Investing in Research Infrastructure in the Behavioral and Social Sciences

DETAILS

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This report has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the Report Review Committee of the National Research Council (NRC). The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making the published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

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NEIL J. SMELSER

CHAIR, COMMISSION ON BEHAVIORAL AND SOCIAL SCIENCES AND EDUCATION

Contents

Executive Summary

In 1997 the National Science Foundation's Directorate of Social, Behavioral, and Economic Sciences (NSF/SBE) began an examination of its funding of research infrastructure. As part of that examination, the Commission on Behavioral and Social Sciences and Education (CBASSE) and other organizations were asked for advice about improving the investment for infrastructure. To help inform its work, CBASSE held a public workshop and invited experts from a wide range of scientific fields to discuss the funding of research infrastructure in the behavioral and social sciences and reviewed previous National Research Council (NRC) reports that have considered infrastructure issues.

The topic of research infrastructure deserves a much more in-depth investigation than can be done given NSF/SBE's time constraints. This report, therefore, is limited to recommendations about process, rather than the many other important issues about research infrastructure.

CBASSE's judgment is that the current process for the selection of infrastructure investment in the behavioral and social sciences at the National Science Foundation should be revised. At present, the selection process used by NSF for the evaluation and selection of infrastructure proposals in the behavioral and social sciences is the same as that for evaluating individual investigator proposals. Yet there are major differences between these two types of proposals in terms of purpose, effective duration, and outcomes. Accordingly, CBASSE recommends that NSF use a different process for the evaluation of infrastructure proposals:

- Criteria used to evaluate behavioral and social science infrastructure proposals should be specific to the strategic and technical purposes of the infrastructure; the current process uses the same criteria for infrastructure proposals and investigator research.
- The duration of infrastructure grants should allow sufficient time for a thorough evaluation of their effectiveness.
- Proposals should include specific, suggested criteria for evaluation of the infrastructure investment at both intermediate and final stages of the grant.

In order to facilitate continual improvement in infrastructure, the investment in it should be systematically measured and managed. CBASSE recommends that NSF/SBE collect data on various kinds of scientific infrastructures so that the information can be aggregated into periodic reports on the overall infrastructure enterprise. CBASSE also recommends that NSF/SBE create an advisory process to focus specifically on changing

research needs, the capacity of current infrastructure to address these needs, the kinds of new infrastructure needed to advance the behavioral and social sciences, and improvements in the infrastructure allocation process.

RESEARCH INFRASTRUCTURE IN THE BEHAVIORAL AND SOCIAL SCIENCES

If the history of science teaches us anything, it is that an infrastructure is an indispensable adjunct to the efforts of individual researchers. . . . In the social sciences, no less than the natural sciences, theoretical advances occur in conjunction with continuous innovations in collective resources for research (Prewitt, 1985:xv, xxi).

Much scientific research is done with tools and resources that are often referred to as research infrastructure. For instance, the Hubble telescope allows astronomers to study the structure of the universe and the origins of galaxies; extremely high-resolution microscopes allow biologists to study the interior of living cells; longitudinal sample surveys allow social scientists to study changes in the demographic characteristics of the population, changes in attitudes, and changes in behavior; functional magnetic resonance imaging allows behavioral and cognitive scientists to study how the brain responds to certain stimuli.

In 1998 the National Science Foundation's Directorate of Social, Behavioral, and Economic Sciences (NSF/SBE) reiterated its continued support for infrastructure investment and expressed an interest in increasing that investment. NSF/SBE asked a number of organizations, including the Commission on Behavioral and Social Sciences and Education (CBASSE) how much of its research funds should be devoted to infrastructure investments and how the its infrastructure investment process might be improved. In support of NSF/SBE's initiative, CBASSE conducted a workshop in November of 1997 to examine improvements that could be made in the funding of research infrastructure for the behavioral and social sciences. (The agenda and attendees are in Appendix A).

Over the years, CBASSE and its predecessor entities at the National Research Council (NRC) have conducted a number of studies related to collective resources for research infrastructure in the behavioral and social sciences. In 1969 and 1989, CBASSE reviews of social and behavioral science progress laid out research infrastructure priorities. In addition, CBASSE's Committee on National Statistics (CNSTAT) has published many reports on infrastructure issues relating to federal data, including questions of confidentiality, strengths of longitudinal data, and data priorities for specific issues such as aging populations. (A list of CBASSE and CNSTAT's recent, relevant publications is in Appendix B.) Several other NRC studies in other sciences have addressed research infrastructure issues (see, e.g., Institute of Medicine, 1990; National Research Council, 1991).

This short report is based on the papers and discussions from the research infrastructure workshop, CBASSE and CNSTAT reports about infrastructure issues, discussions within CBASSE and CNSTAT, and the research experience of the CBASSE

members themselves.

