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Workshop on Planning, Monitoring, and Evaluation of Research and Technology in Indonesia

Summary Report

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Workshop on Planning, Monitoring, and Evaluation of Research and Technology in Indonesia

Summary Report

Jakarta, Indonesia
August 23–26, 1983

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INTRODUCTION

In early 1983, Professor Sukadji Ranuwihardjo, assistant minister for policy coordination, Ministry of State for Research and Technology (MSRT), and Dr. Achmad Amiruddin, then deputy to the chairman of the Agency for the Assessment and Application of Technology (BPPT), expressed interest in meeting with appropriate U.S. officials involved in research and technology planning during their May 1983 visit to the United States. It was thus decided that the Board on Science and Technology for International Development (BOSTID) would arrange a brief ad hoc seminar for invited U.S. experts and the Indonesian visitors. The discussions at this seminar, which was held in Washington, D.C., May 5-6, 1983, centered on how science and technology is planned and coordinated in the United States at the national level, within specific government agencies, at profit-making and nonprofit institutions, within university R&D institutes, and in private industry.

The Jakarta workshop that is the subject of this report was the outgrowth of the ad hoc seminar. This report begins therefore with a brief review of the Washington seminar, followed by a full report on the workshop held in Indonesia the following August.

AD HOC SEMINAR, WASHINGTON, D.C.

The ad hoc meeting held in Washington, D.C., was chaired by William A. W. Krebs, vice president of Arthur D. Little, Inc., and a member of BOSTID, with the participation of the following:

Dr. Domenic Bitondo, president, Bitondo Associates, and staff consultant, University of Michigan

Dr. Ronald Black, director, Office of International Programs, Denver Research Institute

Dr. Mary Carter, associate administrator, Agricultural Research Service, U.S. Department of Agriculture

Dr. George R. Herbert, president, Research Triangle Institute

Dr. H. Guyford Stever, chairman, Commission on Engineering and Technical Systems, National Research Council

Dr. Donald Senich, director, Division of Industrial Science & Technological Innovation, National Science Foundation

Dr. Duane Sunderman, Battelle Columbus Laboratories

Professor Sukadji and Dr. Amiruddin opened the seminar by describing science and technology institutions in Indonesia and the specific responsibility of each (see Appendix A). Dr. H. Guyford Stever then sketched for participants the overall planning and coordination of science and technology in the United States at the national level (see Appendix A). His remarks set the stage for subsequent presentations and discussions on science and technology in the United States.

While no general recommendations or conclusions were formulated as such, the U.S. participants outlined a set of principles that they believed would be useful to the Indonesians in trying to design their own mode of operations for planning and coordinating research and technology:

- Research and technology planning and priority setting should be an open process and should include a broad spectrum of representatives of government, industry, academia, etc., who are brought in early in the planning process.

- Advisory committees should be established representing the stakeholders who will be affected by the planning process. While the membership of the committees should be essentially stable, some turnover in membership may be desirable.

- It is important to ensure that industry--which will eventually implement the technology--is involved early in the research process.

- A research effort or facility should be established only after a need has been clearly defined. Any process should be started slowly and be well managed in order to establish models for new initiatives.

- Management of the research and technology effort should include development of a "middle-management" structure.

- An appropriate reward structure should be established (over and above the pay scales). For example, scientists should participate in the return gained from a scientific initiative, perhaps in the form of increased pay, enhanced position, further research opportunity, needed equipment, publication opportunities, etc.

- Evaluation and assessment should be built into any research initiative to focus management, resources, output (scientific) and other evaluative measures. The assessment should be carried out by individuals well versed in the methodology.

- Research proposals should be evaluated by academic and industrial peers, and the process should not be politicized. If it is, the system will fail.

- The government should be used to "seed" a new initiative, but long-term funding should be sought from private, international, or other sources.

- Technology transfer should be built into any new research plan and coordinated at all levels of management. It has been proven that research and technology are less effective when there is no attempt to transfer knowledge.

JAKARTA WORKSHOP

Following the Washington seminar, Professor Sukadji, assistant minister for policy coordination, MSRT, asked the U.S. National Research Council through BOSTID to cosponsor a workshop in Jakarta on planning, implementation, and evaluation of research and technology, mainly at the national level. Specifically, this workshop was intended to examine methodologies for deriving a research and technology plan from the relevant portions of the fourth 5-year development plan (REPELITA IV) and to discuss how different methods of planning, implementation, monitoring, and evaluation can be used as a basis for the next year's planning.

This workshop was one activity in a larger program of cooperation between BOSTID and the Indonesian government. Begun in 1968, the program has featured a series of workshops on food policy, industrial and technological research, natural resources, rural productivity, and manpower planning. Since 1978, BOSTID's participation has been supported in the context of a science and technology loan from the U.S. Agency for International Development (USAID) to the government of Indonesia. The program with BOSTID calls for two or three activities (panel discussions, workshops, seminars, or small advisory groups) to be organized each year.

Organization of the Jakarta Workshop

The workshop was held in Jakarta, Indonesia, August 23-26, 1983, following a day of site visits to Bandung, the Ministry of Agriculture, and to appropriate offices in the Indonesian Institute of Sciences (LIPI). Workshop chairman Professor Sukadji opened the meeting by informing participants of the government's need to refine the basic criteria for

planning, monitoring, and assessing all research and technology activities in Indonesia (Appendix B). After the response by NRC chairman Dr. F. Karl Willenbrock, a series of papers were presented by the U.S. participants describing research and technology in the U.S. government, specifically in the National Science Foundation and the Department of Agriculture. A presentation was also given on how a method of detailed project planning used by U.S. industry might be applied in Indonesia (Appendix C).

Mrs. A. S. Luhulima from the Indonesian Institute of Sciences then reviewed the R&D organization in the government sector in Indonesia. She was followed by officials from the Ministry of Health and the Agency for Agricultural Research and Development who described research and development in their respective institutes (Appendix D).

All workshop participants (see Appendix E) then focused on three specific topics relating to research and technology:

1. Planning
2. Implementation
3. Evaluation

On the third day, brief working group sessions were held to draft conclusions reached in the three areas; they were presented the following day to all workshop participants for comments. These conclusions are presented in this report as a summary of the workshop.

This meeting provided an exceptional opportunity to involve in the discussions MSRT and BPPT staff and representatives of other ministries and agencies who have an interest in research and technology implementation, monitoring, and evaluation. BOSTID's participation was intended not only to provide the U.S. experience in these areas, but also to inject the perspective of outside views of the policies and plans currently being drafted by the government of Indonesia. In this regard, the Indonesian chairman and U.S. participants met with Dr. B. J. Habibie, minister of state for research and technology and chairman of the Agency for the Assessment and Application of Technology, late in the third day of the workshop to present the preliminary results.

This workshop report was prepared by BOSTID staff officer Rose Bannigan using papers written by the Indonesian and NRC participants. The final draft was reviewed and approved by the members of the NRC panel and the Indonesian steering committee. Sabra Bissette Ledent, BOSTID consultant, edited the report. Grace Kulnarong assisted with the artwork, and Irene Martinez prepared the final version for publication.

SUMMARY OF WORKSHOP SESSIONS

This section summarizes the conclusions of the participants of the Jakarta workshop that arose from their discussion on planning, implementation and monitoring, and evaluation of research and technology. Also included here is a summary of discussions that focused on problems that arise in undertaking research and technology efforts.

PLANNING RESEARCH AND TECHNOLOGY PROGRAMS

The overall success of a project depends heavily on having a well-conceived, comprehensive, and detailed initial project plan. The elements of a well-designed project follow:

Prelude

A good plan begins with an examination of national goals, a recognition of which unit of the national R&D matrix is being addressed, and an understanding of the mission of the organization that is to conduct the program. Further, adequate development of the strategy to be used to address the problem is stressed.

In the initial planning period, actions should not be decreed by management but rather should result from an interactive dialogue between management and scientific specialists in which they propose and debate alternative views of and approaches to the problem. This dialogue must include the individuals who will develop the solution (the problem solvers) and those who will manufacture or have manufactured any equipment needed to implement the solution. Through this dialogue, they will agree on an approach that will likely yield the most cost-effective solution to the problem, a clear definition of the "Why?" of the problem, and an understanding of how--and how much--the solution will contribute to the specific national goal(s).

Plan Outline

A proper project plan includes the following elements.

Title. A clear, concise statement of the subject is formulated.

Background. This statement includes baseline data to define surrounding conditions and facets of the problem as well as a review of literature on state of the art, both domestic and foreign. The views and findings of peers in other organizations working in similar fields are reflected to assure an adequate picture of the current situation and avoidance of duplication. The use of consultants may be appropriate.

Impact Statement. This is a quantitative statement of the anticipated benefits of the project relative to baseline conditions and includes both the immediate results and the long-term benefits following implementation of the solution. This statement should include, whenever possible, quantifiable or measurable elements as they are helpful in describing anticipated impacts. Implicit in the impact statement is a definition of the long-term goals toward which the project is expected to contribute.

Objective. A clear, concise, detailed statement of the short-term project objective is given. This objective must be attainable and within the methodology, available scientific and technical expertise, and facilities of the project.

Methodology. A well-defined statement of methods and the research approach is presented with enough detail to assure feasibility. This detail should include the availability of critical equipment, degree of technical risk, and realization of the time schedule.

Manpower and Organization. This portion of the planning document describes how the project group will be structured and organized and its reporting channels. It also outlines the subprojects and tasks so that individual responsibilities are clear. It may be helpful to include a bar chart that indicates the length of time required to complete an activity, or a program evaluation and review technique (PERT) chart to show the relationship of tasks to their assigned manpower. This section also enumerates in detail the skills of each scientist (by name) who will work on each task, including the time or the fraction of his or her time required. If certain skills are not available in-house, arrangements for obtaining them elsewhere must be clearly defined. The credibility of the project plan and its probable success depend heavily on the scientific and technical skills available.

It is noted here that in countries such as Indonesia where limited skilled manpower is available, well-recognized scientists are often overcommitted. Although skill substitution is sometimes possible, realistic assignments must be based on the actual time that a specialist can devote to a project. Each task and the manpower and time required to accomplish it should be estimated with the participation of the

individual who will do the work. Affixing to the task statement a signature indicates a shared responsibility for its accuracy and reasonableness.

Facilities. This is a clear statement of where the project will be conducted and what equipment or facilities are required. In some cases, opportunities for sharing with other organizations must be explored and the necessary arrangements made. If special equipment or facilities are to be built or procured, a statement of cost is included as well as a reasonable time schedule for their order, delivery, installation and calibration at the project. Since long lead times are usually needed to obtain the appropriate equipment, equipment or facility planning must be carefully coordinated with manpower needs so that operators, for example, are not scheduled until actually needed.

Time Schedule and Milestones. The schedule for the overall project shows the beginning and end of individual tasks and establishes appropriate project milestones. Milestones are points in time when major technical results should appear, when equipment should be ready for service, or when critical decisions should be made. Milestones also indicate when an overall project evaluation or assessment is to be made, so that mid-course corrections can be applied if necessary. Properly developed, the time schedule permits one to judge the effectiveness of project management. Its quality contributes to the credibility of the total plan.

Budget. The budget lists the total expense to the organization (or government) of conducting the project, and it includes routine expenses (salaries and overhead) as well as development expenses (consultants, travel facilities, equipment, special overhead expenses, honoraria). The budget is compiled and displayed on a task-by-task basis, so that both financial and technical progress can be reviewed during project evaluations. Properly compiled, the budget permits one to judge the effectiveness of project management.

PROJECT IMPLEMENTATION AND MONITORING

Although work assignments for professional personnel are actually made during a project's planning phase, these assignments must, nevertheless, be validated during the implementation stage. The official mechanism at the national level is the appointment of a project leader. At the institutional level, project personnel are appointed by the project leader. A common problem of many institutions is that the capability and availability of project personnel, especially the research staff, are not taken carefully into consideration: senior researchers must not be overburdened, and junior researchers must be effectively employed. This all too frequent problem may be intensified by the poor incentive system of a project. To prevent this problem, the assignments of individual scientists should be validated as soon as the schedule for the implementation of a project is determined.

As the project is implemented, it is also monitored. Monitoring is conducted effectively and efficiently only if it has been properly planned. The principal items monitored are man-hours used, money expended, and technical results attained as a function of time.

Monitoring at the national level is conducted through monthly financial reports and quarterly progress reports. Such reports provide data on funds and manpower expended and their relationship to the activities in terms of the totals available. The effectiveness of project monitoring can be improved by developing reporting techniques that reveal technical and scientific progress in relation to manpower expended through to the completion of the project. Some R&D institutes have already developed and implemented these devices.

PROJECT AND IMPACT EVALUATION

Evaluation is an integral part of the planning and implementation process and should occur at successive stages. In the first stage, upon establishment of a plan, alternative proposals and needs are evaluated. For the second stage, each selected program and project is evaluated in light of the objectives of the plan. Finally, when manpower is assigned to projects, alternative uses of individual scientists are evaluated.

Post-performance evaluation occurs at the completion of a project. The present system of post-performance evaluation focuses on administrative issues: Were schedules met? Was money used as authorized? Was the task completed on time?

The concept of post-performance needs to be broadened, however, so that the costs of performing a project or program can be associated in a systematic way with output and impact. In this way, the efficiency and effectiveness of a project or program can be examined and compared with other programs, and, most important, it can be judged whether limited manpower and other resources are being used in the most efficient way to attain the objectives of the overall plan.

Effective post-performance evaluation requires:

- A realistic project or program management and cost accounting system that identifies the actual costs of the resources required to carry out the project and properly assigns them to the appropriate projects or programs. Such cost accounting systems are described as cost centers.
- Identification of the outputs of projects such as new research results, published papers, students trained, new or improved products or techniques.
- Calculation of the costs of specific outputs, professional person-hours per paper published, cost per student trained, or student credit-hours.
- A system for determining the quality of outputs. For example, a peer review system could evaluate published papers by assessing their scientific quality, contribution to new understanding, or their contribution to realizing the objectives stated in the plan. Alternatively, a technical evaluation could assess new

devices for quality, dependability, maintainability, manufacturing ability, etc.

- Use of such information to rank projects/programs according to their achievement of planned objectives, efficient use of resources, and adherence to budget and time schedules.

Whenever feasible, a post-performance evaluation should also include an assessment of impact: Did the results of the project have the intended impact? Were the anticipated benefits realized? Were the results used by the intended users? If so, with what effect? Since part of the planning and review process for the project requires a statement of the expected impact, it is now possible to determine whether that impact was realized and the cost actually involved.

Objective impact analysis can be accomplished in several ways. If baseline data on the state of a system (e.g., deaths per 1,000 live births, net income per farmer, average rice yield per hectare, students educated per full-time faculty member) are available, comparisons can be made at various points in time, allowing determination of how much the particular program or project has contributed to changing the appropriate indicator. In this respect, it is useful to include the users of research results or new products or systems as a part of the review process. This requires broadening the review process to include not only scientifically qualified individuals but also individuals who are knowledgeable about the actual application and use of results.

The loop of planning, implementation, and evaluation is closed when the information on efficiency and cost-effectiveness is explicitly taken into account in allocating resources during the next planning or implementation cycle. This provides an objective method of evaluating and comparing the effectiveness of different managers, research centers, and programs, as well as a basis for improving performance and rewarding good performance.

PROBLEMS ENCOUNTERED IN PLANNING, IMPLEMENTING, AND MONITORING AND EVALUATING RESEARCH AND TECHNOLOGY

In workshop discussions of the R&D planning, implementation, and monitoring process in Indonesia, a number of problems were identified. These problems can be grouped under four general headings: (1) information requirements, (2) supplies and utilization of human resources, (3) performance and accountability, and (4) communications and openness. Because the problems described below pervade many aspects of the planning-through-evaluation process, attention should be directed and appropriate actions taken toward their solution.

Information Requirements

The quality of decision making in research depends on the quality and comprehensiveness of the information available to the decision maker. A good information system has a number of specific characteristics.

First, the information is comprehensible to and appropriate for the decision maker involved. Although the requirements of a scientist or engineer in the laboratory are different from those concerned with issues at the national level, both are information-dependent, and the available information should be in a format designed for the user.

Second, the information should be comprehensive and timely; information that is incomplete in some major respects can be misleading. Without knowledge of the existence of ongoing research projects, those allocating resources are at a disadvantage and may not be able to avoid undesirable duplication. One step that may help in this area would be requiring that a copy of all reports based on research carried out in Indonesia be placed in a central depository.

Third, the information is accurate. Programs and projects that are inaccurately or imprecisely described are of little help. Also, out-of-date information or information not available at the time a decision must be made are of little value.

Fourth, the information system provides appropriate information to individuals at all levels in the research organization. If the information is not made available to those in the more junior positions, their ability to gain in judgment and maturity may be inhibited.

It is also useful to note that the planning-through-implementation process is much improved if quantitative rather than qualitative measures are used. Predictions based on quantitative data against which results can be measured enhance the assessment of projects and programs and permit improved resource allocation.

