

## DEFINITIONS OF “RESEARCH AND DEVELOPMENT” AND OTHER TERMS

At numerous points in this document, the phrases “research and development” (R&D) and “science and technology” (S&T) are used. When used specifically to describe budgetary activity, these phrases take on specific meanings. All data related to **R&D** are based on the definitions employed by the Office of Management and Budget (OMB), the National Science Foundation (NSF), the R&D Budget and Policy Program of the American Association for the Advancement of Science (AAAS), and other federal agencies. All R&D data use the common definitions below:

In this report, **R&D** (or “total R&D”) refers to both the conduct of research and development as well as R&D facilities. The following definitions are used by the Office of Management and Budget, the National Science Foundation, and AAAS:<sup>1</sup>

**Research** is systematic study directed toward fuller scientific knowledge or understanding of the subject studied. The federal government categorizes research as either basic or applied according to the objectives of the sponsoring agency.

- In **basic research**, the objective is to gain fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.
- In **applied research**, the objective is to gain knowledge or understanding necessary to determine the means by which a recognized and specific need may be met.

**Development** is the systematic application of knowledge or understanding directed toward the production of materials, devices, and systems or methods, including design, development, and improvement of prototypes and new processes to meet specific requirements. The term excludes quality control, routine product testing, and experimental production.

R&D funding normally includes personnel, program supervision, and administrative support costs directly associated with R&D activities. Laboratory equipment is also included. Defense R&D also includes testing, evaluation, prototype development, and other activities that precede actual production.

Funding for **R&D facilities** (also known as R&D plant) includes construction, repair, or alteration of physical plant (e.g., reactors, wind tunnels, particle accelerators, or laboratories) used in the conduct of R&D. It also includes major capital equipment used for R&D.

Most of the federal R&D funding data in this report are presented in terms of **budget authority** or **obligations**. Budget authority is the initial budget parameter for congressional action on the President’s proposed budget. Other R&D data sources may express R&D funding in terms of **outlays**, for data sets compiled from retrospective surveys of funding agencies and recipients.

---

<sup>1</sup>Definitions adapted from Office of Management and Budget Circular No. A-11.

**Budget authority** is the legal authorization to expend funds.

**Obligations** represent orders placed, contracts awarded, services received, and similar transactions entered into during a given period, regardless of when the funds were appropriated and when the future payment of money is required.

**Outlays** represent checks issued and cash payments made during a given period, regardless of when the funds were appropriated or obligated. Some surveys refer to outlays as **expenditures**.

Although *science and technology* is used often as generic terminology, in R&D budget data the generic terms take on specific meanings. In the Department of Defense (DOD), **Science and technology (S&T)** refers specifically to the basic research, applied research, and advanced technology development portions of the overall DOD R&D budget (“6.1” through “6.3” in DOD budget terminology), excluding the weapons systems development work that makes up the majority of DOD R&D (“6.4” through “6.7”). Weapons systems development spending is sometimes excluded from discussions of R&D because these investments are uniquely military and are highly specific applications, with little impact on the U.S. civilian economy or knowledge base.

In a 1995 report, the National Academy of Sciences (NAS) Committee on Criteria for Federal Support of Research and Development proposed an alternative method to measure the federal investment in science and technology called the Federal Science and Technology (FS&T) budget (NAS, 1995). The **FS&T budget** included only the federal R&D dollars spent annually on expanding fundamental knowledge and creating new technologies and excluded activities such as the testing and evaluation of new weapons systems. In the fiscal year (FY) 1999 Budget of the United States, the “Research Fund for America” (RFA), a concept similar to the FS&T budget, was introduced. The RFA consisted of only nondefense R&D, and included some non-R&D programs, such as NSF education programs and staff salaries at the National Institutes of Health (NIH) and NSF. In contrast to the FS&T budget, which was constructed from components of the R&D budget, the RFA was constructed of programs that could be easily tracked in the budget process. The FY 2000 budget contained a slight modification of the RFA called the “21<sup>st</sup> Century Research Fund.” More recently, OMB introduced a new FS&T budget in the FY 2002 budget and continues to use this concept in the FY 2003 budget. OMB’s FS&T budget is the successor to the Clinton Administration’s “21<sup>st</sup> Century Research Fund” and contains most of the same programs. Unlike R&D, there are no set definitions for FS&T and thus the composition of the FS&T portfolio has shifted; it is a collection of federal programs designed to be easy to track in the budget process rather than a comprehensive inventory of federal science and technology investments. FS&T is a collection of R&D and non-R&D programs selected by OMB that emphasize basic and applied research and the creation of new knowledge or technologies. It also includes some S&T education and training activities but excludes most development (such as DOD weapons systems development), and is designed to be an alternative measure for the federal investment in science and technology and an alternative way to track federal S&T investments in the budget process. Thus, OMB’s FS&T budget has a similar emphasis but is different from the FS&T concept proposed in 1995 by the NAS as a subset of federal R&D (NAS, 1995).

