

Mechanical Engineering in the FY 2009 Budget

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Table 1: Summary of Mechanical Engineering-Related Programs in the FY 2009 Budget (in millions of dollars)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request
Department of Defense	12,839	12,679	11,475
Department of Energy	3,640	3,940	4,829
Department of Homeland Security	916.8	820.7	901.6
Environmental Protection Agency	427.8	343.5	333.9
National Aeronautics and Space Admin.	1,239	511	446
National Institute of Standards and Tech.	675	673	638
National Institutes of Health	921	911	912
National Science Foundation	426.1	431.7	524.1

Table 2: Detail of Mechanical Engineering-Related Programs in the FY 2009 Budget (in millions of dollars)

	FY 2007 Actual	FY 2008 Estimate	FY 2009 Request
Department of Defense (DOD)			
<i>Army</i>			
Basic Research (“6.1”)	353	379	379
Applied Research (“6.2”)	1,189	1,175	724
Advanced Technology Development (“6.3”)	1,254	1,337	739
<i>Navy</i>			
Basic Research (“6.1”)	482	498	528
Applied Research (“6.2”)	773	801	633
Advanced Technology Development (“6.3”)	751	722	679
<i>Air Force</i>			
Basic Research (“6.1”)	395	421	452
Applied Research (“6.2”)	1,115	1,170	1,044
Advanced Technology Development (“6.3”)	1,030	664	578
<i>Defense Wide</i>			
Basic Research (“6.1”)	294	336	339

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Applied Research (“6.2”)	2,027	1,912	1,844
Advanced Technology Development (“6.3”)	3,175	3,264	3,536
- <i>University Research Initiative (non-add)</i>	275	300	307
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Total DOD	12,839	12,679	11,475
Department of Energy (DOE)			
<i>Office of Science</i>			
Basic Energy Sciences	1,221	1,269	1,568
Advanced Scientific Computing Research	275.7	351.1	368.8
Fusion Energy Sciences	311	286.5	493.1
<i>Office of Energy Effic. /Renewable Energy</i>			
Hydrogen Technology	189	211	146
Biomass and Biorefinery Systems R&D	196.2	198.1	225
Solar Energy	157	168	156
Geothermal Technology	5	19.8	30
Wind Energy	48	49.5	52.5
Vehicle, Building & Industrial Technologies	340	386	406
<i>Office of Nuclear Energy, Science, & Tech.</i>			
Nuclear Energy R&D (includes MOX Fuel)	300.4	258.6	629.7
Univ. Nuclear Reactor Infrastructure & Edu.	16.5	0	0
<i>Office of Fossil Energy</i>			
	580.9	742.8	754
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Total DOE	3,640	3,940	4,829
Department of Homeland Security (DHS)			
<i>Science and Technology Directorate</i>			
Biological and Chemical Countermeasures	313.5	208.0	200.4
Border and Maritime	33.4	25.5	35.3
Explosives	105.2	77.7	96.1
Innovation	38	33	45
Laboratory Facilities	105.6	103.8	146.9
University Programs	48.6	49.2	43.7
<i>Domestic Nuclear Detection Office</i>			
Research, Development, and Operations <i>(FY 09 combines operations with R&D)</i>	272.5	323.5	334.2
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Total DHS	916.8	820.7	901.6
Environmental Protection Agency (EPA)			
Clean Air Research	95.6	99.6	96.9
Air Quality Management	95.5	89.4	95.5
Climate Change Research	14.6	18.3	11.4
Sustainability Research	24.8	22.1	19.9
Drinking Water and Water Quality Research	98.7	104.3	101.4
Nat’l Ambient Air Quality Stds. (NAAQS)*	61.6	-	-
Fellowships	12.2	9.8	8.8
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Total EPA	427.8	343.5	333.9

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National Aeronautics and Space Administration (NASA)

<i>Aeronautics Technology</i>			
Aviation Safety and Security	87	66	63
Airspace Systems	102	100	74
Fundamental Aeronautics	330	270	235
Aeronautics Test Program	74	75	74
<i>Exploration Systems Research & Technology</i>	646	**	**
Total NASA	1,239	511	446

