

## Mechanical Engineering in the FY 2014 Budget

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### INTRODUCTION

Mechanical engineering research and development (R&D) addresses a wide range of problems and applications, from energy conversion and transmission to computer-aided design. Mechanical engineering has a presence in almost everything involving the design, fabrication, operation, or decommissioning of objects or bodies in motion. Current key areas include contributions in fields such as energy, manufacturing, materials & structures, systems & design, environment, transportation, biotechnology, and nanotechnology. This chapter is intended to highlight major activity areas in which mechanical engineering may be found within the federal R&D portfolio, along with their trends in funding. The funding requests discussed in this chapter represent potential – not dedicated – sources of funding for mechanical engineers. Data for funding by agency are presented in Table 1. Recent trends in federally-supported mechanical engineering-related R&D include:

- Emphasis on advanced manufacturing and energy;
- Emphasis in space technology development; and
- Increased focus on industrial partnerships and technology commercialization.

### DEPARTMENT OF DEFENSE (DOD)

Mechanical engineering is prevalent in the Research, Development, Test, and Evaluation (RDT&E) account, which is budgeted for \$67.3 billion in FY 2014, a 6.3 percent reduction from the FY 2012 final of \$71.8 billion.

This request represents the fifth year that the Administration has requested a reduction in funding for DOD's overall RDT&E budget.

DOD's core science and technology (S&T) development accounts are divided into Basic Research (6.1), Applied Research (6.2), and Advanced Technology Development (6.3). Basic Research would see a significant increase from the FY 2012 appropriated amount under the President's budget, increasing to \$2.1 billion, an increase of 7.71 percent. On the other hand, Applied Research and Advanced Technology development would fall to \$4.6 billion (down 2.2 percent) and \$5.2 billion (down 2.4 percent), respectively from the final FY 2012 amounts. The Administration's overall proposal would bring S&T funds to 1.9 percent of DOD's baseline budget, down slightly from FY 2012's 2.2 percent level.

S&T funding for defense-wide account activities would increase by 5.7 percent to \$5.5 billion. Each of the individual service branches would see reductions under the President's request--with the deepest cuts slated for Army accounts at an 8.3 percent reduction to \$2.2 billion; Air Force S&T funds would decline 5.1 percent to \$2 billion, followed by the Navy with a 2.1 percent reduction to \$2 billion. All the branches have received increases in their 6.1 accounts with significant reductions coming in the 6.3 accounts. The Administration has requested an increase of \$51 million for the Defense Advanced Research Projects Agency (DARPA). Within DARPA, Basic Research accounts would increase by 4.5 percent to \$364.5 million; Applied Research would increase by 1.4 percent to \$1.2 billion; and Advanced Technology Development efforts would increase by 6.2 percent to \$1.2 billion. For DARPA's Defense Research Sciences account (listed under basic research), DOD is requesting \$364.5 million which is a 4.3 percent increase over FY 2012. This request represents continuing significant increases for this program compared to the \$194 million in FY 2010 and \$348.7 million in FY 2012.

For the National Defense Education Program, DOD is requesting \$84.3 million, which is a 4.1 percent decrease from the FY 2012 level of \$87.9 million. University Research Initiatives accounts from across the services would decline by a combined 2 percent, from \$337 million in FY 2012 to \$330 million in FY 2014.

MECHANICAL ENGINEERING IN THE FY 2014 BUDGET

**DEPARTMENT OF ENERGY (DOE)**

The Department’s budget for FY 2014 reflects strong priorities for renewable energy and applied scientific research, i.e., in achieving breakthroughs in advanced energy technologies and in building upon relatively new opportunities to fund applied research. Specifically, increases in DOE research programs reflect the sustained interest in stimulating technological innovation envisioned by the America COMPETES Reauthorization Act of 2010.

