

Chapter 1

Federal Research and Development in Alabama

- Approximately \$2.4 billion of federal R&D funds are spent each year in Alabama.
- Alabama ranks 11th among the 50 states, District of Columbia, and Puerto Rico in terms of the amount of federal R&D dollars received annually.
- Approximately 23 percent of all federal funds spent in Alabama each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance) is spent on R&D.

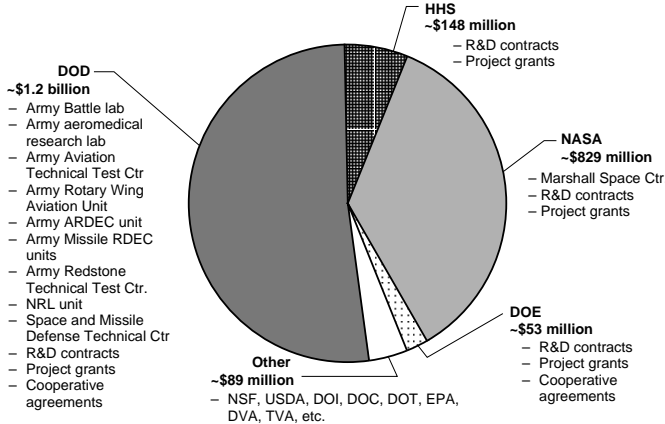


Figure 1.1 – Sources of Federal R&D Dollars Spent in Alabama (Total Federal R&D ~\$2.4 billion)

BACKGROUND

In recent years, the federal government has spent in the neighborhood of \$2.4 billion annually in Alabama on research and development (R&D) activities. On average, federal R&D dollars account for approximately 23 percent of all federal funds spent in Alabama each year on matters other than the direct support of individuals (i.e., such entitlements as retirement, disability, and housing assistance).

Most major federal agencies that currently support federal R&D efforts provide funding for R&D activities in Alabama. Foremost among these agencies is the Department of Defense (DOD), which accounts for 52 percent of all federal R&D dollars spent in the state. The National Aeronautics and Space Administration (NASA) and the Department of Health and Human Services (HHS) account for an additional 35 percent and 6 percent of the federal R&D dollars spent in Alabama, respectively. The remaining federal R&D dollars come collectively from the Departments of Energy (DOE), Agriculture (USDA), and Interior (DOI); the National Science Foundation (NSF); the Environmental Protection Agency (EPA); and several other federal agencies.¹

All federal R&D dollars spent in Alabama either cover the costs of operating federal R&D units in the state, including paying the salaries of federal R&D personnel working at these units, or are awarded as grants, contracts, or cooperative agreements to entities in the state. The following is an overview of what becomes of these federal R&D dollars once they arrive in Alabama.

FEDERAL R&D UNITS IN ALABAMA

Auburn, Alabama, is home to USDA's G. W. Andrews Forestry Sciences Laboratory, Fish Diseases and Parasites Research Laboratory, and National Soil Dynamics Laboratory and DOI's Alabama Cooperative Fish and Wildlife Research Unit.

¹ For a complete agency-by-agency breakdown of these R&D dollars, see Appendix C.

- The G. W. Andrews Forestry Sciences Laboratory is a unit of the Southern Research Station inside USDA's Forest Service. It is on the campus of Auburn University. The laboratory conducts research on vegetation management in southern forests and forest engineering. Specific research activities include developing principles and practices for regenerating and managing pines and hardwoods, as well as gathering data on the impacts, fate, and distribution of herbicides in forests. The forest engineering portion of the laboratory focuses on improving forest management through the mechanization of forest operations. It conducts studies to develop more economical harvesting and regeneration systems. The research project on vegetation management and longleaf pine at the laboratory focuses on how to control undesirable vegetation in southern pine and upland hardwood forests, the fate of herbicides in forest ecosystems, and the development of principles and practices for regenerating and managing longleaf pine. This federal R&D unit annually receives approximately \$2.1 million of federal R&D funds and has about 20 employees.
- The Fish Diseases and Parasites Research Laboratory is a unit of USDA's Agricultural Research Service (ARS) located on the campus of Auburn University. It conducts research on the quality of catfish products and on veterinary bacteriology, parasitology, nutrition, and immunology to address the problems in aquaculture that diminish productivity. Specific research activities of this lab include developing vaccines and vaccine delivery systems to prevent diseases and parasite problems; developing rapid diagnostic tests for the earliest intervention against diseases and parasites; and developing catfish diets that will enhance disease and parasite resistance, meet optimal nutritional needs during growing stages, and reduce fish waste in farm ponds. This federal R&D unit, together with the National Soil Dynamics Laboratory described below, annually receives approximately \$3.1 million of federal R&D funds and has about 35 full-time equivalent employees (FTEs).