National Institute of Standards and Technology (NIST)

<i>Scientific & Tech. Res. & Services</i>			
NIST Laboratories	434	440	535
<i>Industrial Technology Services (ITS)</i>			
Advanced Technology Program (ATP)	79	0	0
Technology Innovation Program (ATP)	0	65	0
Manufacturing Extension Partnership	105	89	4
Construction of Research Facilities	58	79	99
Total NIST	675	673	638

National Institutes of Health (NIH)

NIH-wide SBIR/STTR (excl. NIBIB)	621	612	612
National Institute of Biomedical Imaging & Bioengineering (NIBIB)	300	299	300
Total NIH	921	911	912

National Science Foundation (NSF)

Chemical, Bioeng., Env., & Transport Sys.	128.3	131	173.3
Civil, Mechanical, & Manuf. Innovation	157.3	159.8	201.9
Engineering Education and Centers	115.2	115.9	119.9
Emerging Frontiers in Res. & Innov.	25.3	25	29
Total NSF	426.1	431.7	524.1

* Air Toxics Research and NAAQS programs were combined into the Clean Air Research program in the FY 2008 budget.

** Exploration Systems Research and Technology (ESRT) and Human Systems Research and Technology (HSRT) have been combined into a new theme Advanced Capabilities. This new theme consists of three programs: the Lunar Human Research Program (LHRP), Exploration Technology Development Program (ETDP), and the Human Research Program (HRP).

INTRODUCTION

Mechanical engineering research and development spans a very wide range of problems and applications. Mechanical engineering has a

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presence virtually in anything involving the design, manufacture, operation or decommissioning of objects or bodies in motion. As such, mechanical engineering has a presence from the nano- to galactic scales. This reflects the fact that mankind is actively engaged in exploration and design across this entire spectrum. The function of this chapter is to provide the reader with a sense of the major activity areas in which mechanical engineering R&D may be found and trends in funding within these areas. In this regard, programs and initiatives may be highlighted that are not specifically mechanical engineering focused. It is important to note therefore that the funding requests discussed represent potential sources of funding for mechanical engineers; they do not represent the state of federal funding specifically for mechanical engineering. Funding for application and missions involving mechanical engineering, such as the space shuttle, do not lie within the purview of this analysis. Where possible, these distinctions have been highlighted.

DEPARTMENT OF DEFENSE (DOD)

The FY 2009 budget for DOD Science and Technology (S&T) accounts is \$11.5 billion, which is a \$1.2 billion or 9.5 percent reduction from FY 2008. The reduction reflects the removal of congressional earmarks by the Administration in this year's budget request. The total FY 2009 DOD budget request, which does not include the anticipated supplemental appropriations for war fighting in Iraq and Afghanistan, is \$515.4 billion. The S&T portion represents 2.2 percent of DOD's total budget request.

S&T funds support Basic Research ("6.1"), Applied Research ("6.2"), and Advanced Technology Development ("6.3") at DOD. Basic Research would see an increase of \$65 million or 4 percent to \$1.7 billion, while "6.2" and "6.3" funding would decline. All of the service accounts would see an increase in funding for basic research, with the largest increases going to the Air Force and Navy at 7.4 percent and 6.1 percent, respectively (see Table 2).

The Defense Advanced Research Projects Agency (DARPA) is requesting \$3.3 billion in the FY 2009 budget, which is an 11 percent increase over last year's amount. The budgets for the University Research Initiative (URI) programs that support graduate education in Mathematics, Science, and Engineering would see a 2.1 percent increase to \$307 million.

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DEPARTMENT OF ENERGY (DOE)

The Department's budget for FY 2009 reflects priorities to funding basic scientific research, achieving breakthroughs in advanced energy technologies, and maintaining commitments to a robust nuclear security program. Mechanical engineering related R&D lies primarily in four offices: Office of Science (\$4.7 billion, up 18.8 percent), Office of Energy Efficiency and Renewable Energy (EERE; \$1.25 billion, down 27.1 percent), Office of Nuclear Energy (NE; \$1.4 billion) and Office of Fossil Energy (\$1.2 billion, up 24.6 percent). The NE budget has absorbed \$493 million from the Nuclear National Security Administration (NNSA) for the construction of a Mixed Oxide Fuel Fabrication (MOX) facility which, when subtracted from the total request, gives NE an actual decrease of \$108 million or 11.2 percent.