**Table 1.** Mechanical Engineering in the Federal R&D Budget  
(budget authority in millions of dollars)

	FY 2012	FY 2014	Change FY 12-14*	
	Actual	Budget	Amount	Percent
<b>Dept of Defense RTD&amp;E/1</b>	71,845	<b>67,334</b>	-4,511	-6.3%
<i>Science &amp; Tech (6.1-6.3)</i>	12,058	<b>11,984</b>	-74	-0.6%
<i>Def Adv Res Proj Agency</i>	2,814	<b>2,865</b>	51	1.8%
<b>Dept of Energy</b>				
<i>Office of Science</i>	4,463	<b>4,744</b>	281	6.3%
<i>Basic Energy Sciences</i>	1,645	<b>1,862</b>	217	13.2%
<i>Fusion Energy Sciences</i>	393	<b>458</b>	65	16.5%
<i>Energy Eff &amp; Renew Energy</i>	1,781	<b>2,776</b>	995	55.9%
<i>Nuclear Energy</i>	760	<b>735</b>	-25	-3.3%
<i>Fossil Energy</i>	524	<b>429</b>	-95	-18.1%
<b>Dept of Homeland Security</b>				
<i>Science &amp; Technology</i>	673	<b>1,527</b>	854	126.9%
<b>Environ Protection Agency (EPA)</b>	795	<b>784</b>	-11	-1.4%
<b>Natl Aero and Space Admin (NASA)</b>				
<i>Aeronautics Research</i>	569	<b>566</b>	-3	-0.5%
<i>Space Technology</i>	574	<b>743</b>	169	29.4%
<i>Exploration</i>	3,707	<b>3,916</b>	209	5.6%
<b>Natl Inst of Stand &amp; Tech (NIST)</b>	751	<b>928</b>	177	23.6%
<i>Sci &amp; Tech Res &amp; Serv</i>	567	<b>693</b>	126	22.2%
<i>Industrial Tech Services</i>	128	<b>174</b>	46	35.9%
<b>National Institutes of Health (NIH)</b>				
<i>Bio Imaging &amp; Bioeng (NIBIB)</i>	338	<b>339</b>	1	0.3%
<b>National Science Foundation (NSF)</b>				
<i>Engineering</i>	973	<b>1,087</b>	114	11.7%
<i>Chem, Bio, Env &amp; Trans</i>	172	<b>185</b>	13	7.6%
<i>Civ, Mech &amp; Manu Innov</i>	204	<b>224</b>	20	9.8%

“Source: Agency budget justifications, and DOD “”RDT&E Programs”” (R-1). All figures rounded to the nearest million. Changes calculated from unrounded figures.  
1/ Department of Defense figures are in total obligational authority (TOA).”

Mechanical engineering related R&D can be found mostly in four offices, i.e., Office of Science, Office of Energy Efficiency and Renewable Energy (EERE), Office of Nuclear Energy, and Office of Fossil Energy. The requests for each of these offices are \$4.7 billion, \$2.88 billion, \$0.7 billion, and \$0.4 billion, respectively. Relative to FY 2012 appropriations, these requests reflect increases of \$281 million, or 6.3 percent, for the Office of Science and of \$995 million, or 55.9 percent, for EERE. The Office of Fossil Energy would decrease by \$95 million, or 18.1 percent; and the Office of Nuclear Energy would decline by \$25 million, or 3.3 percent, for FY 2014.

Within the Office of Science, there are three programs in which mechanical engineering related R&D typically occurs; and they all see increases. These are Basic Energy Sciences (BES), \$1.9 billion; Advanced Scientific Computing Research (ASCR), \$466 million; and Fusion Energy Sciences (FES), \$458 million. Fusion Energy Sciences would increase by \$65 million, or 16.5 percent, from an FY 2012 appropriation of \$393 million. BES would increase by \$217 million, or 13.2 percent, from the FY 2012 appropriation of \$1.6 billion. ASCR would increase by \$37 million, or 8.7 percent, from \$428 million in FY 2012.

Mechanical engineering R&D is pervasive within EERE, with several programs receiving noticeable increases. Wind and Solar Energy are requested at \$144 million (56.8 percent increase) and \$357 million (25.2 percent increase), respectively. Two programs are zeroed out in the FY 2014 request, namely, Biomass and Bio-refinery Systems Research, and Demonstration & Development (RD&D). Vehicle and Building Technologies funding would increase to \$575 million (79.1 percent) and \$300 million (39.7 percent), respectively, for FY 2014. The Advanced Manufacturing program (formerly called the Industrial Technologies Program) would also grow by \$252 million for FY 2014 to a total of \$365 million. Geothermal Technology would increase by \$23 million, or 62.3 percent, to \$60 million for FY 2014.

The Office of Nuclear Energy would decrease by \$25 million, or 3.3 percent, to \$735 million in FY 2014. Fuel Cycle R&D would decrease 8.8 percent to \$165 million. Reactor Concepts RD&D would decline by \$38 million, or 34.5 percent, to \$73 million in FY 2014. Nuclear Energy Enabling Technologies would decline by \$9 million, or 12.6 percent, to \$62 million, from FY 2012.

Under the FY 2014 budget request, the Office of Fossil Energy would see an 18.1 percent decrease from the FY 2012 appropriation of \$524 million. Within the Office of Fossil Energy, Fossil Energy R&D (FER&D) programs would increase by \$84 million, or 24.8 percent, in FY 2014.

