley was not involved in these activities before he arrived at NSF (Interview: 1b).[9] A partial explanation of his extensive extra-program activities may be the requirements of an interdisciplinary program: "You spen[d] a lot of time negotiating with other programs" (Interview 1a). Wooley's cosmopolitan nature with regard to NSF can only be partly explained by the interdisciplinary nature of the programs for which he was responsible. It cannot be a complete explanation because the Division Director, the BIP's program director's direct supervisor, stated that Dr. Wooley's predecessors did not engage in such activities (Interview 2). Still the nature of the program director's extra-program activities seems to be directly related to the nature of the program activities.

---

[9] The references to interviews are explained in **Methods** Section (see 39).

The relationships that did pertain to the BIP directly were between Wooley and his NSF peers. By peers, I refer to officers in other programs.[10] These relationships were primarily oriented towards coordination of proposal review. The primary resources tapped in these relationships dealt with reviewer selection, proposal jurisdiction, or joint funding (Interviews: 2, 3).

In the case of reviewer selection, Dr. Wooley would confer with officers in relevant programs to gain knowledge of the best reviewers for particular proposals. A program officer from the Cellular Physiology Program (CPP) involved in "structuring and carrying out the review process" for the Facilities Centers competition is an example. His opinion as to why Wooley conferred with him is straightforward:

> "I started helping John [Dr. Wooley] in May of last year on the Facilities Proposals...He mainly contacted me because I was a warm body. Basically...at that point he just needed some help and the idea...was that he needed help in proposal assignments." (Interview: 2).

---

[10] Although personnel from non-funding programs could be considered, except for those in the Grants and Contracts office, they were not directly relevant to the BIP. The Grants and Contracts office personnel were concerned with routine information concerning awards and total budgets instead of the review process. Other BIP staff dealt with these routine transactions.

The CPP program officer claims that now he does "lots of things for John." This relationship has continued with the BIP program director who has succeeded Wooley.[11] Although the CPP officer does not have anything to do with BIP, he declared that he has had many conversations with the new BIP program director. He gave the example of attending the same site visit during the Facilities Centers competition.

In the case of proposal jurisdiction, Dr. Wooley would follow the usual procedure to return a proposal prior to formal review if it was inappropriate for consideration by NSF as described in Grants for Scientific Research (NSF 78-41A). However, if the proposal is appropriate for NSF review but inappropriate for BIP funding, or it should be considered for joint funding, then Dr. Wooley confers with the appropriate program officer. The conferral is often by phone or immediate conversation. These relationships appear to be for coordination, but they can be a source of conflict because accepting a new proposal for review is a possible drain on the resources of a program, particularly financial resources.

---

[11] Dr. Wooley has been named the Division Director for the new division created to house all interdisciplinary programs within the BBS directorate: Division of Instrumentation and Resources (6/7/87).

Dr. Wooley has directly contributed to the increased number of submissions of multi-user proposals and jointly supported awards (Annual Report: 1986). These increases have increased the demand for funds in the associated programs, but the result has been increases in the program resources including a new division (Budget Summary for 1989). Dr. Wooley's power through control of financial resources and unobtrusive control in setting criteria for interdisciplinary and joint funding has increased through his agency-wide activities. At the same time, he has contributed to an increase in financial resources to all interdisciplinary research.

A final medium for intra-NSF peer relationships is internal organizational issues. Dr. Wooley has participated in such relationships concerning the development of local area networks in the Division of Molecular Biosciences (DMB). His expertise in computers enabled him to help select the software purchased for the DMB network. This decision making further strengthened a relationship with a computer specialist in an administrative division. Although of little direct consequence, the relationship that involved selecting the software for the network could be understood as unobtrusive control. Only certain kinds of work could be

done on certain types of software.[12] It is impossible to judge the effects of software selection upon work improvement in this situation, but the selection of software for an area network is an example of how the program environment is controlled.

3. Relationships with Organizational Superiors

Except for the collaboration on the directorate-wide Facilities Centers initiative Dr. Wooley had little direct and/or immediate contact with organizational superiors. The main relationship with a superior besides those involving the Facilities Centers initiative was one with the DMB Division Director. This relationship was considered one between colleagues by both men (Interview (1a, 2). They were on a first name basis (7/7/87). It also extended to Dr. Wooley's orientation when he first took over as program director (Interview 1a). This is contrasted with the nature of the formal relationship between the division director and the program director which involves allocation of the division funds to the individual program budgets and formal

---

[12] Dr. Wooley was instrumental in obtaining "Open Access" software. It is a combination word processor, database, spreadsheet, and communications package. Dr. Wooley had expressed a dislike of "Lotus" and touted "Open Access." No one was observed using it extensively during the research.

approval of the program funding recommendations (Flow chart of recommended award: no date).

While it is possible for the division director to use the division budget distribution as a means of direct influence over program officer activity it does not appear likely to occur. The budget negotiations are complex and are carried out in cooperation with the BBS Assistant Director as well as with the relevant program directors (7/22/87). The formal approval of funding recommendations by the division director is attenuated by the fact that the formal appeal procedure that declined proposal authors follow skips from the program director directly to the BBS head. There is no formal consideration by the division director in case of appeal (Proposal and Award Manual: 1986). Another mitigating factor unique to the BIP director is his close association with the BBS head due to the Facilities Centers initiative (discussed below). The DMB division director is in a somewhat powerful economic position to influence the program director, but was not observed (directly or indirectly) using this power.

The organizational superior above the division director is the Assistant Director for Biological, Behavioral, and

Social Sciences Directorate.[13] Unlike most program directors, Dr. Wooley was closely associated with the Assistant Director. The sole reason for their close association is the directorate-wide Centers programs, as both of them are directly interested in biotechnology (Washington Post: July 20, 1986, Interviews 1b, 2). Through planning the Biological Research Centers program and conducting the Facilities Centers initiative Dr. Wooley and the Assistant Director developed a close working relationship. They were often observed in meetings, there were numerous phone calls from the Assistant Director's office, and the Assistant Director, like everyone else, was often busy chasing down Dr. Wooley (Notes: 6/22/87 through 3/2/88).