While rapid progress is being made in the design and operation of computer-based information systems, both manual and machine-based systems can be of great value. Although thorny problems remain relating to the classification of information and ambiguity in terminology used in many technical fields, if the system helps decision makers concentrate their efforts on the right problem it is of great value.

Supply and Utilization of Human Resources

Workshop participants found that skilled and experienced professionals are in very short supply in Indonesia, and that this shortage in both technical and managerial talents constitutes a major obstacle to Indonesia's development in science and technology. Although Indonesia is richly endowed in human resources, there is an urgent need to develop such resources and to use the currently available human resources effectively.

In recognition of this shortage, it is proposed that resource allocation decisions be based on the availability of skilled manpower as well as on the funding required. Directing attention to appropriate manpower needs throughout the planning-through-implementation process should help avoid the inefficiencies that result from the overcommitment of available skilled and experienced manpower.

To lessen the adverse effects of the manpower shortage, a number of steps can be taken. For the immediate future, increased interinstitutional flexibility would permit the transfer of available skills and

experience to where they are most needed. A reward system should ensure that individuals with research talent are given the proper incentives to devote full time to research-related activities. For the long term, a major increase in the education and training of personnel at the professional and technician levels is desirable.

Improved R&D planning, implementation and monitoring, and evaluation depend directly on improved utilization of existing human resources and increased investment in the education and training of future human talent.

Performance and Accountability

All research personnel should recognize that they are accountable for their performance. Through such recognition, individuals may take increased pride in their achievements, whether scientific or administrative.

The reward system should be sensitive to the quality of the research performed. A sound system for recognizing the quality of research performance requires the use of professionally qualified individuals who are outside the system being evaluated. This permits both objectivity and competence in the assessment of performance. Review procedures by independent peers can supply decision makers with judgments that they can use in balancing the information they receive from internal sources. Inputs from the intended users of research results are also valuable. It is important for the decision makers to have more than one source of information on which to make judgments.

Frequently, such information channels can operate as feedback loops to keep members of a large organization well informed. Ideally, feedback loops should be both formal and informal and operate over short- and long-term intervals. By strengthening such loops, the ability of both performers and managers to monitor a project's progress and make mid-course corrections in ongoing programs is increased.

In performance assessment, it should be recognized that projects unable to reach their original objectives can also provide valuable information. An analysis of why the original objectives were not reached or why an altered course of action was necessary may keep others from repeating mistakes that may have been costly.

Recognition of the importance of time is a vital element in a well-managed research program. Realistic estimates of the time needed to accomplish a research task can lead to great improvements in scheduling. The long time delays experienced in obtaining equipment and supplies from foreign sources frequently make accurate scheduling very difficult. Nevertheless, realistic time-to-completion estimates are essential for good planning.

Communications and Openness

A research system operates best when there are good communications among the various groups involved in the system, including those at the same

level as well as those at different levels in the hierarchy. While many organizations have systematic procedures for communications from the top managers, different techniques are needed to encourage and facilitate communications from the operating levels to top management. Good research ideas can originate at any level in the hierarchy, and such ideas should be recognized and used. An appropriate combination of the broad perspectives of top management and recognition of the scientific and technical ideas emanating from laboratory workers leads to the most effective research programs and stimulates and encourages creativity at all staff levels.

An "open" system also facilitates linkages to other communities and institutions. Linkages to the private sector can be strengthened to the advantage of both the governmental and private sectors. Strengthened linkages with the international community facilitate keeping abreast of external developments in science and technology.

Another important linkage is made through publication of research results by staff members. Such reports are a means of communication among staff members and a valuable educational activity for both the author and the readers.

Libraries and other information repositories can also facilitate communications between research personnel within institutions and between institutions in adjacent S&T fields, as well as acquaint research staff with international science and technology advances.

APPENDIXES

APPENDIX A
ADDRESSES, WASHINGTON, D.C. AD HOC SEMINAR

Science and Technology Institutions in Indonesia

Achmad Amiruddin
Deputy to the Chairman, Agency for the Assessment
and Application of Technology

Sukadji Ranuwihardjo
Assistant Minister for Policy and Coordination,
Ministry of State for Research and Technology

HISTORICAL INTRODUCTION

Although national policy making in science and technology in Indonesia lies in the hands of the president of the Republic, various governmental agencies and institutes are responsible for delineating and specifying policy details at the operational level.

In 1973, the government established the Ministry of State for Research, which was modified in 1978 to become the Ministry of State for Research and Technology. This ministry is responsible for the formulation and coordination of government policy in research and technology and their application for national development. However, research within the university system still lies within the responsibilities of the minister of education and culture.

Six national science and technology institutes that are not within the responsibilities of a designated ministry fall under the coordination of the minister of state for research and technology:

1. LIPI (Indonesian Institute of Sciences)
2. BATAN (National Atomic Energy Agency)
3. BPS (Central Bureau of Statistics)
4. LAPAN (National Aeronautics and Space Institute)
5. BAKOSURTANAL (National Coordinating Agency for Surveys and Mapping)
6. BPPT (Agency for the Assessment and Application of Technology)

The minister is directly responsible for the evaluation, approval, and control of the research programs of these institutes, and their annual budgets are reviewed and "blue-penciled" by the minister before being forwarded to the minister of finance and the State Planning Agency for approval.

This background document, prepared for NRC participants, was subsequently modified by BOSTID staff based on presentations and discussions during the May 5-6 meeting.

By presidential decrees 44 and 45 of 1974, all technical ministries were asked to establish an agency for research and development to support their individual missions. Among these, the R&D agency of the Ministry of Agriculture is the largest. Under its jurisdiction, many well-established research stations and institutes are located throughout the country. The minister of state for research and technology is responsible for coordinating the functioning of these agencies in the technical ministries to assure good cooperation and their convergence toward the goal of national development. However, their budgets are not controlled by the minister. They are submitted to their respective ministry for further consideration by the Ministry of Finance.

Center for Science, Research, and Technology

The minister of state for research and technology has also the task of developing PUSPIPTEK (Center for Science, Research, and Technology), located in Serpong about 30 km southwest of Jakarta. Initial plans call for the center to accommodate 10 research laboratories: four owned by LIPI, five owned by the BPPT, and a nuclear research center with reactors owned by BATAN:

- LIPI: Laboratories for Instrumentation, Calibration, and Metrology
  Laboratories for Electronics
  Laboratories for Applied Physics
  Laboratories for Chemistry

- BPPT: Laboratories for Materials and Construction Testing
  Laboratories for Engineering Chemistry
  Laboratories for Energy Resources
  Laboratories for Thermodynamics and Engines
  Laboratories for Aerodynamics and Vibration

- BATAN: Nuclear Research Reactor and Laboratories for Nuclear Studies

As stated in the presidential decree of 1976, the main goals of PUSPIPTEK are:

1. To develop the infrastructure for research and technology needed for the acceleration of national development

2. To provide facilities needed by the scientific community

3. To increase public awareness of the role of research, science, and technology in development.

PUSPIPTEK is, therefore, designed to provide technical and laboratory services to other research institutes, government as well as private, upon request. In a special field, such as materials and

structural testing, PUSPIPTEK is expected to function as a coordinating body to promote industrial standardization.

Indonesian Institute of Sciences

The Indonesian Institute of Sciences (LIPI) controls 11 national research institutes concerned with the natural sciences, technology, and social and cultural sciences. Established by presidential decree in 1967, it represents a reorganization of the defunct Institute of National Research and the Indonesia Science Council (MIPI). The role and function of LIPI in the policymaking system in science and technology are very important. With the establishment of the office of minister of state for research in 1973 (subsequently changed to include technology), the coordinating function of the policymaking system in science and technology as well as the administrative and budgetary control of national research and scientific institutes were assumed by the minister of state for research and technology.

Now, under the aegis of that ministry, LIPI's major tasks are:

- To foster the development of science and technology in Indonesia for the benefit of human welfare and the Indonesian people
- To pursue scientific truth, in which academic and research freedom is secured
- To prepare for the establishment of an Indonesian Academy of Sciences.

To implement its major tasks, LIPI performs certain functions, the most important of which are:

- To render advice to the national government on the formulation of a national science policy
- To give direction and guidance on the development of existing research and technology agencies
- To establish collaboration with international agencies and foreign scientific institutes.

Agency for the Assessment and Application of Technology (BPPT)

This agency is chaired by the minister of state for research and technology, who has six deputies, one for each of the following areas:

- Natural resources
- Basic and applied sciences
- Technological development

- Industrial development
- Administration
- Systems analysis/operations research.

Since its establishment by the minister in 1978, BPPT has been active in providing assistance for the establishment of several industries, for example, Nurtanio Aircraft Industries in Bandung, initiation of the railway industries in Madiun, and the shipbuilding yards of PT PAL in Surabaya. In addition, BPPT also provides assistance in solving many interdepartmental problems for the government, such as establishing standards for automotive and other industrial products and developing an industrial estate and bonded warehouse complex on Batam Island, opposite Singapore. BPPT also conducts several projects of its own, for example, a biomass project in Lampung (South Sumatra), solar energy projects in West Java and Nusa Tenggara Timur, artificial rainmaking, and ship design.

Within the newly formed 1983 government, BPPT is officially attached to the Ministry of State for Research and Technology just as the National Planning and Development Agency is attached to the State Ministry of Development. Thus BPPT is expected to be more active in the planning and monitoring of research in universities and other government-operated laboratories, thereby serving the minister of state for research and technology in his function as coordinator of research. In addition, BPPT is expected to act as a channel for the flow of research results from universities and other research laboratories into industry. There have been complaints that much of the research work done in the universities cannot reach the application stage because of the absence of this necessary bridging function.

All these functions naturally require that BPPT be more efficiently and effectively organized, with a capable staff. Currently, scientists and technologists from various universities serve as consultants to BPPT to complement the staff. They are given the title of senior scientist and are assigned to specific projects.

RESEARCH IN INDONESIAN UNIVERSITIES

Forty-three state universities as well as hundreds of private institutions of higher learning have their own research institutes, centers, and laboratories. The formulation of science policy and its implementation within the educational system are fully the responsibility of the minister of education and culture.

Funds for research at the universities are very small, normally not more than 3-4 percent of the total university budget. To supplement these funds, contract research is accepted from government ministries and, to a far lesser extent, from the private community. Because these contract research funds are often as much as seven times the funds available from the university budget, depending upon the quality of the faculty, universities are largely oriented toward contract research, making basic research suffer.

ESTABLISHING PRIORITY AREAS

In 1978, the minister of state for research and technology established the Team for the Formulation and Evaluation of National Major Programmes on Research and Technology, composed of scientists and science managers from universities, departments, and R&D agencies, among others. The main task of the team is to formulate a national program on research and technology and to monitor and evaluate planning and implementation.

The minister subsequently issued five major priorities for research and technology:

- Basic human needs
- Energy and natural resources
- Industrialization
- Security and defense
- Social, economic, cultural, law, and philosophic affairs

Each of these areas covers the categories of land, sea and marine, air and space, and environment, so that these major priorities can be visualized as a national matrix of research and technology. Since its establishment in 1978, the national matrix of research and technology has become the frame of reference for Indonesia's research agenda, whether considered by nonministerial governmental research institutes or ministerial R&D agencies. The content of the matrix has been developed as a rolling plan and revised or redefined to focus more sharply on national priorities through the deliberations of national workshops on science and technology held every 2 years.

The direct leverage of the minister of state for research and technology on nonministerial governmental research institutes is through the scrutiny of their annual budgets. This assures that the programs of these agencies will address the needs of national development and also guarantees the optimal use of financial resources. The coordinative function of the minister of state for research and technology upon ministerial agencies of research and development is implemented through national workshops and coordinating meetings held every year.

Planning and Coordination of Research in the United States at the National Level

H. Guyford Stever
Chairman, Commission on Engineering and
Technical Systems, National Research Council

A decentralized system--which precludes a centralized national planning role for the U.S. government, including science and technology--was established by the founding fathers of the United States when they created the three branches of government: the administration, headed by the president; the Congress with its elected representatives divided into two houses--Senate and House of Representatives; and the judiciary. The judiciary is not discussed here since it is assumed that legality is not a major issue. Therefore, only two branches of the government will be considered, both of which are highly decentralized.

RESEARCH AND DEVELOPMENT IN THE UNITED STATES

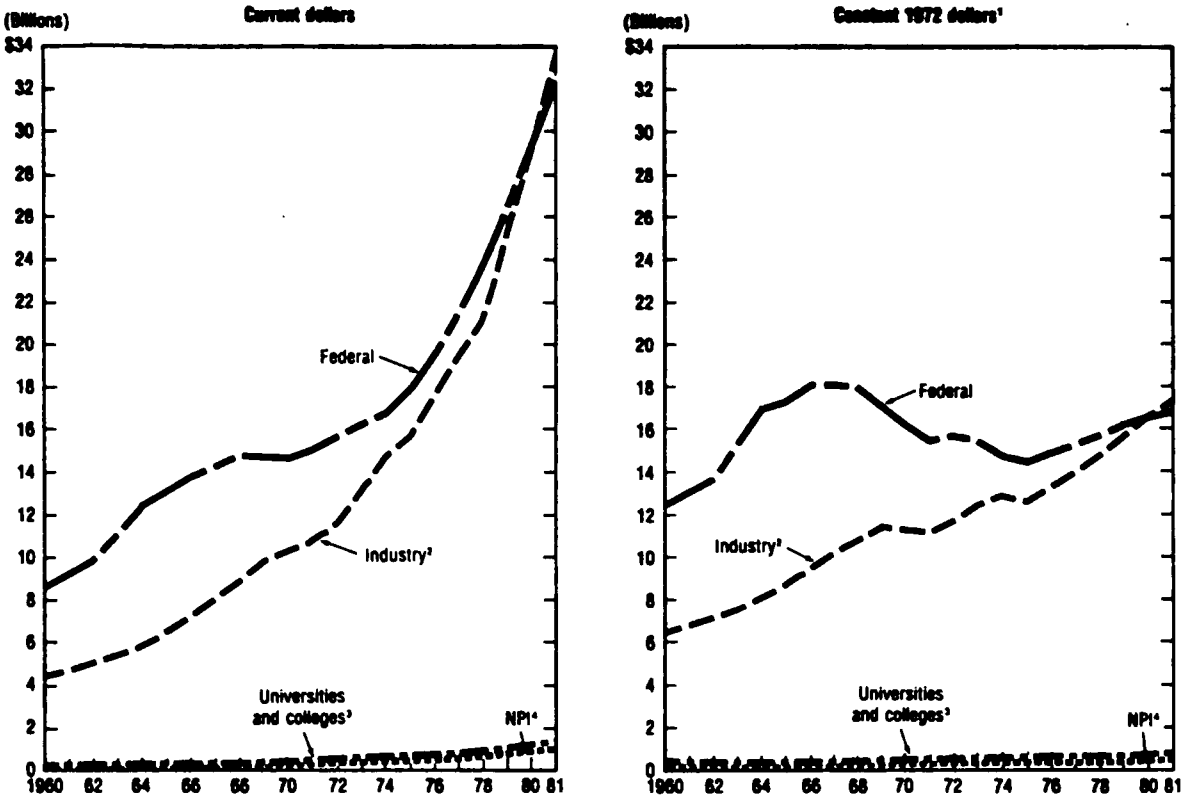
The totality of research and development in the United States is best illustrated by figures taken from Science Indicators (1980), a report published biennially by the National Science Foundation.

According to Figure 1, in 1981 the federal government supplied 47 percent of the national expenditures for R&D; industry supplied 49 percent; and the balance was met by foundations and other private sources. Therefore, support was split, half from the government and half from industry and other private sources.

The performers of R&D are, however, divided quite differently (Figure 2). The federal government itself only uses 13 percent of R&D funds through its national laboratories such as those run by the National Aeronautics and Space Administration and the Department of Energy. Seventy-one percent of R&D funding, which totaled $70 billion in 1981 and is approaching $80 billion in 1983, was spent by industry. Universities and colleges spent about 9 percent; small federal research centers contracted for special purposes spent about 3 percent, and other nonprofit institutions spent 3 percent.

