Annual Report
July 1, 2015 – June 30, 2016
2016 Fiscal Year

Kids can... Think. Discover. Solve. Invent. change the world.
This report marks my first full year as director and the CEEO’s 20th anniversary. It’s amazing to think about how much the CEEO and the world has changed in the past 20 years.

In the summer of 1996, I was a junior Mechanical Engineering student working on one of our very first NASA grants. Myself and one other student were hired for just 4 weeks to help prepare the first teacher workshop. We sorted LEGO materials, helped build wind tunnels, and cobbled together raw HTML to make a website in a corner of Chris Rogers’ fluids lab amid his graduate students doing fluid flow experiments and experiments on wafer polishing. The teachers were excited to learn about engineering and we could see the potential, but they also had lots of feedback about the tools they needed and the constraints of school on their ability to do innovative work. There were no engineering standards for teachers to meet, little to no engineering education research to draw on, and the world wasn’t ready to think about children as engineers.

In contrast, this past summer the CEEO employed over 35 undergraduate and high school students for 10 weeks in our beautiful space at 200 Boston Ave, in addition to CEEO staff and faculty. Every person in our 6,000 square ft space was working on engineering education – from prototyping new ideas for LEGO and National Instruments, to furthering our research on projects like InterLACE and Novel Engineering, to developing a new Portable Maker Studio, to creating resources for our online engineering education program. The students met every morning to share ideas and met with CEEO faculty regularly about ways to integrate projects and new ideas.

In addition to our personnel growth, we now have a number of Tufts University and external university faculty engaged in the Center. We have our own faculty at CEEO, collaborations and grants with Tufts Faculty in different departments, and research projects with faculty in different universities expanding from the US to Spain, Denmark, Australia and more!

Our growth has also impacted more K-12 Teachers. In the world, we have national and local science and engineering standards to point teachers to, and a wealth of research generated at CEEO and elsewhere to draw on to build our tools and interventions. We even had 140 people from 16 different countries spend 3 days at Tufts at our LEGO Learning Symposium and Tufts STEM Education Conference to learn about tools for engaging students in engineering. From as close as Somerville and as far as Guam, the world knows children can engage in engineering and is looking for the best resources to use.

The CEEO is continuing to be a leader in the space of K-16 engineering education.

As always, the CEEO has a lot of accomplishments to share and this report provides only the highlights. For this year, we choose to feature the wide array of work happening around makerspaces and our new Online K-12 Engineering Education (OKEE) program. Both efforts are novel in the K-16 engineering education world and show how the CEEO’s blend of outreach and research work together to create innovation and impact. We share updates on our current successful projects, InterLACE and Novel Engineering, as well as our new CEEO Innovation Fund efforts. Kristen Wendell and her research group joined the Center this year and we were thrilled to be able to celebrate her Presidential Early Career Award for Scientists and Engineers (PECASE) award with her for her innovative research in Community-based Engineering Education projects.

Please be sure to visit us on social media and join our mailing list to keep up on all the latest news and events.

Sincerely,

Merredith Portsmore
Director, Tufts Center for Engineering Education and Outreach
The Tufts Center for Engineering Education and Outreach (CEEO) is a leading innovator in K-12 engineering education. We inject engineering learning into K-12 classrooms to change how students think and learn today, ultimately shaping how they invent tomorrow. We believe all students are budding innovators who will excel by learning through failure, working in teams and solving problems. The CEEO knows Kids Can . . . Think. Solve. Discover. Invent. Change the World.

INSPIRED BY KIDS’ IDEAS
Kids are naturally engaged in figuring out the world, curious about how things work, open to trying new things and not afraid to fail. Yet early classroom experiences often focus on achieving measurable outcomes, coming up with the “right” answer, avoiding failure and memorizing other people’s ideas. At the CEEO, we’re all about shifting the focus back to kids’ ideas. We research how young people build and use their ideas and engineer classroom-tested tools to fuel their creative instincts and support them as they explore the world in new ways.

ENGINEERING A BETTER FUTURE
We are at a critical juncture: we need to inspire and catalyze the next generation of American innovators, or risk losing a competitive edge in the global market. The CEEO believes that by providing our k-12 teachers with the opportunity and support to take risks and be innovative in their teaching, they will engage students in a whole new world of creativity and excitement in the classroom. Our teachers are integral partners as we prepare our students to be world-class innovators who can create a brighter future in a safer, cleaner and healthier world.

MAKING A WORLDWIDE IMPACT
The CEEO’s innovative curricula, educational tools and research are sought by educators, administrators and corporations around the globe. Known for inspiring students to engineer at a young age, the impact of the Center’s work can be felt worldwide.

