Mobilization of Scientific, Engineering, and Medical Manpower: An Interim Report[1]

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AS THE PACE OF THE NATION'S DEFENSE EFFORT ACCELERATES, demands for scientific, engineering, medical, and other technical manpower are pressing more closely upon severely limited resources. The shortages that have already developed, and those that are clearly ahead, have both alarmed those who feel their effects most sharply and brought a measure of public action. At this point it may be helpful to review briefly what has occurred during the past few months and to state the general considerations that seem to militate for and against effective resolution of manpower problems in critically important fields.

General Background

Factors favorable to effective use of scientific manpower. The dramatic and fully publicized research and development accomplishments during and after World War II have created an unprecedented understanding of the central role of research as a source of industrial and military strength. This is reflected in greater willingness on the part of the general public and Congress to view highly trained scientific personnel as a resource that must be used most effectively, and to see the maintenance of a flow of people trained in scientific fields as a major mobilization objective.

College administrators recall the drop in enrollment and the decline in output of trained people during World War II. The number of persons granted Ph.D. degrees in the natural sciences dropped from 2,034 in 1941 to 833 in 1945:[2]

1941	2,034	(Prewar peak)
1945	833	(World War II low)
1946	948	
1947	1,463	
1948	1,947	
1949	2,936	
1950	4,160	(Estimated)

The drop would have been catastrophic if the war had continued for a few more years. Indeed, at the current and contemplated levels of production and research, 4,000 Ph.D.s per year is a thin crop, as shown by these 1950 graduating class figures.[3]

Field	Ph.D.s
Biochemistry	116
Biology	81
Chemistry	953
Geology	113
Mathematics	46
Physics	358

This is the peak annual flow into the scientific corps of a nation of 150,000,000, an economy operating at the level of $290 billion per year, and a research and development program of greater magnitude than the world has ever seen before.

Even with the postwar increase in the number of Ph.D.s produced per year, the total output over the period 1941–50 is still about 3,000 below the number that would have been produced if the 1941 rate had prevailed throughout that period. The significance of this figure is grasped more readily when it is placed against the total number of persons with Ph.D. degrees in scientific fields:[4]

Field	Ph.D. degree
Total	34,000
Chemistry	12,000
Physics	3,400
Geology*	1,400
Biological sciences	7,000§
Agricultural sciences	3,000§
Medical sciences†	3,000§
Other‡	4,200

* Including geophysics.

† Includes such fields as anatomy, pathology, and physiology.

‡ Includes such fields as astronomy, mathematics, and meteorology, and 1,200 engineers.

§ Distribution of total of 13,000 for these three fields estimated by the author on basis of Bureau of Labor statistics data.

The prospect that a relatively high degree of mobilization will continue for a number of years has created apprehension that the danger averted during World War II may not be averted during the years ahead. This apprehension is based in part upon a clearly foreseeable and substantial expansion of demand generated by a vast increase in expenditures for research and development and a rapid build-up of defense facilities and supporting production.

Industry is just beginning to feel the impact of defense orders on production and on the expansion

[1] Based on statements prepared for meetings of the Advisory Councils of the Public Health Service, Feb. 15–17, 1951.

[2] *Report on Scientific Manpower.* Washington, D. C.: Office of Scientific Personnel, National Research Council (Nov. 1950).

[3] *Earned Degrees Conferred by Higher Educational Institutions, 1949–50* (Circular No. 282A, Nov. 1950): Office of Education, Federal Security Agency.

[4] *The Nation's Scientific and Technical Manpower* (Manpower Report No. 3). U. S. Department of Labor, Bureau of Labor Statistics (Dec. 4, 1950).

of physical facilities. Demands for new plants and equipment are expected to increase from about $18.5 billion in 1950 to almost $24 billion in 1951.[5] Even at 1950 levels of construction and other activities generating demands for engineers, the peak crop of 52,000 engineers was easily absorbed. The research and development budgets of the armed forces alone have followed this course:[6]

	Millions
July 1949–June 1950	$ 600
July 1950–June 1951	1,200
July 1951–June 1952	1,500

The significance of these figures lies partly in the fact that there is a substantial lag between the appropriation of funds and the actual generation of demand for manpower. The full impact of the $1.2 billion appropriation for fiscal year 1951 will not be fully felt until this summer.