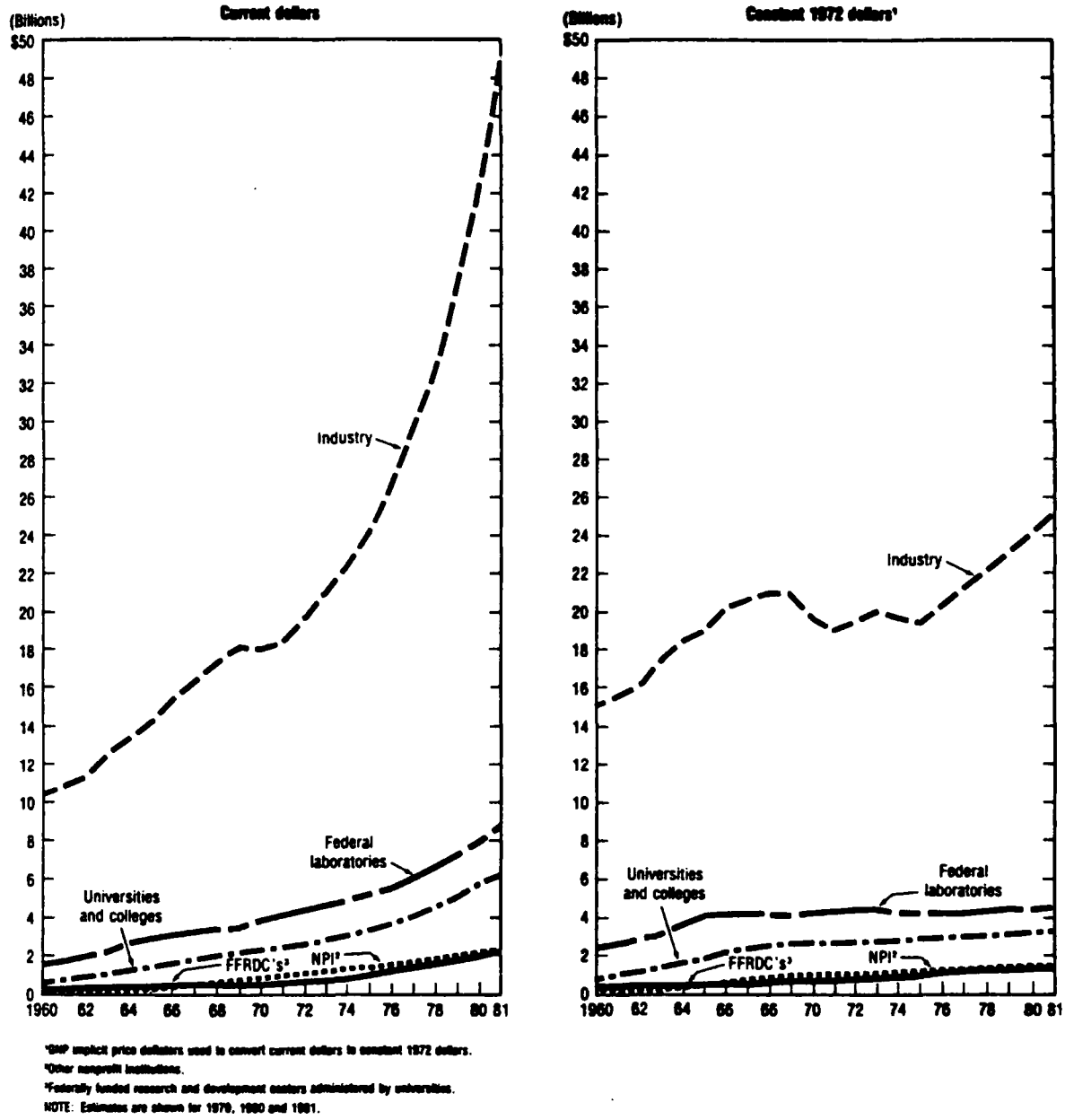
Regarding national R&D expenditures by the character of the work undertaken (Figure 3), in 1981, 13 percent of the total national R&D effort went for basic research, 22 percent for applied research, and 65 percent for development. It is an interesting split and one that prevails in many countries in the world.

Where are the R&D scientists and engineers employed? According to Figure 4, in 1980, 10 percent were located in the federal government,



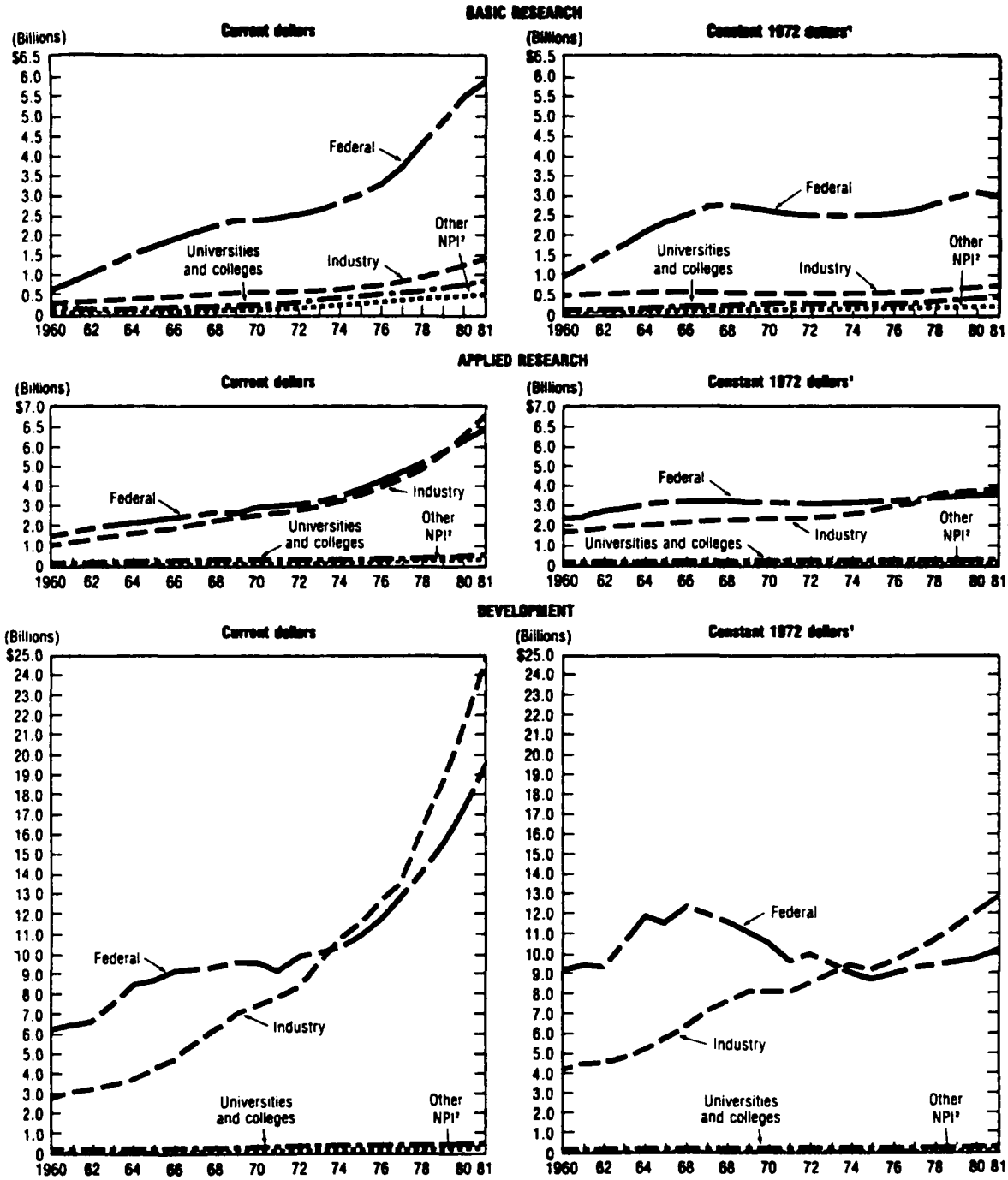
[1]GNP implicit price deflators used to convert current dollars to constant 1972 dollars.
[2]Data are not available on industry resources for research in the psychological and social sciences.
[3]Includes state and local sources which accounted for almost half of these expenditures since 1970.
[4]Other nonprofit institutions.
NOTE: Estimates are shown for 1979, 1980 and 1981.

FIGURE 1 National expenditures for R&D by source. Source: National Science Foundation. 1980. Science Indicators. U.S. Government Printing Office, Washington, D.C., USA.



[1]GNP implicit price deflators used to convert current dollars to constant 1972 dollars.
[2]Other nonprofit institutions.
[3]Federally funded research and development centers administered by universities.
NOTE: Estimates are shown for 1979, 1980 and 1981.

FIGURE 2 National expenditures for R&D by performer. Source: National Science Foundation (1980).



[1]GNP implicit price deflators used to convert current dollars to constant 1972 dollars.
[2]Other nonprofit institutions
NOTE: Estimates are shown for 1979, 1980 and 1981.

FIGURE 3 National R&D expenditures by character of work and source of funds. Source: National Science Foundation (1980).

71 percent in industry, 12 percent in universities and colleges, and about 6 percent in nonprofit organizations. The universities have a higher employment than the percentage of R&D money used. Industry spends almost all of its own money (mostly on applied research), but receives much from the federal government. The universities spend little of their own money for research, but they actually spend 13 percent, almost entirely from the federal government.

Figure 5 shows expenditures by industry for basic research, applied research, and development in the United States. According to the figure, in terms of real dollars, development increased until 1969, leveled off, and then slowly went up again. The same pattern holds for both applied and basic research.

Figure 6 indicates how the percentage of federal obligations for R&D by major budget function has changed over the years. Nonfederal--the private sector--has continued to account for a larger percentage of the effort. The federal portion, which has decreased from 60 percent to less than 50 percent, is now divided among defense, space, and civilian R&D. Until very recently, the U.S. defense and space efforts accounted for less and less R&D, but they are now on the rise. Civilian R&D supported by federal funds is concerned with health, agriculture, and all other areas that are neither defense or space but in which government has some interest.

Figure 7 shows the U.S. trade balance with selected nations for R&D-intensive manufactured products. In the international market, competition is the keenest when R&D-intensive products are involved. As shown in Figure 7, the United States generally had a good balance of trade between 1966 and 1979.

Figure 8 indicates the major fields in which the private sector puts most of its own R&D dollars as well as those received from the government. The government determines to which sector its dollars go. R&D-intensive communications equipment and electronic components receive very high expenditures as well as electronic machinery, aircraft and aircraft parts, guided missiles, and spacecraft.

About 35 percent of the U.S. R&D budget is devoted to so-called civilian pursuits (see Table 1). Health receives the largest share, followed by energy, general science (money given to the universities for basic research in government labs, etc.), natural resources and environment, transportation, and agriculture. Very small amounts are allotted for education, training, social services, veterans benefits, international affairs, commerce and housing, community regional development, and income security.

DETERMINING R&D PRIORITIES

Figure 9 is an organizational chart of the U.S. government. The president and his administration--the White House organization--and the Congress are independent elements of the system, and agreement of both is needed to enact legislation or appropriations. As head of the administration, the president heads a number of individual agencies, i.e., Agriculture, Defense, National Institutes of Health (NIH), the

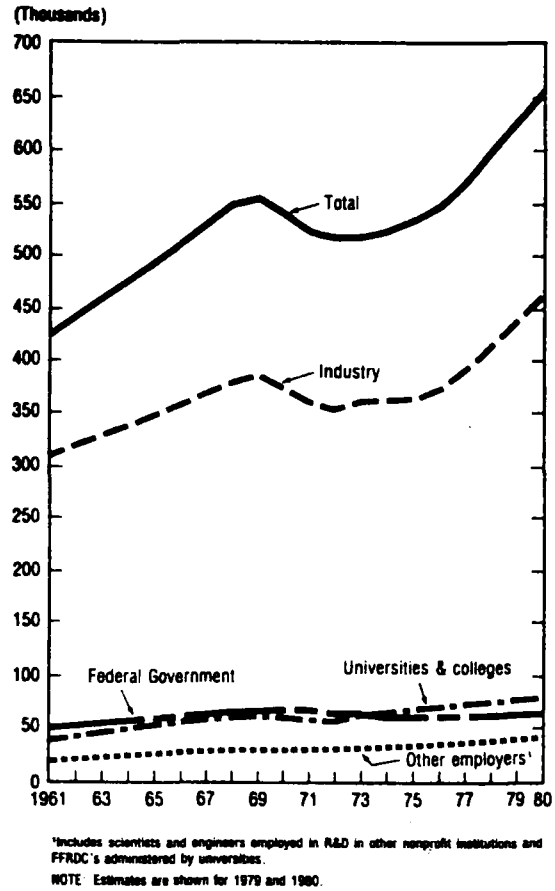


FIGURE 4 Scientist and engineer full-time equivalent used in R&D by sector. Source: National Science Foundation (1980).

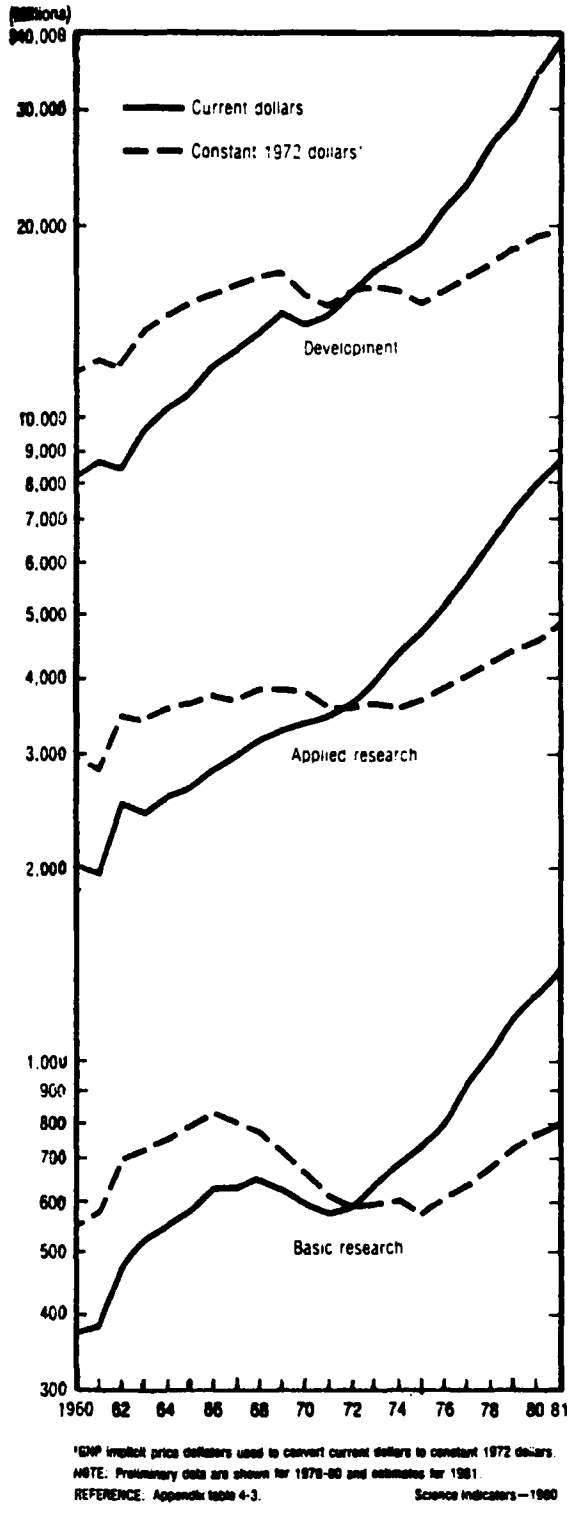


FIGURE 5 Industrial expenditures for basic research, applied research, and development. Source: National Science Foundation (1980).

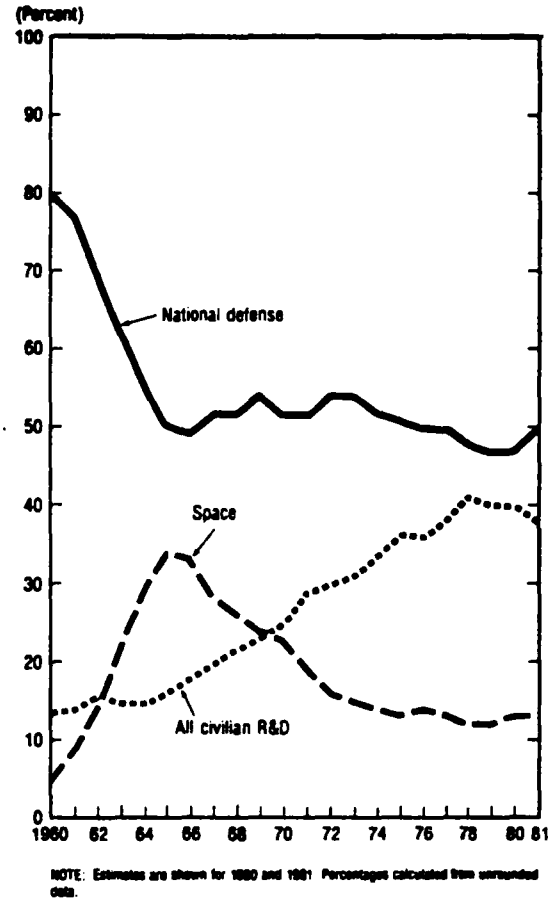
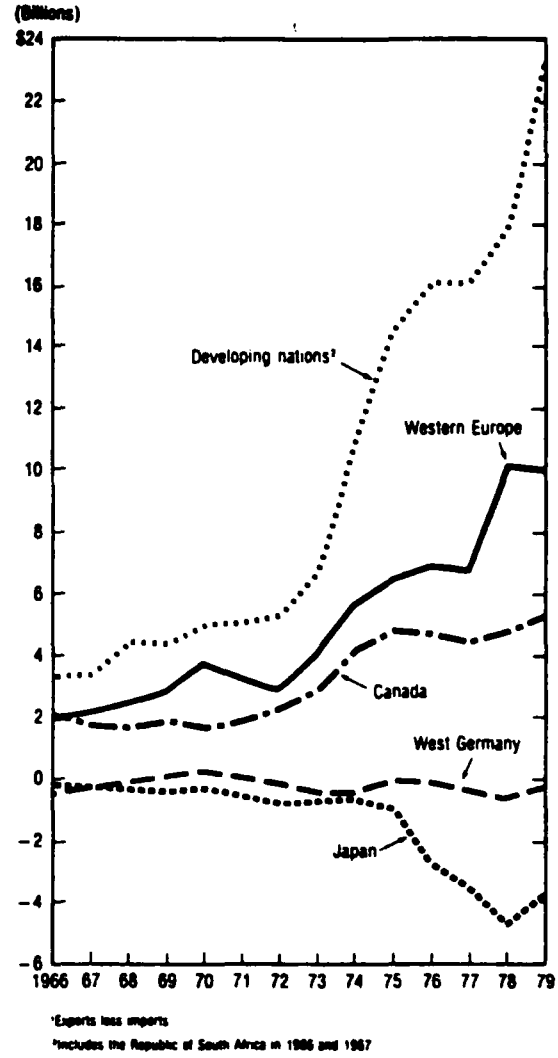


FIGURE 6 Percentage of federal obligations for R&D by major budget function. Source: National Science Foundation (1980).