The topic of research infrastructure deserves a much more in-depth investigation than is possible here, given NSF/SBE's schedule to make changes in their investment strategy in research infrastructure this year. This report, therefore, is limited to a discussion of the processes to improve the allocation of scarce funds for research infrastructure in the behavioral and social sciences. This report:

- discusses briefly the definitions and dimensions of behavioral and social science infrastructure;
- summarizes the modest evidence on trends in the investments in infrastructure;
- recommends a selection process and criteria for deciding among infrastructure proposals; and
- suggests changes to facilitate the effective longer-term management of research infrastructure investments for the behavioral and social sciences.

THE IMPORTANCE AND ROLE OF INFRASTRUCTURE

Background

The strategic importance of research infrastructure to the long-term development of the behavioral and social sciences can be illustrated with examples of two of the most important forms of behavioral and social science infrastructure: sample surveys and functional magnetic resonance imaging (fMRI). Scientifically valuable sample surveys are those for which the sample population is of long-term interest and the survey questions have utility for testing theories and hypotheses. A good example of the importance of surveys can be seen in a recent finding from the National Long Term Care Surveys (NLTCS). The NLTCS showed that rates of chronic disability and institutionalization among older people in the United States are falling dramatically: a smaller proportion of older people are disabled, and disabilities among those having functional problems are less severe. In addition, reduction in the rate of disability is actually gaining momentum, even at very old ages (Manton et al., 1997). Longitudinal sample surveys are very important for observing behavior over time. For example, the Health and Retirement Survey (HRS) has shown that households headed by older persons are more likely to give than to receive money (transfers) across generations: 23 percent gave financial gifts of $500 or more to at least one child or grandchild in the preceding 12 months, but only 2 percent received financial assistance from children over a year's time (Population Reference Bureau, 1996). Both of these examples reveal important findings that would have been impossible to discover without the basic infrastructure of sample surveys.

The ability to "image" the structure and functioning of the brain is a fundamental advance that is being vigorously applied to the study of cognition. FMRI is revealing subtle and intriguing structural property changes and abnormalities that occur in disease and aging. Brain imaging techniques can be used to measure such functions as energy metabolism and activity, with studies done while subjects are actively involved in specific tasks or at rest. Such studies shed light on brain functioning during periods of severe dysfunction or relative remission, during treatment with medication, and so forth. Studies of cognitive functioning are revealing both specificity and generality of function: in some cases, specific brain sites are now identified with functions, while in others imaging is showing the distributed properties of functions.

Definitions

Although most researchers directly and indirectly depend on various kinds of infrastructure for their work, there is no formal or comprehensive definition of research infrastructure for the behavioral and social sciences (Johnson, 1997). The workshop participants spent considerable time debating the definition of infrastructure. NSF/SBE defines infrastructure in two main categories. One is multidisciplinary centers:

> They provide an opportunity for bringing together a critical mass of experts interested in common problems such as violence, environmental decision making, or cognitive science. A novel variation on the traditional center is the "virtual center" which is possible via the Internet (Bertenthal, 1998:3).

Second is the much broader category of scientific instrumentation, with the subcategories of: (1) research instrumentation, tools that cost more than $10,000 and (2) research equipment, tools that cost under $10,000. There are at least five subcategories of research instrumentation (Bertenthal, 1998:46).

(1) platforms and observational systems (e.g., neural imaging equipment, observational coding systems);
(2) computational systems (e.g., supercomputers, mass storage devices, visualization systems);
(3) laboratory and analysis systems (electron microscopes, statistical software, image processing);
(4) communications and network systems (vBNS, Internet); and
(5) information systems and databases (digital libraries, large surveys).

The workshop participants discussed other dimensions and alternatives to the NSF/SBE

classification of infrastructure that would include four major components: social, communicative, mechanical, and intellectual (see Johnson, 1997).

Social infrastructure includes the resources needed to promote research collaboration within and among other fields. Various government agencies provide some of this infrastructure by promoting collaboration through joint requests for proposals, interdisciplinary meetings, and travel. Interdisciplinary centers for research are also a critical part of social infrastructure.

Closely aligned with social infrastructure is communicative infrastructure, which includes the Internet and the many other forms of electronic communications. Workshop participants discussed the new availability of scientific reports and some academic journals in electronic formats. Dissemination of research through print journals as well as through professional meetings and specialized briefings is also part of this kind of communicative infrastructure.

Mechanical and intellectual components of infrastructure come closest to the definitions that NSF/SBE uses. Mechanical infrastructure includes such equipment as magnetic resonance imagers and positron emission tomographers, as well as major computer equipment, including supercomputer systems (Edwards, 1997). It also includes many kinds of specialized equipment that different behavioral and social scientists use in their research, such as the equipment anthropologists use to date their field samples and the equipment that linguists use to record and group sounds.

Much of the workshop discussion focused on intellectual infrastructure, which is similar to what NSF/SBE defines as instrumentation/information systems and databases. These databases are critical for a vast amount of the research in both the behavioral and social sciences. Another part of the intellectual infrastructure is the methodological developments essential to the sophisticated analysis of data collected. The development of methodological tools, such as statistical computer programs, facilitate data analysis (Eddy, 1986). “Methodology differs from other aspects of science in that if it remains separate from the rest of the science it serves, the science will atrophy or at least continue to be limited by methodological constraints that in fact have solutions” (Johnson, 1997:4).

