



INVESTMENT IN

BASIC RESEARCH

by *Emanuel R. Piore*

The Navy through the Office of Naval Research is supporting basic research in about 150 colleges and nonprofit institutions in thirty-six states, the Territory of Alaska, and the District of Columbia. The history, philosophy, and operation of this program are related by the head of its Physical Sciences Division.

The program of the Office of Naval Research was initiated in the fall of 1945, when scientists were returning to their peacetime pursuits and funds were required for this conversion from war to peace. The Office of Scientific Research and Development (OSRD) was liquidating its activities, and it was necessary to conserve some of the scientific assets created during the war. This problem was recognized by many people in high government, industrial, and academic circles. The Navy had the foresight to take action.

Initiated by the Office of Research and Inventions, the program is now under the immediate supervision of the Assistant Chief for Research of the

Office of Naval Research, and its civilian Science Director. ONR was created by and derives its authority from a Public Law passed by the 79th Congress.

Motivation within the Navy for this type of support arose from many factors. As one of the major technical organizations in the country its very existence depends upon healthy and vigorous scientific activity on a national scale. The Navy is deeply concerned with the deficit in technical people produced by the wartime draft laws, which cost the country one to two graduate-school generations of scientists, and felt that something should be done about it. Also a factor was the desire to continue the relationships developed between the military and civilian personnel in the Navy and the scientists in academic and industrial institutions. Thus an investment was made in basic research.

Support of a broad, long range, basic research program by the federal government, in laboratories out-

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side the government, is in a sense a new venture. A government agency's support of research usually arises from its direct operational needs, which stem from the responsibility given to that agency by Congress. Devices must be perfected or problems arise which can be solved only through research. The research which is farmed out, be it basic or applied, has direct bearing on these needs. Certain skills exist at universities which can aid the solution of the problem, and colleges are invited to participate in the research program on the same basis, essentially, as are engineering firms. The research program is formulated, stated, and, in a sense, directed by the governmental agency.

In contrast, ONR tries to stimulate creative scientific activity to insure the existence of a broad base for applied research and development. Thus support is given to the traditional source of creative thinking—the universities—stimulating their normal function of research and graduate instruction.

Program

In the program administered by the Physical Sciences Division there are about 500 individual research problems or tasks. Approximately 1,800 senior scientific investigators and 2,000 graduates are participating, with an annual rate of expenditure in the neighborhood of \$20,000,000. With the exception of nuclear physics, which emphasizes large machine construction and large teams of scientists, the average task is spending around \$20,000 per year and about half of the 500 tasks are allotted less than \$15,000 per year.

When the Navy entered this research activity, initial support was directed to the nuclear physicists returning to their home institutions from war work, and to conservation and conversion of some OSRD and NDRC activities. The program has grown to include all fields of interest to the Navy. The Physical Sciences Division expanded and now functions through eight branches, each headed by a civilian scientist with research experience in his specialty. During the fiscal year 1947-1948, the percentage allocation of the total sum available to this division was as follows: physics—15 percent, nuclear physics—30 percent, mechanics and materials—12 percent, mathematics—8 percent, chemistry—8 percent, fluid mechanics—7 percent, electronics—11 percent, and geophysics—9 percent.

The concentration of funds, due to the pattern of the initial support, is to be found in the highly populated states with their large institutions of scientific competence in many fields. In addition, the larger schools started their research planning as soon as the war demands on science diminished to meet the needs for graduate instruction. ONR funds were spent in just such places as would permit scientists to return to work on fundamental problems and instruct a new generation of scientists.

The smaller institutions, faced with tremendous undergraduate enrollment as young men left the armed forces, and having only a limited interest in graduate instruction, did not formulate plans immediately for research and graduate instruction. Thus the smaller schools were brought into the program at a later date. At present about forty percent of the projects are to be found in the smaller institutions. The balance thus reached appears to be appropriate.

Operations

Worthwhile research proposals are now coming into the Office of Naval Research at a rate representing about three times the number that the Office can currently support. They are forwarded to the branch heads, who, in consultation with various scientific and technical groups, inside and outside the Navy, recommend support to the Executive Committee which in turn recommends to the Chief of Naval Research execution of contracts with the institutions.

In selecting a project for support, careful consideration is given to the scientific merit of the undertaking, the research ability of the investigators, the training possibilities the project will afford to young men, the institution's background in the subject and the endorsement of its administration, and the potential impact of the research on the present and future needs of the Navy. Each branch in the Physical Sciences Division uses a different pattern to determine by the first four of these criteria support of a given project. In some fields existing National Research Council committees or specially created NRC committees, such as the Committee on Earth Sciences, the Committee on Astronomy, and the Committee on Pure Mathematics, review all proposals submitted. In other fields such as electronics, where the Navy has its own special competence, the proposed project is circulated to scientists in the Naval

bureaus and laboratories. Some committees have, at times, been created by the Office of Naval Research with memberships outside the Navy Department to aid in the evaluation process. The chemistry and nuclear physics branches function in this manner.

This diversity in the administrative procedure of the branches is premeditated because support of basic research by a federal agency is a new activity and a pattern for evaluation and selection of projects worthy of support must be evolved. These three different methods of evaluation being tried all bring sound scientific judgment to the evaluation of a specific project. This aspect of the operation should not be underestimated, for it determines the relationship of the federal government to those receiving its support.