[1]Exports less imports
[2]Includes the Republic of South Africa in 1966 and 1967

FIGURE 7 U.S. trade balance with selected nations for R&D-intensive manufactured products. Source: National Science Foundation (1980).

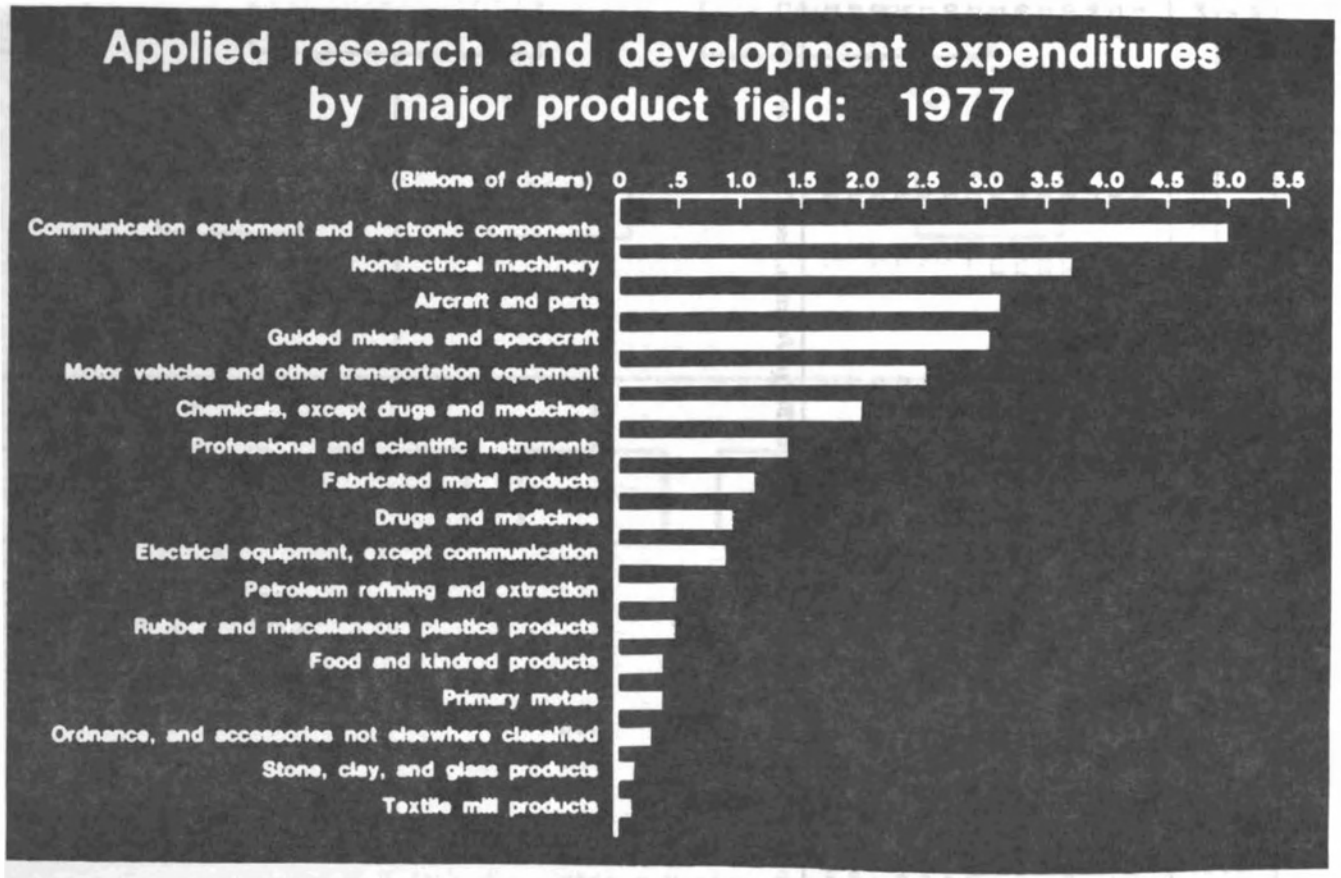


FIGURE 8 Applied research and development expenditures by major product field. Source: National Science Foundation.

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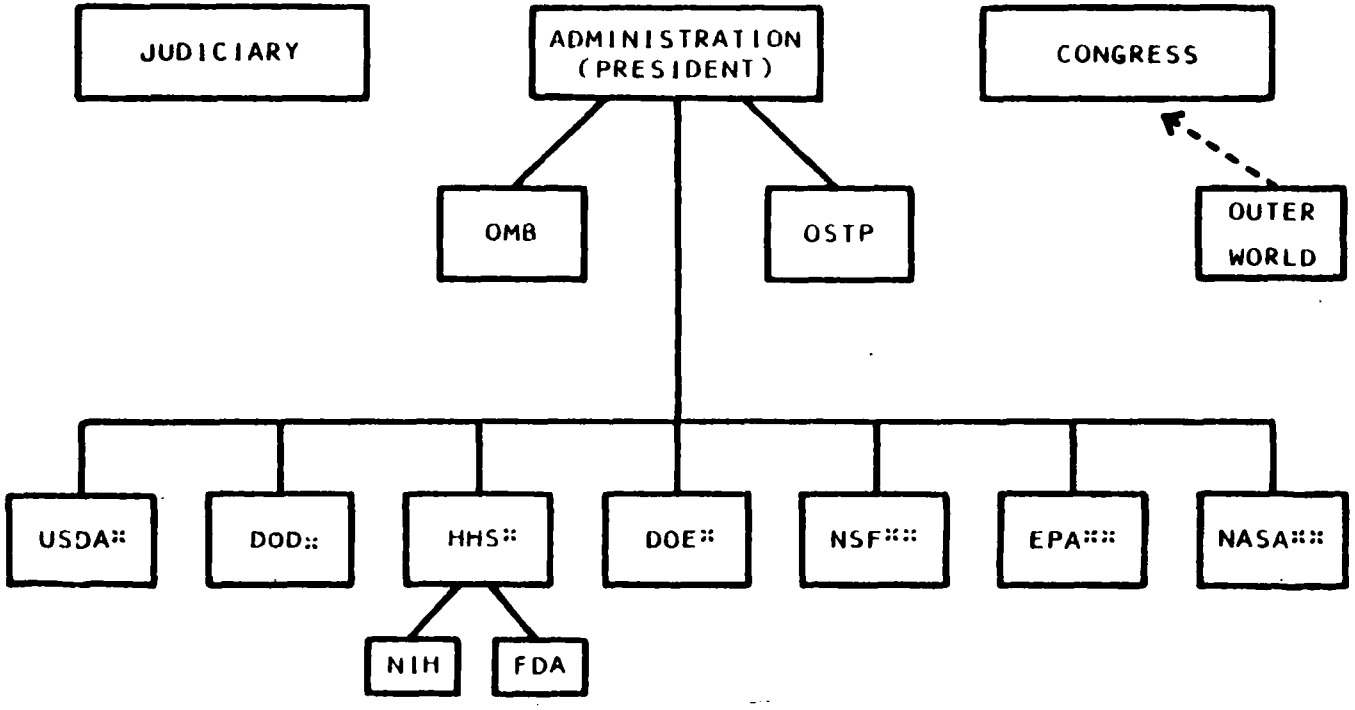
TABLE 1 Distribution of Federal R&D Funding Among Civilian Areas

R&D function	Percent of the Federal R&D total					Percent of the civilian Federal R&D total				
	1977	1978	1979	1980	1981	1977	1978	1979	1980	1981
Health	11.0	11.2	11.7	11.7	10.8	30.0	29.3	30.1	30.7	31.5
Energy	10.7	11.8	11.9	11.4	9.9	29.3	30.9	30.7	29.9	29.0
General science	4.1	4.0	3.9	3.9	3.7	11.1	10.4	9.9	10.2	10.7
Natural resources and environment	3.1	3.4	3.5	3.2	2.9	8.6	8.9	9.0	8.3	8.5
Transportation	3.0	2.9	2.8	2.8	2.5	8.1	7.6	7.1	7.4	7.2
Agriculture	1.9	1.9	1.9	1.9	1.8	5.2	4.9	4.9	4.9	5.3
Education, training, employment, and social services	1.0	1.3	1.2	1.5	1.0	2.6	3.4	3.1	3.9	2.8
Community and regional development	.4	.3	.4	.3	0.3	1.2	.9	1.1	.9	.9
International affairs	.3	.2	.4	.4	.3	.8	.6	1.0	1.0	1.0
Veterans benefits and services	.4	.4	.4	.4	.4	1.2	1.1	1.1	1.0	1.1
Commerce and housing	.3	.3	.3	.3	.3	.8	.8	.8	.8	.9
Income security	.2	.3	.2	.1	.2	.6	.7	.5	.4	.5
Administration of justice	.1	.2	.2	.1	.1	.3	.4	.4	.4	.2
General government	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2

SOURCE: National Science Foundation, *Federal R&D Funding by Budget Function, Fiscal Years 1979-81* (May 1980), p. 3; and unpublished data.



*DEPARTMENTS

**INDEPENDENT ESTABLISHMENTS AND GOVERNMENT CORPORATIONS

DOD = Department of Defense
DOE = Department of Energy
EPA = Environmental Protection Agency
FDA = Food and Drug Administration
HHS = Department of Health and Human Services
NASA = National Aeronautics and Space Administration
NIH = National Institutes of Health
NSF = National Science Foundation
OMB = Office of Management and Budget
OSTP = Office of Science and Technology Policy
USDA = U.S. Department of Agriculture

FIGURE 9 Organizational chart of the U.S. government.

Food and Drug Administration, and the National Science Foundation (NSF). All of these agencies have a number of subunits.

These agencies have access to an immense number of scientists and engineers, not only those on their own staff but also those who serve in an advisory capacity. An additional resource is the National Research Council (NRC) which is the operating arm for the National Academy of Sciences and the National Academy of Engineering. It is a private, Congressionally-chartered scientific body which can be called on by all parts of the government for scientific input. Thus each agency taps considerable expertise in putting together its R&D program. Agency R&D programs are normally based on scientific merit or, for basic research, on scientific promise. For applied research, it is a combination of judged needs as well as promise of the field. Applied development is based on a direct need. The Department of Defense, for example, requires all three kinds of research, but R&D conducted for this department is for its own use. This is not true at NSF or at the Department of Agriculture. These agencies may conduct basic research, applied research, and initial development, but the users of this research are elsewhere: farmers and the food industry. Each of these various government agencies can make very strong cases for R&D support.

In determining R&D priorities, all government agencies must first develop their own R&D plans, which are then sent to the Office of Management and Budget (OMB). This office has been instructed by the president about the administration's priorities. A budget is then agreed to after negotiations between OMB and individuals from the various agencies. Following this process, the president sends the budget to Congress, where it is defended by the president as well as by the heads of the agencies.

In its approval process for the budget, Congress calls on experts in many fields to give their opinions on R&D priorities. Professors, as well as experts from other parts of the private sector, are asked to testify. Congress then releases its version of the budget which is negotiated between the two houses of Congress and the administration. Sometimes the differences are great, and consequently, no budgets are passed. In this case, agencies continue on the same basis as the previous year--a continuing resolution. However, budgets are usually passed.

In establishing priorities, the United States has witnessed some quite interesting examples of the use of decentralization in handling a problem. For example, during the energy crisis, various agencies set up units intended to handle the problem or contribute to its solution. Because these government units "coordinated," and then ignored directions, the Congress stepped in and agreed with the president that the United States should strengthen some of its agencies by reorganizing the Atomic Energy Commission into the so-called Energy Research and Development Agency (ERDA), later changed to the Department of Energy (DOE). This was the way in which the United States addressed the energy crisis. Those who believe in centralized government say that although much may have been accomplished, it is a very inefficient form of government. Nevertheless, while it may be inefficient, it was all conducted in public, and everyone had a chance to be heard.

In the United States, expertise is used in a very good way in a decentralized system, and problems are solved better in the long run than if one person with too much power is making single decisions. Either the President or the Congress can slant the program to their own objective, but neither can get things through too quickly and unreasonably.

Several examples of U.S. R&D agencies and how they operate within the science and technology structure will be outlined in this seminar. There is in the United States a fairly good balance between industry, academia, and government, but there is always a tug between priorities: for example, space and defense versus agriculture. The nation's health budget is another good example. For the last 10-15 years, the administrations have tried to reduce the NIH budget, but they have never succeeded because it is always reestablished by Congress.

APPENDIX B
OPENING ADDRESS, JAKARTA WORKSHOP

Sukadji Ranuwihardjo
Assistant Minister for Policy Coordination,
Ministry of State for Research and Technology

I would like to welcome you to the Workshop on Planning, Monitoring, and Evaluation of Research and Technology in Indonesia. His Excellency Minister B. J. Habibie regrets not being able to officially open this workshop, but he expresses his special thanks to our colleagues from the U.S. National Research Council who have come to Indonesia for this endeavor. This once again proves the sincerity and closeness of our cooperation in science and technology for the advancement of the general welfare of the Indonesian people.

Science and technology have played an important role in Indonesia's national development, and their application affects almost every aspect of our lives in this modern world. In 1984, Indonesia will begin its fourth 5-year national development plan (REPELITA IV). Although this country has been affected tremendously by the impact of the current world recession, causing it to face stringent financial difficulties, Indonesians are struggling to maintain the momentum of their planned development efforts so that by the sixth 5-year plan, national development will have reached the stage of takeoff for strong, self-sustaining growth. In his speech to the Parliament on August 16, 1983, President Soeharto emphasized the crucial importance of the coming fourth 5-year plan which covers the period 1984-1989.

Together with strengthening achievements in national development, the fourth 5-year plan should provide a strong foundation for the self-propelling growth of national development, striving to reach the national goal of a just and prosperous society within the framework of Indonesia's national philosophy--Pancasila. In that context, science and technology will play an even more important role in national development. Indonesia is entering a watershed of accelerated industrial development backed up by a strong agricultural sector. This will result in a more balanced economic structure, away from a heavily agricultural economy.

The responsibility of the minister of state for research and technology is to coordinate all research activities in Indonesia and to ascertain that they are consistent and support national development efforts. Although the basic guidelines were formulated in March by the People's Consultative Assembly as part of the National State Policy, its derivations have yet to be translated by all government agencies into more operational programs and projects.

In 1978, the minister of state for research and technology outlined a national matrix to be used as a basic framework for the overall program of research and technology. This matrix is widely known among research communities in Indonesia. Initially, research programs and project proposals are monitored and administratively evaluated on the basis of their compliance with this matrix. In this particular task, the minister is assisted by a group of Indonesian scholars and research managers from the universities as well as from the national research institutes and R&D agencies of the various technical ministries. They are grouped into five sections that correspond to the national research matrix:

1. Basic human needs
2. Energy and natural resources
3. Industrialization
4. Security and defense
5. Social, economic, cultural, law, and philosophic affairs.

In the near future, the role of this group will be strengthened when a presidential decree creates a National Research Council. This group will be reorganized into that council.

To coordinate all research and technology activities in Indonesia more effectively, it is desirable to improve continuously the methodology, systems, procedures, and basic criteria for planning, monitoring, and assessing the research results so that they directly support national development efforts. The Indonesian government has devoted a substantial amount of its yearly development budget to this purpose, and it has always been determined that these funds are used in the most efficient way.

Thus, the output of this workshop is very important to the people of Indonesia. It is expected that this endeavor will result in some practical recommendations toward increasing the efficiency of research and development activities in Indonesia.

To our American colleagues participating in this workshop, we sincerely hope that you will share with us your expertise and experience in the field of planning, monitoring, and evaluation of research activities. Through a free interchange of ideas with Indonesian participants, we hope that more insight can be obtained, constraints can be more clearly identified, and positive steps can be elaborated toward the objectives of this workshop.