## **USER NOTES**

### **Constant Dollars**

Year-to-year changes or historical data series are usually expressed in constant dollars to remove the effects of inflation. Funding data in this report have been converted to constant dollars using the GDP deflators found in Historical Table 10.1 of the OMB *Budget of the United States Government, Fiscal Year 2003*.

### **Purchasing Power Parity**

International R&D funding data in this report are presented in two ways: 1) as a ratio of R&D spending to the gross domestic product, which provides an indication of R&D spending relative to the total economic activity of a country; and 2) converted to U.S. dollars using purchasing power parity (PPP) exchange rates as an indicator of absolute effort. PPP exchange rates are based on estimates of the purchasing power of different currencies, and are used to equalize price levels across countries. In other words, the theory behind PPP is that the price of identical goods in different countries should be equal after adjusting for the rate of exchange between currencies.

### **Historical Data Series**

Many historical data series of R&D by performer, discipline, and character, as well as data on R&D expenditures by nonfederal funding sources, are compiled from detailed surveys of agencies and performers conducted by the NSF's Division of Science Resources Statistics (SRS). SRS conducts annual surveys (using the definitions above, as well as standardized definitions of science and engineering disciplines, performer categories, etc.) of federal agencies, industrial performers, universities and colleges, and nonprofit organizations to determine the actual disbursement of federal funds allocated to R&D in the budget process and to determine the composition of nonfederal expenditures on R&D. NSF submits U.S. data on R&D to the OECD, which compiles R&D data for its member nations and selected other nations using standardized definitions and reporting standards.

### **Data for FY 2000 and Preliminary Data for FY 2001 and FY 2002**

Each year, the NSF Survey of Federal Funds for Research and Development collects information on the previous year's actual obligations and on preliminary estimates for the next two years. The most-recent data available from NSF were collected in FY 2001; therefore, the most current data available are for FY 2000, with preliminary estimates available for FY 2001 and FY 2002. Since data for the FY 2001 were collected well into that fiscal year (about 6 to 10 months after the start of the fiscal year), the preliminary estimates are generally a good indication of the actual levels that will be reported in later surveys (NSF, 2002a). Estimates for FY 2002, however, are based mainly on the agencies' budget requests, which frequently differ from actual appropriations; therefore data for FY 2002 are more speculative.

## **American Association for the Advancement of Science Data Sources**

AAAS derives its data from OMB data and data provided by the various federal agencies that perform R&D. OMB requires agencies to submit data on R&D programs as part of their annual budget submissions. Specifically, agencies provide data (reported on MAX Schedule C as part of the budget process) on funding levels for basic research, applied research, development, R&D facilities, and major capital equipment for R&D. These R&D figures rarely correspond to budget line items as found in appropriations bills or the President's budget. Agencies make determinations as to what proportion of budget line items is classified as R&D; many budget line items have both R&D and non-R&D components. Agencies also differ in their reporting. For example, some agencies classify program direction or management support as R&D; others do not. Some data are collected by AAAS from individual agencies after the release of the budget, and reflect agency and AAAS revisions to OMB-submitted data. The motivation of the AAAS effort is to wade through these disparate agency approaches counting only those items deemed to be R&D.

## **Fields of Science and Engineering**

In the Survey of Federal Funds for Research and Development, NSF collects data on federal obligations for basic research and applied research in S&E, classified in eight broad research fields consisting of a number of detailed fields (see Appendix I, Table 1). The broad fields are life sciences, psychology, physical sciences, environmental sciences, mathematics and computer sciences, engineering, social sciences, and other sciences not elsewhere classified (n.e.c.). The term *not elsewhere classified* is used for multidisciplinary projects within a broad field and for single-discipline projects for which a separate field has not been assigned. Table 1 presents the detailed fields grouped under each of the broad fields, together with illustrative disciplines of detailed fields.