This relationship although singular is significant. The relationship is evidence that intra-organizational relationships are linked to changes in funding patterns. Dr. Wooley's relationship with the Assistant Director has been continued even more closely since Dr. Wooley has been appointed Division Director of the new Division of Instrumentation and Resources (6/2/88). There has also been

---

[13] The title Assistant Director for the Directorate is misleading. This position is the ranking superior in the directorate. He is given the title Assistant in reference to his subordinate status to the Director of the entire Foundation. See organizational chart, Appendix A.

increases in interdisciplinary and joint funding (Annual Report: 1986, NSF Budget Summary: 1989). Whether increases in interdisciplinary and joint funding led to the relationship between Dr. Wooley and the Assistant Director or the relationship between them led to increased attention and funding cannot be determined with the data available. The link is probably bi-directional. A BIP program existed before Dr. Wooley became program director, however, few resources were committed and little was accomplished until Wooley's arrival (Interview 2). Either way, the relationship is linked to Dr. Wooley's accumulation of power and to the increase in interdisciplinary and joint funding. Inter-organizational power relationships are linked to changes in organizational output at NSF.

B. Inter-organizational Relationships

1. Other Funding Agencies

The NIH is the only science funding agency other than NSF contacted by the BIP officers during the observation period (7/7/87, 7/30/87, Interviews 1a, 4, and 5). Dr. Wooley indicated that he "had very heavy contacts...the coordination with NIH has been, I think, very good. The Program officer equivalent at NIH was very helpful in

understanding what goes on at NIH and other instrumentation programs." (Interview 1a). The contact person in the NIH was in an analogous position supervising the funding of instrumentation (7/30/87). The motive behind this contact is coordination of funding. There are proposals being declined for lack of funds, so coordination of funding rather than competition for quality proposals is more important (Form 7 document: 7/1/87).

Dr. Wooley discussed the problem of PI's who answer no to the question: Was this proposal submitted to any other Federal Funding Agency? "...they honestly say no, then apply to NIH the day or so after they send in the NSF proposal. He said that you have to check and recheck to make sure." (7/7/87). Most of the checking and rechecking can be done on the mainframe computer because there is an interagency link. Contact with the personnel is often required just before the panel meeting because of the lag time between the submission to NIH and the entry of the information into the computer. A reciprocal relationship is documented in a letter from a Biomedical Research Support Program administrator at NIH:

> "I learned recently of your upcoming review of BIP applications... So that I can better monitor the application overlaps between our SIG program and

your program, I would very much like to attend the review..." (5/2/88).

This relationship is voluntary and can be explained sufficiently by the usefulness of exchanges between the agencies as a method of attaining the goal of efficiently spending funds (Hall et al.: 1977, NSF Annual Report: 1986). Although there is no data available on specific proposal outcomes this example describes possible effects of inter-agency interaction on the funding of proposals.

2. Reviewers

Two types of reviewers are used in the BBS directorate (Grant Policy Manual: Sect.230 , Cole et al.: 1978). These are mail reviewers and advisory panel members. The two types of reviewers are distinguished by the service they render to the program officer and by the character of their relationship with the program officers. The mail reviewers have oblique, impersonal contact with program officers. The large number of mail reviewers does not permit an involved relationship. The request for a scientist to review a proposal is a computer generated form letter (Master form: no date). Mail reviewers are not informed as to the fate of the proposals they review (PAM: I-7). It is not unreasonable to find that many of the mail reviewers for

proposals are not known by the program officers. The BIP kept a file of CV's from PI's in proposals as one means of gaining knowledge about the pool of reviewers for future cycles. Half of one day was spent attempting to track down CV's either in the file or by finding them on the mainframe computer by identifying proposals they had submitted previously. Six of seven missing CV's were obtained in this manner (5/25/88).

Panel members in contrast to the mail reviewers had immediate as well as oblique contact with BIP personnel. The immediate contact occurred most during the actual panel meetings. Some contact with all of the reviewers was necessary prior to the meetings in order to arrange the meeting dates and to provide the required travel and lodging. The administrative contact with the reviewers was handled most by Dr. Sperlich, the associate program director. Contact was often over the phone (7/9/87, Interview 4). I observed numerous panel members speak to Dr. Sperlich on a first name basis during panel meetings, and there was at least one record of a 'regular' panel reviewer stopping by to say hello while in Washington on business (3/2/88).

Panel members are usually trusted reviewers, an example of a Panel member who was not previously a mail reviewer was

not observed, although it is certainly possible. Many of the Panel members for the Facilities Centers seemed well known to the BIP support staff, who were observed speaking with them during meetings (7/16/87, 3/2/88). The fact that the program officers knew the panel members could be attributed to required knowledge of scientists in the field; but the administrative support staff's acquaintance with the panelists suggests that the relationship between BIP personnel and the panel reviewers is more enduring or broader. More evidence for a more enduring relationship comes from the observation that some of the program officers with whom the observer was acquainted were originally panel reviewers, and that some of the panel reviewers met during the Facilities Centers panel were discovered to be former program officers (7/16/87).[14]

More on panel reviewers and their relationship with the program officer will be discussed in the following section. The important observation here is that mail reviewers are nearly "anonymous" whereas panel reviewers are more directly and immediately involved with NSF personnel and the review process. The panel reviewers' knowledge of the process, and their interaction with the program officers appears to be an important part of more than the Program officers' funding

---

[14] This was not the case with the BIP officers.

decisions concerning proposals.