Manpower and not money will limit the volume of research. The forces creating demands for the services of scientists and engineers are so vast that refined measurements of demand for the period ahead are simply a means of identifying where shortages will be most extreme. In the face of these demands, an inevitable decline in the output of engineers and scientists has set in. Although 52,000[7] engineers graduated in 1950—the postwar peak—only about 30,000 are graduating this June. Thereafter, the annual rate of output will be about as follows:

Year	No. graduates
1952	25,000
1953	20,000
1954	17,000

This drop can be quite precisely predicted through 1954 because those who will graduate in that year entered college last fall. The September 1950 group of engineering freshmen numbered about 30,000.

Moreover, the output of students receiving a B.S. degree in the natural sciences reached a peak in 1950:[8]

Year	No. graduates (B.S. degrees)
1948	34,000
1949	45,400
1950	57,400

As is true of the output of engineers, these are peak levels, and a sharp decline will occur during the next four years even if no students should be inducted into the armed forces. A reduction to 50 or 60 per cent of 1950 output levels is probable by 1954. By selected field, these patterns of output are optimistic even if the proportion of all college graduates in scientific fields rises:

Field	B.S. degrees*	
	1950	1954
Total	57,400	34,300
Chemistry	10,500	6,300
Physics	3,400	2,100
Geology	3,000	1,900
All other	40,000	24,000

* About 60 per cent of 1950 levels.

Not only will the output of persons with B.S. degrees decline, but the pool from which Ph.D. candidates are drawn will shrink. This suggests that relatively greater attention must be paid to drawing undergraduates into scientific and technical fields early in their college careers, perhaps through expansion of scholarships at the expense of graduate fellowships.

Finally, there is weighty evidence that the demand for physicians and other health personnel will far outstrip the supply. Population increase, needs of the armed forces, civilian defense requirements, demands of medical schools, and staffing of national, state, and local public health services will, as estimated by the Health Resources Advisory Committee of the National Security Resources Board, create a need for 32,600 additional physicians by 1954. The same group estimated a net increase over that period—graduates minus those who will die or retire—of about 10,600, leaving a deficit of 22,000 doctors. "Obviously and inescapably we shall see a grave shortage of physicians during the next five years for the needs of a mobilized economy."[9]

President Roosevelt's request in 1944 to Vannevar Bush to frame a long-range scientific policy for the nation produced *Science the Endless Frontier*. This volume proposed the establishment of a National Science Foundation. The proposal in turn was the focus of widespread lay and scientific discussions and general public debate extending over a five-year period and ending with the establishment of the National Science Foundation.

In 1947 the President's Scientific Research Board—a group of scientific administrators from the military and civilian research establishment set up by executive order—issued a report (*Science and Public Policy*) that dealt with scientific policy for the nation and particularly for the federal government.

The debates preceding passage of the *Atomic Energy Act* saw physicists and other scientists actively engaged in discussions of general public policy and of such specific questions as civilian versus mili-

[5] *Building America's Might, A Report to the President by the Director of Defense Mobilization*, No. 1 (Apr. 1, 1950).

[6] Budget for Military Funds of the Department of Defense for Fiscal Year 1952, p. 23. (Transmitted by the President to Congress on Apr. 30, 1951.)

[7] All figures relating to engineers are drawn from S. C. Hollister. *The Developing Critical Shortage of Engineers* (A Report to the Engineering Manpower Commission of the Engineers Joint Council (Dec. 18, 1950).

[8] *Nation's Scientific and Technical Manpower (Manpower Report No. 3)*. U. S. Department of Labor, Bureau of Labor Statistics (Dec. 4, 1950).

[9] *Medicine, Mobilization and Manpower*, a paper presented to the Council on Medical Education and Hospitals of the American Medical Association by Howard Rusk, chairman of the Health Resources Advisory Committee of the National Security Resources Board (Chicago, Feb. 12, 1951).

tary control of atomic energy development, patent policy in this field, and the place of private industry in atomic energy development.

