CENTER FOR COMPACT AND EFFICIENT FLUID POWER

EDUCATION AND OUTREACH SUMMARY

This document summarizes the EO projects that are currently active in the CCEFP.

The mission of the Education and Outreach Program of the NSF Center for Compact and Efficient Fluid Power (CCEFP) is to develop research inspired, industry practice directed education for pre-college, university and practitioner students; to integrate research findings into education; to educate the general public; and through active recruiting and retention, to increase the diversity of students and practitioners in fluid power research and industry. The vision of the Education and Outreach Program is a general public that is aware of the importance of fluid power and the impact of fluid power on their lives; students of all ages who are motivated to understand fluid power and who can create new knowledge and innovate; industry that capitalizes on new knowledge to lead the world in fluid power innovation; and participants in all aspects of fluid power who reflect the gender, racial and ethnic composition of this country. The strategy of the Education and Outreach Program is to develop and deliver high quality projects that wherever possible capitalize on existing, broadly distributed education and outreach networks to maximize program impact; to develop projects that can be replicated and/or adapted by other educators and program leaders for new audiences; and to leverage coordinate the accomplishments of individual Education and Outreach projects to facilitate the progress and successes of other Education and Outreach projects.

The EO program is divided into six thrust areas with each thrust area having several projects. Some projects are focused on STEM education with examples drawn from fluid power when appropriate, while other projects are specific to fluid power technology and its application.

Thrust A: Public Outreach

The purpose of the public outreach thrust is to bring the message of fluid power to the general public

Project A.1 Interactive Exhibits

The purpose of this project is to create interesting exhibits that convey the basic message of fluid power as well as exhibits that highlight CCEFP research. Prototypes and exhibits developed and field-tested at the Science Museum of Minnesota, an organization affiliated with the CCEFP, will serve as models for dissemination to other science museums around the world. [Project Leader: Jay Newlin, SMM]

Project A.2 Fluid Power Youth Science Team

Youth Science Teams (YST) are an existing activity at the Science Museum of Minnesota. A YST contains six to 12 high school students, typically from Twin Cities

urban schools with high percentages of minority students. The students develop program activities around an area of science including exhibit and display creation and peer teaching of K-12 groups at the museum and in the classroom. One or more YSTs will be formed around the topic of fluid power. The first fluid power YST is tasked with creating hands-on fluid power activities for K-12 students and creating a display that highlights research projects in the CCEFP. [Project Leader: Kristen Murray, SMM]

Project A.3 Public Television Video

Twin Cities Public Television is creating two 30 minute television documentaries on fluid power. The first introduces fluid power and the second highlights careers in fluid power. A third, ten minute, stand-alone video will introduce the Center for Compact and Efficient Fluid Power. This project is in collaboration with NFPA and other fluid power organizations around the world. [Project Leader: Kim Stelson, UMN]

Project A.4 Web Site Information Repository

The goal of this project is for the CCEFP web site to be a leading repository of information on fluid power. Examples of information to be included are: information and archived presentations on CCEFP research, REU reports, RET curriculum, K-12 classroom visit curriculum, links to fluid power tutorials, world list of fluid power degree granting institutions, list of undergraduate and graduate fluid power courses in the U.S., professional training courses, fluid power videos, and more. [Project Leader: Alyssa Burger, UMN]

Thrust B: Pre-College Education

The purpose of the education thrust is to bring fluid power education to K-12 student audiences with a focus on middle and high school students.

Project B.1 Project Lead The Way

The National Fluid Power Association (NFPA) and Project Lead The Way (PLTW) are affiliated organizations within the CCEFP. NFPA has funded Project Lead The Way to include fluid power in several of the PLTW high school and middle school courses. Faculty, staff and students of the CCEFP and engineers from CCEFP member companies are serving as subject matter experts (SMEs) for PLTW. CCEFP faculty and students will also work with PLTW to develop the hands-on fluid power activities to complement the PLTW curriculum (ties to B.3.) CCEFP faculty will participate in summer PLTW teacher training workshops. This project also reports to the NFPA Board. [Project Leader: Linda Western, CCEFP]

Project B.2 FIRST Robotics Teams

The goal of this project is to create additional curricular material on pneumatics for use by high school FIRST Robotics teams. Two types of material are being developed: (1) web-based self learning material for students, and (2) workshop curriculum for delivery by mentors. The goal is for 100% of FIRST Robotics teams to learn the basics of pneumatics and to at least consider the use of pneumatics in the design of their robot. [Project Leader: Will Durfee, UMN]