3. Primary Investigators

The program officer's relationship with the primary investigator (PI) is predominately one of negotiation. Most of the contact between the author of the proposal and the program officer was observed to be one of information demand and supply. Phone calls from PI's concerned with the status of their proposal or the program's review cycle were received daily. Dr. Wooley circulated a memo to the support staff concerning the telephone call burden. He acknowledges that the "phone load to BIP and BCP is so high, but that is the nature of a multiuser program".[15] Dr. Wooley stated that he was "still negotiating with investigators from the 'spring panel' [and] if someone says their proposal went through the spring round of BIP - that is, it is a status inquiry for BIP, I will have to talk to them" (Memo: 7/5/87).

Most of the PI's were recognized when they telephoned, however the recognition (for the observer at least) was purely name recognition, given the number of times that the

---

[15] Biological Centers Program was announced, but no funds were available till the next fiscal year. This did not stop the inquiries from potential PI's drafting proposals

PI name was encountered in the administrative tasks of 'getting the proposal ready' (8/10/87). Ironically, the program officers were less likely to recognize the name of a PI than the support staff because the former were less involved with the administrative tasks. Dr. Wooley recognized only those who were the most persistent in calling (hence leaving a large number of messages) or were connected with a problematic proposal. The associate program officer, who was more concerned with the administrative details, recognized PI names more often than Wooley. The staff would recognize the most. Recognition meant that the PI could be identified with the program or initiative, and the PI's proposal could be quickly located in the offices or carts in the area so that the 'status' could be determined.

Although PI's are the reason for the existence of the Foundation, if the PI was not recommended for award their proposal was quickly processed for decline and little attention was given to them (Proposal and Award Manual: I-12). Decline letters are generated for all proposals before the panel meets if possible to avoid delay. The reasoning behind this is two-fold: from an administrative perspective the waste is small because only a small percentage of proposals in any competition are funded and the processing

is therefore quicker when declines are pre-generated. Second, by informing a PI of a decline as quickly as possible, the PI is given a more time before the next target date to submit another proposal (7/21, 7/22/87 Also Proposal and Award Grant Manual: I-7, and Time-Flow chart: no date). Before the panel recommendations and the preliminary decisions are made, no information regarding the funding status is released by the program staff.

The most important interaction between the PI and the program officer was the negotiation for those receiving and likely to be receiving awards (See Proposal and Award Manual (1986) for complete discussion of legal obligations and requirements, also Cole et al.: 1978, 150-158). The negotiations occurred between Dr. Wooley and the PI over the telephone (7/28/87). Most of the conversation observed was not subject to public disclosure. The most general topics covered were increases in cost-sharing by the university, possible discounts on instrumentation, removing a few 'laundry list' items from otherwise excellent proposals, and duration of the grants. These topics were generated from agency concerns. Negotiations for awards to Facilities Centers proposals were more likely to include continued funding sources or organizational topics (See Centers Program Solicitation Flier: NSF 86-89 for criteria and

specific topics of interest).

The PI is important to the program officer only when the proposal becomes an award. Prior to the award, it is the review process which seems important. The PI is shunted to the administrative staff (many of the telephone messages were never directly answered by Dr. Wooley) until the proposal is recommended for award (Interview: 1b, Memo: 7/5/87). From the perspective of the PI, the program officer is observed to be more attentive to the agency process than the scientist. This focus on agency processes is in agreement with Morrison (1975) discussed above.

C. The Advisory Panel Meeting

An examination of an important encounter between the program officer and reviewers can shed light on the relationships between them. The advisory panel meeting is the only such encounter. It was also easy to examine due to its bounded nature.[16] Although, it is impossible to reveal any of the actual transactions within the two meetings observed, I can present a fictional account of interactions

---

[16] The advisory panel meetings in the BIP associated programs usually lasted two days and were confined to a small number of rooms.

with the panel meeting.[17] It is not a composite picture because of the relative ease reviewers, proposals and projects could be identified by knowledgeable readers.

The Facilities Centers and the Science and Technology Centers Panel meetings were both observed. They had similar agenda's with meetings beginning at 8:00am and ending at approximately 5:00pm. The mechanism for soliciting verbal comments from Panel members were equivalent in that beginning with the primary reviewer (the reviewer selected by the program director as most competent to review the proposal) each reviewer would provide a short verbal comment followed by open discussion by any Panel member. Most often the discussion was limited to the actual reviewers. The PI names for each proposal were written upon an easel after the open discussion (in which hopefully some kind of closure was reached). The last session at the end of the Panel meeting was devoted to specific overall movement of PI's who were ranked in the 'accidental' method in which the discussion of proposals was ordered (alphabetically by PI last name within specialties). The result was minor changes in the ranking of proposals, if any. Also in the last session the program

---

[17] The following account is based on notes taken during the July 16-17, 1987 and the March 2-3, 1988 advisory panel meetings of the Centers programs. During the meetings I was free to take notes as there was no work to do.

officer solicited recommendations for modification and other issues of importance from the panel members.

The total number of reviewers for an NSF proposal according to Cole et al. was usually between four and ten. The official statement by NSF is "four to eight" with exceptions explained in writing (Proposal and Grant Manual: I-5). The Facilities Centers, being larger more complex proposals, officially had 18 or more. However, only four to six reviewers actually had read the proposal before the meeting. The BIP proposals fell within the range provided by Cole et al, usually around three reviewers very familiar with the science and often the instrumentation and two reviewers who may have special expertise for part of the proposal. Considerations of Conflict of Interest (COI), past reviewer history if any, areas of competence, as well as age and geographic status were used to choose reviewers for both cycles. Funding decisions were made in the same way for BIP and Facilities Centers programs. Without exception the Panel rank ordering was used as the basis for funding decisions. Only two or three were modified due to facts not available before or during the Panel.[18] Funding

---

[18] The observations were complete before the final approval from all levels of NSF was given for all proposals in the Panel meetings observed. The flexible character of the funding for the growing program made it possible for proposals to be 'carry-overs' to the next fiscal year. However, at least 95% of the award letters for the BIP Panel

decisions are black boxes that can be opened at any time. They begin as black boxes for individuals or 'fixed points' that are based upon individual experience.[19] The fixed points of individuals are thrown together during panelist interaction and become more and more 'fact-like', in the Latour and Woolgar sense of the term (1986). Finally, the program officer translates the ranking into his or her funding decision. The decisions is to fund, not fund, or fund at a reduced level. Funding at a reduced level is not usually possible for the instrumentation program because half an instrument cannot be purchased (See "site" section above). A case of reduced funding resulted from reviewers showing that discounts were available or cheaper instruments capable of the same operations may be bought. Even though a superior can question a funding decision (open a black box) it requires resources that are not readily at hand for the superior.