The net result of activities such as these has been not only to create unprecedented interest in public affairs among scientific groups, but to make them more effective in expressing their opinions—including their views on scientific manpower—in a manner that influences administrative and Congressional action.

The expansion of research by the federal government—both within its own laboratories and through support of research in industry, private foundations and associations, and universities—has been accompanied by a phenomenal growth of advisory groups composed of lay and scientific people. These groups provide a means of bringing a broad array of scientific judgment to bear upon public policy and of acquainting a large group of scientists with the considerations of public policy that affect the decisions of the federal government in the field of science.

The cumulative effect of the activities of these advisory bodies has been to keep the heads of the executive agencies, military and civilian, more keenly aware of the significance of research and of scientists than before World War II. Communication among the scientific, political, and administrative worlds is not perfect, but it is certainly freer than when those who knew the military potentialities of atomic fission had a hard time being heard.

Before World War II, there were no channels—or only very tortuous and relatively ineffective channels—through which scientific matters and questions of general policy relating to science and scientific manpower could be brought effectively to the point of decision in the executive agencies and in Congress.

Unification of the armed forces, whatever else remains to be done, has resulted in the establishment of a single point in the Department of Defense where manpower mobilization questions under the jurisdiction of the armed forces, including the mobilization of scientific manpower, can be resolved. The existence of three very loosely coordinated sets of armed forces manpower policies during World War II effectively forestalled consistent and reasonable action on many important questions. The Research and Development Board, a consolidated research planning organization for all three branches of the armed forces, had no counterpart before or during World War II.

The Interdepartmental Committee on Scientific Research and Development, created by executive order in 1947, is a device for drawing together the federal agencies with research responsibilities, and for transmitting to the Bureau of the Budget and the President the combined views of the research enterprises of the federal government.

The National Science Foundation can, by directing its attention to basic questions of national scientific policy, also exert substantial influence upon both Congressional and executive thinking and action.

Factors impeding effective mobilization of scientific manpower. From the experience of World War II, it would be relatively easy to set up the principles of, and the administrative machinery for, complete mobilization of manpower. More important, scientists would be more inclined to accept the burdens imposed by a plan for full mobilization if it could be assumed that a full effort were called for.

It is the in-between stage, and the impossibility of setting a single clear goal—like winning a shooting war—that create problems. To cite a specific example, if we could assume that our armed forces would not go above 3.5 million or so for five years, and that for the indefinite future each crop of 18-year-olds would go in for 27 months of service, we could ignore the problems of sustaining the flow of trained men. We could simply take a two-year decline in output of college-trained scientists and rely on the group returning from military service to supply the necessary men. But since this assumption cannot safely be made, the difficult political and moral problems involved in sustaining a flow of highly trained manpower through college must be faced and resolved.

The major problems of defense mobilization fall into three areas—economic stabilization, production, and manpower. For the first two of these, both centralized authority and a central operating organization exist—the Economic Stabilization Administration and the National Production Administration under the Office of Defense Mobilization. These agencies have their problems, and they may undergo some mutations, but machinery exists and it is operating.

In the manpower field, including scientific and technical manpower as part of the total problem, the situation is quite different. A clear declaration of national policy exists:

> We must rely heavily on science and technology. The most effective use must be made of our supply of individuals having the special skills required to develop and produce the necessary equipment and to use and maintain it in the armed forces . . . this involves constantly increasing our mobilization potential through training and educational programs to expand our supply of persons with highly developed skills essential to civilian and military activities.[10]

Although this policy sets a general course, its implications are not always clear "at the operating level." Authority and responsibility are in practice somewhat fragmented, and the two are not always lodged in the same place.

The major agencies that have performed various staff and operating functions relating to manpower—engineering, scientific, and medical, as well as other groups—include the Office of Defense Mobilization, the Office of Education of the Federal Security Agency, the National Security Resources Board, the Office of Defense Manpower of the Department of Labor, the Department of Defense, and the Selective Service System. These pieces will probably fit together in shifting patterns for some time to come.

[10] National Manpower Mobilization Policy, promulgated by the President in a memorandum to heads of executive departments and agencies, Jan. 17, 1951.