Other definitions of infrastructure come from the offices at the National Science Foundation and the National Institutes of Health that fund infrastructure activities across many sciences. The Office of Science and Technology Infrastructure (OSTI) and the National Center for Research Resources (NCRR) have similar definitions of different aspects of infrastructure, but they give different emphasis to different forms. (Appendix C summarizes their definitions of infrastructure). OSTI and NCRR generally have not funded infrastructure in the behavioral and social sciences in the past.

Both existing and other possible definitions of research infrastructure are not mutually exclusive. For example, research centers and data archives may have tools and electronic

networking network infrastructure embedded in them. And, over time, infrastructure needs--and definitions--are likely to change with advances in the sciences, such as the development of new kinds of computers for geographic information systems and new magnetic resolution imagery for studying the brain. With regard to change, a major question arises in the case of databases because of their complexity and the need for historical consistency. "The costs of change would be disproportionately borne by the administrators, while the costs of maintaining the status quo are disbursed across the research community" (Smolensky, 1997:3).

Issues of change and cost are also involved in archiving databases so that they are accessible to the research community. In 1962 the Inter-University Consortium for Political and Social Research (ICPSR) began archiving political and social digital data and making it available to member organizations. ICPSR and other archives face the issues of developing accessible documentation, ensuring the integrity of the data archived and the migration of the files from one electronic medium to another as technology changes (Vavra and Rockwell, 1997). International databases face additional problems of making the data comparable despite differences in national data collection methods and definitions. Another problem is that many datasets in other countries are not publicly available. "There is no international body, or union of national bodies, which supports such an infrastructure [of public use data tapes]" (Smeeding, 1997:13).

The changes in the process of selecting infrastructure investments recommended in this paper would apply to any definition of infrastructure the NSF/SBE wants to use. If NSF/SBE accepts the recommendation to change the current selection process for infrastructure proposals, they will also want to reconsider their definition of what constitutes infrastructure proposals that would be covered by the new process.

Trends in Infrastructure Investments

> There is an implacable law of the economics of knowledge, first stated as far as I know by the German physicist Max Planck; each incremental unit of new knowledge costs more than the last … for a constant increment of gain at the frontier we … find ourselves allocating more and more resources (Kennedy, 1997:11).

Workshop participants spent some time discussing past trends in infrastructure investments. The Methods, Measurement, and Statistics program in NSF/SBE had twice the number of awards in 1996 as the Methods, Measurement, and Data Resources program did in 1980, but it did not have twice the funding. Although the two programs are not strictly comparable (see Levine, 1997), the rough comparison is suggestive because the needs and costs of behavioral and social science infrastructure have been increasing over time.

Looking at the first 65 years of this century, a survey by Karl Deutsch and his colleagues found that only about 25 percent of the major scientific advances in the behavioral

and social sciences required intensive capital investments in the first three decades of the century; in the next 35 years, 62 percent of the major scientific advances rested on intensive capital investments (Deutsch et al., 1971).

> The perception of social science work as cheap--a notion that is widespread among laymen and some university administrators--seems based on the experiences before 1930, when only one-fourth of all major social science contributions required major amounts of capital. Since 1930 more than three-fifths of all contributions have required relatively large amounts of capital, particularly for survey research and large scale tabulations, and this proportion seems likely to increase in the future. If explicit quantitative results are desired, the requirement for capital support becomes still stronger. Low-budget research, the work of lone individuals, or work on nonquantitative topics may play a smaller and smaller role. The industrial revolution in the production of knowledge has not only reached a large part of the natural sciences but has reached the social sciences as well (P.457).

The workshop participants agreed with Featherman (1997) that the Deutsch article needs to be updated to give a more current analysis of behavioral and social science trends in research infrastructure. There are only a few studies that have looked specifically at infrastructure issues in behavioral and social sciences.

Almost 30 years ago, the Committee on Science and Public Policy (of the National Academy of Sciences) and the Social Science Research Council (1969) published a study of outlook and needs in the behavioral and social sciences. Much of the research infrastructure needs specified in the report focused on data issues. But the study also used a questionnaire of academic departments in universities to estimate the cost of research equipment per full-time-equivalent faculty member and by discipline within the behavioral and social sciences. (Psychology had the highest per faculty cost; political science and history had the lowest.) The report also estimated the space requirements of behavioral and social science academic departments and the cost of computer service per department. (Agricultural economics departments had the highest computer cost per department and anthropology had the lowest.) The report estimated that costs for research equipment would increase 56 percent during the next decade.

In a study of research frontiers 10 years ago, experts in 30 different areas of behavioral and social science research described not only recent scientific advances, but also what would be needed to ensure future progress (Luce et al., 1989). The most frequently mentioned recommendations were for more infrastructure, such as computer resources, computerized data bases, longitudinal surveys, and interdisciplinary research centers. In no discipline was the existing infrastructure considered to be adequate for future scientific work.