The example below is <u>not</u> a usual scenario in that most proposals are funded according to the rankings given during

---

were mailed to the PI's before the end of the observation period.

[19]The idea of a 'fixed point' originated with Andy Pickering at the University of Illinois as a concept for black boxes at the individual level **before** they are used during interaction, at which time Latour's concept can be used.

the Panel meeting, but for purposes of illustrating the process the following account is useful:

The BIP Advisory Panel has ranked a proposal as "must fund" and placed it within the middle of the first quartile of all proposals considered. This proposal by Dr. Jones is a request for money and computer hardware to develop a new software package that integrates five current analyses programs for the sequencing of medium size DNA fragments. A sample of comments from the four mail reviewers include: "This is a well-known researcher with an impressive track record. The research conducted by the PI and other potential users of the software package is on the frontiers of mid-range DNA sequencing. The value of integrating these analyses programs into a single package will not only advance Dr. Jones' research, but will certainly produce a quantum leap in DNA sequencing research in the next five years when it is made widely available. The hardware Dr. Jones has selected is the best currently available and is fully justified. The salary for a half-time programmer is reasonable. I would rate this proposal as Excellent."

Panel members review the proposal similarly to the mail reviewers. Three of the Panelists individually rate the proposal 'excellent,' one rates it 'excellent to very good,' and another Panelist rates it 'very good.' The program

officer directing the panel session points on an easel, divided into four blocks, to a spot in the middle of the first quartile and claims that "by the discussion so far, you would put Jones about here. What do you think?" By this time the Panelists have begun to read their notes for the next proposal for review, and only one of Jones' reviewers looks up and says "yeah, that looks about right." Another reviewer then states "I thought it should go somewhere above Black's proposal [another PI] ... right there," as the program director moves her hand up to a point across from a PI name above Black's where she writes 'Jones.' The Panel meeting ends with the Jones' proposal in the middle of the first quartile.

A few days after the Panel meeting the program director, using the carefully preserved sheet from the easel, has made a priority list which she then asks a program assistant to type immediately. The program assistant types the list in place of the panel summaries he has been constantly transcribing from the handwritten comments scrawled by primary reviewers. The program assistant returns to the program director with a typewritten priority list, also stored in a PC file for quick revision, that becomes the 'master list.' This list with Jones' proposal ranked in the "must fund" category is subject to

minor changes in the time between the Panel meeting and the forwarding of the program directors' "approved for funding" list sent to her superiors.

For example, in the case of Dr. Jones' proposal, a late mail review arrived a week after the Panel meeting. The reviewer, a specialist in computers, is not familiar with the science described in Jones' proposal, but claims that two of the analyses programs to be integrated cannot be run upon the particular hardware configuration requested by Jones. In fact, this reviewer stated that a much cheaper computer could be used for the three remaining analyses programs that can be integrated. The program director quickly called a computer industry representative who has served upon panels for the BIP before but could not attend this particular meeting for some reason. The representative confirmed the late reviewer's objection. The program director now reexamines both the mail and the panel reviews, noting that the panelist who rated Jones' proposal 'very good' was worried about the fact that two of the analyses programs were not written in the same language, but could not be sure of his criticism due to lack of experience in programming.

The program director calls Jones on the phone to confront him with the problem. Jones claims that the

objection cannot be correct, and that he felt that the incompatibility of the languages would not be a problem, citing that his team could handle it. Jones, however, could not give a specific answer as to what prototype software or hardware could be developed to rectify the incompatibility. The program director decided to lower the priority of the Jones' proposal to a 'decline for lack of funds' rating. This decision was made with the knowledge that at least three other proposals had just missed the funding cutoff point on the list. These three were to have the decision delayed until the next fiscal year so that funding could be obtained without having the proposals go through another Panel. The program director informed Jones that his proposal was not to be funded until he could satisfactorily resolve the issue. She encouraged a resubmission of the proposal. She revised the master list and finally gave to a program assistant for typing and insertion in the Jones' proposal jacket, an edited printout of the Panel summary in which the new information concerning the late mail review and the new ranking modified the previous comments and ranking. The old version of the Panel summary was removed from the proposal jacket and thrown away.

The above account illustrates the fact that the program officer does more than just accept the opinion of the panel

in the review process. The majority view was that the proposal was excellent. The fact that there were a large number of good proposals that were awaiting funding, and that there was a mechanism by which the questionable proposal could be placed in limbo contributed to the modified priority.

Dr. Wooley and the rest of the program officers who were involved with the panels claimed that they are there to keep the discussion moving and to make sure all of the NSF criteria are discussed (Interviews 1a, 3, and 4). This can be interpreted as part of the disguising of the centralization of power pointed out by Perrow (see page 18). While this particular fictitious example did not include considerations of agency criteria, such considerations were observed to play a role in changing the perspectives of the panel members when dealing with conflicting reviews. The interpretation of the program officer is strongly considered in these instances.

The program officer has the power to structure the panel meeting to the extent of assigning categories to cover the variety of interdisciplinary proposals. While this was not a problem encountered within Cole et al.'s study it is of concern for interdisciplinary funding. As a program officer stated: "How do you make these decisions about

apples and oranges?" (Interview 3). This is a concern derived from the new emphasis upon interdisciplinary research at NSF. The juxtaposition of certain types of proposals could influence their overall priority ratings. While an alphabetical basis for the order of presentation is used to prevent systematic bias, this is only within the categories created by the program officer.

