ing the "creative imagination" would, of course, vary enormously and could never be measured. But given the conditions and the approach, there would, I believe, be no doubt about its effect. For in that dark saying of Shelley's, "Poetry administers to the effect by acting upon the cause," there are latent innumerable possibilities of the development of the human mind (perhaps by infection), some realization of the virtues of humility, and a sense of the uncertainties latent in the most advanced speculations.

I believe that the "values" that will emerge from literature are, on the whole, best left to grow, through slight but wise guidance, from the thing read, once the desire to read has been aroused and maintained; that more harm than good is done by assuming the attitude that "you *ought* to read so-and-so." The dichotomy is there—the dichotomy that started at the end of the 17th century and has been growing steadily ever since. At the roots of it there is both an emotional antipathy (often a willful misunderstanding) and a tendency to rely upon the apparent fact rather than upon its more profound implications.

Perhaps it is too much to hope for what Oppenheimer calls "the happy symbiosis of science and the general culture of an age." We could, I believe, go far toward improving the present position. And among the most important things that should be done is to foster, by all possible means, the associations of the scientist with the arts man—informally and constantly, with unobtrusive encouragement of the free exchange of ideas. For this we must teach the arts man two things: to rid himself of the frequent defensive snobbishness (not uncommon on university staffs as well as among the students) and to acquire at least the basic vocabulary of the scientist, so that he may speak with him in the gate. For this is perhaps the crux of the matter: whereas the scientist knows, or thinks that he knows, the technical vocabulary of, let us say, the esthetician or the literary critic, the arts man will, unless he takes the trouble to master the minimum technical vocabulary of the scientist, find himself confronted with an impregnable barrier, which is easily converted by the less intelligent scientists into something resembling a *mystique*. One difficulty, of course, lies in the sheer physical means of providing this contact; the growth of the specialized institutions on either side of the fence is steadily decreasing the possibility of undergraduate intercourse on these lines, which still obtains, to a greater or lesser extent, in the colleges of the older British universities.

For it is the growth of the whole man that both sides are seeking, and in that growth, civilized intercourse between students—the free and informal exchange of ideas—is at least as important as any formal instruction that can be given in the classroom. If, in addition, we can insure that in every university there are a few teachers of stature, whether in arts or sciences, who can in their teaching move with some measure of ease from one side to the other and who can create the current sympathy which is essential to understanding, then we shall have done much. Is it a dream to think of a university in which the arts teachers will have studied at least the history of science, and in which all teachers of science will be equipped to teach English as an integral part of their work?

References and Notes

1. See the proposals of the "Principles of science" tripos, as published and discussed (but not yet approved by the university) in the Cambridge University *Reporter* during 1957.
2. I have suggested some of these in a little book called *The Apple and the Spectroscope*. The working of an image can be suggested by a valve, in which a current passes from cathode to anode, through a grid, which selects and filters the particles of meaning that pass over to the object from the image, as in "My love's like a red, red rose."
3. For example, changing meanings of words in relation to civilizations, manners, and sociological problems.
4. This would be perhaps in terms of optics—the graduations of shadow on the edge of meaning.

News of Science

Evolution of the Organization of the Federal Government for Scientific Activities: 1947 to the Present

Major Developments Since 1947

In the years since 1947, a number of significant changes have occurred in the organization of the Federal Government for scientific activities. New agencies with important scientific responsibilities have appeared. Several existing agencies have undergone reorganization, with the step-by-step evolution of organization for research and development in the military departments being of considerable importance. During this period federal scientific programs have burgeoned in size and diversity.

Atomic Energy Commission

The Atomic Energy Commission is exceeded only by the Department of Defense in the magnitude of its scientific activities. The war-born program of nuclear research and production was transferred from military to civilian control in January 1947, but it was more than a year later before the Manhattan Engineer District turned over the last of its contracts to the Atomic Energy Commission. The commission inherited from its predecessor a mode of operation which it continued and further developed. Most of its operations, including research and development, are performed under contract with industrial concerns, academic institutions, and other nonprofit organizations. An important but not large segment of research activity is carried out for the commission in the laboratories of other federal government agencies.

The commission conducts approximately two-thirds of its total research and development program in government-owned facilities operated under contract by industrial and institutional contractors. Some of these, like the Oak Ridge National Laboratory, the Los Alamos Scientific Laboratory, and the Argonne National Laboratory, had their beginnings in the Manhattan Project era. Others, such as the Ames Laboratory, Bettis Plant, and the Brookhaven National Laboratory, have been established since 1947.

In its early years, the commission managed its research and development program through five divisions: production, research and development, engineering, military application, and biology and medicine. In 1949 the Atomic Energy Commission placed the division of engineering within a new division of reactor development. The division of research continued to have cognizance over research reactors and was authorized to participate in advanced reactor work and supporting research. To coordinate the research aspects of the work carried on in its several divisions, the commission relied mainly on several program committees.

The next major change in the commission's organization which had a bearing on the management of its research and development program occurred in 1954 with the appointment of an assistant general manager for research and development. This action served to raise research and development to a level earlier accorded manufacturing operations by the creation of an assistant general manager for manufacturing.