More recently, specific information on selected research infrastructure comes from three separate NSF surveys--on academic facilities, research instruments, and research

instrumentation. These three surveys are taken in different years and, therefore, provide a blurred rather than a focused snapshot of the distribution of research infrastructure in the behavioral and social sciences. They suggest that the behavioral and social sciences have received about 2 percent of the total research expenditures for facilities, equipment, and instrumentation in the early 1990s: see Table 1. It is impossible to say whether that is an appropriate percentage without relating current levels with needs in the behavioral and social sciences and then doing a similar analysis across the other sciences. But it is possible to suggest that survey data that could be aggregated to give more focused details on the facilities, instruments, and instrumentation resources in the behavioral and social sciences would help make the future decision process on research infrastructure more informed.

The fragmentation of information on infrastructure investments in the behavioral and social sciences is exacerbated by the lack of any comprehensive data on data infrastructure itself. The biggest data collector in the country is the federal government because of the critical importance of public information and data required to organize and manage a modern government, economy, and society. NSF has a small but essential role in developing this behavioral and social science infrastructure by supporting innovative datasets, especially prototypes and new statistical measurement research. NSF also encourages research data collection that other government agencies would not fund: such investment exploits the original federal investment in data and provides intellectual leadership to the federal government and the research community. A systematic collection of data on infrastructure investments in data itself would be important to help NSF/SBE to make decisions on allocating their resources for research infrastructure most effectively.

Currently, NSF/SBE's investment in all infrastructure activities represents 15–17 percent of the NSF social, behavioral, and economic research budget (Butz, 1997). The Directorate has publicly asked whether this is the right percentage: many workshop participants felt--and CBASSE members agree--that this is not the right question. There are several necessary prior questions: What is the current infrastructure doing? How are the sciences developing? Where are the research opportunities? How much infrastructure is needed to address the most important scientific questions. This report does not attempt to answer these questions; it does recommend a process by which they can be realistically addressed.

SELECTION PROCESS FOR RESEARCH INFRASTRUCTURE PROJECTS

Current Process and Possible Modifications

The current selection process for infrastructure proposals is virtually the same as that for individual investigator proposals at NSF: see Exhibit 1. The key fact is that proposals for research infrastructure compete directly with other proposals for research (on the same basis and at the same time), although there are systematic differences between infrastructure and

TABLE 1 Expenditures for Research Infrastructure for Social Sciences and Psychology as a Percentage of Expenditures for Research Infrastructure Expenditures for all Sciences, circa mid-1990s

Category of Infrastructure	Social Sciences	Psychology
Public and private research and development expenditures at academic institutions (1994)[a]	5.4%	2.0%
Research facilities expenditures (1996–1997)[b]	1.8%	1.2%
Scientific equipment expenditures (1994)[a]	2.5%	1.5%
Instrumentation expenditures (1993)[c]	*	*
Total, circa 1993–1997[d]	1.4%	1.0%

* Too small to be listed.

[a] Data from National Science Foundation/SRS, Survey of Scientific and Engineering Expenditures at Universities and Colleges: 1994.

[b] Data from National Science Foundation/SRS, Survey of Scientific and Engineering Research Facilities at Universities and Colleges: 1996.

[c] Data from National Science Foundation/SRS, Survey of Academic Research Instruments and Instrumentation Needs: 1993.

[d] This is the percentage of total expenditures for facilities, equipment, and instrumentation as reported in the above surveys that is spent on the social sciences and psychology.

Exhibit 1 Current Review Process for Infrastructure Proposals (and Investigator Proposals) in the Behavioral and Social Sciences at the National Science Foundation

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Timing

Proposals are reviewed twice a year at the same time as investigator proposals.

Criteria

1) What is the intellectual merit of the proposed activity?
2) What are the broader impacts of the proposed activity?

Reviewers

Independent external reviewers submit written reviews. Two panel members also prepare independent reviews. Advisory panels discuss independent reviews and write a panel summary.

Priority Recommendation

Advisory panel members base priority ranking on written reviews and panel discussions with varying kinds of possible summary ratings depending on the panels.

Funding Recommendation

Funding is based on the NSF program director's judgment informed by the panel and outside reviews generally.

Duration

1-5 years with most grants for 3 years or under.

Page Requirements

15 pages

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investigator proposals. Those differences include three major factors:

- The scientific outcomes from investments in behavioral and social science infrastructure create knowledge, data, and methods that can be publicly shared at little cost among many researchers. This distinction applies both to the generation of very large sets of cross-sectional and longitudinal data and to the qualitative advances of knowledge generated in collaborative and interdisciplinary settings provided by centers, institutes, and scientific conferences.
- Proposals for infrastructure facilities and instrumentation are usually more costly to funders than grants to individual researchers pursuing discrete projects. (If the former were calculated on a per user basis, however, they might be a bargain.) Accordingly, the necessary collective resources for infrastructure are more difficult to mobilize than those for individual research grants.
- Infrastructure investments typically require a longer time to reach full productivity than investments in discrete individual-investigator research proposals.

