Appendix F

RESEARCH AND DEVELOPMENT EXPENDITURES, 1941–53

Research and Development Expenditures, 1941–53

Scientific and engineering research and development activities are now widely used means of deliberately producing or accelerating technological changes. Such activities are undertaken by businesses seeking to reduce costs, to perfect new processes or products, or to improve the quality of existing products. They are pursued at the laboratories of universities and other nonprofit institutions in the quest for new scientific and technical knowledge. They are conducted by the Federal Government, or organizations operating under Government contracts or grants, to advance the design of military weapons and equipment, expand the effective base of natural resources, hasten the civilian application of atomic power, improve agricultural practices and products, or contribute to medical science. From an economic standpoint, research and development activities are an instrument of growth and competition, opening up new fields of investment.

Trend of Expenditures

Comprehensive statistics on research and development expenditures are still crude, but some idea of the scope and trend may be obtained from estimates compiled from a variety of sources by the Research and Development Board and by its successor, now designated as the Office of the Assistant Secretary of Defense (R&D). These estimates are intended to exclude construction and other capital expenditures, except as reflected in depreciation charges; they include some research and development costs which are not covered in the research and development category of the Department of Defense budget. For these reasons and others, the Federal Government component of the expenditures series shown in Table F–1 differs from the Federal Government figures shown in *The Budget of the United States Government: Fiscal Year 1955*, "Special Analysis H: Research and Development", and also in the 1953 report of the National Science Foundation entitled *Federal Funds for Science: II. The Federal Research and Development Budget, Fiscal Years 1952 and 1953.* Since the differences are merely definitional, the Government figures included in the totals in Table F–1 are consistent and reconcilable with the figures presented in these other sources.

The cumulative expenditures of the Federal Government,[1] industry, and nonprofit institutions for scientific and engineering research during the

[1] State and local governments also make some contribution to scientific and engineering research and development—especially indirect, as in aid to schools of higher learning and medical centers (included in our "nonprofit" category).

period 1941–53 approached 30 billion dollars. In 1953, the total outlay was about 4 billion dollars,[2] well over four times the 1941 figure. The rise was, of course, due in part to inflation; but much of it was real, in view of the large increase in professional research personnel, whose "productivity" may also be presumed to have advanced.[3]

During the period under consideration, a significant change occurred in the relative shares of the total research and development cost borne by Government and industry.[4] The Government expenditure in 1953, about 2.5 billion dollars, comprised over three-fifths of the national total; the industry contribution, about 1.4 billion dollars, comprised almost three-eighths; nonprofit institutions accounted for the small remainder. In 1941, on the other hand, the Government share was two-fifths and the industry share less than three-fifths.

Despite the change in the source of financing, business enterprises continue to perform most of the research and development work. In 1953, activity at industrial laboratories accounted for about 2.8 billion dollars, or 70 percent of the total outlay of 4 billion dollars. The work done at Government laboratories accounted for about 0.8 billion dollars, or one-fifth of the national outlay. Thus, the workload distribution between Government and industry was not much different from that prevailing in 1941. The Government-industry share of the total workload declined a little, however, as nonprofit institutions, benefiting from Government contracts and grants, increased their share from about 5 percent in 1941 to about 11 percent in 1953.

Trend of Employment

About one out of every four scientists and engineers in the Nation is employed in research and development.[5] The number engaged in such activity more than doubled between 1941 and 1953, reaching 192,000 in the latter year. (See Table F–1.) During this period, the distribution between Federal Government and industry did not differ much from the pattern of expenditures according to site of activity; but the personnel share of the

[2] This estimate, which incorporates a Government figure of 2.5 billion dollars, is consistent with the "current" national estimate of "between 3.5 and 4.0 billion dollars" shown in "Special Analysis H" of *The Budget of the United States Government: Fiscal Year 1955.* The latter version is based on a lower Government figure, 2 billion dollars, which excludes "very substantial costs associated with research and development carried in other [Defense] budget categories."

[3] A "productivity" advance is indicated in a survey made by the National Industrial Conference Board of the 1946 and 1951 research and development activities of 125 companies.

[4] The details presented here and in subsequent paragraphs on the participation of the Federal Government, industry, and nonprofit institutions are based on the statistics underlying Table F–1.

[5] Report of the Office of the [Assistant] Secretary of Defense (R&D), Department of Defense, *The Growth of Scientific Research and Development* (RDB 114/34), July 27, 1953, p. 1.

nonprofit institutions (15 percent in 1953) consistently exceeded their money share.

The personnel figures cited in Table F–1 omit nonprofessional research workers and other supporting workers (e. g., clerical and administrative). It has recently been estimated that, on the average, 1.5 full-time equivalent supporting workers are required in industry for each professional research worker.[6] The ratio varies, of course, according to type of research activity; but the figure 1.5 appears reasonable for the three categories combined—i. e., Federal Government, industry, and nonprofit institutions. On this basis, it may be estimated that almost 500,000 full-time equivalent professional and supporting personnel were engaged in, or otherwise chargeable to, research and development in 1953.