APPENDIX C
PRESENTATIONS BY NRC PARTICIPANTS, JAKARTA WORKSHOP

The National Science Foundation and Science Policy

L. Vaughn Blankenship
Director, Division of Budget and Program Analysis,
Office of Planning and Resources Management,
National Science Foundation

The National Science Foundation (NSF) is an independent agency of the federal government. It was established in 1950 and grew out of the experience of the United States in World War II of successfully harnessing the talents of university scientists and engineers to the needs of government. Its primary objective is to oversee and maintain the general health of basic science and engineering in the United States in order to maintain the broad base of scientific and technical knowledge and trained manpower that is the underpinning of the U.S. economy. It accomplishes this objective primarily through the use of grants in support of advanced research and graduate education in the sciences and engineering in the universities and colleges of the United States.

In fiscal year (FY) 1983, the federal government provided $6 billion or almost 67 percent of the total U.S. investment in basic research. In the same year, private industry accounted for 19 percent of the total, a fraction that has declined since the early 1960s when industrial funding constituted about 28 percent of the total investment. The remaining basic research funds were provided by the academic sector (10 percent) and nonprofit institutions (4 percent).

Since the 1950s, the rationale for the federal role in supporting basic research in science and engineering has become broadly understood and accepted regardless of which political party controls the White House or the Congress. Federal support of such research is justified when the government itself is a direct user of the results, as in the case of national defense, or when important, broad areas of high-risk science and engineering research would be underfunded, in terms of their potential long-term payoff, by the private sector. It is this latter research that provides much of the knowledge on which solutions to our current and future economic, social, and technological problems, many currently unforeseen, will ultimately depend.

THE U.S. RESEARCH SYSTEM AND SCIENCE POLICY

In the United States, research and development are supported by and performed in private industry, academic institutions, the federal government, state and local governments, and a small number of not-for-profit centers and institutes. In general, the research supported and

performed by industry is aimed at developing new products or processes that will help to keep it competitive, profitable, and technologically viable. Universities and colleges perform much of the basic research in the United States while training future scientists and engineers. This arrangement assures that the next generation of technicians, professionals, and scientists are kept at the "cutting edge" of science and technology since they are exposed to, and have an opportunity to participate in, faculty research activities. This highly trained manpower is a key to the economic vitality and innovativeness of American industry.

Most of the research and development supported by the federal government, including that portion conducted in its own laboratories, is tied directly to its responsibilities under the U.S. Constitution: providing for the common defense; maintaining the health and welfare of the general public; regulating various activities to maintain the quality of life of citizens. In this context, as already mentioned, the foundation's role and its broad charter to maintain the "health of science" is unique.

State governments participate in research primarily through their support of state universities and colleges where much of the fundamental research is conducted. Beyond that they, and to a lesser extent, local governments conduct some very applied work usually tied directly to their regulatory or service provision responsibilities. The not-for-profit sector is small but in some areas, such as applied policy research, quite important in the total national research and development (R&D) picture.

There is no single source of "national science policy" that determines overall priorities and budgets for this research system as a whole. Instead, decision making is decentralized and disjointed, with each sector operating according to its own assumptions, values, and institutional structures. Underneath this apparently disorganized arrangement, however, a number of networks and mechanisms provide some sense of common order and shared concerns, values, and priorities.

Professional and scientific societies provide an important environment for communication among scientists and engineers working in all sectors. Scientific and technical journals are another important means of communication. The ties between universities and government laboratories on the one hand and universities and industrial laboratories on the other are frequently close. Not only are academic institutions the source of trained manpower for these other sectors, but many engineers and scientists move back and forth among these sectors as consultants, advisors, and employees. The National Academies of Sciences and Engineering provide still another forum for interaction among scientists and engineers.

Growth in federal support of R&D has not kept pace with industrial R&D spending in recent years. As a result, in 1980 industrial R&D spending exceeded expenditures by the federal government for the first time. However, it is still the case that if there is a single focal point for discussions of "national science policy," it occurs in the context of the federal budget process, since over half the funds for total research and over two-thirds of the funds for basic research in the United States are still provided by the federal government.

Even the federal budget process for R&D, however, is decentralized. There is, for example, no single "R&D budget," no single "ministry for science and technology." Instead, federal support of research is the sum of program requests from individual "mission" agencies submitted as part of their overall budget request to the Office of Management and Budget in the Executive Office of the President and subsequently approved by the Congress as part of the appropriations process.

Most R&D funds are part of larger appropriations and do not show up as line items in the budget. Consequently, research support is influenced by broader policy considerations. In recent years, for example, the federal government has placed considerably less emphasis on energy demonstration programs than was previously the case, since it has determined that such projects are well within the capability of private industry. Overall coordination of science policy thus occurs in the context of reviews of larger policy issues, as a part of the budget process in the White House and the Congress. The role of NSF has traditionally been that of a "balance wheel" to ensure that no nationally significant area of science or engineering is overlooked in the focus on "mission-related" programs.

NSF ORGANIZATION AND MANAGEMENT

The National Science Board and the director of the National Science Foundation are the chief sources of policy making within NSF. The board is composed of 24 members. They, along with the director, are appointed by the President, with the advice and consent of the Senate, and serve 6-year terms. In recent years, board members have been appointed from industry, government, and, most frequently, academia. Virtually all have strong scientific or engineering credentials; some are still practicing scientists though most are research or educational administrators. The three most recent directors have been a behavioral scientist, an engineer, and, currently, a physicist.

The National Science Foundation is organized primarily around disciplinary lines and thus tends to parallel the structure of scientific and engineering disciplines as found in most universities and colleges. Each major unit, or directorate, is headed by an assistant director. These directorates--mathematical and physical sciences; engineering; biological, behavioral, and social sciences; astronomical, atmospheric, earth, and ocean sciences--are composed of divisions containing research programs generally organized around disciplinary specialties such as theoretical physics, topology, computer engineering, genetics, and stellar astronomy. The exception to this rule is the Directorate for Scientific, Technological, and International Affairs, which has a "problem" or "area" rather than disciplinary focus for its organizational structure. It is here, for example, that NSF's programs in international sciences are located.

The National Science Foundation itself neither performs research nor directly manages any laboratories or active research projects. Its professional staff, most of whom have Ph.D.s in science or engineering, are either permanent civil servants or "rotators"--scientists or

engineers who have taken leave from their positions in universities or, occasionally, industry or other government agencies to work as program directors/managers for 1 or 2 years in one of the disciplinary programs. About 30 percent of the professional staff are in the latter category. The organizational hierarchy is thus very "flat," with a large number of highly trained scientists and engineers at the "bottom" serving as managers.

The primary activities of the NSF are organized around research proposals. These proposals focus on a particular scientific problem and present (1) a review and analysis of previous and/or current research related to the problem; (2) a proposed plan of work and a general time schedule; and (3) a requested budget and list of resource requirements including, especially, equipment and trained manpower. As a general rule, they are unsolicited and are submitted by a single individual, a principal investigator, located most often in a university or college.

The program director/manager in a disciplinary program receives a continuous stream of such proposals over the course of a year (in FY 1983, for example, over 28,000 were received by NSF as a whole). The proposals are reviewed for their scientific excellence by experts in the scientific area represented by the proposals. Sometimes these experts are members of advisory panels; sometimes they are ad hoc reviewers, selected by the program director for their expertise.

The reviewers' evaluations are the primary basis for the program director's decision to fund, or not fund, a given proposal. About one-third to one-half of the proposals received in a given year will be funded, typically at a budget somewhat lower than the requested amount. Since graduate students frequently serve as research assistants on funded projects, NSF's support of research has a significant impact on the training of the next generation of scientists and engineers.

In a legal sense, a grant (funded project) is a contract, of sorts, between the National Science Foundation and the university, which is responsible for assuring that the funds are used according to the terms of the approved proposal and budget. On a day-to-day basis, however, the research activities are directed by the principal investigator, sometimes with the assistance of a co-principal investigator, who made the initial proposal. Once an award is made, the involvement of the NSF program director/manager or the university research administrator in the actual conduct of the work is limited to administrative approval of major changes in plans, budgets, or terms of the award. Responsibility for the scientific results rests solely with the principal investigator.

A research system such as this, with a high degree of decision decentralization and autonomy for the investigator, makes a number of critical assumptions about the underlying structure of the scientific community, scientific values, and motivations. First, it assumes that a "community of scientific peers" exists and can be identified. Second, it assumes that this community is the best judge of the quality and worthwhileness of a particular piece of work. It also assumes that this community is sufficiently free from external political, economic, or other social controls or constraints to ignore such scientifically extraneous values and base its judgment of an idea solely on an evaluation of its technical merits. Third, it assumes a high degree of

motivation on the part of the individual researcher to do the highest quality work possible in an autonomous environment where supervision by a hierarchical superior--or anyone else--is minimized and where innovative ideas and creative approaches to problem-solving are strongly encouraged and rewarded. Finally, it assumes the existence of a well-developed, public, communication system in which the publishing of scientific results is the sine qua non of a scientist's existence.

It is only through such an open system of communication that the relevant research communities are able to assess the results of work. Ideally these assessments determine the recognition, status, and scientific prestige of an individual. Within the university, they are the basis for promotion and tenure decisions. They also provide the basis for peer evaluations of the next research proposal submitted to the National Science Foundation.

Within NSF, scientific advisory panels perform three critical roles. As already indicated, these panels are sometimes used to help review individual proposals. More commonly, they provide advice on future scientific priorities and program directions. Every 3 years they are asked to review the funding decisions of the program director/manager by looking at a sample of awards and declinations. The results of this evaluation are reported to the National Science Foundation director--answering a number of questions about the way in which the program has been managed. The evaluation is intended to assure that NSF program officers are, in fact, basing their decisions on the scientific merit of proposals rather than on other, extraneous matters.

The continuous infusion of "new blood" at the program director/manager level, the extensive use of advisory panels to help determine priorities and evaluate program results, reliance on peer review by experts, and the important policy role of the National Science Board--composed of experts from different walks of life--helps keep the foundation more flexible, responsive, and open to new ideas than is often the case for more traditional government bureaucracies. This openness is critical for an organization responsible for the support of basic research.

Support "Modes"

NSF research support is provided in a variety of "modes" depending generally on the particular program and the scientific structure and sociology of the discipline it represents.

Mode 1: Individual Research Projects

The most frequent mode is that of the individual research project. In this mode, the research team consists of a principal investigator, possibly one or more senior scientists, graduate research assistants and postdoctoral fellows, and a small secretarial and technical support staff all organized around a specific research problem. The average annual cost is between about $50,000 and $75,000, depending on such

factors as the amount of equipment, the number of senior investigators and the amount of time they give to the project, and the indirect cost rate. There is a finite time for completion, and probably no one is employed full-time on the project. The individual project mode is very common in such fields as chemistry, mathematics, sociology, economics, and engineering.

A variant of the individual project mode is found in the Small Business Innovation Research program which the foundation developed, initially, in response to congressional pressures to provide research support to small, technologically oriented companies. There is evidence that such firms account for a significant share of innovative products and processes that are introduced in the market. They are also a powerful lobby group in the American political system and enjoy a great deal of support in the Congress.

Each year since 1976, a certain percentage of the foundation's budget has been congressionally "set aside" for this program. Proposals from researchers in small businesses are submitted in response to a program announcement that describes industrially relevant research areas of interest to the foundation. The intent is to provide awards ($25,000 each) that will allow an investigator to test the feasibility of a new technology, product, or process. The underlying economic assumption is that the risk factor is such that these firms could not raise capital in the private market. Thus a government program is required to assume the risk because of the long-term social benefits arising from new products and innovations developed by small companies.

Investigators receiving "Phase I" support are eligible to submit a proposal for a larger "Phase II" project, based on the results from the feasibility test. The Phase II proposal must also be accompanied by evidence of potential venture-capital funding. If the research conducted during Phase II successfully demonstrates the technological viability of the innovation, it is assumed that venture capital will be available to support its development and marketing.

Mode 2: University-based Centers and Laboratories

A second mode of NSF research support is represented by university-based centers or laboratories such as the materials research laboratories, the coordinated experimental research facilities in computer science, and the cross-disciplinary research centers in engineering planned in FY 1985. Typically they will have a somewhat more identifiable, permanent character--for example, a distinctive name; a small, full-time support staff; a part-time faculty director; and, occasionally, will occupy one or more floors or even an entire building. These centers receive multi-year funding and support a number of senior scientists, often from more than one department, plus postdoctoral fellows and graduate research assistants.

Although the entire center is organized around a research theme or domain such as polymers, biotechnology, robotics, ceramics, computer graphics, or radio astronomy, actual research may be structured around individual faculty projects that are part of the "package" upon which

the NSF funding decision was based. Because senior scientists and multi-user equipment and associated technical support staff are significant features of these centers or laboratories, their annual costs can range from $250,000 to $500,000.

There are two interesting variants of this second mode: regional instrumentation facilities and university/industry cooperative research centers.

1. Between 1978 and 1984, NSF established 14 regional instrumentation facilities intended to make costly research instrumentation accessible to a number of qualified users in academia, industry, and government laboratories. This introduced some economies of scale into measurement where the cost of specialized instruments, and the required support staff, were too expensive to be provided to a single investigator.

   These facilities are located on a university campus, occupy a distinctive location, have administrative and technical support staff, a part-time director, receive multi-year funding on the order of $150,000-$250,000 a year, and each specializes in a specific type or class of instrument (e.g., mass spectrometers, lasers and electron microscopes) available at cost to users with particular measurement needs.

2. Since 1973, the foundation has provided support for the planning and operating phases of a number of university/industry cooperative research centers. The foundation provides the seed money to a university to establish a center that focuses on an area of research (e.g., robotics, welding, materials handling, and automation) of direct interest to industry. Individual companies become participants in the centers, contributing money and equipment. In return, these companies have direct access to university faculty and several times a year are invited to participate in research meetings where individual projects are discussed and future research plans are outlined. Within 3-5 years, NSF funding is phased out and industrial funding becomes the primary source of support.

   Currently, there are 12 such centers with 120 faculty participants drawn from a variety of departments, 18 postdoctoral fellows, and 195 graduate students. There are 173 industry memberships, supported by 118 different companies. Since 1973, the foundation has provided almost $11 million, and matching funds from industry have equaled an estimated $16 million. These centers have been innovative mechanisms for linking academic research most closely to the longer-term technological needs of industry and for providing faculty and graduate students in engineering and science a "window" on industrial research.

Mode 3: National Facilities

The third major mode of research support provided by the foundation is represented by the funding of major national facilities. In some

disciplines, such as physics, these are referred to as user facilities; in other disciplines, such as atmospheric sciences and astronomy, they are called national centers. They are built around large-scale, expensive research instruments with supporting, full-time, technical, administrative, and research staffs. User facilities, such as the Electron Storage Ring at Cornell University or the Synchrotron Radiation Laboratory at Michigan State University, are supported at and managed by academic institutions. National centers, such as Kitt Peak, the Very Large Array, or the National Center for Atmospheric Research, are stand-alone facilities, operated under contract by university consortia like Associated Universities, Inc.

The scale of annual foundation support is significant, amounting to as much as $10-$20 million. Unlike university centers or laboratories which are primarily used by local faculty, these facilities are national resources, available to scientists and engineers nationwide. Individual investigators must apply for time on the facility, and a peer review committee evaluates and decides on each request. Frequently a scientist will require additional support to construct or purchase an instrument to "hang," for example, on a telescope or on the storage ring in order to conduct an experiment. Application for this funding will be made directly to the relevant disciplinary instrumentation program in the NSF. It is estimated, for example, that almost 2,000 astronomers a year design and carry out experiments in this fashion at the foundation's astronomy centers.

There are also scientific staffs at the centers who conduct research on these facilities both in order to advance their own professional careers and to be in a better position to assist visiting scientists in setting up and carrying out their experiments. Establishing the appropriate balance between staff and visitor time on and use of these facilities is a sensitive and important resource allocation decision in their effective management.

A variant of this mode of support is represented by the foundation's funding of the Academic Oceanographic Fleet. The fleet consists of 25 research vessels ranging in size from 64 to 245 feet. Each vessel is operated by a different institution under contract with the foundation which covers about 70 percent of the annual operating costs. The balance is contributed by two other federal agencies--the Office of Naval Research and the National Oceanic and Atmospheric Administration. Funding decisions are based on plans for research voyages submitted by each institution.

Research proposals submitted by individual investigators to the NSF oceanographic program include a plan for ship use. These individual plans provide the basis for an institution to develop its annual ship schedule. The administrative office for the University National Oceanographic Laboratory System (UNOLS), the association of academic ocean science research institutions supported by the foundation, organizes national meetings for its members to facilitate coordination of institutional plans. This ensures the optimal scientific use of the resources represented by the academic research fleet.

Setting Priorities

The establishment of programmatic and budgetary priorities for the basic research supported by the foundation is both a "top-down" and a "bottom-up" process. It involves a large number of actors representing a variety of institutional interests, perspectives, and values. Some are more likely to participate at the "bottom," others near the "top." The results are summarized each year by the appropriation and authorization bills signed by the President, but the process begins about 18-24 months earlier with the initial preparation of budget estimates for submission to the Office of Management and Budget. Even that beginning point is artificial. Priority setting is in fact a seamless web, a continual process. The formal budget process--its beginning and end--captures a part of it, but only a part.