These differences helped frame the workshop discussion and CBASSE's conclusion that differences between infrastructure investments and individual research grants should be reflected in a revised selection process for behavioral and social science research infrastructure. Although infrastructure proposals are qualitatively different from investigator research proposals, they are also complementary. Many individual proposals hinge on past and current infrastructure investments, which makes the selection process crucial for future research.

Workshop participants discussed the current and various possible modifications of the current process of funding research infrastructure. One approach is simply to continue the current situation, in which proposals for infrastructure compete directly with individual research grants. This inevitably raises the question: “How many individual research projects could we support if we did not support this infrastructure proposal?” This approach involves comparability difficulties because it does not recognize the differences between individual research and infrastructure activities outlined above.

A second approach would have proposals for infrastructure compete among a number of existing infrastructure activities. This would not have the comparability problems between infrastructure and individual research and might seem appropriate if a ceiling on infrastructure expenditures existed. But it would create other comparability problems because of the different dimensions of infrastructure, such as new data surveys and new research centers.

A third approach somewhat expands the second one: proposals for infrastructure would involve a competition among existing and proposed infrastructure activities that address similar purposes. This approach might seem appropriate if there is a ceiling on infrastructure

expenditures for specific purposes. But it would generate other comparability issues, for example, between existing infrastructure with considerable past investments and track records and new proposals with no historical experience.

Recommended Selection Process

In the opinion of CBASSE members, behavioral and social science research infrastructure is too important to the long-term development of the sciences to continue to be funded under the current process used for individual research grants. Rather, a separate selection process for infrastructure proposals should be developed, one that is consistent with the characteristics of research infrastructure. The development of a new process would include modifications to the current funding cycles, project duration, criteria for evaluation, and selection criteria. CBASSE offers these recommended changes to the selection process for NSF's Directorate for Social, Behavioral, and Economic Sciences.

Funding Cycles

Workshop participants discussed the strengths and weaknesses of making decisions about infrastructure investments serially (see Suzman, 1997). Currently, individual infrastructure projects have different cycles for review, renewal, or termination; they depend on when the project was first funded. Changing the current system to recompeting all infrastructure at the same time would create an unnecessary and inefficient hiatus in research and might overload the research management or fiscal structure. Instead, there would be different timing for directly competing activities and for new activities. If some researchers or institutions want to compete explicitly with an existing infrastructure project, they would need to submit a competing proposal at the time of renewal for the existing project. New proposals that are not substantively competitive with current projects would be submitted in any funding cycle.

Project Duration

The current duration for individual and infrastructure research grants in NSF/SBE is 3–5 years. That span is usually not long enough to evaluate the long-term productivity of many infrastructure projects, so grants for infrastructure should be lengthened to reflect the time it takes for them to become effective investments. And since the appropriate duration of an infrastructure grant is likely to vary, no single time frame should be applied to all proposals: part of the grant application process should include the applicant's proposal for an appropriate duration for the grant and schedules for interim reviews. Reviewers of the proposal would be asked to suggest appropriate duration to the funding agency, which would make the final decision.

Evaluation Criteria

Currently, the implicit evaluation criteria of an existing infrastructure project is whether the project is actually functioning and being used. But more detailed criteria would give both the funders and grantees more specific goals for the investment. Thus, CBASSE recommends that grant applicants be required to propose criteria for both interim and final evaluations, and reviewers should also be asked to suggest criteria. NSF/SBE should adopt evaluation criteria at the beginning of every infrastructure project to help guide a thoughtful evaluation at the end.

Selection Criteria

> Presently there is no widely accepted way for the Federal government in conjunction with the scientific community to make priority decisions about the allocation of resources in and across scientific disciplines…. Whenever there is some amount of comprehensive coordination and decision-making, it is supremely important that the criteria of choice be appropriate. There is no virtue in doing the wrong thing efficiently. Any scheme of oversight must begin with explicit discussion of and agreement about the goals to be achieved. (National Science Board, 1998:1,7).

Workshop participants discussed in some detail the need to have infrastructure proposals judged on criteria that are appropriate for each infrastructure project. They also discussed illustrative criteria for selecting infrastructure projects. In general, the participants agreed that each proposal for scientific infrastructure needs to address long-term strategic scientific questions and be able to meet technical requirements to answer these questions. Both aspects, moreover, should be outstanding to merit funding. The criteria for assessing the strategic and technical parts of the proposal should, therefore, include strategic and technical criteria.

For evaluation of the strategic aspects of infrastructure projects, illustrative criteria for evaluation might include (Levine, 1997:5):

- scientific justification: How likely is it that the data will stimulate research leading to important discoveries … extending to other fields? How likely is it that the data will stimulate research leading to significant improvements or innovations in investigative methods?
- general utility. Will the knowledge forthcoming from research utilizing these data justify the large investment in collecting them?
- demand. What is the probability that the project will result in research

proposals to NSF? To NIH or other agencies?

For evaluation of the technical aspect of research infrastructure projects, illustrative criteria might include:

- the availability of the infrastructure (whether center, equipment, or electronic network) for individual researchers in multiple disciplines and the expected rate of use of the infrastructure;
- the ability of the proposing group to administer the proposed infrastructure activity responsibly, efficiently, and effectively; and
- the relationship of the proposed project's cost to the importance of the questions to be addressed and to the costs of other infrastructure projects.