At the moment, the manpower function is performed for the Office of Defense Mobilization by a Manpower Policy Committee and not by an operating agency. A Committee on Specialized Personnel has been established to supply this Manpower Policy Committee with information on the supply of, and demand for, specialized personnel, and to recommend policies for training, allocation, and utilization of these people. This action came after a period of study and a set of recommendations by the Scientific Manpower Advisory Committee (the "Thomas Committee") under the chairmanship of Charles Thomas, of the Monsanto Chemical Company. But the new advisory committee is a far cry from the operating agency recommended by the Thomas Committee,[11] which dissolved itself upon creation of the new Committee on Specialized Personnel.

In this complicated and changing administrative situation, it has been difficult to secure general decisions affecting engineering, scientific, and medical personnel. It has been even more difficult to take action with respect to these specialized groups because the machinery for administering decisions is rudimentary. Until a single agency is given general authority in the field of manpower comparable to that now in effect in the fields of production and economic stabilization, the groups working on scientific manpower problems, both within and outside the federal government, will operate under severe handicaps.

Although virtually all categories of medical and scientific personnel are in extremely short supply, provision of manpower for industrial production will not cause acute difficulties for some time to come, except for a few occupations in a few areas. It is quite possible that the pressures required to bring about the establishment of a unified manpower agency will not be strong enough until industrial manpower problems are acute. In the economic stabilization and production fields, single operating agencies were not established until inflation threatened the stability of the economy and expansion of production became essential to national survival. Meanwhile, policies and administrative organizations for scientific, medical, and related manpower will apparently be handled as appendages to the general mobilization machinery.

Until decisions are reached on how the armed forces are to secure their manpower, a number of problems in the general manpower field must remain unresolved. The minimum age at which men will be drafted, for example, has an obvious effect upon college training. A decision on policies governing the call-up of reservists has to be linked to total plans for the increase and maintenance of the armed forces. The Department of Defense was understandably disinclined to overhaul the reserve system until the universal military service issue was settled.[12]

[11] *Plans for the Development and Use of Scientific Manpower.* National Security Resources Board (Jan. 12, 1950).

[12] The Senate hearings on this bill—S. 1—are a gold mine of opinion and facts on all aspects of the manpower problem. (Hearings on the Universal Military Training Act of 1951 [S. 1, 1st Session, 82nd Congress], before the Preparedness Subcommittee of the Committee on Armed Services.)

Current Problems—College Training and Call-Up of Reservists

Two problems relating to scientific, medical, and engineering manpower have been particularly pressing over the past few months—namely, establishment of a means of ensuring a flow of students through college in the face of expanding demands for military manpower and establishment of a mechanism for recalling reservists in a manner least disruptive to essential activities.

A deferment program, established by Executive Order 10,230 on March 31, 1950, was spelled out by General Hershey. The general principles of the plan were developed over a two-year period of study by six advisory committees to the Selective Service System under the general chairmanship of M. H. Trytten, director of the National Research Council's Office of Scientific Personnel. It provides for deferment of students now in college and graduate or professional school on the basis of satisfactory performance and class standing, with final authority for deferment retained by local boards. Since most high-school students who graduated last June are not likely to be called before the fall semester, and since those who enter college in the fall will probably remain until the end of the year, they need only be accepted by a college in order to enter the freshman class next fall.

Announcement of the plan raised a furor of substantial proportions centering around charges that bright boys and those with money enough to attend college would be left as civilians while all others would serve in the armed forces. In all likelihood, however, this program will go into effect. Although the plan was devised as a stopgap pending the enactment of a long-term universal training and service law, it may well serve, with modifications, as the basis for ensuring an uninterrupted flow of college-trained specialists, now that such a law has been enacted.

Whereas policies with respect to college training will determine the output of scientifically and medically trained people in the years ahead, a more immediate problem is the manner in which the armed forces call up their reserves. The basic issue here is that the armed forces have traditionally regarded reservists as property on which they had a lien. This was a logical and defensible policy when reserve components were small, and when the bulk of the reserve forces was currently trained, cohesive, and relatively small.