One point not apparent from the above discussion is that the premises of the reviewers' decisions were set by the BIP staff. Dr. Wooley divided the Panel into sub-panels each working with different biological fields, for example cell and neuro-biology, structural biology, environmental biology , and plant science. Reviewers were selected based on these topics. The panelists also had four rough categories to place proposals in, from highest priority to lowest (sometimes the lowest category would be left off of the easel for clarity reasons). They were told that only the first quartile and maybe part of the second would be funded. Although only rough categories they were made by the program officers after personal consideration. This could be seen as the first step in managing uncertainty, and it is the program officers who have taken it. It would be interesting to follow the development of categories and methods of review for interdisciplinary review further.

D. The Program Officer and Power

Science studies and complex organization studies points of view both contain power as an important concept. For Callon and Latour the ability to set the premises for and to win controversies, and the ability to become an obligatory passage point are central to becoming a powerful actor. Perrow considers complex organizations to be tools for the centralization of power. Observation of the program officer reveals relationships that can be interpreted using this framework. Power is the ability to extract valued outputs from a system in which other persons or groups either seek the same outputs for themselves or would prefer to expend their effort toward other outputs (Perrow: 1986, p.259). Modification of the funding process by either practice or structure is a sign of power at NSF.

Dr. Wooley can theoretically modify the peer review process <u>after</u> the selection of reviewers. The program officer acquires legitimation and funding recommendations from scientists (reviewers) in the process of his decision making as BIP program director. Although, the program officer must strive to enlist scientists to review proposals, the reviews become a legitimate resource to support a particular viewpoint. The verbatim reviews can be

indirectly modified through panel meeting discussions and selective quotations of reviews during negotiations with PI's.

In this sense the program officer can disguise the power to influence the content of proposals. The interpretation of reviews was considered part of the program officers' activities (Cole et al: 1978). Theoretically, the program officer could influence the funding of a proposal or a future proposal submission in a manner contrary to the tone of the written reviews by offering a selective interpretation of the reviews to the PI. In this way, the ability of the program officer to influence the content of proposals is partially disguised by the copies of the reviews that become the permanent record. Only in the case of the program officer writing a letter to the PI or editing the panel summary would this influence be recorded.

Dr. Wooley can be linked to structural modifications within the review process. He was responsible for increased interdisciplinary and joint-source funding practices which resulted in a change in the structure. In his own words: "I institutionalized the instrument development." (Interview 1a). He has directed the Biological Instrumentation Program, and is credited with its efficiency and growth. The latest Foundation Annual Report has described his

ability to encourage and foster multiuser funding decisions (1986: 55). In discussions with NSF personnel the observer noted that Dr. Wooley had a reputation for being persistent (5/25/88). He confirmed this characterization by declaring that if you try hard enough in enough different directions you will get what you want. As BIP director Dr. Wooley was responsible for a funding of approximately $15 million in 1987 (Budget Summary: 17). As a coordinator of the Centers programs and as Director of Instrumentation and Resources, Dr. Wooley had become responsible for approximately $42 million. This is nearly three times the 1987 amount. These figures do not take into account the amount of other programs' funds which were negotiated by Dr. Wooley for joint funding, both in NSF and NIH. In terms of the responsibility for economic resources, Dr. Wooley has increased in power.

The increase in economic power is partially due to Dr. Wooley's position as Division Director of the newly created Instrumentation and Resources Division. This structural change within the BBS Directorate needed approval by the Assistant Director. Dr. Wooley's close interaction with the Assistant Director can be interpreted as influential in both the creation of the new division, and in Dr. Wooley's appointment as director. In terms of structural power, Dr.

Wooley has explicitly aimed at making an instrumentation funding structure permanent. In an interview, Dr. Wooley stated:

> "You establish patterns and you establish agreements and you establish working arrangements... [it] has become easier and easier for me to count on certain ways of doing business... once those kinds of contacts and networks are established then it becomes much easier for the rest of the work to be done... I hope I have institutionalized these. I mean that's the goal, the goal should be... to institutionalize a way of doing business that becomes somewhat experience independent on the part of the program officer..." (Interview 1a).

In terms of organization structure, Dr. Wooley has created a new position of power within the BBS Directorate.

Dr. Wooley's increase in organizational power was also due to resources that transcend the organizational boundaries. When Dr. Wooley became program director for BIP, it was less than five years old. There had been trouble finding a program director (Interview 1a). It was not well funded, though funding was increasing each year (Interview 2). He stated that part of his job was "an

effort to popularize..., to make a broader range of the community be aware of... what NSF could do through press releases through letters to the community... I actively pursued increasing the awareness of what the Instrumentation Program was and what it could do." (Interview 1a). Dr. Wooley mentioned a number of ways of getting his message to scientists. These included panel members, the 'source of grant statement' on publications, scientific societies' publications, grants and contracts officers from various research institutions, and referrals by other NSF programs. Dr. Wooley gave the example of panel members who were "a number of people who could diffuse, who knew what the BIP could and could not do. Those people represent a large resource." (Interview 1a). The resources tapped by Dr. Wooley extend beyond the organization in a web (Simmel: 1955).

Dr. Wooley could extract economic resources from a variety of programs other than his own through his relationships with people inside and outside the Foundation, particularly other program officers. By his efforts to establish and increase interdisciplinary funding Dr. Wooley became the obligatory passage point through which a large amount of financial resources passed. His relationship to the BBS Assistant Director through work in interdisciplinary

funding further established the channels that passed through his office. Finally, he was placed in charge of a Division within the NSF organizational structure. The original voluntary and informal practices became formal relationships. By enrolling other agency personnel, Dr. Wooley was responsible for the construction of a new division, in what might be considered a 'hot' area of science funding. The flow of funding into this 'hot' area is increasing, as are the submissions of proposals, making Dr. Wooley a more powerful and legitimate actor. This new status may have an effect on how strongly his opinions are considered by scientists working in the field.