This year, the DOE request attempts to restore the funding trajectory mandated in the America COMPETES Act for the Office of Science. Three programs in the Office of Science include substantial portions of mechanical engineering related R&D, and all three are requesting increased funding to support program growth and development. Basic Energy Sciences (BES) at \$1.6 billion would increase by \$298 million or 23.5 percent from FY 2008. Advanced Scientific Computing Research (ASCR) at \$369 million would increase by \$17.6 million or 5.0 percent. Fusion Energy Sciences (FES) at \$493 million would increase by \$207 million or 72.1 percent. The funding increases for FES reflect restored funding for the ITER fusion energy project that was not funded in 2008.

Nuclear Energy R&D has been reconfigured relative to the FY 2008 appropriation by eliminating the line item for Fuel Cycle Research and Facilities (FY 2008 \$458 million) and combining it with Research and Development (FY 2008 \$259 million). The FY 2009 request for Research and Development is \$630 million which is \$87 million less than the combined FY 2008 appropriation. This includes increases for in the Advanced Fuel Cycle Initiative from \$179 million to \$301.5 million; Nuclear Hydrogen from \$9.9 million to \$16.6 million; and Nuclear Power 2010 from \$133.8 million to \$241.6 million. The Generation IV program has been reduced from \$114.9 million to \$70 million.

For FY 2009, the total request for EERE is 27 percent less than the FY 2008 appropriated level. Nearly all of the programs within EERE include substantial portions of mechanical engineering related R&D. Biomass

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and Bio-refinery Systems R&D at \$225 million is increased 13.5 percent. Building Technologies at \$123.8 million is increased 13.5 percent. Geothermal Technology at \$30 million is increased 50 percent. Hydrogen Technology at \$146.2 million is reduced 30.6 percent, although several of the project reductions were transferred to other programs. A substantial portion of the EERE cuts come from reduction of non-program related Weatherization and Intergovernmental Activities to \$58.5 million for FY 2009 from \$282.2 million, and the zeroing out of \$186.6 million in FY 2008 Congressional Directed Activities.

Under the FY 2009 budget, the Office of Fossil Energy would see a 24.6 percent increase over FY 2008 to \$1.12 billion. Fossil Energy R&D (FER&D) programs would increase by a meager \$11.1 million or 1.5 percent in FY 2009 as a result of restructuring the FutureGen project. Clean Coal Technology would also be zeroed out as \$149 million would be transferred to the FutureGen project, which instead of constructing a near zero emissions hydrogen economy and coal fire plant would focus on smaller scale carbon sequestration projects.

DEPARTMENT OF HOMELAND SECURITY (DHS)

The FY 2009 request for DHS is \$50.5 billion, a 7 percent increase. The budget continues to be centered around the five themes established in 2007: protecting the nation from dangerous people, protecting the nation against dangerous goods, protecting critical infrastructure, building a nimble emergency response system and culture of preparedness, and strengthening and unifying DHS operations and management. While the FY 2009 budget for the Science and Technology Directorate would increase 4.6 percent from \$830.1 million to \$868.8 million, there are increases and decreases contained within it. Increases include: border and maritime, 38 percent to \$35.3 million; explosive countermeasures, 23.8 percent to \$96.1 million; innovation portfolio, 36 percent to \$45 million; and Laboratory Facilities, 41.5 percent to \$146.9 million. Decreases include: chemical and biological countermeasures, 3.8 percent to \$200.4 million; and university programs, 12.6 percent to \$43.8 million.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

The FY 2009 request for EPA is \$7.1 billion, a slight decrease from \$7.4 billion in 2008. Although many programs have been cut, the EPA's Science and Technology account would rise slightly from \$760 million

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for FY 2008 to \$763 million in FY 2009. Attempts to determine all of these changes will be ongoing, as certain program modifications by EPA have altered the function of existing programs. The Climate Protection Program would receive \$11 million, almost \$7 million below FY 2008. The Clean Air Research account would fall to \$96.9 million from \$99.6 million. Fellowships also fall slightly to \$8.8 million. Sustainability Research would also fall to \$19.9 million for FY 2009, \$2 million less than 2008 (see Table 2).