Project B.3 Fluid Power Demonstration Curriculum

Hydraulic and pneumatic demonstration curriculum and accompanying hands-on project kits will be developed for K-12 classrooms, with an initial focus on middle and high schools. The curriculum and kits also connect to PLTW, FIRST Robotics and Science Museum projects. [Project Leader: John Lumkes, Purdue]

Project B.4 Research Experiences for Teachers (RET)

RET is an NSF program whose purpose is to improve science, technology, engineering and mathematics (STEM) education in schools by funding high school teachers to spend the summer in a university research lab. The teacher completes a research project and develops curriculum to be used in their classes. Every summer the CCEFP hosts at least eight RET teachers, divided among CCEFP a minimum of one per university site. The CCEFP RET focus is on fluid power instructors at community colleges and teachers from high schools participating in the PLTW program. The CCEFP RET program has opportunities for interaction among the teacher-researchers at the seven sites. [Project Leader: Will Durfee, UMN]

Thrust C: College Education

The purpose of the education thrust is to bring fluid power education to undergraduate and graduate engineering student audiences. The vision of the college education program is that every undergraduate mechanical engineering student in this country be exposed to fluid power in their required curriculum.

Project C.1 Research Experiences for Undergraduates (REU)

REU is an NSF program whose purpose is to provide undergraduate STEM students with a summer experience in a university research lab. An objective of the program is to increase the number of top students applying to graduate school in STEM areas. Every summer the CCEFP hosts at least 14 REU students, a minimum of two per university site. The CCEFP REU students begin the summer with an orientation to and instruction in fluid power technology, its applications and the research activities of the CCEFP. (Note: pending future funding as an REU site, the orientation will take place in one location at a 2-day REU fluid power boot camp that will include hands-on training.) Continuing interaction among CCEFP REU students at the seven sites occurs throughout the summer. The CCEFP actively recruits women and underrepresented minority students for its REU program. [Project Leader: Will Durfee, UMN]

Project C.2 Inserting Fluid Power Curriculum into Existing Undergraduate Engineering Courses

Every undergraduate mechanical engineering student in the United States takes an introductory course on system dynamics. Typically, the course text has a chapter on fluid system dynamics, but that chapter does a poor job on covering the system dynamics of modern fluid power. One objective of this project is to create a comprehensive mini-book on fluid power system dynamics that replaces the fluids chapter in these courses. The mini-book will first be used in system dynamics courses at the seven CCEFP universities and then will be disseminated nation wide. A second objective of this project is to develop a mini-book on fluid power that is

suitable for use in the introductory course on fluid mechanics taken by all mechanical engineering students. If this project is successful, every undergraduate mechanical student in the United States will be exposed to fluid power. A third objective of this project is to develop and include fluid power examples, including CCEFP research results, into the undergraduate and graduate courses taught by CCEFP faulty [Project Leader: Will Durfee, UMN]

Project C.3 Fluid Power Lab for Controls Courses

Most engineering universities in the United States have a lab component for their elective introductory or advanced controls course. The typical controls lab has a DC electric motor driving an inertial load. To engage student interest in a challenge exercise, many labs have a motor driven inverted pendulum. The goal of this project is to develop an equally exciting and engaging controls lab station that uses fluid power. If every controls course in the United States included a fluid power lab exercise, large numbers of students would be exposed to fluid power. For success, this lab station must fit on a table top, run from 110V/15A power, be relatively quiet and clean, and be low cost. Curricular material for the lab will also be developed. Components for the lab station will be sold to universities at reasonable cost by one or more NFPA member companies. *[This project to start at a later date. Project Leader: TBN]*

Project C.4 Fluid Power Trainer for Fluid Power Lab Courses

Several engineering universities have elective fluid power courses at the undergraduate or graduate level. A barrier for other universities to develop a fluid power course is the cost and time to create a fluid power lab. The goal of this project is to develop a low cost hydraulic and pneumatic fluid power training station for use in a university level fluid power course. Curricular material for the training station will also be developed. It is expected that the fluid power trainer will be manufactured and sold at reasonable cost by one or more NFPA member companies. The project also connects with D.4. *[This project to start at a later date. Project Leader: TBN]*

Project C.5 Advanced Graduate Courses

The goal of this project is to develop new, semester length graduate courses in fluid power at the seven CCEFP universities, or the enhancement of existing graduate level fluid power courses. [Project Leader: Will Durfee, UMN]

Thrust D: Industry

The purpose of the industry thrust is to connect with industry.