The program director had all three attributes necessary for Rosabeth Kanter's notion of power linked to credibility: the ability to get things done, to be visible, and to be relevant. He was administering and/or planning for three different programs. He negotiated with a large number of personnel within and without NSF. He was involved in programs that were new and all had growing budgets. As the 1986 Annual Report describes him: Under his leadership "his program has emerged as one of the Foundation's leading activities...more multi user proposals have been jointly reviewed with other NSF instrumentation programs, resulting in a substantial increase in jointly supported awards. This

works to the benefit of the entire science and technology community, as requests for multiuser equipment now include sub-projects from chemists, materials scientists, or engineers, as well as biologists. [He] has proven especially effective in helping to assure the coordination needed in reviewing these proposals." He has also been a "highly effective liaison to NSF's Office of Advanced Scientific Computing" (1986: 55). He is able to get relevant things done in a visible manner. Dr. Wooley is an excellent example of the link between power and legitimacy.

V. Discussion

The results of this research indicate that the program officer can influence the types and content of proposals submitted to NSF. Activities other than those directly related to funding decisions can also play an important role by influencing the background against which the decisions are made. Activities involve other NSF personnel such as the program officer's superiors and peers (other program officers). Coordination with funding agents from other agencies can also have an impact on funding levels which in turn may affect proposal submissions.

Significant relationships within the funding process include those with other program personnel, reviewers (especially panel members), and the PI's themselves. Other program personnel can limit access to the program officer supplying time for him or her to participate in activities which can garner legitimacy and power within the organization. Increased power and legitimacy may increase the priority with which the officer's program and interests are considered by upper levels of the administration. The increased status could lead to the program being labelled a 'hot' field, thereby increasing proposal submissions in this area. This may be due to changes in the content of proposals in order to qualify for evaluation in the 'hot'

area.[20]

The reviewers supply the program officer with a legitimating resource for making funding decisions and for negotiating awards and resubmissions. The written comments of reviewers can be interpreted by the program officer after they have been submitted to the program. They can also be negotiated with panel reviewers during the advisory meeting. The program officer can thus maintain agency interests while gaining the legitimacy of outside scientific review. This does not imply that the program officer is improperly interpreting reviews, rather that the program officer must negotiate between scientific and agency needs in the review process.

Finally, the program officer spends a lot of time negotiating with the PI's who received awards. The negotiations revolve around many issues, but can include the nature of the research, the amount of the award, and the responsibilities of the research institution with regard to the PI. The PI provides a resource by the publication of articles and/or by acknowledging NSF funding, thereby legitimating the program and agency. The program officer

---

[20] Changes to a proposal to better chances for acceptance by different funding agencies such as NSF and NIH appeared common. By analogy, the likelihood of changes for submission to different programs appears substantial.

may also find the PI a medium for communication between the agency and scientists who could potentially submit proposals.

The potential power of the program officer to modify the funding of science could equal the authority vested in the position. However, the realization of the power of the program officer depends upon the relationships established within and without NSF. These resource relationships are based upon the mechanics of the peer review process at NSF and upon the structure and practices within NSF as a complex organization.

The capricious nature of funding decisions discovered by the NAS study (1981) may be attributed partly to the variety of ways in which different program officers manage their resources. One avenue of research suggested is the difference that the advisory panel may make in the negotiations between the program officer and the PI. Another avenue is the character of the relationship between the reviewer and the program officer. This would involve ascertaining the PI's interpretation of the reviewers' and program officer's recommendations., which were not possible within the confines of this research. Another suggestion would be to examine the status and power of programs and personnel <u>within</u> NSF as a factor in determining changes in

funding patterns. Finally, the relationship between changes in the content of proposals and the content of scientific theories and research should be examined. Such a probe could document a link between non-scientific and social elements and the content of scientific knowledge.

REFERENCES

Aldrich, Howard. (1978) "Centralization Versus Decentralization in the Design of Human Service Delivery Systems: A Response to Gouldner's Lament," in R. Sarri and Y. Hasenfeld, eds. The Management of Human Services. Columbia University Press. pp. 51-79.

Barnes, Barry (1982) T.S. Kuhn and Social Science. Columbia University Press: New York.

Blau, Peter M. (1977) Inequality and Heterogeneity. Free Press: New York.

Bloor, David. (1976) Knowledge and Social Imagery. Routledge and Kegan Paul: London.

Callon, M. (1980a), "Struggles and Negotiations to Define What is Problematic and What is Not: The Sociologic Translation" in Knorr K., R. Krohn, and R. Whitley, eds. The Social Process of Scientific Investigation. D Reidel: Dordrecht, Holland/ Boston, USA/ London, England.

Callon, M. (1980b) "The state and technical innovation: a case study of the electrical vehicle in France," Research Policy, Vol. 9, pp. 358-76.

Cole, Robert E. (1979) Work, Mobility, and Participation: A Comparative Study of American and Japanese Industry. University of California Press.

Cole, S., L. Rubin and J. Cole. (1978) Peer Review in the National Science Foundation, Phase One of A Study. Washington, D.C., National Academy of Sciences.

Cole, J., and S. Cole. (1981) Peer Review in the National Science Foundation, Phase Two of A Study. Washington, D.C., National Academy of Sciences.

Cole S., J. Cole and G. Simon. (1981) "Chance and Consensus in Peer Review," Science. 214:881-86.

Cozzens, S. (1986) "Editor's Introduction" Social Studies of Science, Vol. 16, pp. 9-21.

Downey, Gary L. (1988) "Change and Continuity in Negotiating Knowledge: Assymetries in Practice-Oriented Approaches to Science," in Coherent Worlds: Essays in Honor of

Nelson Goodman, Mary Douglas and David Hull, (1988) eds.

Forman, P. (1971) "Weimar culture, causality and quantum theory, 1918-1927," Historical Studies in the Physical Sciences. 3: 1-115.