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA's budget for FY 2009 is \$17.6 billion, an increase of 2.9 percent over the \$17.1 billion provided in the FY 2008 omnibus appropriations act. The Constellation Systems and the International Space Station program account for a significant portion of the increase in NASA's FY 2009 budget. Constellation Systems, which help develop capabilities and supporting research and technology for human and robotic exploration, would receive \$3.0 billion, an increase of 23 percent or \$576 million. The International Space Station (ISS), which is a joint project with Russia, Japan, Canada, and several European countries to build a laboratory complex in orbit, would receive \$2.1 billion, a 13.6 percent or \$247 million increase (see Table II-12). Additionally, \$285 million is being shifted from the Space Shuttle program, which is set for retirement in 2010, and being used to fund Space and Flight Support for ISS.

Mechanical engineering-related research is primarily conducted in the Aeronautics Research Mission Directorate (ARMD). Aeronautics research would decrease for the fourth consecutive year. The Administration's FY 2009 request for ARMD is \$446.5 million, which is a decrease of \$65.1 million. The ARMD is charged with funding researching to produce cleaner, safer, and more efficient aircraft. The budget includes \$62.6 million, a decrease of \$3.9 million below FY 2008, for the Aviation Safety and Security Program; \$74.6 million for the Airspace Systems Program, a reduction of \$25.5 million; and \$235.4 million for Fundamental Aeronautics, a decrease of \$34.5 million.

Additionally, ARMD along with the Federal Aviation Administration (FAA) are focused on fundamental research challenges to the Next Generation Air Transportation System (NextGen), which will require new concepts and capabilities.

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NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

The President's request for NIST in FY 2009 is \$638 million, a decrease of \$35 million or 5.2 percent from FY 2008; however, this amount does not include \$82 million of earmarked funds (see Table 2). Mechanical engineering R&D activities within the NIST budget request may be found in two areas: the NIST laboratory portion of the Scientific and Technical Research Services (STRS), and Industrial Technology Services (ITS). STRS provides the measurement and standards infrastructure to support advances in technology and manufacturing. ITS consists of the Technology Innovation Program (TIP) and the Hollings Manufacturing Extension Partnership (HMEP).

The total FY 2009 budget request for STRS is \$535 million. NIST will fund several new initiatives in the areas of Nanotechnology: Environment, Health & Safety Infrastructure and Bioscience Measurement & Standards.

The ITS FY 2009 budget request is \$4 million, which is a reduction of \$146 million. The \$4 million request is for the shutdown of the Hollings Manufacturing Extension Partnership (HMEP), however Congress provided HMEP with \$89 million in FY 2008 to continue its collaboration with industry to bring products to market. The Administration would not provide funding for TIP, just as it did not request funding for its predecessor, the Advanced Technology Program (ATP) in prior years, but Congress appropriated \$65 million in 2008.

NATIONAL INSTITUTES OF HEALTH (NIH)

The total FY 2009 NIH budget request is \$29.5 billion, equal to FY 2008. The majority of NIH institutes and centers will see no increases in funding in FY 2009 (see Table II-9). Taking into account inflation, the NIH will actually realize a decrease in funding.

The largest percentage increase in the FY 2009 budget request would go to the NIH Roadmap for Biomedical Research, also known as the Common Fund which is administered through the Office of the Director (OD). The Roadmap would receive \$534 million in the FY 2009 budget which is an 8 percent increase over the \$496 million appropriated in FY 2008 (see Table II-10). The importance of engineering to the health sciences was one of the drivers for creating the NIH Roadmap for

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Biomedical Research. Additionally, last year NIH launched Pathways to Independence, a program to support scientist at the beginning of their research careers which combines research and training awards. The FY 2009 budget request for this program is \$71 million, which is substantially more than the \$15 million it was started with last year.