Project D.1 Intern Program

The CCEFP intern program coordinates the placement of U.S. undergraduate engineering students as summer engineering interns in fluid power companies. The program provides engineering students with opportunities to gain practical experience working in the fluid power industry and provides industry with access to a diverse pool of talented engineering students. The program works with existing intern programs and assists companies in developing new intern programs. An

important component of the intern program is active recruitment of women and underrepresented minority students. [Project Leader: Linda Western, CCEFP]

Project D.2 Resume Bank

The project develops and maintains a resume bank of all CCEFP undergraduate, graduate and post-doc students. The resume bank is available to CCEFP member companies. [Project Leader: Alyssa Burger, UMN]

Project D.3 Specialized Short Courses

The objective of this project is to develop of one to five day advanced level professional short courses that the highlight subject matter expertise of the CCEFP faculty and the Center's research activities. The audience for these courses is degreed engineers in design and manufacturing positions at fluid power companies. [Project Leader: Mike Gust, UMN]

Project D.4 Transportable Universal Fluid Power Laboratory for Professional Training Courses

The Milwaukee School of Engineering (MSOE) has the most comprehensive set of professional fluid power short courses in the United States. The most popular offering is Introduction to Hydraulics which is not only given several times a year at MSOE but is also delivered on-site at several companies. The hands-on component of Introduction to Hydraulics uses six state-of-the art hydraulic trainer stations that can be taken on the road. The second most popular course is Control Strategies for Dynamic Systems. This course uses unique, state-of-the-art electrohydraulic motion control laboratory stations. Currently, these stations are too large to be moved so that the Controls Strategies courses can only be delivered at MSOE. The goal of this project is to develop a transportable version of a fluid power laboratory station, expanded to include pneumatics, so that several courses, including Controls Strategies, can be delivered on-site at companies and other universities. [Project Leader: Medhat Khalil, MSOE]

Project D.5 The Fluid Power Coloring Book

The "Anatomy Coloring Book" is used world-wide by medical school students as part of their formal training in anatomy. The pedagogic theory is that the act of actively coloring a drawing anchors knowledge that is detailed and complex and that is tied to a three-dimensional object. This project takes the same approach to create training materials for learning about complex fluid power components for an audience of industry engineers. The first coloring book explains how a two-stage hydraulic servo valve works. [Project Leader: Roz Dolid, MTS]

Project D.6 CCEFP Webcasts

Every two weeks, the CCEFP hosts a webcast with two to three presenters, each describing their research project. The webcasts are open to all CCEFP students and faculty and to all CCEFP member companies. The webcasts are the primary means for internal communication about research advances. [Project Leader: Alyssa Burger, UMN]

Thrust E: Filling a Diverse Pipeline

The purpose of the diversity program is to change the face of fluid power by providing opportunities for a diverse population to become involved in fluid power. Every research and every education project at every CCEFP institution is committed to actively recruit underrepresented and minority students to participate. [Project Leader: Alyssa Burger, UMN]

Native American Programs

A particularly important component of the diversity thrust is targeting the Native American population with the goal of increasing the number of Native Americans choosing college level STEM (Science, Technology, Engineering and Mathematics) tracks. The CCEFP Native American Programs are centered at the University of Minnesota because of the large number of Tribal Colleges in the upper Midwest and the large population of Native Americans in Minnesota and its surrounding states.