Each kind of infrastructure project in the behavioral and social sciences should also meet specific criteria. For example, proposals for data infrastructure would have a necessary condition that all data be clearly documented and made publicly available. Other specific questions for data infrastructure proposals could follow guidelines previously recommended by the NRC (National Research Council, 1996):

- Are survey measurement methods relevant, valid, advanced, and novel?
- Do the data fill a niche that is unfilled by other datasets?
- Will the data be linked or integrated with other data sources?

Because infrastructure organizations typically involve a social structure (laboratory, center, organized research unit), the leadership, division of labor among investigators, pattern of reporting, effectiveness of support staff, and communication capacity with other organizations should be evaluated, possibly by site visits. This dimension of institutional effectiveness has been used in the evaluation of different kinds of national laboratories, and there is good reason to believe that such questions can be valuable in evaluating other infrastructure organizations as well.

Other specific criteria for evaluating organizational infrastructure projects such as research centers might include:

- scientific excellence and promise, which involves primarily, but not exclusively, the quality of the behavioral and social science personnel involved and the quality of a steering committee to oversee the major projects;

- the demonstrated or promised capacity to adapt, as installations, to different scientific requirements, needs, and opportunities; and
- assessment of the balance between investment in *existing* facilities and the start-up costs of *new* facilities.

These criteria are illustrative of the kinds of issues that should be addressed in evaluating proposals for what can be called the intellectual research infrastructure. Specific criteria should also be developed for proposals for other kinds of infrastructure, such as equipment and instrumentation. The development of criteria specific to infrastructure that recognizes its strategic and technical nature is what is important in improving the resource allocation process.

CBASSE recognizes that the proposal and review process described above will be more demanding and more time-consuming than the current selection process for infrastructure projects. But given the strategic importance of infrastructure investment and the relative longevity of the investment, more rigor in the selection process is appropriate.

EFFECTIVE MANAGEMENT OF THE INVESTMENTS IN RESEARCH INFRASTRUCTURE

Workshop participants discussed the longer-term issues of how to improve the management of all investments of research infrastructure in the behavioral and social sciences. They noted the increase in behavioral and social science infrastructure in the private sector, especially private opinion and marketing surveys. They also discussed the need for improvement of the federal infrastructure for the support of research infrastructure in the social and behavioral sciences. But a number of participants said that improving the management of behavioral and social science infrastructure investment is not the sole responsibility of the sponsors of research, who have neither the human nor the financial resources to manage the entire social and behavioral science infrastructure and research portfolio. One suggestion discussed at the workshop was for a new organization:

> …[to have a number of social science organizations] collaborate in appointing a Standing Committee on Social Science Infrastructure. We need a continuous process of identifying and monitoring the status of our infrastructure … and to have "a subcommittee of the Standing committee focus on the domestic databases and the data collection enterprise that collects them.… Elements of data infrastructure, including the long-term databases or time series, should be evaluated regularly (Featherman, 1997:2).

Other scientific research communities have assumed some responsibility for monitoring, analyzing, and evaluating their infrastructure investments (see Institute of Medicine, 1990; National Research Council, 1991). In order to maximize the continuing

effectiveness of any changes that NSF/SBE makes to the process of infrastructure investments, CBASSE suggests that NSF/SBE develop an advisory process to focus specifically on improving the allocation of research infrastructure investments in the behavioral and social sciences.

The responsibilities of this proposed advisory process could include (see Fischhoff, 1998):

- identifying the evolving new research opportunities in the behavioral and social sciences;
- assessing the appropriateness of current infrastructure in the behavioral and social sciences for addressing those opportunities, that is, the pattern of infrastructure investments rather than the evaluation of specific projects;
- proposing new kinds of research infrastructure that might be needed to address the identified new opportunities; and
- proposing improvements in the way allocation decisions are made, using the methods from statistical decision theory, economics, operations research, and management science for thinking about the importance of different research activities and how to choose among them.

An advisory process could provide open meetings to gather information, establish a web site to receive comments from researchers across the country, and produce periodic reports on research infrastructure in the behavioral and social sciences. The Advisory Council to the NCRR at NIH produces a strategic plan once every 4 years and measures how much of the previous strategic plan's goals have been achieved. This may be a process that NSF/SBE could effectively adopt, either with its current advisory committee or some other process. Optimally, the advisory process would help NSF accomplish its goals of vitalizing the research infrastructure in the behavioral and social sciences.

In the course of the workshop discussions and CBASSE's subsequent deliberations, a number of substantive questions arose that could not be addressed in this short report. For example:

- What should be the long-term relationship between the NIH and NSF units that explicitly fund infrastructure projects outside behavioral and social sciences (NCRR and OSTI, respectively) and NIH and NSF funders of infrastructure investments in the behavioral and social sciences?
- What have been the successes and failures of behavioral and social science infrastructure investments in other countries?