- The National Soil Dynamics Laboratory is a unit of USDA's ARS located on the campus of Auburn University. It conducts research on developing the knowledge required for managing soil for sustainable and profitable agricultural production. Specifically, it conducts research on tillage, traction, soil compaction, and crop residue management to enhance conservation farming. In addition, the laboratory conducts research on organic wastes to enhance soil quality and soil structure. The funding and staffing information for this federal R&D unit is included in those presented immediately above for the Fish Diseases and Parasites Research Laboratory.
- The Alabama Cooperative Fish and Wildlife Research Unit is part of DOI's U.S. Geological Survey (USGS). This unit is on the campus of Auburn University. It conducts research on fish and wildlife ecology and investigates the production, utilization, management, protection, and restoration of populations of fish and wildlife. Specific research activities of this unit include assessing flathead channel catfish populations in the Tallapoosa River and examining the effects of surface mine reclamation on aquatic communities. This federal R&D unit annually receives approximately \$177,000 of federal R&D funds and has two FTEs.

Birmingham, Alabama, is home to a Department of Veterans Affairs (DVA) R&D unit.

- While the principal focus of the Birmingham VA Medical Center is providing medical care to veterans, it is also the location of a number of research activities. In a recent year, this federally owned and operated facility was the site of 148 projects with total funding of approximately \$3 million. These R&D activities focus on a wide range of topics, including radiotherapy, drug therapy, neutrophils, HIV, congestive heart failure, and neoplasms.

Dothan, Alabama, is home to DOD's Army Aeromedical Research Laboratory, Army Aviation Technical Test Center, Rotary Wing Aviation Research Unit, and Air Maneuver Battle Laboratory.

- The Army Aeromedical Research Laboratory at Fort Rucker is a unit of DOD. It conducts R&D on the health hazards of Army aviation, tactical combat vehicles, and selected weapon systems; assesses the stress and fatigue of those operating these systems; and designs the criteria on which to base standards for entry and retention in Army aviation specialties. Specific areas of interest include medical study of visual/auditory functions, man-machine integration, physiological responses to operational environments, impact of continuous operations on individual and crew performance, testing of aeromedical evacuation life support equipment, development of improved means of patient evacuation, and airworthiness. This federal unit annually receives about \$5 million of federal R&D funds, virtually all of which are spent on in-house activities, and has a staff of about 80 people, half of whom are civilians.
- The Army Aviation Technical Test Center at Fort Rucker is a unit of DOD. It conducts R&D on the performance, reliability, and maintainability of fixed-wing and rotary-wing aircraft, aircraft components, and related ground support equipment. This federal unit annually receives about \$9.6 million of federal R&D funds, all of which are spent on in-house activities, and has a staff of about 120 people, close to 100 of whom are civilians.
- The Rotary-Wing Aviation Research Unit at Fort Rucker is a unit inside DOD's Army Research Institute for Behavioral and Social Sciences headquartered in Alexandria, Virginia. Additional sites are in Orlando, Florida; Fort Benning, Georgia; Fort Knox, Kentucky; Fort Monroe, Virginia; Fort Leavenworth, Kansas; Fort Bragg, North Carolina; Fort Hood, Texas; Heidelberg, Germany; and Boise, Idaho. It conducts research on simulation-based aircrew training. Specific research activities of this unit include researching the best use of flight simulation, part-task trainers, and other information technology tools to improve the efficiency of Army rotary-wing flight training. Through the use of such instructional resources as simulators,

PC-based instructional tools, and part-task training aids, the unit also tries to reduce the heavy reliance on the aircraft as the primary means of pilot training. The program employs a number of research simulation tools, including the Simulator Training Advanced Testbed for Aviation (an Apache flight simulator), a TH-67 low-cost, commercial flight simulator, an OH-58D Kiowa Warrior Simulator and an Intelligent Flight Trainer for the TH-67 aircraft. This federal R&D unit annually receives approximately \$2 million in federal R&D funds, only a portion of which is spent on in-house R&D activities, and has about nine civilians directly involved in R&D activities.

