

CENTER FOR COMPACT AND EFFICIENT FLUID POWER



A National Science Foundation Engineering Research Center



Dear Friends and Supporters of CCEFP:

Your support creates unprecedented impact across the fluid power research and technology communities. We are raising awareness of fluid power innovation; we are educating the next generation of leaders; we are teaching relevant fluid power concepts to hundreds of students each year; we are answering industry's needs with innovative solutions. Your contributions to the Center for Compact and Efficient Fluid Power are critical to our continued success. Because of supporters like you, and our education partners, more than **\$4,800,000** was raised for fluid power initiatives this past year. These funds were utilized for leadership, advocacy, innovation, education, and networking. We appreciate your commitment to building a better fluid power community.

CCEFP IMPACT: 2016 CCEFP Annual Report



LEAD | In our 11th year, the CCEFP directly supported over \$1,457,000 in fluid power research including \$1,289,000 for university research projects and \$168,000 for Project AME, the Additive Manufactured Excavator. The Center also expended \$266,000 for strategic initiatives such as the development of a new Department of Energy program, \$91,000 for education programs, and \$174,000 for industry engagement. Additionally, CCEFP faculty were awarded \$2,200,000* in associated fluid power research and \$1,500,000

through national lab in-kind support was received for Project AME. Universities impacted directly by CCEFP include Marquette University, Milwaukee School of Engineering, Purdue University, University of California at Merced, University of Illinois, Urbana-Champaign, University of Minnesota, and Vanderbilt University. Other universities and organizations indirectly impacted include Georgia Institute of Technology, Iowa State University, Oak Ridge National Laboratory, and Texas A&M University.

** Based on CCEFP 10-year average*



INNOVATE | Significant progress executing the CCEFP research strategy was made this past year. Director Stelson (Minnesota) was assisted by three Deputy Directors who were responsible for one of three priorities for fluid power advancement. These priorities include Off-Highway Vehicles (Prof. Sun, Minnesota); Human Scale Systems (Prof. Barth, Vanderbilt); and Fluid Power Manufacturing (Prof. Harris, Georgia Tech). Notable achievements include developing new sources of fluid power research support from four government agencies: the Department of Energy's (DOE) Office of Energy Efficiency & Renewable Energy (EERE), the Department of Defense (DOD) Advanced Robotics for Manufacturing (ARM) Institute, National Institute of Standards and Technology (NIST), and National Science Foundation's (NSF) Emerging Frontiers in Research Innovation (EFRI).



ADVOCATE | Center faculty, staff, and industry representatives made three visits to Washington D.C. to meet with more than 30 Congressional legislators and staffers to advocate for increased fluid power research support. This resulted in a *new* Department of Energy Mobile Fluid Power Research Program which will fund \$5,000,000 in research in the next year. Work is currently underway to expand this program to \$10,000,000 annually.

Center representatives participated in two Advanced Robotics Manufacturing (ARM) Institute roadmapping sessions resulting in fluid power actuation now considered a key enabling technology. ARM funding is estimated at \$178,000,000 over the next five years. A CCEFP letter-writing campaign compelled the National Science Foundation to incorporate

\$15,000,000 for soft robotics research in the recent Emerging Frontiers for Research Innovation (EFRI) program announcement.

A NIST award to the CCEFP resulted in the first U.S. fluid power manufacturing technology roadmap being completed. This landmark document will be influential in securing additional funding for manufacturing research. Coatings and tribology, key enabling technologies identified in the fluid power manufacturing roadmap, are also of great interest to DOD. Director Stelson and Deputy Director Harris are working with our lobbyist to clearly articulate our manufacturing strategy and identify likely government funding programs. Visits are planned to the Office of Naval Research in Washington D.C., Aberdeen Proving Ground and Wright-Patterson Air Force Base.



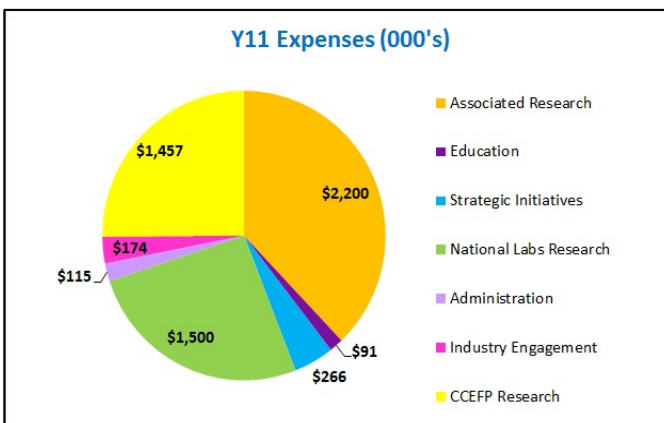
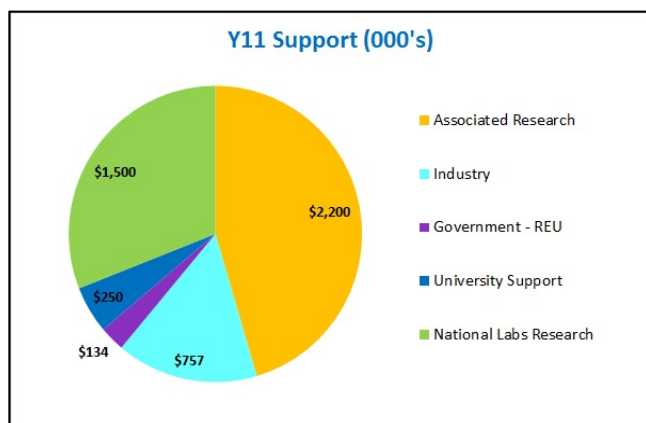
EDUCATE | Without question, hands-on research experience is the best way to educate students and future workforce. The CCEFP directly sponsored 10 research projects (details can be found on ccefp.org). The Additive Manufactured Excavator project and the summer undergraduate research program also funded students on various fluid power projects. Combined, Center-led activities resulted in 17 faculty researchers, 15 graduate students, and 25 undergraduate students engaged in fluid power research.

On an ongoing basis, CCEFP offers *Fundamentals of Fluid Power*, a massive open online course (MOOC) offered through Coursera. In 2016, over 8,600 participants, of which 54% are engineering professionals, enrolled in the MOOC.

In partnership with the National Fluid Power Association, CCEFP coordinated two major education and outreach initiatives for technical school students (Fluid Power and Applied Mechatronics Training and Employment Network) and college undergraduate-level students (NFPA Fluid Power Vehicle Challenge). In its first year, over 50 students from nine universities participated in the NFPA hands-on fluid power design challenge.



NETWORK | The CCEFP is supported, in part, by contributions to the Pascal Society of the NFPA Education and Technology Foundation. Industry supporters along with faculty and student researchers attended CCEFP Summits and the Fluid Power Innovation & Research Conference (FPIRC). In 2016, 196 individuals attended FPIRC16 and another 67 attended the Spring CCEFP Summit held at Texas A&M University. Attendee demographics were 60-70% industry and 30-40% faculty/students. The Center also held monthly Industry Engagement Committee teleconferences and the monthly CCEFP Webinar Series, one of our most popular activities with industry. In our 11th year, over 225 individuals registered for the Webinar Series, 78% of which were from industry.



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