Basically there are two decisions that must be made: How large should the budget be? How should it be allocated among alternative uses? These decisions are made at successive levels of specificity in the bottom-up and top-down process. They are also incremental and generally begin with what _is_, and argue "up" or "down" rather than begin _de novo_ and argue from first principles.

THE POLICY CONTEXT

At the very broadest level, economic and political considerations are paramount and, in general, scientific, engineering, and technological considerations are of subsidiary importance.

- How much research and development do the policy and economic objectives of the administration require?
- Given a set of priorities and a set of economic and budgetary constraints (forecasts), how much research and development can the federal government afford?
- What is the "appropriate" role of government and industry in the support of research and development?
- How should responsibility for supporting and managing research and development be allocated among different policy objectives and different federal agencies?
- What is the appropriate balance between basic research, basic "mission-oriented" research, applied research and development?

These questions, of course, are not necessarily asked, nor answered, explicitly. Neither are they necessarily dealt with sequentially nor are they ever really "answered" once and for all. Instead, they remain largely implicit in the warp and woof of arguments, policy discussions, compromises, and debates that go on within an administration and between the President and the Congress. They are answered, at least momentarily, in the federal budget, but the answers are never "final." They change, usually incrementally, in response to changes in the economy, changes in political party control of the White House or the Congress, and changes in the key actors in the process.

The answers--the total size of the budget for basic research; particular programmatic/policy emphases within this budget; the proportions to be managed by the NSF and the respective "mission" agencies--set the broad framework within which the foundation's priorities can and do emerge. The views of the National Science Foundation, as represented by the director and the National Science Board, may have some independent impact on the size and shape of this framework. However, their influence is probably very small in comparison with that exercised by top political appointees in other major federal agencies, key members of the Congress, the Office of Management and Budget, the President's Science Advisor and his staff, and, of course, the President himself.

Foundation-Wide Considerations: The Scientific Context

As would be expected, the question of scientific and technical opportunities becomes a much more important consideration in establishing priorities at the level of the National Science Foundation. In addition, broad strategic issues that bear on the research infrastructure and cut across disciplines or scientific opportunities become much more prominent. Such issues include the "health" of research universities; trends in graduate science and engineering education; employment patterns for scientists and engineers; changes in the relationships between research sectors, e.g., industry and academia; public attitudes, or the attitudes of "elites," which affect support for the funding of research or graduate education; changes in the funding balance between basic and applied research; the state of pre-college education and training in science and mathematics; support for research facilities or instrumentation.

At the level of the NSF, there is also a sense of the appropriate, relative distribution of support among the different fields of science and engineering as well as between "big" (large instruments and facilities) and "little" science. This sense of balance reflects broader, government-wide historical funding patterns as well as more explicit decisions about which fields of science and engineering will be supported by which agencies.

For example, over 90 percent of basic mathematical and anthropological research in universities is funded by NSF. These disciplines have had little or no role in the mission-oriented programs or other agencies as they have defined them. In contrast, although the NSF supports about 75 percent of all basic academic research in the earth and ocean sciences, a number of other agencies such as the National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), the Office of Naval Research (ONR), and the National Aeronautics and Space Administration (NASA) have significant applied missions relating to them. In this case, the funding patterns reflect both formal and informal understandings among the agencies and with the OMB, the Congress, and the academic scientific community regarding missions and appropriate funding roles. The division of roles and responsibilities is even more explicit in areas like high-energy physics or many of the biological sciences where federal agencies--the Department of Energy in

the case of physics, and the Department of Agriculture and the National Institutes of Health in the case of biological sciences--have traditionally had strong applied and basic research programs to support their missions.

The sense of the appropriate distribution of resources among disciplines is also informed by perceptions of the relative prestige and generic importance to both "fundamental, basic knowledge" and "fundamental technology" that each enjoys. As might be expected, given the foundation's orientation toward the academic world, perceptions of relative prestige and scientific value tend to parallel those found in the major academic research institutions. When priorities are set, it is very helpful to have disciplinary representatives on the National Science Board as well as in the Office of Science and Technology Policy (OSTP), including, especially, the President's Science Advisor.

In any given budget distribution, the foundation-wide allocation of resources among disciplines and among "big" and "little" sciences reflects the underlying consensus emerging, as part of the budget process, on several important issues:

- The relative scientific quality and generic "fundamental importance" of different disciplines.
- The appropriate funding role of the NSF in different fields.
- The willingness of the external political community--the OMB, the White House, the OSTP, and the Congress--and the external scientific community to "buy off" on a particular distribution.
- The nature of infrastructure problems and the appropriate foundation role in responding to them.

The direction this consensus takes and its impact on the allocation of resources depends very much on the "disciplinary and institutional balance of power" among the key actors in this process as well as on their objective opportunity for exercising influence on the choices as they develop in the budgeting process.

Under normal circumstances, there is a strong bias toward maintenance of the status quo in the relative allocation of resources--if not in a single year, because of a "lumpy" item such as a large piece of equipment, then over 2 or 3 years. The effect of "lumpy" items or "special initiatives" on relative resources allocation may also be smoothed by requiring offsetting <u>decreases</u> in other parts of a discipline's research program. Nothing is scrutinized more closely by the board, the director, the advisory committees, the NSF staff, and the scientific community than the relative percentage increases for different disciplines. Trends over time become major points for debate and argument as well as sources of satisfaction and feelings of achievement.

Many events can challenge the existing equilibrium, sometimes to the point of causing a major reappraisal and change. One class of events are more or less intrinsic to academic science and scientific institutions themselves.

In recent NSF history, for example, a consensus emerged that although pure mathematical research was both very important for many other fields of science and close to making some significant breakthroughs in understanding basic mathematical questions, it was

comparatively underfunded by the NSF. For these reasons, a willingness to relax the "rules" and let mathematics funding have larger-than-usual increases emerged. It helped that reasonably large percentage increases could be gained with only small absolute changes, since this minimized the perceived impact of the adjustment on the relative funding position of other disciplines.

The stimulus for relatively larger increases for computer research in recent years stemmed from other factors: a feeling that university research in computer science was too theoretical and required a substantial increase in experimental (computing) facilities; the fact that significant increases in student enrollments in computer science had occurred, largely in response to student perceptions of future job opportunities; the belief that some of the best faculty and brightest graduate students were being diverted out of basic academic research and teaching careers by the higher salaries and more attractive research environments of industry; a more generalized belief that basic advances in this area were important to other disciplines. The effectiveness of those arguing the case for relatively greater increases for computer research was enhanced by three things: (1) the relatively small size of the amounts required, (2) the perception that the program was taking some offsetting decreases elsewhere to accommodate these changes, and (3) the opportunity to align scientific and professional arguments with the concerns of the Congress and others about the competitiveness of the U.S. computer industry.

Like computer research, a persuasive argument was made in recent years that basic research in plant biology should be given an extra shot in the arm because of its long-term relationship to industrial and agricultural technologies which the external political community felt were economically important. It was also the case that significant breakthroughs in fundamental research in DNA, genetics, and molecular biology appeared to open the way for new, highly innovative work in plant biology--work that was not appropriate to or funded by the much more applied, crop-oriented research of the USDA. These things together provided a persuasive argument for relatively larger increases for basic research in plant biology.

In each of these, and similar, cases, the presence of one or more persuasive advocates on the board or on the foundation staff was also an important ingredient for shaping the debate, keeping attention focused on the issue, and persuading others to go along. However, without the ability to appeal to significant "scientific opportunities" and to align scientific values with larger economic, social, or technological concerns, it is unlikely that they would have succeeded in producing an adjustment in the relative allocation of resources, however small. Each also required a lot of formal and informal consensus building and fence mending within the foundation and the board as well as within various parts of the scientific community.

Much more dramatic efforts to change the status quo often result from events and efforts external to the foundation. In 1968, for example, as a partial consequence of the Mansfield Amendment directing the Department of Defense (DOD) to limit its research programs more strictly to its national security mission, the NSF was given responsibility for

14 university-based materials research laboratories previously supported by the Defense Advanced Research Projects Agency (DARPA). The nature of the research supported in these laboratories has been a frequent source of controversy and review over the years, and the laboratories have been modified to better fit the NSF basic research, disciplinary-oriented mode. In FY 1985, $30 million will be provided for their support.

In 1971, the Office of Management and Budget directed the foundation to develop two new programs as part of a federal experiment to see if government-funded R&D could be made more useful to, or even transferred to, the civilian sector. Perhaps the best-known element in this experiment was the foundation's Research Applied to National Needs (RANN) program.

The OMB and congressional "charter" for RANN was to support research addressing important national needs not being adequately treated elsewhere by the government. The establishment of this program represented a significant resource "blip" in the existing distribution of funds. Between its creation and its demise in 1977, it obligated over $500 million in pursuit of its charter. In practice, its management style was much more active, and the research it supported much more applied, directed, and multidisciplinary than was traditional for the foundation. Two perceptions, shared by many in the academic research community, the NSF program staff, and on the board were critical to its eventual demise: (1) the work it supported was generally second-rate, scientifically; and (2) the funds it used would otherwise have been available to support "high-quality basic research" if the program had not existed. This latter view was not shared in the Congress and the OMB during RANN's early years.

More recently, the engineering community mounted a major effort to increase support for engineering in the National Science Foundation. Although NSF has had an engineering research program since its early days, the perception existed that it was a step-child, hostage to the physicists, seriously underfunded relative to its importance to the economy and to the enrollment and funding problems engineering faculties were encountering on the campus in the late 1970s and early 1980s. There was also a feeling that engineering had special problems and needs that made it different from science and that would not get a sympathetic hearing in the "scientific culture" of the foundation.

In addition to a slight increase in the number of "engineers" on the National Science Board, the internal status of the engineering research program was changed in 1979 when the Division of Engineering was combined with the remnants of the RANN program into a Directorate for Engineering and Applied Science. A proposal to include some of the materials research program in the reorganized group was dropped in the face of opposition from the affected research communities.

The next step occurred in response to continuing pressure from engineering societies and to a bill, introduced by the chairman of the NSF's House Authorization Subcommittee, which would remove engineering from the foundation and combined it with the National Bureau of Standards (NBS) into a new National Technology Foundation. The threat of such a competitor for federal funding of basic research in science was

taken very seriously, and the NSF reorganized again, distributing responsibility (and the few remaining dollars) for "applied science" throughout the foundation and purifying engineering in a new Directorate for Engineering.

Since then, support for engineering research has increased by almost 76 percent from $83.8 million in FY 1981 to a proposed $147.1 million in FY 1985. However, during this same period, the total NSF research budget has increased by about 50 percent so that the "redistributive" effects of this large increase have been kept down. In FY 1981, engineering accounted for 9.5 percent of the NSF research budget. In the FY 1985 request, it would be at 11.2 percent of the total.

Other examples of externally initiated changes to the NSF status quo might be discussed--the Small Business Innovation Research Act, for example, requiring NSF support of research by small businesses, or the dramatic cut in the funding of social science research in the spring of 1981 by the OMB--but all appear to have certain things in common. Issues of economics, technology, or social policy generally loom as large or larger than questions of scientific opportunities or needs. It is also true that in each case the foundation responded by adjusting its budgetary or programmatic definitions, allocations, and management policies so as to minimize the effects of the change on the budgetary status quo and on the foundation's traditional conceptions of its purpose, responsibilities, and "style."

Program Level: Planning and Decision Making

At the "bottom" of the NSF planning and resource allocation process is the division, organized around disciplines, and the program directors/managers, responsible for one specialized area of research within the division. From the perspective of the research community, this is probably the most critical part of the organization.

Advisory committees offer their suggestions and funding priorities to division directors and program officers. The free flow of research proposals and reviewers' comments on them are a vital source of scientific market information on trends, priorities, and emerging opportunities and needs in the discipline.

While these same staff members receive directives and budgetary guidelines from the "top," they also have a critical role to play in articulating the directions of research and priorities, identifying infrastructure problems and resource requirements, and communicating these views and concerns up the hierarchy as well as representing their constituency within the foundation, in meetings of the National Science Board, and in interagency meetings with program officers from other federal agencies.

As expected at this level, questions of scientific quality, merit, and need dominate discussions of resource allocation. The "politics" that occur in any proposed allocation--whether among different specialties or different categories like instrumentation, post-doctorate awards, or graduate student support--are the "politics of the discipline," reflecting its basic sociology and prestige structure within academia.

There is the same strong bias in favor of the status quo which is found at the foundation level. After all, the budget reflects an evolutionary equilibrium of the contending viewpoints and priorities most acceptable to the relevant scientific and institutional constituency. If a particular program officer or an external event such as the proposed combination of portions of material research with engineering threatens the established "social contract" among different segments of the discipline and the foundation, there are a number of channels for protecting it, ranging from the director and the National Science Board to the OMB, the President's Science Advisor, and the Congress.

Once the basic budgetary decisions represented by the appropriation and authorization bills are made for a given year and funds are internally assigned to programs for "budget execution," the final stage in the resource allocation process occurs: the selection and funding of specific research proposals from among all of those submitted. Scientific considerations and considerations of scientific opportunities, quality, and balance--as determined in large part through the peer review process--become paramount. The program officer exercises discretion in the selection of reviewers, the interpretation of their remarks, and the size, composition, and timing of the project budget. These decisions are, of course, subject to review by a division director and, every 3 years, by a scientific evaluation panel. But scientific merit and scientific needs are the key determinants of this choice.

American Agricultural Research and Technology

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This presentation will touch upon four areas for the consideration of this workshop: (1) agricultural research policy in the United States, (2) the planning process within the Agricultural Research Service, (3) some of the federal quality control and regulatory agencies that operate within the Department of Agriculture and in other federal departments, and (4) some of the actors who bring about the process of technology transfer within the agricultural research system.

U.S. AGRICULTURAL RESEARCH POLICY

The technology used today in the American agricultural production complex is the direct result of a partnership involving the federal government; the land-grant university system, including the state agricultural experiment stations; and the private sector, including American industry, private universities, and research foundations. No one group alone could even approach the contribution made by this combined effort.

Currently, research is federally funded when:

1. The federal government is the user of the research--for example, defense research and research to maintain federally owned resources.

2. There is a shared responsibility between the federal government and another interest--state, local, or private.

Both the administration and the Congress recognize the following as appropriate federal agricultural research responsibilities:

- To provide leadership for the nation's food, agricultural and forestry research, education and rural development programs.

- To identify priority research and education needs by continually examining the problems and issues confronting the various parts of the agricultural community and society.

- To support science and education programs that ensure long-term efficiency in the performance of the agricultural production and marketing systems and enhance the competitive position of U.S. agriculture in world markets.

- To conduct research relating to departmental action and regulatory functions.

- To foster research and knowledge-transfer programs that provide broad societal benefits and significant economic gain to the nation.

- To undertake research where the private sector and state-supported studies alone are deemed unlikely to invest adequately in the national interest.

The process of setting research priorities involves the cooperation of the federal government, the states, and industry. A number of actors have played important roles in the research priority-setting process for USDA: the Joint Council on Food and Agricultural Sciences, the Users Advisory Board, commodity groups, and other government-industry cooperators in research planning.

This organizational complexity is compounded further by the characteristics of agricultural research. To a larger extent than is true for other domestic areas that enjoy public support for research, public policy initiatives in agriculture relate to the spectrum of research activities from basic to highly applied. Research must be responsive to immediate problems--the corn blight, for example--but must also be far-ranging enough to provide a scientific offset to natural forces that would otherwise reduce agricultural production. Research must encompass not only the hundreds of products made possible by the geographic and climatic breadth of the United States, but also the national goals advanced for American agriculture: productive efficiency and sustainability, environmental compatibility, nutritional soundness, and distributional equity.

AGRICULTURAL RESEARCH SERVICE

The Agricultural Research Service (ARS) within USDA is primarily concerned with national priorities. Its facilities--approximately 150 laboratories of varying size--are located strategically across the major farm and rangeland ecosystems and climatic zones of the United States and eight foreign countries. Thus, it has the ability to carry on research in several different geographic locations working on the same national problem.

ARS is developing a strategic plan to guide the agency into the next century and beyond. This plan identifies and explains the main problems that confront the agricultural industry and charts the minimum courses of action that will provide the research needed for solutions. The plan is being developed under the leadership of ARS senior staff

with input from more than 500 ARS scientists and in consultation with colleagues from the universities and industry. The first two phases of the plan are now complete.

The first phase includes a catalog of research options that ARS may consider over the next 20-50 years. The second phase of the plan considers implementation of certain of these options over the next 6 years, 1984-1990. Assuming a constant-dollar funding for this time period, the third phase of the plan--operational planning, the one now under way--is an action phase in which decisions are made about which programs to strengthen, which programs to deemphasize, where research will take place, etc.

The six objectives of the strategic plan develop the means to:

- Manage and conserve the nation's soil and water resources for a stable and productive agriculture
- Maintain and increase the productivity and quality of crop plants
- Increase the productivity of animals and the quality of animal products
- Improve the system for delivery and conversion of raw agricultural commodities into food and useful products for domestic consumption and export
- Promote optimum human health and performance through improved nutrition
- Integrate scientific knowledge on agricultural production and processing into systems that optimize resource management and facilitate the transfer of technology to end users.