The mission of the National Institute of Biomedical Imaging and Bioengineering (NIBIB) is to improve health by leading the development and application of emerging and breakthrough technologies based in a merging of the biological, physical, and engineering sciences. The President's FY 2009 NIBIB request of \$300 million represents an increase of \$2 million or 0.5 percent, which becomes a decrease when inflation is taken into account. The budget for NIBIB Extramural Research would remain constant at \$273 million while that for intramural research would increase to \$10.8 million. The breakdown for extramural and intramural research within NIBIB is reflective of NIH's push to fund extramural research. NIBIB's Research Management and Support request is \$16.3 million, an increase of \$2 million or 12 percent.

NIBIB funds the Applied Science and Technology (AST) program, which supports the development and application of innovative technologies, methods, products, and devices for research and clinical application that transform the practice of medicine. The FY 2009 request for AST is \$159.4 million, down \$0.6 million. Additionally, NIBIB funds the Discover Science and Technology (DST) program, which is focused on the discovery of innovative biomedical engineering and imaging principles for the benefit of public health. The FY 2009 request for DST is \$90.1 million, also a \$0.6 decrease from FY 2008.

NATIONAL SCIENCE FOUNDATION (NSF)

The total FY 2009 NSF budget request is \$6.9 billion, an \$882 million or 13.6 percent increase over the \$6.0 billion appropriated in 2008 (see Table II-7). It is worth noting that the 2008 omnibus bill funded NSF at a level considerably lower than the President's original FY 2008 budget request of \$6.4 billion, which was set at a level commensurate with the intended doubling of the NSF budget over ten years (starting from 2006).

The request is divided into six appropriation accounts. Research and Related Activities (R&RA) comprises the dominant part of the total NSF request at \$5.6 billion, reflecting a 16.4 percent increase over the FY

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2008 estimate. There are eleven activities under R&RA, including the Engineering Directorate (ENG). The FY 2009 budget request for ENG is \$759 million, a 19.2 percent increase over the FY 2008 estimate. Noteworthy, \$127 million of this \$759 million represents the SBIR/STTR program,¹ which ENG manages for all of NSF. The request for ENG, less the SBIR/STTR program, is then \$632 million, making it the fifth-largest activity in RR&A.

For FY 2009, ENG will continue to support research and education efforts related to broad, Foundation-wide priority areas and the Administration's interagency R&D priorities, along with three new Foundation-wide priority areas: Adaptive Systems Technology (\$3.5 million), Dynamics of Water Processes in the Environment (\$0.5 million), and Science & Engineering Beyond Moore's Law (\$4.0 million). The following initiatives received increases: Cyber-enabled Discovery and Innovation (up 110.1 percent to \$16.8 million), Cyberinfrastructure (up 7.1 percent to \$60 million), National Nanotechnology Initiative (up 2.2 percent to \$140 million), and Networking and Information Technology R&D (up 45.9 percent to \$28.0 million). Funding for the Climate Change Science Program (\$1.0 million) remains level. The Human and Social Dynamics priority area initiative concluded in FY 2008, with funds returning to core programs for continued support.

All six divisions of ENG receive increases in the FY 2009 request over the FY 2008 estimate. Chemical, Bioengineering, Environmental, and Transport Systems (CBET) is up 32.3 percent to \$173 million; Civil, Mechanical, and Manufacturing Innovation (CMMI) is up 26.3 percent to \$202 million; Electrical, Communications and Cyber Systems is up 13.0 percent to \$94 million; Industrial Innovation and Partnerships (which houses the SBIR/STTR program) is up 15.8 percent to \$141 million; Engineering Education and Centers is up 3.4 percent to \$119.9 million; and Emerging Frontiers in Research and Innovation is up 16.0 percent to \$29 million. While mechanical engineering continues to participate in programs across these divisions and, indeed, throughout the Foundation, traditional mechanical engineering research will principally lie in CBET and CMMI.

¹ Small Business Innovation Research / Small Business Technology Transfer