Emphasis on Early Applicability

Most research and development activity is deliberately oriented toward early practical applications, rather than toward increasing the store of "basic" or "fundamental" knowledge. This practical stress promises a significant early expansion of our investment potential.

The dominant interest of industry in applications is understandable. Large companies, however, do recognize the need to expand the horizons of basic knowledge. A study of 191 large companies for 1951 shows that 42 percent of their research and development funds went toward the creation of new products or processes, about 50 percent toward the improvement of existing products or processes, and the remaining 8 percent to "programs uncommitted to specific problems." [7]

Federal research and development funds are also being channeled mainly into activity promising early applications, especially in the interest of defense. A study made by the National Science Foundation shows that only 6 percent of the Federal research and development obligations in the fiscal years 1952 and 1953 supported basic research.[8] "Special Analysis H" of *The Budget of the United States Government: Fiscal Year 1955* states that "more than 90 percent" of the Federal expenditures are for "development, applied research, and new facilities." The President's *Budget Message* calls for more funds for the National Science Foundation so that basic research may be expanded and more graduate students trained.

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[6] This ratio is cited for January 1952 by the Bureau of Labor Statistics and the Research and Development Board, *Industrial Research and Development: A Preliminary Report* (Washington, January 1953), p. 7; and by the Bureau of Labor Statistics in cooperation with the Department of Defense, *Scientific Research and Development in American Industry: A Study of Manpower and Costs* (BLS Bulletin 1148, Washington, 1953), pp. 18–20.

[7] See De Witt C. Dearborn, Rose W. Kneznek, and Robert N. Anthony, *Spending for Industrial Research, 1951–1952* (Harvard University Graduate School of Business Administration, Boston, 1953), p. 68.

[8] *Federal Funds for Science: II, op. cit.*, p. 9.

Although most Federal research and development funds are now devoted to projects sponsored by the Department of Defense and the Atomic Energy Commission, it would be a mistake to assume that the results will not be largely applicable, sooner or later, to civilian purposes. Indeed, many products that are now familiar—like steel alloys, aluminum, synthetic rubber, and high-octane gasoline—received encouragement in earlier periods of emergency. Similarly, today's research on guided missiles, jet planes and engines, helicopters, heat- and corrosion-resistant metals and alloys, electronic automatisms, etc., will provide new civilian opportunities. The many thousand scientists and engineers now engaged in defense research and development are, in effect, being readied to facilitate this conversion.

Atomic research and development programs are also paving the way to new peacetime industries. Rapid progress is being made in harnessing atomic power for the production of electrical energy. Radioisotopes are finding new uses in industry, agriculture, and medicine. Even in early 1953, only two-fifths of the scientists and engineers engaged in atomic research and development were concerned with fissionable materials and weapons. Another one-fifth were working on nuclear reactors, which are needed for generating electrical energy. The remaining two-fifths were employed in basic and applied research in the physical sciences (physics, chemistry, and metallurgy), mathematics, and the life sciences (biology, medicine, and biophysics).[9]

[9] American Society of Mechanical Engineers, *Uranium, Plutonium and Industry* (U. S. Atomic Energy Commission, Washington, March 1953), p. 13. The discussion of Atomic Energy Commission programs in "Special Analysis H" of *The Budget of the United States Government: Fiscal Year 1955* also emphasizes the nonmilitary applicability of military research and development results.

ABLE F-1.—*Estimated research and development* [1] *expenditures and employment in the United States* [2], *1941–53*

Year	Expenditures [3] (millions of dollars)	Research scientists and engineers employed [4] (thousands)	Year	Expenditures [3] (millions of dollars)	Research scientists and engineers employed [4] (thousands)
1941	900	87	1948	2,610	133
1942	1,070	90	1949	2,610	144
1943	1,210	97	1950	2,870	151
1944	1,380	111			
1945	1,520	119	1951	3,360	158
			1952	3,750	180
1946	1,780	122	1953 [5]	4,000	192
1947	2,260	125			

[1] "Research and development" embraces basic and applied research in the sciences (including medicine) and in engineering, and the design, development, and testing of prototypes and processes. The term is meant here to exclude quality control, product testing, market research, sales promotion, sales service, and research in social sciences and psychology.

[2] Includes Federal Government, industry, and nonprofit institution programs.

[3] Expenditures include salaries of professional and nonprofessional research personnel and of administrative and other supporting workers; other chargeable overhead; and materials. Capital investment is excluded, except as reflected in depreciation charges.

The Federal Government component of the series presented here may be reconciled with, though it is based on a definition different from, the Federal Government series shown in *The Budget of the United States Government: Fiscal Year 1955*, "Special Analysis H: Research and Development." It excludes capital outlays; but it incorporates a sizable adjustment for Department of Defense funds devoted to research and development although not explicitly budgeted for such purposes.

[4] Presumably refers to full-time equivalents; excludes nonprofessional research workers and supporting nonresearch (e. g., clerical and administrative) workers.

[5] Preliminary.

Source: Office of the Assistant Secretary of Defense (R&D), Department of Defense. (For 1941–52 estimates, see *The Growth of Scientific Research and Development* [RDB 114/34], July 27, 1953, pp. 10–12.)