- When does the funding of research centers accelerate the development of interdisciplinary research and under what conditions is it less effective?
- How can the scientific tools of risk analysis, value-of-information analysis, and integrated assessments be applied to the selection process for infrastructure proposals to improve the process and the scientific outcomes?

CONCLUSION

This report has focused on how to change the process of selecting infrastructure research projects in the behavioral and social sciences at NSF. At present, the selection process used by NSF for the evaluation and selection of infrastructure proposals in the behavioral and social sciences is the same as that for evaluating individual investigator proposals. Yet there are major differences between these two types of proposals in terms of purpose, effective duration, and outcomes. Accordingly, CBASSE recommends that NSF use a different process for the evaluation of infrastructure proposals.

- the criteria used to evaluate behavioral and social science infrastructure proposals should be specific to the strategic and technical purposes of the infrastructure;
- the duration of infrastructure grants should allow sufficient time for a thorough evaluation of their effectiveness; and
- proposals for infrastructure projects should include suggestions for specific criteria for their evaluation at both intermediate and final stages of the project.

In order to facilitate continual improvement in infrastructure, the investment in infrastructure should be systematically measured and managed. Therefore, CBASSE suggests that NSF/SBE collect data on various kinds of scientific infrastructure for aggregation into periodic reports. CBASSE also suggests that NSF/SBE create an advisory process to focus specifically on changing research needs in the behavioral and social sciences, the capacity of current infrastructure to address these needs, the kinds of new infrastructure needed to advance these sciences, and improvements in the infrastructure allocation process.

In 1976 an NRC committee studying the social sciences in the NSF concluded:

> In suggesting that there are major needs and opportunities, not now being met, for supporting large scale and long-term research, the Committee (on Social and Behavioral Science Programs in the National Science Foundation) is not proposing that the Foundation (NSF) depart from its basic practice of supporting the best-conceived, best-justified projects that come to it as unsolicited proposals. On the contrary, we believe that a considerable volume

of good proposals for large-scale and long-term research would come to the Foundation if it were perceived as interested in entertaining them (National Research Council, 1976:44.)

CBASSE members are convinced that this earlier finding is still relevant today.

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Appendix A

Workshop: Decision-Making for Research Infrastructure in the Behavioral and Social Sciences

November 13, 1997
National Academy of Sciences
2101 Constitution Avenue, N.W., Washington, D.C.
AGENDA

Discussion	Presenter(s)
10:00 Introduction	*Baruch Fischhoff,* CBASSE Moderator
I. Decision-Making Process for Infrastructure Issues and Priorities	*William Butz,* National Science Foundation
II. Decision-Making Process for Specific Types of Infrastructure	*David Featherman,* University of Michigan
A. Domestic Data Collection	*Robert Hauser,* University of Wisconsin
	Norman Bradburn, NORC, University of Chicago
	Howard Silver, Consortium of Social Science Associations
	Felice Levine, American Sociological Association
12:30–1:00 Lunch in Meeting Room	
1:00–4:00	*Timothy Smeeding,* Syracuse University
B. International Data Collection	
C. Archives	*Richard Rockwell,* University of Michigan
D. Centers	*Eric Wanner,* Russell Sage Foundation
E. Research Dissemination	*Richard Suzman,* National Institutes on Aging
F. Labs and Other	*William Howell,* American Psychological Association
	David Johnson, Federation of Psychological, Behavioral, and Cognitive Sciences

III. Returning to the Decision-Making Process for Behavioral and Social Sciences Infrastructure Issues and Priorities

Bennett Bertenthal, National Science Foundation

Wendy Baldwin, National Institutes of Health

Kenneth Prewitt, Social Science Research Council

PARTICIPANTS

Douglas Anderton, Social and Demographic Research Institute, University of Massachusetts, Amherst, MA.

Christine Bachrach, National Institute of Child Health and Human Development, Bethesda, MD.

Wendy Baldwin, Deputy Director, Extramural Research, National Institutes of Health, Washington, DC.

Bennett Bertenthal, Assistant Director, Social, Behavioral, and Economic Sciences Directorate, National Science Foundation, Arlington, VA.

Norman Bradburn, National Opinion Research Center, University of Chicago, Chicago, IL.

William Butz, Division Director, Division of Social, Behavioral, and Economic Science Research, SBER, National Science Foundation, Arlington, VA.

Cheryl Eavey, Director, Program on Methodology, Measurement, and Statistics, SBER, National Science Foundation, Arlington, VA.

Eugenia Grohman, Associate Director for Reports, Commission on Behavioral and Social Sciences and Education, National Research Council, Washington, DC.

David Featherman, Institute for Social Research, University of Michigan, Ann Arbor, MI.

Baruch Fischhoff, Department of Social and Decision Sciences, Carnegie Mellon University Pittsburgh, PA.

Robert Hauser, Institute for Research on Poverty, University of Wisconsin, Madison, WI.

William Howell, Executive Director for Science, American Psychological Association, Washington, DC.

David Johnson, Executive Director, Federation of Psychological, Behavioral and Cognitive Sciences, Washington, DC.