- In conjunction with LEGO, the CEEO developed ROBOLAB and LabVIEW for LEGO Mindstorms — robotics software and training tools that have helped more than 10 million students learn math, science, engineering and technology.
- The CEEO’s Student Teacher Outreach Mentorship Program (STOMP) has sent more than 200 TUFTS students into 60 Massachusetts classrooms and sparked 10 programs across the U.S.
- The CEEO’s SAM Animation software, which empowers students and teachers to express their ideas using stop-motion animation, has attracted 20,000-30,000 users and is available on every continent.
Who We Are And What We Do

CEEO’s Impact at a Glance

Cumulative number of teachers impacted by STOMP, Novel Engineering, and InterLACE since 2001

649

Cumulative number of K-16 students impacted by STOMP, Novel Engineering, and InterLACE since 2001

10,872

Cumulative number of classrooms impacted by STOMP, InterLACE, and Novel Engineering since 2001

600

Number of countries visited by CEEO Faculty, Staff, and Students in FY 2016

14

CEEO.tufts.edu pageviews from 134 different countries in FY 2016

15,200

OKEE.tufts.edu pageviews from 109 different countries in FY 2016

63,400

WeDo.DrEChallenges.com pageviews from 129 different countries since 2013

190,000

NovelEngineering.org pageviews from 118 different countries since 2014

19,600

Who We Are And What We Do

Project and Program Overview: FY 2016 Milestones

New Grants
Development of a New Class in the Science and Engineering of Music, Tufts University
LEGO Education Sponsored Research, LEGO Education
4-D Curriculum Visualization Tool Design – Design Specification Development, 100Kin10
Maker Studios in Schools: Bring Creativity and Play to the Classroom, LEGO Foundation
Billund Builds Music, Capital of Children

Closed Grants
The Development of a Robotic Companion for Children with Autism Spectrum Disorder, Samsung
LEGO Learning Lab, LEGO Education
Interactive Multi-Touch Collaboration Table for the Classrooms, Templeman Automation
Billund Builds Music, LEGO Foundation
Billund Builds Music, Capital of Children
Developing an Innovative Online Weight Management Program for Childhood Cancer Survivors (collaborative grant with Tufts Friedman School of Nutrition), Tufts University
Prepare and Inspire: Designing an Integrated and Sustainable STEM Model for Indonesia, United States Agency for International Development (USAID)

New Gifts
Research on Autism and Robotics, Fundació Sant Joan de Déu
LEGO Education Outreach Gift, LEGO Education
CEEO Student Fund for Makerspaces in Australia, Lend Lease
Advancing Engineering Education Through Project-Based Learning, National Instruments

Workshops at the CEEO in FY 2016

Co-Ed Robotics
July 6–10, 2015
Grades 3-8
Co-Ed Robotics
July 13–17, 2015
Grades 3-8
Girls Design and Engineering Week
July 20-24, 2015
Grades 4-7
Engineering, Earthquakes, and More!
July 20–24, 2015
Grades 5-8
Musical Instruments
Grades 4-6
Mini Makers
August 3–7, 2015
Grades 5-8
Helper’Bots
August 10-12, 2015
Grades 1-2
LEGO Summer Engineering Institute for Educators: Beginning EV3 Workshop
LEGO Summer Engineering Institute for Educators: Intermediate EV3 Workshop
August 3–7, 2015
Engineering, Earthquakes, and More!
August 3–7, 2015
Grades 5-8
Airplane Building Workshop
October 4, 2015
Grades 9-12
Systems Engineering with EV3
December 4–9, 2015
Grades 6-8
Toy Testing for ES93: Final Projects
December 11, 2015
Ages 4-8

Danish High School Students LEGO Engineering Workshop
Oct 13 & 14
Toy Testing for Visiting Teachers
October 14, 2015
Ages 4+ Airplane Building Workshop
October 4, 2015
Grades 9-12
Systems Engineering with EV3
December 4-9, 2015
Grades 6-8
Toy Testing for ES93:
November 20, 2015
Ages 4–8
Toy Testing for ES93: Prototypes
February 5, 2016
Ages 4-8 Laser Cutting for 3D Construction
April 9, 2016
Ages 10-13
April Vacation LEGO Workshop
April 19-22, 2016
Ages 3-7

Who We Are And What We Do

Top 10 Countries Following CEEO on Social Media

Canada
US
UK
Spain
Turkey
India
Indonesia
Australia
Denmark

2,521 fans
45 countries

1,353 followers
10+ countries

2016 Annual Report Tufts University

Page 8
Graduating and New Students in FY 2016

2016 CEEO Graduates

Mary McCormick
Ph.D. in Education
Dissertation: The Complex Dynamics of Student Engagement in Novel Engineering Design Activities