An important feature of the commission's policy-formulating machinery has been the presence of scientists in key roles. From the beginning the General Advisory Committee has been composed almost exclusively of scientists, and there has been at least one distinguished scientist on the commission itself since its establishment.

In its relations with the military departments, the commission's principal mechanism for day-to-day coordination has been the close working relations maintained between the division of military application and the Armed Forces Special Weapons Project. At the policy level, the Military Liaison Committee serves as the major mechanism for mutual interchange of advice and information between the Department of Defense and the commission. The development of reactors for military use in propulsion and electrical power generation is programmed and coordinated by the director of reactor development of the Atomic Energy Commission. His staff includes military officers who participate in the planning and execution of the military component of the reactor program.

Department of Defense

A series of major changes have taken place in the organization for military research and development since 1947 and, indeed, the organizational situation in each of the military departments is still in flux.

After World War II, the Office of Scientific Research and Development, which had been responsible for a major share of the research and development conducted for the military services during the war, began disbanding. To fill the remaining void, the Secretary of War and the Secretary of the Navy in June 1946, established the Joint Research and Development Board composed of two representatives of each department and a chairman, Vannevar Bush. The board, and the committees through which much of its work was done, represented an interim arrangement for the study of military research and development programs and for reaching agreement between the two departments on common policies, allocation of responsibility for projects in which both were interested, and joint use of facilities. The National Security Act of 1947, which established the Office of the Secretary of Defense and the Department of the Air Force, provided stronger machinery for the coordination of military strength and development programs.

Secretary of Defense. The Secretary of Defense was given broad responsibilities for effecting the unification of the activities of the three military departments. Specifically, he was to establish general policies for, and to exercise general direction, authority, and control over, the national military establishment, and to eliminate unnecessary duplication in a number of fields, including research. [*Note.* The Department of Defense Reorganization Act of 1958 revised the policy declaration of the National Security Act of 1947 to make it clear that the three military departments are under the control of the Secretary of Defense.]

Research and Development Board. To advise and assist him in this, the statute established a Research and Development Board, which reported to the Secretary of Defense. The board consisted of two representatives of each military department and a civilian chairman appointed by the Secretary of Defense. The board's mission included the preparation of an integrated military research and development program, rendering advice on trends in scientific research of relevance to national defense, and recommending measures of interservice coordination and allocation of responsibilities.

The board was assisted by a staff of several hundred military and civilian personnel, whose efforts were supplemented by more than 2000 consultants. The board also created a network of committees and panels. The committees, ordinarily composed of representatives of the three military departments, were largely organized in terms of military programs and problem areas. Most of the panels, which were generally composed of scientists from outside the government, rendered advice on the work undertaken in the major scientific disciplines. The board's staff performed a number of studies of the military research and development programs, organization, budget, and related subjects. The committees and panels reviewed scientific programs and made recommendations as to adequacy and promise in these programs. Acting on the basis of the findings of its staff and the recommendations of its committees, the board reviewed and passed on major programs, made recommendations on the research and development budget to the Secretary of Defense, and concerned itself with various interservice problems such as the assignment of responsibilities, the common use of facilities, and the recruitment of scientific manpower.

The board also developed a system for classifying the research and development effort into categories and programs, and for relating these to the operational needs of the military services. It requested each department to report on the progress of its research and development work in accordance with a standard reporting system, and authorized a unified technical information service administered by the Air Force.

In the first years of unification, the board performed a particularly useful function in providing a forum for the reconciliation of the diverse viewpoints of the three services, and for the exchange of information on activities of common concern. [*Note.* As a result of a number of studies of the organization of the Department of Defense, many changes were effected by the Department of Defense Reorganization Act of 1958. In the areas of research and development, the major change was the establishment of the position of director of defense research and engineering. As outlined by the President, the director will have three functions: first, to be the principal adviser to the Secretary of Defense on scientific and technical matters; second, to supervise all research and engineering activities in the Department of Defense, including those of the Advanced Research Projects Agency and of the Office of the Director of Guided Missiles; and, third, to direct research and engineering activities that require centralized management. Further, it will be his responsibility to plan research and development to meet the requirements of our national military objectives instead of the more limited requirements of each of the military services. This position has not yet been filled.]

Assistant to the Secretary of Defense (Atomic Energy)

Another official in the office of the Secretary of Defense with responsibility for research and development matters is the Assistant to the Secretary of Defense (Atomic Energy). The incumbent of this position also serves as chairman of the Military Liaison Committee, which is the focal point for policy liaison between the Atomic Energy Commission and the Department of Defense. He is responsible for advising the Secretary of Defense; formulating plans, policies, and programs; and representing the department on atomic energy matters.

Other Organizational Developments

The weapons systems evaluation group, responsible to the Assistant Secretary of Defense (Research and Development), was established in 1948. It provides the assistant secretary and the joint chiefs of staff with analyses and evaluations of the comparative effectiveness and costs of present and future weapon systems, and of their influence upon strategy, tactics, and organization. The group, which must be intimately aware of data gathered by the intelligence agencies and of strategic plans, as well as the latest technical developments, has the function of bringing scientific potentialities into a productive relationship with operational needs. In 1955, in response to a recommendation of the second Hoover Commission, the department transferred this activity to contract operation.