Alan Kraut, Executive Director, American Psychological Society, Washington, DC.

Felice J. Levine, Executive Director, American Sociological Association, Washington, DC.

Rose Maria Li, DBSB/CPR, National Institute of Child Health and Human Development, Bethesda, MD.

Joan Lucariello, American Psychological Society, Washington, DC.

Eleanor Maccoby, Department of Psychology, Stanford University, Stanford, CA.

Charles Manski, Department of Economics, Northwestern University, Evanston, IL.

Norman Metzger, Executive Director, Commission on Physical Sciences, Mathematics, and Applications, National Research Council, Washington, DC.

Robert Moffitt, Department of Economics, Johns Hopkins University, Baltimore, MD.

Daniel Newlon, Program Director, Economic, Decision, and Management Sciences, SBER, National Science Foundation, Arlington, VA.

Kenneth Prewitt, President, Social Science Research Council, New York, NY.

Richard Rockwell, Institute for Social Research, University of Michigan, Ann Arbor, MI.

Catherine E. Rudder, Executive Director, American Political Science Association, Washington, DC.

Howard Silver, Executive Director, Consortium of Social Science Associations, Washington, DC.

Timothy Smeeding, Center for Policy Research, Syracuse University, Syracuse, NY.

Neil Smelser, Center for Advanced Study in the Behavioral Sciences, Stanford, CA.

Miron Straf, Director, Committee on National Statistics, National Research Council, Washington, DC.

Richard Suzman, Director, Office of Demography of Aging, National Institute on Aging, Bethesda, MD.

Barbara Boyle Torrey, Executive Director, Commission on Behavioral and Social Sciences and Education, National Research Council, Washington, DC.

Eric Wanner, President, Russell Sage Foundation, New York, NY.

Appendix B

Commission on Behavioral and Social Sciences and Education Selected Reports that Dealt with Infrastructure Issues

Committee on National Statistics (CNSTAT)

Providing National Statistics on Health and Social Welfare Programs in an Era of Change: Summary of a Workshop, 1998.

Small-Area Estimates of School-Age Children in Poverty: Interim Report 2--Evaluation of Revised 1993 County Estimates for Title 1 Allocations, 1998.

The Bureau of Transportation Statistics: Priorities for the Future, 1997.

Preparing for the 2000 Census: Interim Report II, 1997.

Assessing Policies for Retirement Income; Needs for Data, Research, and Models, 1997.

Statistics on U.S. Immigration: An Assessment of Data Needs for Future Research, 1996.

Integrating Federal Statistics on Children: Report of a Workshop, 1995.

Modernizing the U.S. Census, 1994.

Private Lives and Public Policies: Confidentiality and Accessibility of Government Statistics, 1993.

Disability Statistics: An Assessment, 1990.

Income and Poverty Statistics: Problems of Concept and Measurement, 1988.

Creating a Center for Education Statistics: A Time for Action, 1986.

Sharing Research Data, 1985.

Commission on Behavioral and Social Sciences and Education (CBASSE)

Leading Edges in Social and Behavioral Sciences, Luce, R. Duncan, Neil J. Smelser, and D. Gerstein, eds., 1989.

Behavioral and Social Science Research: A National Resource, Robert McC. Adams, Neil J.

Smelser, and Donald J. Treiman, eds., Committee on Basic Research in the Behavioral and Social Sciences, 1982.

The Federal Investment in Knowledge of Social Problems, Volume 1, Study Project on Social Research and Development, 1978.

The Funding of Social Knowledge Production and Application: A Survey of Federal Agencies, Study, Volume 2, Study Project on Social Research and Development, 1978.

Studies in the Management of Social R&D: Selected Policy Areas, Volume 3, Study Project on Social Research and Development, 1978.

Social and Behavioral Science Programs in the National Science Foundation: Final Report, Committee on the Social Sciences in the National Science Foundation, 1976.

Appendix C

Other Definitions of Research Infrastructure

The National Science Foundation established an Office of Science and Technology Infrastructure (OSTI) that funds such activities as:

- science and technology centers;
- major research instrumentation
- awards for the integration of research and education, early career awards, and model institutions of excellence (see National Science Foundation, 1998).

Almost all of the infrastructure funded by OSTI is in scientific fields other than the behavioral and social sciences.

The National Institutes of Health's (NIH) National Center for Research Resources (NCRR) provides “a comprehensive range of human, animal, technical, and other resources to enable biomedical research advances.” One of NCRR's eight objectives is to improve and maintain the nation's biomedical research infrastructure which includes:

- research tools and technologies;
- collaboration among scientists;
- science education and the public's understanding of science;
- enhanced capacity of mathematical modelling and bioinformatics; and
- construction and renovation of research facilities (National Institutes of Health, 1998).

These definitions of research infrastructure both differ somewhat in emphasis but include research instrumentation and research centers. But the NCRR and OSTI definitions also include science education. And the NCRR and the NSF/SBE directorate definitions explicitly mention information, i.e. bioinformatics and widely shared databases respectively.