The Advanced Research Projects Agency-Energy (ARPA-E), whose mission is to support early-stage energy technology innovations, is also a potential funding source for mechanical engineers. ARPA-E funding would increase significantly by \$104 million, or 37.8%, to \$379 million.

### **DEPARTMENT OF HOMELAND SECURITY (DHS)**

R&D for DHS has been divided between the Science and Technology Directorate (S&T) and the Domestic Nuclear Detection Office (DNDO), which fund mechanical-engineering related activities. The budget proposes funding DNDO's only R&D account, R&D and Operations, at \$211 million in FY 2014, a 1.9 percent decrease. The total FY 2014 budget request for the DHS S&T Directorate is \$1.5 billion, a 126.9 percent increase from the FY 2012 funding level of 673 million. S&T's Research, Development, and Innovation budget would increase 75.6 percent from \$266 million in FY 2012 to \$467 million in FY 2014. Laboratory Facilities would increase 371.4 percent from \$182 million in FY 2012 to \$858 million in FY 2014. University Programs would decrease by 16.2 percent from \$37 million in FY 2012 to \$31 million in FY 2014.

### **ENVIRONMENTAL PROTECTION AGENCY (EPA)**

The FY 2014 budget request for EPA is \$8.1 billion, a \$296 million decrease from the FY 2012 enacted amount of \$8.4 billion. The EPA's Science and Technology account would decline by \$11 million in FY 2014 to \$784 million.

Mechanical-engineering-related R&D is found in several programs. The Global Change program would receive \$20.4 million, a \$2 million decrease from the FY 2012 enacted amount. The Clean Air Research account would rise by \$4.7 million to \$83.2 million in FY 2014. The Air, Climate, and Energy Research account for FY 2014 would remain relatively flat at \$2.1 million from the FY 2012 enacted level of \$1.9 million. Safe and Sustainable Water Resources would rise \$3.6 million to \$117.8 million for FY 2014.

## NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA)

NASA's budget request for FY 2014 is \$17.7 billion, roughly the same amount as in FY 2012. In accordance with the terms of the NASA Reauthorization Act of 2010 (P.L. 111-267), significant changes continue to occur for NASA's programming in FY 2014, including the continued development of a series of new commercial development, exploration, R&D, and technology demonstration programs. These efforts represent a significant expansion in NASA's R&D portfolio, including several new programs geared towards partnerships with the commercial sector. Offsetting some of these increases, NASA's Space Operations budget is reduced by 7.2 percent to \$3.8 billion, largely due to the decommissioning of the Space Shuttle program. Similarly, NASA's Education programs are reduced by 30.8 percent to 94.2 million, a \$42 million decrease from FY 2012, due to a reorganization of STEM education programs throughout the federal agencies.

The Aeronautics Research Mission Directorate (ARMD) funds mechanical-engineering-related research to produce cleaner, safer, and more efficient aircraft. The Administration proposes \$566 million for ARMD's core aviation efficiency programs for FY 2014, a decrease of 0.6 percent from \$569.4 million in FY 2012. The new Space Technology budget portfolio would receive \$743 million, representing an increase of \$169 million, or 29.4 percent, to support research in technologies such as communications, sensors, robotics, materials, and propulsion. Some of this funding was previously categorized under Cross-Agency Support, but will now be directed through the Innovative Partnerships Program (IPP), which includes the Small Business Innovative Research (SBIR) and Small Business Technology Transfer Research (STTR) initiatives.

NASA's Exploration budget would increase to \$3.9 billion, up 5.5 percent, from the \$3.7 billion for FY 2012. This increase is principally due to Exploration's management of the Administration's Commercial Spaceflight programs, which increase 102.3 percent under the budget request to \$821 million, up from a planned lull in award funding in FY 2012 which totaled \$406 million. Exploration will also manage \$1 billion for NASA's Multi-Purpose Crew Vehicle, a 14.4 percent decrease from FY 2012, as well as \$1.4 billion for Space Launch Systems, a 7.5 percent decrease. Explorations R&D program account would increase by 20.2 percent to \$364 million in FY 2014. Mechanical engineering is needed

for the design, development and testing, packaging, launching, and deployment of new exploration systems.

### **NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)**

The Department of Commerce's National Institute of Standards and Technology (NIST) would receive \$928.3 million in the Obama Administration's FY 2014 budget request, an increase of \$177.3 million over its FY 2012 budget.

The total request for NIST is divided into three separate appropriations. Under the FY 2014 budget request, Scientific and Technical Research and Services (STRS) program would receive \$693.7 million, a \$126.7 million increase over the FY 2012 enacted amount. Mechanical-engineering-related activities are prevalent in this program.