- The Air Maneuver Battle Laboratory at Fort Rucker is a unit of the Army inside DOD. It is one of 11 battle laboratories established to define the horizontally integrated capabilities required to operate and field an effective Army. This laboratory conducts research on advanced concepts and technology relating to the contribution of air maneuver forces and operations. Specific research activities of this laboratory focus on such areas as developing information technologies to support extended range communications, mobile command and control, and tactical reconnaissance. This federal unit annually receives about \$1.3 million of federal R&D funds, only a portion of which is spent in-house, and has six civilian personnel.

Huntsville, Alabama, is home to NASA's George C. Marshall Space Flight Center; and DOD's Army Aviation Research, Development, and Engineering Center; eight directorates and one initiative of the Army Missile Research, Development, and Engineering Center; Redstone Technical Test Center; Space and Missile Defense Technical Center; and Space and Missile Defense Battle Lab.

- The George C. Marshall Space Flight Center is a unit of NASA. It conducts R&D on space propulsion and transportation systems, microgravity, and optics technology. The center also conducts research on global hydrology, astrophysics, and space physics. Among the R&D activities under way at the center are

ones focusing on growing the purest possible protein crystals to advance the design of drugs to fight diabetes, AIDS, emphysema, cancer, and other diseases. Other R&D activities focus on improving the substance and production of inorganic materials with semiconducting, insulating, and/or stabilizing properties that are central to many aspects of modern communication, transportation, and other systems. This federal facility annually receives a total of approximately \$2.3 billion, at least \$687 million of which directly involves R&D efforts. The center has about 2,822 FTEs, only a portion of whom are involved in R&D activities. A substantial portion of its funds is spent on the maintenance and operation of R&D equipment and facilities. In a recent year, over \$275 million of R&D contracts were awarded by the center, about \$58 million of which were made to entities based in Alabama.

- The Army Aviation Research, Development, and Engineering Center is a unit of DOD. Its headquarters and Aviation Engineering Directorate are in Huntsville, Alabama, at the Redstone Arsenal, while its Applied Technology Directorate is in Fort Eustis, Virginia, and its Aeroflight Dynamics Directorate is at Moffett Field, California. The Aviation Engineering Directorate conducts R&D on aviation systems and subsystems, with a specific emphasis on their weaponization. Particular research areas of interest to the directorate include aeromechanics, structures, materials, propulsion, avionics, airworthiness, design integrity, and safety. The directorate is also intensely concerned with aviation mission equipment, integration, and survivability; aviation equipment reliability and maintainability; and aviation ground support. This federal unit annually receives approximately \$9.8 million of federal R&D funds, about \$2.6 million of which are spent on in-house activities, and has about 146 civilian personnel, only a portion of whom are directly involved in R&D activities. The headquarters and administrative units of the center annually receive approximately \$13 million of federal R&D funds, about \$1.9 million of which are spent on in-house

activities, and has about 31 civilian personnel, only a portion of whom are directly involved in R&D activities. In October 1999, the Aviation Research, Development, and Engineering Center was provisionally merged with the Missile Research, Development, and Engineering Center, which is also headquartered in Huntsville.

- The Advanced Systems Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate interfaces with the other parts of the Army to determine missile weapon system requirements and with the technology community to determine the status of and to provide future direction regarding R&D in missile technology. This federal unit annually receives about \$11.9 million in federal R&D funds, approximately \$1.4 million of which are spent on in-house activities, and has about 35 civilian personnel, only a portion of whom are directly involved in R&D activities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.
- The Missile Guidance Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on all aspects of missile guidance systems, including sensors; terminal guidance technologies; control devices; data links for semiactive, beam rider, and command systems; data links for unmanned vehicle systems; missile fire control functions; and hardware and software systems for missile systems functions. It annually receives about \$42 million in federal R&D funds, approximately \$13.9 million of which are spent on in-house activities, and has about 186 civilian personnel, only a

portion of whom are directly involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.