The Survey only collects S&E field data for federal funding of basic research and applied research. It does not collect S&E field data for development or R&D plant funds. In addition to collecting data on the past year's funding, the Survey also collects preliminary estimates from federal agencies on allocations for the current and next fiscal years for the broad fields of S&E; however, data on the detailed fields are not collected.

## **Reclassification of Federal Obligations for Research**

From time to time, agencies responding to the NSF Federal Funds Survey change their procedures for classifying research obligations by field of research. These changes can have profound effects on the apparent distribution of funding for S&E fields. For example, in FY 1996, NSF changed its classification of engineering and the environmental sciences research activities so that its support of mechanical engineering appeared to be much less and its funding of oceanography much greater. In FY 2000, the National Aeronautics and Space Administration (NASA) and the NIH reclassified their R&D and R&D plant funds. NASA reclassified the Space Station as a physical asset and Space Station Research as equipment, and transferred funding from "R&D" to "R&D Plant." NIH reclassified all of its "development" into "research" (mainly applied research) (NSF, 2002a).

The NASA reclassification resulted in the agency reporting a \$2.3 billion decline in FY 2000 budget obligations for development activities from their FY 1999 levels, and a comparable \$2.5 billion increase in obligations for R&D plant (NSF, 2002a). Conversely, NASA's reclassification did not significantly affect the S&E research field distributions, since most of its changes had an impact on its development and R&D plant totals. The NSF Federal Funds survey does not collect S&E field data for development or R&D plant funds. However, there were also substantial changes in reported obligations for NASA's basic research and applied research that probably are unrelated to Space Station reclassifications and these confound analyses of the agency's overall funding trends (NSF, 2002a).

NIH reclassified all of what it previously called "development" activities as "research" (NSF, 2002a). This reclassification resulted in NIH reporting a \$2.2 billion decline in FY 2000 budget obligations for development activities from their FY 1999 levels (NSF, 2002a). Most of the development funds are now classified as applied research, and only a small amount was reclassified as basic research (NSF, 2002a). NIH's applied research obligations grew 35 percent between FY 1999 and FY 2000, and basic research grew 16 percent.

In addition to affecting the distribution of funds by character of work, the NIH reclassification of development funds also significantly affected the distribution of funding of S&E research fields. NIH funding of most S&E research fields changed significantly between FY 1999 and FY 2000 (see Appendix I, Table 2). Reclassification of development funds by NIH resulted in apparent substantial increases in FY 2000 for psychology (199.3 percent), physical sciences (193.5 percent), environmental sciences (800.6 percent), engineering (102.5 percent), and social sciences (90.9 percent) (NSF, 2002a). Several of the major shifts in funding of the broad fields can be accounted for by changes in one of the component detailed fields. For example, in psychology, the major changes in funding occurred in the detailed field of psychological sciences, n.e.c. (an apparent 213.7 percent increase); in the environmental sciences, the change can be accounted for by changes in environmental sciences, n.e.c. (an apparent 800.6 percent increase); and in the physical sciences, most of the change can be attributed to a large increase in funding of chemistry (an apparent 221.7 percent increase). In addition, two detailed fields of S&E that NIH started funding in FY 2000 were not funded in FY 1999: physical sciences, n.e.c., and metallurgy and materials engineering. There were also several fields that were funded in FY 1999 but not in FY 2000: environmental biology, biological and social aspects of psychology, physics, computer sciences, and sociology.

The reclassification of R&D and R&D plant funding at NASA and NIH had a significant impact on the overall federal funding trends between FY 1999 and FY 2000. Between FY 1999 and FY 2000, basic research and applied research increased in real terms by 10 percent and 15 percent, respectively (NSF, 2002a). R&D plant obligations apparently grew by 125 percent, whereas development obligations plummeted by 42 percent (NSF, 2002a). Some portion of these changes was probably due to actual funding trends (for example, basic and applied research each have been annually increasing since FY 1996) (NSF, 2002a). The majority, however, probably resulted from agencies' revised reporting categorizations (NSF, 2002a). Therefore, reclassification of R&D and R&D plant funding by federal agencies affects funding trends in both the character of work and S&E research fields, confounding any attempts to analyze balance in the federal R&D portfolio.