Also reporting to the Assistant Secretary of Defense (Research and Development) and to each chief of staff is the Armed Forces Special Weapons Project, established in 1946. This group provides technical, logistic, and training support for atomic weapons to the military departments, and maintains liaison between the Atomic Energy Commission and the Armed Forces in research and development on atomic weapons in areas not covered by the military liaison committee.

Contractor-Operated Research Centers

Each of the three military departments has made extensive use, since 1947, of an organizational device first employed by the Office of Scientific Research and Development during World War II, the contractor-operated research center, usually in facilities which the government owns.

While these centers vary widely in the nature of their management control and the scope of their mission, they all have one thing in common—a primary contractual relationship with one or more of the military departments. This new and steadily growing institutional arrangement has been particularly well suited to research in broad problem areas associated with weapons systems development. Each military department has also used such centers for the conduct of operations research.

For example, in 1949 the Army established the Operations Research Office, managed by the Johns Hopkins University; the Navy utilized the OSRD-born Operations Evaluation Group, operated by contract with the Massachusetts Institute of Technology; and the Air Force activity encouraged and financed the creation of the RAND Corporation, an independent research group with a broad range of research interests.

By 1955 there were roughly two dozen such research centers engaged almost entirely on work for the three military departments. The nature of the contractual arrangements between the military departments and the universities, other nonprofit organizations, or commercial concerns operating the centers, enables the directors of the centers to carry out their programs free from many of the administrative problems posed for scientific work by governmental procedure and organization.

National Science Foundation

The National Science Foundation was established by Act of Congress in 1950. This culminated a movement which began in 1945 when extensive congressional hearings revealed that an overwhelming majority of the nation's scientists, educators, and business leaders favored the creation of such an agency as had been proposed in Vannevar Bush's report, "Science—The Endless Frontier."

Under the terms of the act of 1950, the foundation's authority is vested in the National Science Board and the director of the foundation. The board consists of 24 members appointed by the President with the advice and consent of the Senate. The director is also named by the President with the advice and consent of the Senate.

The foundation's responsibilities, as set forth in the act, were clarified and elaborated by Executive Order 10521, issued in 1954. Of major importance is the foundation's support of basic research in the sciences through grants to investigators, usually in universities. The foundation has a fellowship program and other programs designed to aid in the training of scientists and in improving the quality of science teaching. It is also concerned with expanding the dissemination of scientific information. It is charged with responsibility for developing and encouraging the pursuit of a national policy for the promotion of basic research and education in the sciences and with appraising the impact of research on industrial development and on the general welfare.

To meet these responsibilities the foundation maintains a staff in Washington which is organized into six principal divisions and offices.

National Aeronautics and Space Administration

One major change in the organization of the Federal Government for scientific activities that has occurred since the publication of the National Science Foundation's study which appears in part above is the absorption of the National Advisory Committee for Aeronautics by the recently created National Aeronautics and Space Administration. The new agency, which will eventually control many of the scientific activities now under the direction of the Department of Defense, has responsibility for all space programs which are not primarily associated with national defense. The area of jurisdiction of this agency is currently being defined. Further information concerning the NASA can be found in *Science* [**128**, 582 (12 Sept. 1958); **128**, 826 (10 Oct. 1958); **128**, 889 (17 Oct. 1958); **128**, 994 (24 Oct. 1958)].

U.S.-Euratom Agreement for Cooperation Signed

An agreement between the United States and the six-nation European Atomic Energy Community (Euratom) was signed on 8 November 1958 in Brussels. The agreement for cooperation in the civil uses of atomic energy has as its major objective the bringing into operation in the Community in the next five to seven years of approximately 1 million electrical kilowatts of nuclear power capacity, using reactor types developed in the United States.

It is expected that the provisions for wide dissemination of information under the program will provide industrial organizations in the Community and the United States with valuable engineering experience, and technological and economic data concerning the operation of nuclear power plants in Europe under conditions that will be nearly competitive with conventionally fueled plants.

The agreement, expected to come into force after Congress convenes in January 1959, contains the major objectives of the United States and Euratom on the joint nuclear power program, whose capital cost, exclusive of fuel, is expected to be about $350 million. These provisions include:

1. Financial guarantees by the United States of up to $90 million for a 10-year operating period with respect to the cost and integrity of the fuel elements required in the reactors;
2. Long-term assurance of an adequate nuclear fuel supply at prices equivalent to those offered to domestic U.S. industries;
3. Guarantee for a 10-year period of a market for the plutonium recovered from the power reactors in the program;
4. Long-term line of credits of up to $135,000,000 to cover a portion of the capital costs of the nuclear power plants; and
5. A long-term assurance by the United States chemical reprocessing services will be available under terms comparable to those then available to U.S. industry.

An integral part of the program is a