These six objectives describe the aims of ARS scientists, and the words "develop the means to" are important. ARS is a research agency; farmers and ranchers, action agencies, and the private sector will actually achieve the stated objectives.

This plan assumes constant-dollar funding for ARS programs during the balance of this decade. The current ARS budget of about $460 million represents 10 percent of the total national effort in agricultural research. Other performers include the states, other federal agencies, private foundations, and the private sector.

QUALITY CONTROL AND REGULATORY AGENCIES

The following are brief descriptions of the quality control and regulatory agencies that are part of the U.S. Department of Agriculture:

- Soil Conservation Service (SCS) is responsible for developing and carrying out a national soil and water conservation program in cooperation with landowners and operators and other land users and developers; with community planning agencies and regional resource groups; and with other federal, state, and local government agencies.

- Food Safety and Inspection Service (FSIS) is responsible for assuring that meat and poultry products for human consumption, which are moving in interstate and foreign commerce, are safe, wholesome, and accurately labeled.

- Animal and Plant Health Inspection Service (APHIS) conducts regulatory and control programs to protect and improve animal and plant health for the benefit of man and his environment.

- Agricultural Marketing Service (AMS) provides current information to producers, processors, distributors, and others to assist them in the orderly marketing and distribution of farm commodities.

- Federal Grain Inspection Service (FGIS) carries out the provisions of the U.S. Grain Standards Act to ensure integrity in the inspection, weighing, and handling of American grain.

- Food and Nutrition Service (FNS) administers programs that make food assistance available to people who need it. Included are the Food Stamp Program, the National School Lunch Program, the Summer Food Service Program for Children, the Child Care Food Program, and the Special Milk Program for Children.

- Human Nutrition Information Service (HNIS) performs research in human nutrition to improve professional and public understanding of the nutritional adequacy of diets and food supplies as well as the nutritive value of foods.

The Department of Health and Human Services has two agencies that are concerned with the quality control and regulation of food products:

- Food and Drug Administration (FDA) activities are directed toward protecting the health of the nation against impure and unsafe foods, drugs and cosmetics, and other potential hazards.

- National Institute for Occupational Safety and Health (NIOSH) assures safe and healthful working conditions for all working people. Occupational safety and health standards are developed and research and other activities are carried out through the Centers for Disease Control and the National Institute for Occupational Safety and Health.

The Department of Labor includes the following agency:

- Occupational Safety and Health Administration (OSHA) which develops and promulgates occupational safety and health standards; develops and issues regulations; conducts investigations and inspections to determine the status of compliance with safety and health standards and regulations; and issues citations and proposes penalties for noncompliance with safety and health standards and regulations.

Finally, there are independent agencies:

- Environmental Protection Agency (EPA) protects and enhances our environment today and for future generations to the fullest extent possible under the laws enacted by Congress.

- Consumer Products Safety Commission (CPSC) protects the public against unreasonable risks of injury from consumer products; helps consumers evaluate the comparative safety of consumer products; develops uniform safety standards for consumer products and minimizes conflicting state and local regulations; and promotes research and investigation into the causes and prevention of product-related deaths, illnesses, and injuries.

TECHNOLOGY TRANSFER

The mechanisms currently available for the transfer of technology to its users include the USDA Extension Service, with its system of county agents in every state; the land-grant college/university system, with its state agricultural experiment stations; agribusiness; commodity and cooperative associations; and the Agricultural Research Service.

Most ARS presentations at scientific and professional meetings result in specific industrial inquiries, and many receive spot announcements in technical journals. The number of inquiries is often an indication of the commercial potential of the development. Reprints of the presentations, individual comments, and specialized summaries are employed to answer these inquiries and thus generate further interest. These inquiries are also good contacts for individual follow-up and are an indication of a specific company's interest. Correspondence with industry is another avenue of communication. ARS receives requests for information and also provides unsolicited information to potential users.

The major laboratories and research centers of ARS are visited by thousands of technical representatives of various companies annually. These visits are used to promote ARS research and development, to obtain information on industry's interest, to develop contacts and working relationships, and to secure data and recommendations for guidance of its research program. ARS has good industrial contacts in most of the currently planned research areas.

Many conferences and meetings provide opportunities to inform and promote ARS development by personal discussion. For industrial activities, careful selection is necessary to ensure that the level of industrial representatives ARS is trying to contact attend the meetings.

Probably the most effective contacts are field visits or meetings. With the present staffing, only a fraction of all companies can be contacted in the field. Thus, these contacts must be carefully selected and utilized. For industrial development activities, the contact level is normally with presidents, vice presidents, directors of research, division chiefs, or comparable personnel. Industrial reception of our visits has been excellent and profitable.

Planning and Evaluation of Research: Industry Practices, Applied to National Programs

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Effective evaluation of research and the overall success of a research project depends on the development of a comprehensive, detailed project plan. The evaluation process has two facets: evaluation of the project's results against the organizational goals, and evaluation against the detailed project plan. It is important, therefore, to describe the overall planning process--starting with goals and ending with project accomplishments--in order to develop evaluation methods for these two facets. This is as true of a national science and technology program as it is of an industrial S/T program.

What follows is a description of an industrial planning process, using for illustration purposes some Indonesian plans.

The S/T planning process is outlined in Figure 1. The first step in the planning process (see the first box in Figure 1--organizational goals) can be illustrated in Indonesia's case by the national objectives of Indonesia listed in Figure 2. (All Indonesian illustrations are not to be construed as complete or correct. They are only given here to permit readers to relate the given planning process to Indonesia's plans.)

The next step in the planning process is to determine S/T policy. The elements of an S/T policy are shown in Figure 3, while Figures 4 and 5 illustrate an S/T policy that could apply to Indonesia. In Figure 1, S/T policy consists of two elements: (1) definition of the technologies (i.e., strategic technical areas [STA] Item B, Figure 3) and (2) determination of the S/T strategy (Item C, Figure 3). For example, the four levels of S/T strategy listed in Figure 4 can occur simultaneously over several technologies, but most likely the S/T strategy will start with Phase I and progress through the other phases with time as the country becomes more developed. This S/T strategy is in support of the national objectives in Figure 2. The information in Figures 5 and 6 help define the product areas that are important to Indonesian national objectives.

S/T policy still requires the proper definition of the strategic technical areas (STA) within which the S/T projects must be planned. A strategic technical area includes four parts: (1) the technical skill (or scientific discipline), e.g., heat transfer (Figure 7); (2) the activity of the scientific discipline (i.e., how it is used, for example to analyze, Figure 7); (3) the product on which it is used (e.g., analysis of the radiator of an automobile, Figure 8); and (4) what the

product is used for (e.g., to cool the engine of an automobile). Figure 9 gives an example of a strategic technical area. By defining technical areas in this way, scientific disciplines are tied to products or processes which are in turn tied to national objectives. It also provides a better focus for the S/T project activities, as well as better communication between managers and engineers, because engineers work within scientific disciplines (technical skills) and managers work with products and manufacturing processes. Figure 10 defines the S/T strategy in more detail.

The following example is given to illustrate the planning process described above. To support the national objective, "Develop potential to produce goods and services" (see Figure 2), it is decided that the S/T strategy of "technology adaptation for processes" (Figure 3) will be followed, "using existing technology for processing" (Figure 4). This will "increase the value added" (Item 1, Figure 5) in manufacturing a product demanded by the domestic market as defined by Item 2, Figure 5 (for example, manufacturing tapioca from cassava by adopting an existing process). The strategic technical area within which the technology adaptation must occur is defined as the scientific discipline chemistry, which is used to formulate a process to convert cassava into tapioca.

The next step is to determine the S/T program (Figure 11). The S/T project proposals are developed by the engineer and scientists to be consistent with the product and process areas and the S/T policy. For example, one proposal could be to design and test a laboratory-scale prototype process to manufacture tapioca from cassava. Another proposal might be to study the basic chemical process used in the manufacture of tapioca.

Proposals (Item I, Figure 11) are developed by all S/T organizations in their areas of scientific competency, and their priority should become apparent because of their relationship to the national objectives. Detailed project plans are developed for those proposals that are approved for funding. Item II, Figure 11, lists the basic requirements of the project plans. Finally, Item III, Figure 11, lists the critical items that must be followed as the project progresses.

Figure 12 lists some of the items important during the implementation phase to accomplish the project. These are:

Item I. Selecting the proper S/T organization to be responsible for the project (this is usually the organization that submitted the successful research proposal).

Item II. In assigning professional personnel to the project it is important not only to assign the proper scientific skill with the proper experience level but also to make assignments according to the role the professional must play on the project. For example, if the project technical strategy requires innovation to develop new ideas, a person who is a technical innovator and also has the proper scientific discipline should be assigned. However, if a project requires running a series of tests on a tight schedule, a person having project administrative leadership qualities

should be assigned. This requires a supervisor/subordinate agreement on the role emphasis for each project assignment.

Item III. The task description for each assignment is then based on the STA (scientific discipline) and the role emphasis. The performance factors are also a function of these two dimensions--STA and role. (For example, in a project requiring innovation, the number of ideas generated in the scientific discipline represented by the STA is the important performance factor.) The effectiveness of these results can also be evaluated according to the usefulness of the ideas (for example, the number of ideas that were useful in solving the problems in the innovative project).

Item IV. Mid-course correction of the project can then be carried out as a result of (1) new inputs, (2) accomplishments, (3) changed manpower assignments, and (4) changed objectives.

Figure 13 lists eight areas that must be considered in the evaluation of an S/T organization and its program. This is a different but complementary approach to that previously given here. Details of the kinds of questions that can be asked during reviews in each of these areas are not presented, but they are available. With some adaptation, the questions can be applied to any program and to any organization, whether it is a national laboratory or industrial laboratory.

FIGURE 1
TECHNICAL PLANNING PROCESS

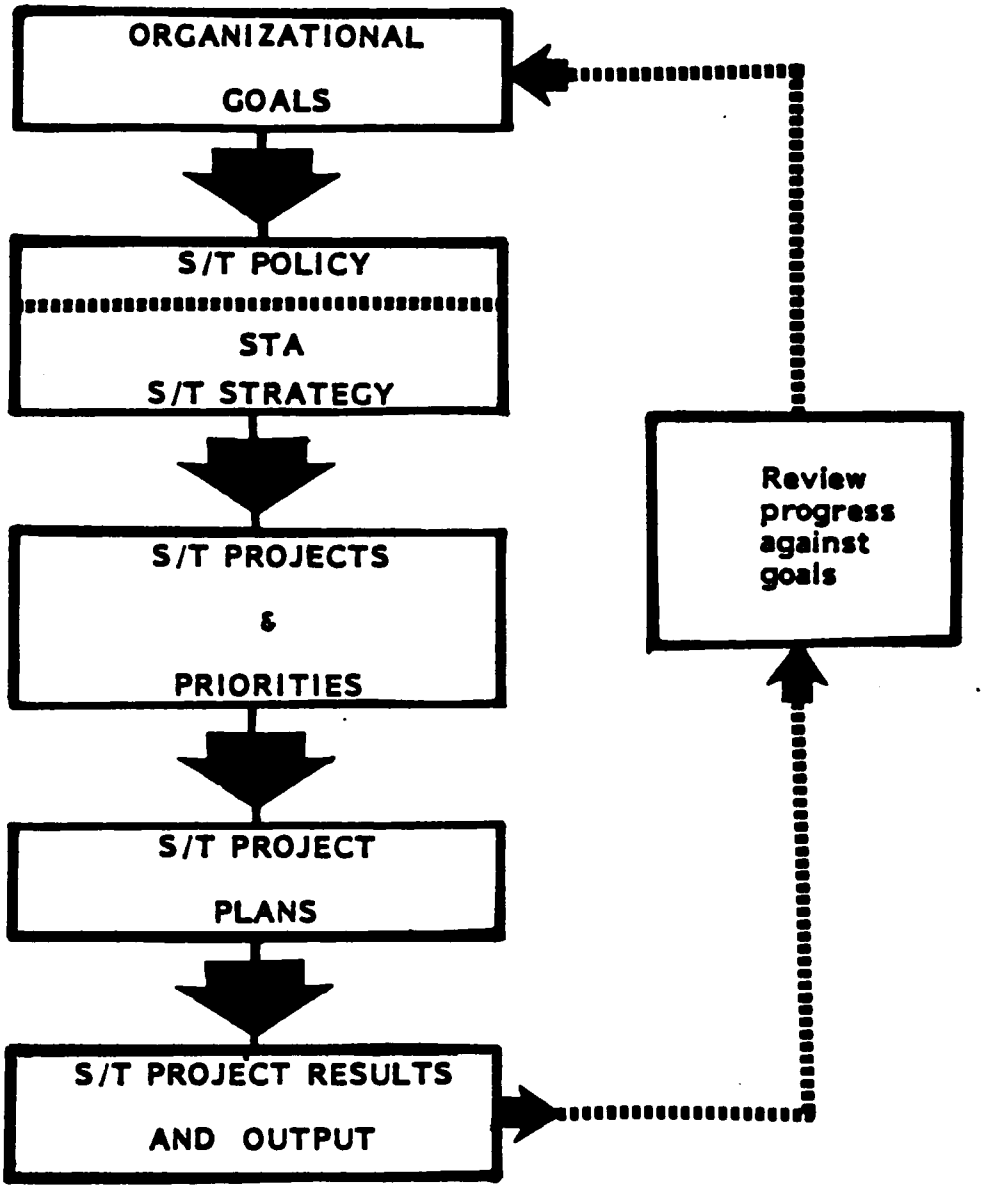

FIGURE 2

INDONESIAN

NATIONAL OBJECTIVES

- DEVELOP POTENTIAL TO PRODUCE GOODS AND SERVICES
- PROTECTION OF THE NATION
- ADVANCE CULTURAL ENDOWMENTS OF THE NATION
- TRANSFORMATION TO INDUSTRIAL SOPHISTICATION

FIGURE 3

DETERMINATION OF S/T POLICY

A. SELECTION OF PROCESS AND PRODUCT AREAS

B. SELECTION OF STRATEGIC TECHNICAL AREAS

- HOW DEFINED
- WHAT ARE THEY
- WHO DEFINES THEM
- FUNCTION OF INDUSTRIES AND SELECTED PRODUCTS AND PROCESSES.

C. DEFINING THE S/T STRATEGY

- RANGE OF STRATEGY
  - TECHNOLOGY ADAPTATION FOR PROCESSES
  - TECHNOLOGY APPLICATION FOR NEW PRODUCTS AND PROCESSES
  - TECHNOLOGY ADVANCEMENT FOR EXISTING PRODUCTS AND PROCESSES
  - TECHNOLOGY INNOVATION OF NEW TECHNOLOGY FOR NEW PRODUCTS AND PROCESSES.

FIGURE 4

TECHNICAL GOALS

TECHNOLOGY TRANSFER AND DEVELOPMENT

I - USE EXISTING TECHNOLOGY - PROCESSES

II - INTEGRATE EXISTING TECHNOLOGY FOR NEW-
- PRODUCTS
- PROCESSES

III - DEVELOP NEW TECHNOLOGIES

IV - ADVANCEMENT OF SCIENTIFIC KNOWLEDGE

FIGURE 5

VEHICLES FOR TECHNOLOGY TRANSFER

1. DEVELOPMENT OF MANUFACTURING PROCESSES TO INCREASE VALUE -ADDED.

2. PRODUCT DEMAND OF DOMESTIC MARKET AS A FUNCTION OF:

   - GEOGRAPHY
   - ENDOWMENT
   - GROWTH OF ECONOMY
   - SIZE OF MARKET
   - COMPETITIVENESS

FIGURE 6
SELECTED INDUSTRIES

1. AERONAUTICS AND AEROSPACE

2. SHIPBUILDING

3. LAND TRANSPORTATION

4. ELECTRONICS AND TELECOMMUNICATIONS

5. ENERGY

6. FACILITIES ENGINEERING INDUSTRY

7. AGRICULTURE EQUIPMENT

8. DEFENSE

9. SERVICE INDUSTRIES

FIGURE 7
DEFINITION OF STRATEGIC TECHNICAL AREAS

STA	TECHNOLOGY	APPLICATION	PRODUCT/ SERVICE
$STA_{(1)}$	HEAT TRANSFER	ANALYSIS	
$STA_{(2)}$	HEAT TRANSFER	ANALYSIS	

FIGURE 8
PRODUCT/SERVICE OF A STRATEGIC TECHNICAL AREA

STA	TECHNOLOGY	APPLICATION	PRODUCT/ SERVICE
$STA_{(1)}$	HEAT TRANSFER	ANALYSIS	AUTOMOBILE RADIATOR
$STA_{(2)}$	HEAT TRANSFER	ANALYSIS	"COLUMBIA" SPACECRAFT

FIGURE 9
EXAMPLE OF SPECIFIC CAPABILITIES

"GOOD GLASS HANDLING CAPABILITY"

"STATE OF ART PRODUCTION SKILLS IN CLEANING, CUTTING, BENDING AND LAMINATING MEDIUM TO HIGH VOLUME QUANTITIES OF STANDARD FLOAT GLASS, STANDARD SHEET, AND TEMPERED GLASS IN SIZES OF 0.5 TO 5 SQ. FT. AND THICKNESSES IN THE RANGE OF 0.1 TO 0.5 IN."