- The Software Engineering Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on all aspects of computer hardware, software, and engineering for weapons systems requiring computer automation, with a particular emphasis on built-in test capabilities for computer systems. It annually receives about \$19.4 million in federal R&D funds, approximately \$4.5 million of which are spent on in-house activities, and has about 136 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.
- The Propulsion and Structures Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on all types of rocket propulsion technology, including propellants, ignition systems, gas operated power systems, propulsion systems controls, propulsion mechanics, structures, and materials. It annually receives about \$13.2 million in federal R&D funds, approximately \$7.7 million of which are spent on in-house activities, and has about 127 civilian personnel, only a portion of whom are directly involved in R&D ac-

tivities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.

- The Engineering Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on new missile and weapon system concepts, hardware technology, critical process technology, software, and statistical methodology, with a particular focus on such areas as microelectronics and manufacturing and production technologies. It annually receives about \$24.6 million in federal R&D funds, approximately \$17.2 million of which are spent on in-house activities, and has about 665 civilian personnel, only a portion of whom are directly involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.
- The Systems Simulation and Development Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on aeroballistics, flight dynamics, aerodynamics, simulation theory and technology, math model verification and validation techniques, and real-time, time-critical simulation technology. It annually receives about \$29.7 million in federal R&D funds, approximately \$6.5 million of which are spent on in-house activities, and has about 100 civilian personnel, only a portion of whom are directly involved

in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.

- The Weapons Directorate is a unit of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates are also located. This directorate conducts R&D on missile, laser, microwave, and beam weaponry, with a particular focus on such matters as target signatures, electromagnetic propagation phenomena, electro- and magneto-optical interactions and materials, physics of the atmosphere, photochemical processes, optical computing, image processing, and high-energy lasers. It annually receives about \$8.6 million in federal R&D funds, approximately \$3.8 million of which are spent on in-house activities, and has about 59 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.
- The Technical Management Directorate and the Applied Technology Initiative are units of DOD's Army Missile Research, Development, and Engineering Center. The center is headquartered in Huntsville at the Redstone Arsenal, where all its directorates and the initiative are also located. This directorate oversees the R&D activities of the center and annually receives approximately \$12 million of federal R&D funds, all of which are spent in in-house activities, and has about 315 civilian personnel, all of whom are directly involved in R&D activities. The initiative receives about \$51.7 million of federal R&D funds, ap-

proximately \$1.7 million of which is spent on in-house activities, and has about 16 civilian personnel. In October 1999, the Missile Research, Development, and Engineering Center was provisionally merged with the Aviation Research, Development, and Engineering Center, which is also headquartered in Huntsville, Alabama.

- The Redstone Technical Test Center is a unit of DOD. It is located at Redstone Arsenal and is the site of the Army's aviation and missile R&D test facilities. These facilities include wind tunnels, airworthiness units, and flight ranges. This federal facility annually receives approximately \$29 million of federal R&D funds, all of which are spent on in-house activities, and employs about 145 civilians, only a portion of whom are directly involved in R&D activities. A substantial portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.
- The Space and Missile Defense Technical Center is a unit of the Army inside DOD. The center conducts R&D on the missile technologies for the Ballistic Missile Defense Organization and on space and space-related technologies for the Army. Specific R&D activities of the center focus on such areas as high-energy lasers; directed energy weapons; structures; materials; weapons lethality, vulnerability, and survivability; optics, radar, and laser radar technology; high-performance microelectronics; sensor phenomenology; electromagnetic technologies; miniature interceptors; advanced computer hardware and software; and gallium nitride microwave power amplifiers. This federal unit annually receives about \$300 million in federal R&D funds, virtually all of which is spent on in-house activities, and has about 400 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.
- The Space and Missile Defense Battle Laboratory is a unit of the Army inside DOD designed to provide warfighters with the

very latest space and missile defense capabilities. It is one of 11 battle laboratories established to define the horizontally integrated capabilities required to operate and field an effective Army. Its R&D activities focus on high-performance computing and simulations. The unit's Advanced Research Center is an R&D computational test-bed for missile defense programs, while its Simulation Center conducts R&D on future space and strategic defense applications. This federal unit annually receives about \$15 million of federal R&D funds, approximately \$4.5 million of which is spent on in-house activities, and has about 91 civilian personnel, only a portion of whom are directly involved in R&D activities. A portion of these funds is spent on the maintenance and operation of R&D equipment and facilities.

Mobile, Alabama, is home to DOD's Naval Research Laboratory *USS Shadwell* and the Department of Transportation's (DOT's) Fire and Safety Test Detachment.