Garfinkel, Harold. (1967) Studies in Ethnomethodology. Prentice Hall: Englewood Cliffs, NJ.

Gieryn, Thomas F . "Relativist/Constructivist Programmes in the Sociology of Science: Redundance and Retreat" in Social Studies of Science, Vol. 12 (1982)

Gouldner, Alvin (1958) "Cosmopolitans and Locals: Toward an Analysis of Latent Social Roles--II." Administrative Science Quarterly, 2: 444-480.

Groeneveld, L., N. Koller, and N.C. Mullins (1975) "The Advisers of the United States National Science Foundation," Social Studies of Science, Volume 5, pp.343-54.

Gustafson, T. (1975) "The Controversy over Peer Review," Science. Volume 190 (4219), pp. 1060-66.

Hall, Richard, J. Clark, P. Giordano, P. Johnson and M. Roekel. (1977) "Patterns of Inter-organizational Relationships," Administrative Science Quarterly. 22: 3, 457-71.

Hensler, D. (1976) for the Committee on Science and Technology of the U.S. House of Representatives, National Science Foundation Peer Review, U.S. Government Printing Office, Washington, D.C.

Latour, B. and S. Woolgar (1986) Laboratory Life: The Construction of Scientific Facts, 2nd Edition. Princeton University Press, Princeton, New Jersey.

Kanter, Rosabeth (1977) Men and Women of the Corporation. Basic Books: New York. pp. 164-197.

Knorr-Cetina, K. (1982) "Scientific Communities or Transepistemic Arenas of Research? A Critique of Quasi-Economic Models of Science." in Social Studies of Science, V. 12, pp. 101-30.

REFERENCES

Knorr-Cetina, Karin. (1980a) The Manufacture of Knowledge:An Essay on the Constructivist and Contextual Nature of Science. Pergamon Press: Oxford.

Knorr-Cetina, K. and A. Cicourel (1981) Advances in Social Theory and Methodology, Routledge and Kegan Paul, Boston, London and Henley.

Knorr K., R. Krohn, and R. Whitley, eds. (1980). The Social Process of Scientific Investigation. D Reidel: Dordrecht, Holland/ Boston, USA/ London, England.

Kuhn, Thomas S. (1970) The Structure of Scientific Revolutions, second edition. The University of Chicago Press, Chicago.

Latour, Bruno. (1987) Science In Action, Harvard University Press, Cambridge, MA.

Latour, Bruno. (1980) "Is it Possible to Reconstruct the Research Process? Sociology of a Brain Peptide" in Knorr K., R. Krohn, and R. Whitley, eds. (1980). The Social Process of Scientific Investigation. D Reidel: Dordrecht, Holland/ Boston, USA/ London, England.

Lofland, John and Lyn Lofland. (1984) Analyzing Social Settings: A Guide to Quantitative Analysis, Second Ed. Wadsworth Publishing Company: Belmont, CA.

Lomask, M. (1976) A Minor Miracle: An Informal History of the National Science Foundation. National Science Foundation, Washington, D.C. (U.S. Government Printing Office # 038-000-00288-1)

Callon, Michel. (1980) "Struggles and Negotiations to Define What is Problematic and What is Not: The Sociologic Translation" in Knorr K., R. Krohn, and R. Whitley, eds. The Social Process of Scientific Investigation. D Reidel: Dordrecht, Holland/ Boston, USA/ London, England.

March, James and Herbert Simon. (1958) Organizations. John Wiley and Sons: New York.

National Science Foundation (1983) NSF Grant Policy Manual, NSF 77-47, revised 4-15-1983.

REFERENCES

National Science Foundation (1985) Proposal and Award Manual, NSF Manual Number 10, reprinted November, 1986.

Perrow, Charles. (1986) Complex Organizations: A Critical Essay. Third Ed. Random House: New York.

Pfeffer, J., G.R. Salancek, and H. Leblebici (1976) "The Effect of Uncertainty on the Use of Social Influence in Organization Decision Making," Administrative Science Quarterly, Volume 21, pp. 227-45.

Rip, Arie. (1986) "Mobilizing Resources Through Texts" in M. Callon, J. Law and A. Rip, Mapping the Dynamics of Science and Technology. The MacMillan Press Ltd.: London.

Shapin, Steve. (1979) "The politics of observation: cerebral anatomy and social interests in the Edinburgh phrenology disputes," in Roy Wallis, ed. On the Margins of Science: The Social Construction of Rejected Knowledge. Sociological Review Monograph, no. 27 (University of Keele). Routledge and Kegan Paul: London.

Small, H. G. (1974) Report on Citation Counts for National Science Foundation Grant Recipients and Non-Recipients. Institute for Scientific Information: Philadelphia.

Thomas, Lewis (1975) The Lives of A Cell. Bantam Books: Toronto.