Source: Page 38 in Planned Innovation, by Frank R. Bacon and Thomas W. Butler, Jr. Industrial Development Division, University of Michigan, Ann Arbor, Michigan.

FIGURE 10
S/T STRATEGY

- TECHNOLOGY ADAPTATION FOR PROCESSES
  - INCREASE VALUE ADDED
- TECHNOLOGY APPLICATION FOR
  - NEW PRODUCTS
  - NEW PROCESSES
- TECHNOLOGY ADVANCEMENT FOR
  - PRODUCTS
  - PROCESSES
- TECHNOLOGY INNOVATION
  - NEW TECHNOLOGY FOR NEW AND EXISTING PRODUCTS AND PROCESSES.

FIGURE 11

DETERMINATION OF S/T PROGRAM

I. PROJECT PROPOSALS DEFINITION

- BASED ON S/T POLICY
  - PROCESS & PRODUCT AREAS
  - STRATEGIC TECHNICAL AREAS (STA)
  - S/T STRATEGY
- BY ALL S/T ORGANIZATIONS
- PROPOSALS CONSIST OF
  - TECHNICAL OBJECTIVE
  - TECHNICAL APPROACH
  - EXPECTED END RESULT
- PRIORITIES DETERMINED FROM S/T POLICY

II. PROJECT PLANS OF APPROVED PROJECTS

- TECHNICAL TASK STATEMENT
- TECHNICAL OBJECTIVE
- TECHNICAL APPROACH
- TECHNICAL MILESTONE EVENTS
- TECHNICAL MILESTONE SCHEDULE
- MANPOWER ASSIGNMENT BY MILESTONE
- EXPENDITURE PLAN BY MILESTONE AND TIME
- END TECHNICAL RESULT (COMPLETION)

III. REVIEW TECHNICAL ACCOMPLISHMENTS

- TECHNICAL OBJECTIVES
- MILESTONE EVENT
- MILESTONE SCHEDULE
- EXPENDITURES BY MILESTONE AND TIME
- DEGREE OF END ITEM ACCOMPLISHMENT

FIGURE 12

IMPLEMENTATION OF S/T PROGRAM

I. SELECT RESPONSIBLE S/T ORGANIZATION

II. MANPOWER ASSIGNMENTS BY:

- STRATEGIC TECHNICAL AREA (STA)
  - SCIENTIFIC DISCIPLINE
  - EXPERIENCE LEVEL
- FUNCTIONAL MANAGERIAL AND TECHNICAL ROLES NEEDED BY PROJECT
  - TECHNICAL GATEKEEPER
  - TECHNICAL INNOVATOR
  - MARKET GATEKEEPER
  - CHAMPION
  - PROJECT ADMINISTRATIVE LEADER
  - MENTOR
- SUPERVISOR/SUBORDINATE AGREEMENT ON STA AND ROLE EMPHASIS FOR EACH PROJECT ASSIGNMENT.

FIGURE 12 (Continued)

III. DEVELOPMENT OF TASK DESCRIPTION FROM STA AND ROLE EMPHASIS.

- TECHNICAL TASK DESCRIPTION FROM MILESTONES AND PROJECT PLAN
- PERFORMANCE FACTORS
  - IDEAS GENERATED
  - PROBLEMS SOLVED
  - IDEAS CHAMPIONED
  - IDEAS DISCOVERED EXTERNALLY
- EFFECTIVENESS OF RESULTS
  - USEFULNESS OF IDEAS
  - NUMBER OF PROBLEMS SOLVED
  - NUMBER OF IDEAS DISCOVERED
  - USEFULNESS OF RESULTS TOWARD ATTAINMENT OF TECHNICAL GOALS

IV. MID-COURSE CORRECTION OF PROJECT PLANS AS A RESULT OF:

- NEW INPUTS
- PROJECT ACCOMPLISHMENTS
- LACK OF MANPOWER
- ADDITION OF MANPOWER
- CHANGED OBJECTIVES

FIGURE 13

ASSESSING PROGRESS OF AN S/T PROGRAM

1. ORGANIZATION'S GOALS
2. S/T MANAGEMENT OBJECTIVES
3. S/T ORGANIZATION
4. S/T PERSONNEL
5. S/T PLANNING
    - A. BUDGET
    - B. TECHNICAL
6. S/T OPERATIONS
7. S/T MANAGEMENT CONTROLS
8. S/T PROGRAM PERFORMANCE
    - A. EFFECTIVENESS
    - B. EFFICIENCY
    - C. UTILIZATION OF S/T PRODUCTS

APPENDIX D
PRESENTATIONS BY INDONESIAN PARTICIPANTS, JAKARTA WORKSHOP

R&D Organization in the Government Sector of Indonesia

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INTRODUCTION

This paper outlines the organization of research and development (R&D) within the Indonesian government, but no analysis is given of how efficient and effective the organization is in planning, monitoring, and evaluating R&D programs and projects.

CURRENT R&D ORGANIZATION IN THE GOVERNMENT SECTOR

In Indonesia, research and technology development are being conducted in various R&D institutions, centers, and universities primarily in the government sector, and, to a certain extent, in state and private companies, private research institutions, and private universities.

Following the reorganization of all ministries in 1974, each ministry had its own R&D agency or an R&D center. The function of an R&D agency is to formulate policies and coordinate R&D activities within the ministry concerned, and to formulate its own programs and budgets and monitor and control its own R&D activities.

The following ministries have R&D agencies: Department of Foreign Affairs, Home Affairs, Information, Trade, Cooperatives, Agriculture, Forestry, Industry, Communications, Tourism-Posts and Telecommunication, Social Affairs, Health, Religious Affairs, Manpower, Transmigration, and Education and Culture. The head of the R&D agency is appointed by the president and is directly responsible to the minister concerned. The R&D agency is on the same level as a directorate general and belongs to the first echelon unit.

An R&D agency is subdivided into centers. Depending on its scope of work and activities and its institutional development, some R&D agencies also have R&D institutes, such as the Agency for Agricultural Research and Development (AARD) and the Agency for Industrial Research and Development.

Some ministries such as the Department of Defense and Security, the Department of Finance, and the Department of Public Works have an R&D center. In the case of the Department of Public Works, in addition to having an R&D center, three directorates conduct research, studies, and investigations to provide technical support and services to the

directorate general concerned. In the case of the Department of Mining and Energy, one R&D center, two development centers, and three research directorates provide technical support and services to the directorate general concerned.

There are also nondepartmental agencies for research and technology:

- BAKOSURTANAL (National Coordinating Agency for Surveys and Mapping) produces base maps, and topographical, oceanographical, meteorological, and other thematic maps. This agency is also responsible for surveying, inventorying, and evaluating natural resources.

- BATAN (National Atomic Energy Agency) conducts research on nuclear energy, the exploration for uranium, and the production of isotopes and their applications.

- BPS (Central Bureau of Statistics) is responsible for collecting and analyzing national statistics.

- BPPT (Agency for the Assessment and Application of Technology) explores technologies compatible with the situations and conditions in Indonesia, and by special assignment is also responsible for their applications in industries.

- LIPI (Indonesian Institute of Sciences) is responsible for research activities in the social sciences and humanities, engineering sciences, and natural sciences. LIPI also provides scientific and technical services such as information, instrumentation, and calibration; formulates national science policy to be proposed to the government; and handles the popularization of science in society.

- LAPAN (National Aeronautics and Space Institute) concentrates on the use of space technology for resource inventory, weather forecasting, and communications.

These nondepartmental agencies are directly responsible to the president of the Republic of Indonesia, but technically they are coordinated by the minister of state for research and technology.

Since 1978, facilities for the Center for Science, Research, and Technology or PUSPIPTEK have been under construction in Serpong, near Jakarta. PUSPIPTEK is planned to be a science town, equipped with laboratories, a computer center, and other facilities. The main tasks of PUSPIPTEK are: (1) to develop the infrastructure for research and technology, (2) to provide facilities needed by the scientific community, and (3) to increase public awareness of the role of research, science, and technology in national development. The laboratories for materials and construction testing and for instrumentation are already in operation. PUSPIPTEK is under the supervision of the minister of state for research and technology.

The structure of R&D organizations in the government sector is described below.

Minister of State for Research and Technology (MENRISTEK)

According to presidential decree no. 25, 1983, the primary functions of the minister of state for research and technology (MENRISTEK) are: (1) to prepare the formulation of government policies related to research and development, and the application and use of research and technology in national development and planning; (2) to coordinate all research and technology activities in the government sector; and (3) to coordinate the operational activities of BAKOSURTANAL, BATAN, BPS, BPPT, LAPAN, and LIPI related to research and technology.

In the formulation of national programs of research and technology, MENRISTEK is served by an advisory body, PEPUNAS RISTEK (Team for the Formulation and Evaluation of National Major Programmes on Research and Technology). This team is composed of scientists, engineers, and science and R&D managers from universities, R&D agencies, and other agencies, appointed by the MENRISTEK. The team is divided into five groups, each concerned with one of the five priority areas listed in the national research and technology matrix: (1) basic human needs, (2) energy and natural resources, (3) industrialization, (4) security and defense, and (5) social, economic, cultural, law, and philosophic affairs. It is the task of each group to submit a list of recommended research programs in its respective priority areas to MENRISTEK.

Budget for Science, Technology, and Research

The main source of funds for R&D and other scientific and technical activities is the government budget, which is divided into a routine budget and development budget. The routine budget finances wages and salaries, maintenance, travel costs, etc., while the development budget provides for specific sectoral allocations.

The budget for science, technology, and research activities in the development budget are grouped under "Sector 15: Science, Technology, and Research." This sector does not include capital investment in laboratory buildings (except for PUSPIPTEK), R&D activities conducted in state universities, and the activities of BAKOSURTANAL.

Mechanism for Planning, Monitoring, and Evaluation

Because the government serves as the primary source of funds, the mechanism for planning, monitoring, and evaluating R&D programs and projects is based on the organizational structure of R&D within the government sector, and the national financial budgeting system. The primary "valves" in the budgeting system in Indonesia are: the National Planning Board (BAPPENAS) for programs and projects, and the Department of Finance for the financial aspects. The priorities of all programs

and projects are expected to be based on the Guidelines of State Policy (GBHN) and the 5-year development plan (REPELITA). The national R&D matrix is also taken into consideration.

To better understand the mechanism for planning, monitoring, and evaluating R&D programs and projects, the case of LIPI is illustrated here. Within LIPI, a master plan covers its 5-year development, based on the ideas and proposals of the R&D institutions and other units that compose the institute. Using this master plan, each year--usually in August--each institute and project propose their yearly program and project (including budget) to the chairman of LIPI. The format used for this proposal is called the "terms of reference" (TOR). After review by the LIPI planning team, and with the agreement of the chairman of LIPI, the TORs are then sent to the office of the MENRISTEK for review and agreement. In October-November, based on the TOR, each institute and project fills in the Daftar Usulan Provek (DUP-Project Proposal), which again after review by the LIPI planning team is sent to: (1) BAPPENAS, (2) the Department of Finance (Directorate of Budget), (3) the office of the MENRISTEK, and (4) the office of the SETNEG (State Secretariat). After review of and discussions on each project, after the ceiling of the LIPI budget is set, and after agreement by BAPPENAS and the Department of Finance, each project then fills in the Daftar Isian Proyek (DIP-Project Form), including its operational budget. Only after the DIP is signed by BAPPENAS and the Department of Finance can the project be started on the first of April of the respective fiscal year.

The monitoring and evaluation of LIPI projects are conducted at different levels. Within an R&D institute, the project leader and the director of the institute are responsible; at higher levels, the deputy chairman of LIPI is responsible for the monitoring and evaluation of all projects in the institutions under his supervision. The chairman of LIPI is responsible for these duties with regard to LIPI's programs and projects.

R&D Program in the Ministry of Health

Drh. Hartono
Ministry of Health

The R&D program in the Ministry of Health is carried out by the National Institute of Health Research and Development (NIHRD). This institute is primarily responsible for coordinating R&D activities in the field of health needed to promote the health status of the Indonesian people.

The National Institute of Health Research and Development consists of six research centers:

1. Health Services R&D Center (Surabaya)
2. Nutrition R&D Center (Bogor)
3. Biomedical Research Center (Jakarta)
4. Pharmaceutical Research Center (Jakarta)
5. Health Ecology Research Center (Jakarta)
6. Cancer Research and Radiology Development Center (Jakarta)

Each of these research centers is responsible for coordinating and carrying out research activities in its respective field.

PROGRAM PLANNING

R&D programs in the health field are formulated in five annual programs that correspond to the 5-year development plan. Research and development activities conducted during REPELITA IV (1984-1989) will focus on:

- Communicable disease problems
- Noncommunicable disease problems
- Health ecology and environmental health problems
- Food and drug control
- Nutrition
- Health system and management
- Health services

To implement these programs within REPELITA IV, a yearly budget is established by formulating research projects on topics that include:

- Strengthening the health R&D
- Research on communicable diseases

- Research on noncommunicable diseases
- Research on health ecology and environmental health
- Pharmaceutical research
- Health services research
- Health system and management R&D

Each project is based upon research proposals obtained from scientists in the six research centers and from scientists outside the NIHRD.

Research project selection is carried out in two phases, the first within each research center and the second phase within the NIHRD. The first phase of project selection is conducted by scoring the research proposals using three selection criteria: (1) relevance to the existing health program, (2) methodology, and (3) feasibility.

In the second phase, each directorate general of the Ministry of Health is consulted to obtain the priority ranking of the accepted proposals obtained in the first phase of selection.

Finally, the following reports are submitted by the principal investigator of the research project as stipulated in the contractual agreement for the project:

- Monthly financial report
- Quarterly progress reports
- Final report
- Executive summary which briefly covers the objectives of the research, research results, and recommendations for better health programs based on the results
- Scientific report.

Agency for Agricultural Research and Development

Joko Budianto
Agency for Agricultural Research and Development

INTRODUCTION

The Agency for Agricultural Research and Development (AARD) was established by presidential decree in 1974. Prior to this time, research was conducted under a directorate general for each of the following areas: food crops, estate crops, forestry, fisheries, and animal husbandry. The division of activities among its various research institutes for industrial crops is shown in Table 1.

TABLE 1 Activities of the Research Institutes for Industrial Crops, by Commodity

	Research Institute			
Commodity	T. Karang	Manado	Malang	Bogor
Pepper	***	*	-	**
Cloves	***	*	*	**
Coconut	*	***	*	**
Cotton	-	**	***	**
Tobacco	*	*	***	**
Cashew nuts	**	**	**	***

*Supporting
**Participant
***Leader

In 1982, the commodity-oriented programs included the following categories:

- Paddy, corn, soybeans, cassava, potatoes, wheat, citrus, orchids
- Cattle, sheep and goats, chickens, ducks
- Tuna, shrimp

- Coconuts, cotton, cloves, pepper, tobacco, cashew nuts
- Rubber, coffee, palm oil, cocoa

Problem-oriented programs focus on agroeconomics, land resources, transmigration, agricultural energy, germplasm, water management, and animal reproduction.

From 1975 to 1982, the total manpower employed by AARD increased from 3,599 to 5,625. The scientific staff increased from 400 to 1,389, while other personnel increased from 3,199 to 4,236. Researchers at the Ph.D. level expanded from 15 to 67; master's level, 215 to 251; university graduate level, 0 to 814; and bachelor of science level, 170 to 257.

Currently, 360 researchers are studying for advanced degrees, and it is projected that approximately 300 members will be sent for advanced degrees in the future.

Based on a conversion rate of 625 Indonesian rupiahs to US$1, from 1976 to 1982, the AARD development budget increased from $14.2 to $33.6 million: the routine budget increased from $3.2 to $12.9 million, and contributions from the government estates and the sugar factories increased from $3.8 to $15.3 million.

SETTING RESEARCH PRIORITIES

Generally, the priority of research activities is based on national development and agricultural development objectives as well as current needs for a technology.

The national development guidelines of state policy require that priorities for the application of science and technology be established in accordance with agreed-upon criteria, among which are:

- To stimulate employment
- To maximize the utilization of domestic resources
- To improve the balance of payments.

The objectives of agricultural development are:

- To increase food production for the improvement of nutritional levels
- To improve farmers' incomes and welfare
- To increase employment opportunities
- To increase exports and reduce imports of agricultural commodities
- To support industries that process agricultural products
- To optimize the utilization of natural resources and protect environmental quality
- To stimulate more integrated and harmonious rural development.

The results of research activities are communicated through four channels:

- From each directorate general to extension workers (for translation, adaptation to local conditions, delivery to farmers)
- Directly to key farmers or producers, and private and government production units
- To other government agencies for use in policy formulation, planning, and programming
- To universities, schools, and publishers to add to existing knowledge.

APPENDIX E
LIST OF WORKSHOP PARTICIPANTS

UNITED STATES PARTICIPANTS

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