- The *USS Shadwell* is a unit of DOD's Naval Research Laboratory. While the center of all of the laboratory's R&D activities is in the District of Columbia, it maintains a decommissioned ship as a floating laboratory in Mobile Bay. The focus of all activities on this ship, formerly the *USS Shadwell*, is developing, testing, and implementing techniques and equipment for use in shipboard firefighting. The funding and staffing for this ship are modest and are included in that for the main laboratory in the District of Columbia.
- The Fire and Safety Test Detachment is a unit of the Coast Guard Research and Development Center inside DOT's Coast Guard. It conducts research to improve marine fire protection and safety through the use of full-scale fire tests and evaluations. Specific R&D activities of this unit include investigating compartment burnouts, flammable liquids in drums, cargo and machinery space fires, container fire protection, hatch cover fire resistance, explosion suppression, deck foam systems, halon

alternatives, and smoke movement. The test site is on Little Sand Island in Mobile Bay and includes a tanker, a Victory ship, and a fire test area on the island. This federal R&D unit annually receives approximately \$305,000 in federal R&D funds and has one civilian employee.

Montgomery, Alabama, is home to DOI's Alabama District Office of Water Resources.

- The Alabama District Office of Water Resources is a unit of DOI's USGS. It oversees the R&D activities of USGS's National Water-Quality Assessment (NAWQA), Ground-Water Resources Assessment, Toxic Substances Hydrology, and Federal State Cooperatives programs. The NAWQA program conducts research on the nation's surface and groundwater resources to better understand the effect of pesticides, erosion, and bacterial contamination on water quality. The Ground-Water Resources Assessment program studies groundwater systems to develop models and simulations to better understand the workings of these systems. The Toxic Substances Hydrology program studies the behavior of toxic substances in hydrologic environments. These research activities investigate subsurface contamination at local releases and aquatic ecosystem contamination on a watershed and regional scale. The Federal State Cooperatives program studies the effects of agricultural chemicals, floods, droughts, and waste disposal on water supply and groundwater quality. This federal unit annually receives approximately \$1 million in federal R&D funds.

Muscle Shoals, Alabama, is home to the Tennessee Valley Authority's Environmental Research Center.

- The Environmental Research Center (ERC) is the headquarters of the Tennessee Valley Authority's (TVA) Environmental Research and Services organization. ERC is responsible for cleansing the soil at Muscle Shoals contaminated by R&D conducted many years ago on fertilizer and munitions. To accomplish this, ERC has had to conduct R&D on how to clean up

soil contaminated with chemicals. Specifically, ERC develops enhanced bioremediation technologies for cleanup of PCBs and PAHs, researches biofilter technology to convert pollutant gases and liquids to harmless forms, studies the use of constructed wetlands and their value in removing heavy metals and organic pollutants from industrial and municipal wastes, provides economically feasible biomass conversion technologies for waste materials, and develops improved processes to convert wastes into useful products and environmental sensors for the detection and quantification of pollutants in various environments. In recent years, the resources devoted to environmental R&D by ERC have declined significantly because most of the cleaning up of Muscle Shoals is complete. Indeed, the cleanup of Muscle Shoals is scheduled to be finished in FY 2001. In FY 1998, only about \$5 million was spent on environmental R&D at ERC. By FY 2000, TVA expects this amount to fall to zero.

FEDERAL R&D GRANTS TO ALABAMA ENTITIES

Every major institution of higher education in Alabama is the recipient of significant federal R&D dollars each year through grants made by federal agencies to faculty, graduate students, and research centers. The vast majority of the R&D grants are made by HHS, NSF, DOD, and NASA to individual faculty members and therefore ultimately inure to the benefit of such institutions as the University of Alabama, Auburn University, the University of South Alabama (USA), Tuskegee University, and Alabama A&M University. The table below shows the number of R&D grants active in FY 1998, highlighting those made by HHS, NSF, DOD, and NASA to parties at the various institutions and estimates of the total dollars transferred to them in FY 1998 pursuant to the terms of these grants. Among the grants in the "Other Agencies" category going to the University of Alabama are ones from the Department of Justice (\$3 million), the Department of Education (\$2 million), and the Department of Transportation (\$2 million).