In addition to the problems associated with individual fields, the over-all scientific policy of the Office of Naval Research is reviewed periodically by the Naval Research Advisory Committee, which consists of fourteen scientists and engineers. Dr. Warren Weaver of the Rockefeller Foundation was the first chairman; Dr. Karl T. Compton, former president of the Massachusetts Institute of Technology, is the most recent chairman. The Committee derives its existence and authority from the public law which established the ONR.

The various advisory committees perform a valuable function in selection of projects; however, the success of the entire operation depends on the caliber of the scientists responsible for planning and administering the scientific program. To continue a fresh point of view in the organization, scientists are invited to join the staff, on leave of absence from their home institutions, for one- to two-year periods. At present, the heads of the electronics, physics, and geophysics branches are on leave of absence from their universities. It is hoped to expand this arrangement so that ONR staff can return to research laboratories on leave for periods of time. Such an arrangement assures a program planned and administered by scientists who have intimate contact with the problems that face the research worker.

Coordination and Security

In any special field, provided the projects are unclassified, every worker of competence knows what is going on in that field through his normal contacts, with other investigators, maintained at meetings,

conventions, and through personal relations. Coordination and duplication in basic research are not thorny problems. No one wants to duplicate some one else's work. In addition to the normal mingling of scientists and their interchange of information, the various advisory committees, composed of some of the most important investigators in the field, perform a coordinating function and in addition to that, the ONR, from time to time, holds conferences in which almost all the investigators participate. Such conferences, for example, have been held in cryogenics, spectroscopy, and polymers. The free discussion automatically achieves coordination and eliminates unnecessary duplication.

Basic information about our physical universe cannot be security-classified, or locked behind steel doors. It is important that the most imaginative people in the scientific field do creative work, and this is only possible in a free atmosphere which does not impose classification. Classification in the field of basic research is a result of ignorance, fear, and lack of confidence in one's ability to progress with time. Once the scientists of this country are active, they will be creative and maintain their leadership. Publication through normal technical channels of research results is one of the instrumentalities that keeps research free, and therefore, is encouraged. This, in the traditional manner, stimulates further scientific progress and accelerates its application.

At times, in some projects, the classification problem does arise. The need for classification may be raised either by the investigator or the Navy. When that happens the researcher and his university are consulted to determine whether the classified part of the project should be continued there, under security rules, or removed to a commercial or naval laboratory, where security is handled in routine operations. To date there have been no disagreements where such problems have arisen. Of the five hundred university projects in the Physical Sciences Division, only three carry security classification.

Future

The number of scientifically worthwhile projects that are rejected for lack of funds indicates that the level of basic research in this country can be increased. Surveys have been made in specialized fields and they too show that more work can be done. The ONR program is bound to produce imaginative and

creative investigations by the current crop of graduate students. Some will find support in industrial and government laboratories, but others will remain in the academic environment and additional funds will be required to give their research ideas an opportunity to blossom. Although the eventual level of scientific operations in the country is not only a scientific, but also a social and economic problem, there is every indication that at present it should be higher. The Steelman report recommended that ultimately two hundred fifty million dollars should be spent annually on research.

Current planning in the Navy is to keep its expenditure in basic research at approximately the present level, so that a balance will be maintained with other Naval activities, and so that basic research has a normal uninflated environment in the Navy. Thus science must look for other sources of funds.

This points to a need for a National Science Foundation. The Navy Department is on record for this legislation. Such legislation was part of the program of the 79th and 80th Congresses, but never became law.

The experiences and operations of ONR do indicate that the National Science Foundation should not be the sole government agency supporting basic research. The ONR has been careful not to become the only naval activity engaged in basic research, because giving authorization to a single group has certain dangers found to be inherent in monopolies—the danger, for example, of fostering a too-narrow point of view and too-restrictive policy. To make certain that this does not develop, it seems best to have a number of agencies in the field.

In addition, any agency that has extensive development responsibilities and programs should be in the research field so that its development programs will feel the full impact of the current thinking in research; otherwise there is real danger that development may atrophy. This must be accomplished organizationally in such fashion as to give research freedom and prevent development from absorbing and pushing research out of the way. The Navy has done this very much in the same way as the large industrial establishments have, by separating research laboratories from the development units. The bureaus deal primarily with the development of equipment and secondarily with research. ONR's primary responsibility is research.

If and when a National Science Foundation is enacted into law, the program currently supported by the Navy may require revision. Some fields may receive added emphasis, others less. The precise pattern this shift takes will depend upon the character, chart, and policies of the Foundation.

Evaluation

All of us, both officers and civilians in ONR, feel that we are engaged in a very important experiment, investment in basic research. This experiment has two aspects. The first is continuing the relationship developed during the war between scientists on one hand and the Naval officers on the other, which has had a profound effect on naval thinking and procedure. The second is the support of basic research on a broad and comprehensive scale by the federal government. ONR experience will be vital to any other organization that Congress may create for that purpose on a comparable or larger scale.

ONR experience has demonstrated that federal support is possible without in any way limiting the freedom, initiative, and creative thinking of the scientific worker, provided the agency is concerned only with research and does not have other operational responsibilities.

Another demonstration of the Office's successful operation is its use as an instrumentality by other governmental agencies. The Atomic Energy Commission, to name only one agency, has used ONR facilities to allocate funds for basic research.

Whatever the future may bring, the Office of Naval Research has helped to keep alive basic research in this country for the past three years, stepping in when there was no one else able to carry the burden. Such pioneering is a tribute to the Navy's vision and its recognition of the fact that scientific strength is national strength and the best preparedness for any eventuality.