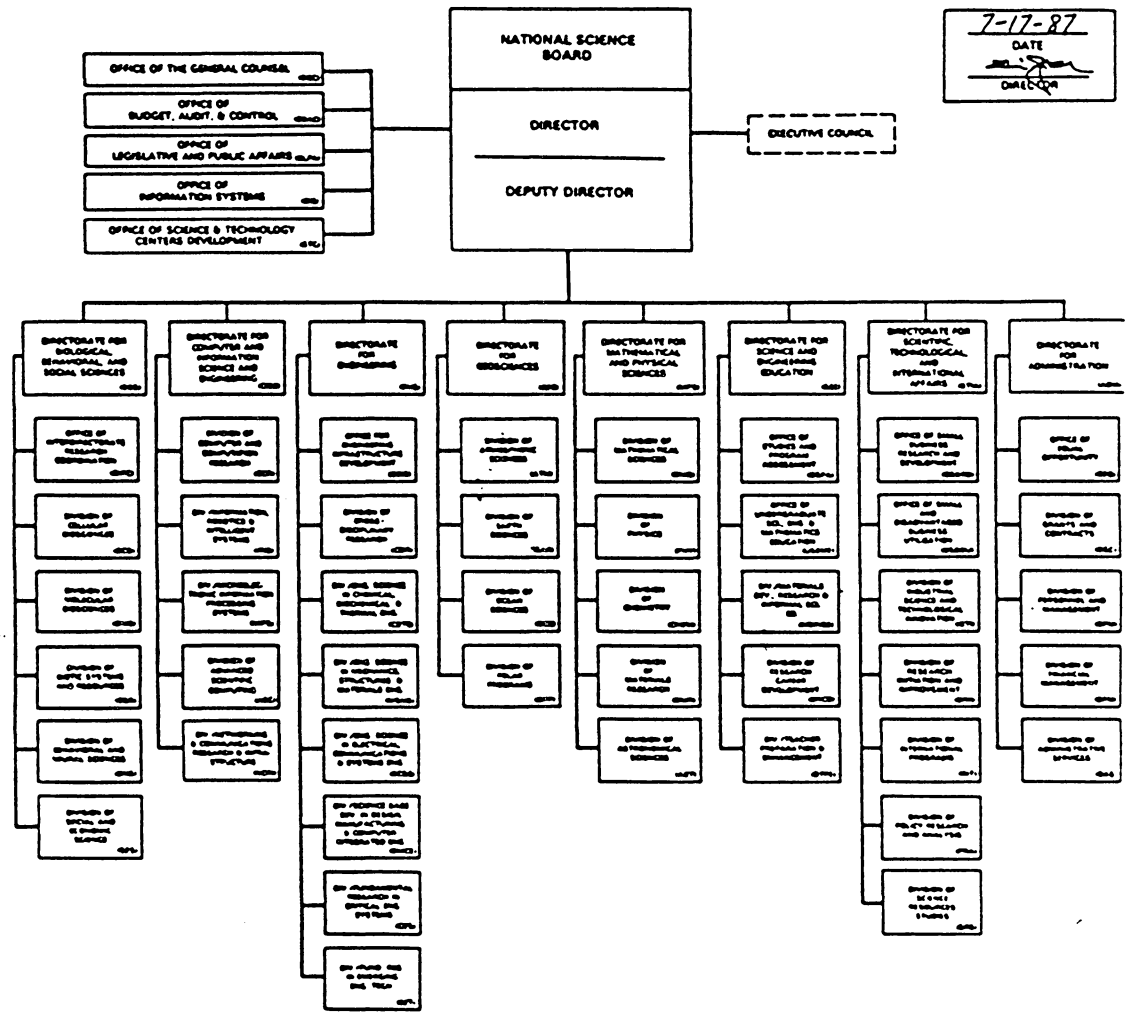
Woolgar, Steve. (1982) "Laboratory Studies: a comment on the state of the art," Social Studies of Science. 12: 481-498.

Yin, Robert K. (1984) Case Study Research. Applied Social Science Research Methods Series, volume 5. Sage Publications: Beverly Hills.

REFERENCES

APPENDIX A

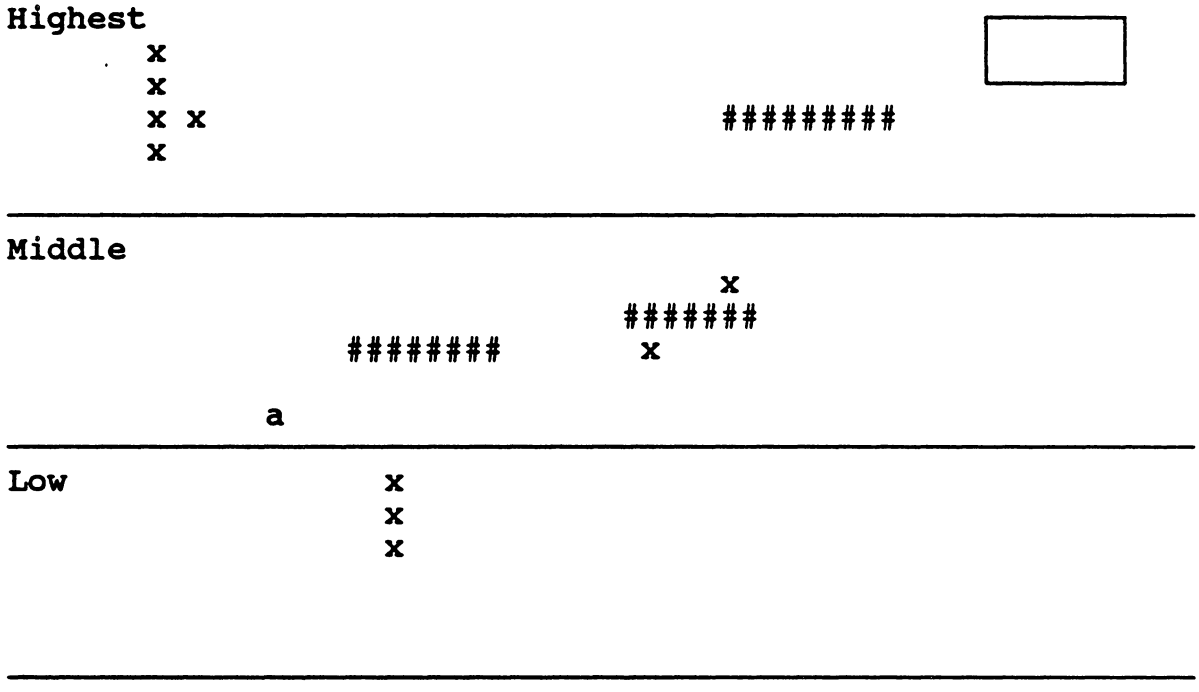
NATIONAL SCIENCE FOUNDATION



APPENDIX B

Example of Easel Taken From 3/2/88 panel

x = before I arrived
a = After " "
[# = crossed out name]



The vita has been removed from the scanned document