Table 1.1 – Sources of Federal R&D Grants to Higher Education in Alabama

Institution	HHS		NSF		DOD		NASA		Other Agencies		Total	
	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#	Amount	#
U of Alabama	\$137M	559	\$6M	103	\$3M	19	\$5M	160	\$9M	43	\$159M	884
Auburn	\$2M	24	\$2M	39	\$2M	14	<\$1M	17	\$6M	247	\$12M	341
USA	\$10M	54	<\$1M	8	0	0	<\$1M	3	<\$1M	3	\$10M	68
Tuskegee	\$3M	5	0	0	\$1M	2	<\$1M	20	\$2M	27	\$6M	54
Alabama A&M	<\$1M	2	<\$1M	1	\$1M	7	\$1M	20	\$2M	38	\$4M	68
Other	\$1M	12	<\$1M	7	\$1M	2	<\$1M	8	<\$1M	2	\$2M	31
Total	\$152M	656	\$9M	158	\$7M	44	\$6M	228	\$18M	360	\$193M	1,446

These activities are particularly significant because they fund much of the “basic research” so critical to expanding our knowledge and understanding of fundamental scientific phenomena. In addition, these funds account for a substantial portion of the dollars available each year to various academic departments within these institutions, such as the School of Medicine at the University of Alabama at Birmingham.

Several other nonacademic institutions in Alabama also receive a significant amount of federal R&D grants each year. Foremost among the institutions that received R&D grants in FY 1998 are the Southern Research Institute in Birmingham (\$17 million), Blue Cross/Blue Shield in Birmingham (\$1 million), and Tensor Technology in Huntsville (\$1 million).

Scattered among these grants, as well as among the contracts discussed in the section below, are small business innovative research (SBIR) awards. These are special awards made by the SBIR programs supported by the 10 federal agencies with annual budgets for extramural R&D of more than \$100 million. In a recent year, small businesses in Alabama received 70 SBIR awards totaling \$19 million. Examples include a \$700,000 award from the Army to Quality Research, Inc., in Huntsville for work on a virtual reality battlefield management tool for command, control, and communications nets and a \$750,000 award from HHS to Bioelastics Research, Ltd., in Birmingham for work on injectable implants to correct urinary incontinence.

Also included among these grants are formula grants from federal agencies. Formula grants differ from the much more common project grants in that the money transmitted via formula grants is allocated to a state or one of its subdivisions in accordance with a distribution formula prescribed by law or regulation. Among the formula grants benefiting Alabama are ones valued at more than \$7.3 million from USDA's Cooperative State Research, Education, and Extension Service (CSREES) to State Agricultural Experiment Stations, forestry schools, and veterinary colleges for the support of research in agriculture, forestry, and animal health and disease. Similarly, a modest formula grant goes from DOI's USGS to the Water Resources Research Institute in Alabama every year to foster research in water and water-related problems.

OTHER FEDERAL R&D ACTIVITIES IN ALABAMA

Several entities in Alabama also receive notable sums in the form of contracts or cooperative agreements from federal agencies for specific R&D efforts. The majority of these funds go to Nichols Research Corporation, which in FY 1998 received close to \$133 million in DOD R&D contracts for its engineering, analysis, and design effort in support of national and theater missile defense programs; battle management/command, control, and communication systems; and sea-, air-, ground-, and space-based sensor systems. In addition, Teledyne Industries (\$76 million), Dynetics Inc. (\$62 million), Mevatec Corporation (\$41 million), Colsa Corporation (\$34 million), CAS Inc. (\$32 million), and the Boeing Company (\$31 million) received very large R&D contracts from federal agencies in FY 1998. Note that these amounts are in addition to any federal R&D grants also received by these companies. For example, Dynetics also received \$65,000 in R&D grants in FY 1998. The University of Alabama (\$42 million), Alabama A&M (\$1 million), and Auburn University (\$1 million) also received contracts from various federal agencies to conduct R&D for the federal government. Although these amounts are notable, they do not come close to eclipsing the funds that these institutions receive from federal R&D grants.

A total of \$35 million of federal R&D dollars was also received in FY 1998 by entities in Alabama in the form of cooperative agreements. By far the largest of these cooperative agreements (\$19 million in FY 1998) came from DOE to Southern Co. Services Inc., in Birmingham for work on a hot gas cleanup test facility for coal gasification and pressurized combustion. Other federal agencies awarding cooperative agreements to Alabama-based entities include USDA, DOD, and NSF. Among these latter cooperative agreements is an award supporting one of NSF's Materials Research Science and Engineering Centers—the Center for Materials for Information Technology at the University of Alabama.