Project E.1 G-Camp

Fond du Lac Tribal and Community College, together with the National Center for Earth-Surface Dynamics, organizes camps known as *gidakiimanaaniwigamig* (Our Earth Lodge, in Anishinaabe), for students in 6th through 8th grade. Offered during the summer as well as after school and weekends (on a quarterly basis), these camps provide students with a mix of lab science and field science experiences. Program highlights include an introduction to the scientific method and a focus on Native American culture .The CCEFP co-hosts a Gidakiimanaaniwigamig Science Camp in Cloquet, Minnesota once each year. [Project Leader: Alyssa Burger, UMN]

Project E.2 LEGO Camp and FIRST Robotics Team

Fond du Lac Tribal and Community College, located in Cloquet, MN, offers a Lego Camp program intended to introduce STEM-related initiatives and post-secondary options to middle and high school students. Using Lego Dacta equipment, students are instructed in small machines, mechanical and structural engineering, and robotics. The CCEFP co-hosts a fluid power Lego camp during one of the camp's six-hour sessions, introducing students to basic fluid power technology. The CCEFP also mentors a Cloquet FIRST Robotics team. [Project Leader: Alyssa Burger, UMN]

Project E.3 Minnesota TRIBES Support

The CCEFP will partner with the Minnesota TRIBES project to include fluid power content into the for teachers in grades 6-8 in central and northern MN districts with high proportions of American Indian students. [*This project to start at a later date.* Project Leader: Alyssa Burger, UMN]

Project E.4 Pre-Engineering at FDLTCC

Work with Fond du Lac Tribal and Community College (FDLTCC) to develop a pre-engineering program. The goal is to increase the number of Native Americans who enter engineering and the number of Native American engineering transfer students to four year engineering programs. The project will start by creating a version of UMN course ME2011 Introduction to Engineering tailored for FDLTCC needs. [*This project to start at a later date.* Project Leader: Will Durfee, UMN]

Project E.5 AISES Activity Support

In conjunction with the NCED, IT APEXES, and the NorthStar LSAMP, the CCEFP is coordinating, sponsoring and hosting all activities of the giiwed'anang (North Star) AISES alliance. Goals of this alliance include: 1) engaging students in STEM-related activities, 2) interesting students in pursuing their education at two-year and/or four-year schools and universities, 3) developing a student cohort network. The network involves students in Minnesota, Wisconsin, North Dakota and South Dakota. [Project Leader: Alyssa Burger, UMN]

Recruiting Programs

Project E.6 Minority Recruiting

Recruiting for REU students, RET teachers, FIRST teams, prospective graduate students, faculty, industry interns, industry jobs is a function of the center. To diversify the face of fluid power it is essential that women and underrepresented minorities be actively recruited for positions. A particular emphasis for the center is recruiting Native Americans. This project conducts minority recruiting functions and coordinates minority recruiting throughout the center and works with CCEFP LSAMP and AGEP institutions. [Project Leader: Alyssa Burger, UMN]

Thrust F: Evaluation

The purpose of the evaluation thrust is to provide comprehensive and rigorous evaluation of the CCEFP education and outreach projects and program.

Project F.1 Evaluation of Education and Outreach Program

The evaluation project will determine if the education and outreach program is meeting its goals of (1) increasing awareness of and education in fluid power at the pre-college, college and professional level, and (2) increasing the number of women and under-represented minorities in engineering and specifically in fluid power. [Project Leader: TBA]

Project F.2 The CCEFP Alumni Society

All CCEFP participants, including faculty, graduate students, post-docs, undergraduate research students, REUs, RETs and special program participants automatically become members of the CCEFP Alumni Society and receive periodic newsletters and requests for information on current status. Membership starts with a CCEFP information package given to every participant when they start their formal affiliation with the CCEFP. An exit interview to measure experiences and to gather follow up contact information is given when the participant completes their formal CCEFP affiliation. The Alumni Society database will be used for long-term follow ups when evaluating program impact. [Project Leader: Alyssa Burger, UMN]

Administration of the EO Program

The EO Program is headed by Education Program Co-Directors Linda Western and Will Durfee. The Co-Directors report to Center Director Kim Stelson. Education Outreach Director Alyssa Burger is responsible for program implementation. The

Education and Outreach Network (EON) has one representative from each of the seven universities plus one from the Science Museum of Minnesota. The EON facilitates communication among the CCEFP sites and is the core working group for the EO Program. The Education Advisory Board (EAB) is an external group of experts that provides guidance, advice and oversight for the EO Program.

Three times a year, every EO project completes a project update report in the same four-up format as the research project updates. Project progress is evaluated by a committee whose members are the Education Program Co-Directors, the Education Outreach Director, The Center Director, the Industrial Collaboration and Technology Transfer Director, at least one industry representative and at least one member of the EAB.

The responsibility for fluid power education and outreach rests with every CCEFP participant. Each research and test bed project in the center has an EO component. The EO activities of individual research projects are reported in the project update reports.