Industrial Technology Services (ITS) would receive \$174.5 million, a 36.33 percent increase over the FY 2012 enacted amount. This category consists of \$153 million (a \$25 million increase) for the Hollings Manufacturing Extension Partnership (MEP) and \$21.4 million to continue the new Advanced Manufacturing Technology Consortia (AMTech) that was proposed by the Obama Administration in FY 2012. AMTech will "promote industry consortia to tackle common technological barriers" related to nanotechnology products.

Finally, Construction of Research Facilities (CRF) would receive \$60 million, a 9 percent increase from the FY 2012 enacted amount of \$55 million.

### **NATIONAL INSTITUTES OF HEALTH (NIH)**

While mechanical engineers are ever more partnering with physicians and researchers across all of the institutes comprising NIH, mechanical-engineering-related R&D is mostly found within the National Institute of Biomedical Imaging and Bioengineering (NIBIB). NIBIB requests \$338.9 million for FY 2014, an increase of 0.3 percent from the FY 2012 enacted amount of \$337.7 million. The budget for NIBIB Research Grants would decrease by 0.6 percent to \$226.2 million. Funding for intramural research would remain flat at \$11.4 million. NIBIB's Research Management and Support request is also flat with respect to FY 2012 at \$19.8 million.

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 2014 request for AST is \$168.2 million, a 0.9 percent increase from FY 2012. Additionally, NIBIB funds the Discovery Science and Technology (DST) program, which focuses on the discovery of innovative biomedical engineering and imaging principles for the benefit of public health. The FY 2014 request for DST is \$86.94 million, a 0.1 percent decrease from FY 2012. The Technological Competitiveness–Bridging the Sciences program, which funds interdisciplinary approaches to research, would receive \$20.3 million in FY 2013, the same level as in FY 2012.

#### **NATIONAL SCIENCE FOUNDATION (NSF)**

Currently, NSF's annual budget represents 21 percent of the total federal budget for basic research conducted at U.S. colleges and universities. When medical research supported by the NIH is excluded, NSF's share becomes 58 percent.

The FY 2014 budget would expand several NSF programs significant to the mechanical engineering profession, including \$222.8 million for the Science, Engineering, and Education for Sustainability (SEES) program (41.9 percent increase), \$325.1 million for Graduate Research Fellowships (33.8 percent increase), and \$223.7 million for Faculty Early Career Development (3.5 percent increase). The budget request also includes \$50.7 million (69 percent increase) for the Directorate-collaborative program, Research at the Interface of the Biological, Mathematical, and Physical Sciences (BioMaPs) to accelerate understanding of biological systems for application to new technologies, particularly in the field of clean energy. The Climate Change Education Program has been zeroed out in the FY 2014 budget request. NSF has also proposed continued funding for the Cyber-enabled Materials, Manufacturing, and Smart Systems program at \$300.4 million for FY 2014, an increase of 112.1 percent over the enacted FY 2012 level.

Within the Research and Related Activities (R&RA) account is the NSF Engineering Directorate (ENG), which would receive \$1.1 billion in FY 2014, up 11.7 percent from FY 2012. The budget for ENG includes \$177 million, an increase of 20.4 percent over the \$147 million for FY 2012,

mandated for the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs that ENG administers for all of NSF. The request for ENG, less the SBIR/STTR program, is \$911 million, a 10.4 percent increase over FY 2012.

All divisions of ENG would receive increases under the FY 2014 request. The Chemical, Bioengineering, Environmental and Transport (CBET) Systems division would receive \$185 million, a 7.5 percent increase. The Civil, Mechanical, and Manufacturing Innovation (CMMI) division would receive \$224 million, a 9.8 percent increase. The Electrical, Communications, and Cyber Systems (ECCS) division would receive \$118 million, a 10.3 percent increase. Engineering Education and Centers (EEC) would increase by 1.6 percent to \$126 million; and Emerging Frontiers in Research and Innovation (EFRI) would increase by 3.2 percent to \$32 million. While mechanical engineering continues to participate in programs across all these divisions, as well as agency wide, traditional mechanical engineering research is most pervasive in CBET and CMMI.

## CONCLUSION

Although mechanical engineering research disciplines receive overall increases in the FY 2014 budget request, these numbers are moderated since they are compared to the FY 2012 budget, given the late passage of the FY 2013 budget. Mechanical engineering lies at the core of many national research priorities and endeavors, including energy, advanced manufacturing, transportation, building infrastructure, environment, and health care. Thus, with the uncertainty and on-going cuts in the current budget environment, sustained science, engineering, and technology funding for research agencies remains a real challenge, with strong consequences on our country's health, prosperity, welfare, and security.