Now the reserve forces are extremely large, and a substantial portion of the reserve is simply a reservoir of manpower available on call by the armed forces, rather than a relatively modest, specifically trained group. Recall of reserves—particularly those with scarce skills—without regard to the need for the individual in essential civilian employment threatens to disrupt large areas of defense production, research, and medical care. What is needed is a complete change in the concept of the function of reserve components, the size of the reserves, and the factors that will enter into decisions to call up individuals.

The Department of Defense is fully aware of this problem and realizes that drastic changes in reserve policy are needed. It has agreed to produce a plan for handling the reserve problem. In the interim, those who are faced with the loss of critically important reservists can ask for, and will probably receive, a six-month delay in call-up. There is no uniform policy on release of reservists from the armed forces. Reservists are called up independently by each branch of the armed forces, and each branch of the service has decentralized call-ups. This procedure makes it impossible to balance total military and total civilian requirements, and to select individuals rationally.

Call-up of medical and related reservists is an exception to this generalization, largely as a result of agreements worked out between the Department of Defense and the Health Resources Advisory Committee to the Office of Defense Mobilization (originally advisory to the National Security Resources Board), under the chairmanship of Howard Rusk. The problem was twofold: determination and administration of a reasonable division of the total medical and related manpower pool between the civilian economy and the armed forces, and establishment of criteria to guide the call-up of individual reservists.

To solve the first problem, the Department of Defense has agreed to submit its total prospective requirements for medical and related personnel to the committee for comment and advice. Although the committee has no authority to set the level of armed forces medical manpower requirements, it advises the President, and its advice will undoubtedly be taken seriously. This procedure was inaugurated in mid-year because the call for the first half of 1951 had already been planned. This method is extremely significant as a precedent for dealing with all categories of scarce, highly trained manpower.

So far as selection of individual reservists for call-up is concerned, the Department of Defense submits to the Rusk Committee a single requisition stating the number and types of medical manpower it intends to call up. The committee sets quotas by state, and the state committees advise the armed forces as to which individuals should be called up. Their decisions are based on the relative essentiality of reservists in civilian life.

This reserve plan, which is simple, sets a number of significant precedents. The three branches of the armed forces have agreed that the Department of Defense will place a single consolidated requisition for these types of manpower. The Department of Defense has agreed that civilian groups should select the individuals who will be called. The branches of the armed forces have agreed to exchange reservists in order to ensure the most effective use of the men called. Most significant, the Department of Defense has agreed to effective review of the over-all allocation of medical personnel between military and civilian life.

If these principles were extended to cover scientific manpower, some of the most acute current difficulties would be resolved, and many that can be clearly foreseen would be mitigated.

Prospective Problems—Effective Allocation and Utilization of Specialized Manpower

Even with an adequate college-training program and a revamped armed forces reserve policy, shortages of engineering, scientific, and medical manpower will be acute. Indeed, they will be so acute that the question of allocation—voluntary or compulsory—will almost certainly be more intensively considered and debated during the next few months. The competing demands for highly trained manpower will in all probability lead to disruptive competitive bidding and piracy among industrial concerns, universities, and the government, on a scale that will require either voluntarily negotiated agreements or controls involving some degree of compulsion.

If compulsion is to be avoided—and the case against compulsion is so obvious on a number of grounds that it need not be discussed—the cooperation of individual scientists and the groups into which they are organized will be essential. Representatives of scientists, engineers, and the medical professions have given generously of their time over the past few months on advisory groups to federal agencies, formulating plans and advocating their adoption.

Even with the wholehearted aid of the scientific, medical, and engineering community it will be difficult to arrive at sound policies and carry them out in an atmosphere of crisis, where powerful and conflicting forces are in operation. It is, indeed, unrealistic to expect that the multitude of problems bearing on the training and use of highly specialized manpower will ever be "solved," because the problems keep changing. For this reason, the continuing aid, criticism, and cooperation of individuals and groups from outside the federal government are indispensable, even though those who participate in this complex process may at times feel that rejection or modification of some of their ideas and proposals means that their efforts have been ineffective. Specialized groups cannot, and should not, expect to settle all elements of national policy affecting them and their work, but they should and can have a voice if the pattern of collaboration developed over the past few years persists.