Ganga Kasi
M.S. in Human Factors Engineering
Thesis: A Human Factors Approach To Enhance An Individual’s Motivation To Collaborate In An Online Learning Environment
Currently: In Singapore, exploring options for using human factors engineering in the field of early childhood education

Dan Luo
M.S. in Mechanical Engineering
Thesis: Measuring the Frequency Response Function of X-Braced Guitar Top and Guitar
Currently: Physics and math instructor at Boston Architectural College

Hamid Mansoor
M.S. in Computer Science
Master’s Project: Digital Worksheet Project
Currently: Pursuing Ph.D. in Computer Science at Worcester Polytechnic Institute studying under Prof. Lane Harrison

Astrid Veroy
M.S. in Human Factors Engineering
Thesis: Influence of Gamification on Collaboration and Self-Organization in a CSCL Environment

New Graduate Students

Matthew Mueller
Pursuing Ph.D. in Mechanical Engineering
B.S. in Mechanical Engineering
Tufts University, 2015

Devyn Curley
Pursuing M.S. in Mechanical Engineering
B.S. in Mechanical Engineering
Tufts University, 2015

Jennifer Scinto
Pursuing M.S. in Mechanical Engineering
B.S. in Mechanical Engineering
Tufts University, 2016

Jennifer Thomas
Pursuing M.S. in Mechanical Engineering
B.S. in Civil Engineering
Brown University, 2014

Sam Woolf
Pursuing M.S. in Mechanical Engineering
B.S., Mechanical Engineering and Mathematics
Tufts University, 2013

Gabi Vukasin
M.S. in Mechanical Engineering
Thesis: Modeling Error in Optical Angle of Arrival Measurements for Position and Orientation Estimation in Sensor Networks
Currently: Pursuing Ph.D. in Mechanical Engineering at Stanford with research in the Micro Structures and Sensors Lab on MEMS resonators

Checking in with CEEO Alumni

Brian Gravel, Ph.D., Science Education

“The CEEO shows that it’s not hard to engage children in solving complex problems, and that children can engage in the practices of engineering,” says CEEO alumnus Dr. Brian Gravel. While earning his Ph.D. in Science Education from Tufts University, Brian served as the CEEO’s SAM Animation Project Manager and oversaw the development of and educational research on stop-motion animation software for students and teachers. Upon graduation, Brian launched Tufts’ Elementary STEM M.A.T. program, which prepares elementary school teachers to engage their students in science, technology, engineering, and mathematics.

Currently an Assistant Professor of Education and Director of Elementary Education at Tufts, Brian leverages his mechanical engineering background and experience at the CEEO to develop new learning technologies, to study the impact of those learning technologies, and to study scientific reasoning and representation in schools and makerspaces. His research focuses on representational practices in science and engineering and he is working on three NSF-funded projects in this arena. In SIMSAM (Simulation, Measurement, and Stop Action Moviemaking), Brian and colleague Dr. Michelle Wilkerson (U.C. Berkeley) examine how middle school students use modeling technologies to reason about physical phenomena. STEM-LMS: Investigating STEM Literacies in Makerspaces looks at how youth and adults develop and communicate representations and understandings within makerspaces, while Engineering Inquiry for All in Nedlam’s Workshop, Malden High School’s makerspace, asks how educators can use digital maker practices to empower youth to be problem solvers in the world.

As Director of Elementary Education, Brian helps prepare teachers who are attentive to student thinking and who recognize the productive resources students bring to classrooms. “Kids are nascent scientists and mathematicians,” says Brian. “Tufts graduates encourage children to use the tools of mathematics and science to engage with ideas, develop ideas about the ways in which the world works, and refine their emerging STEM practices.”

The Elementary Education program combines Tufts’ strong partnerships with urban schools and Tufts’ robust research in STEM education. “The STEM education research faculty are also the teacher preparation faculty, making this program an exceptional environment for research and practice to inform one another,” explains Brian. Ultimately, this combination of research, practice, and partnerships advances both teaching and learning.

Riley Jack Meehan
Education, 2015
Engineering and Design Teacher, High Tech High, San Diego, CA

Ashley Russell
Human Factors Engineering, 2011
Principal Engineer, Cambridge Consultants Lecturer, Tufts University, Medford, MA

Eric Fournier
Mechanical Engineering, 2013
Quality Engineer, Penumbra, Inc. Alameda, CA

“At the CEEO, I learned the power of collaboration and community. Collaboration helps me to push myself, to do exciting work, and to develop new ideas. Tufts is a community of people who believe that young people have powerful and amazing ideas. I find these people inspiring. Together, we are creating opportunities for children to be resourceful learners who actively develop a deep understanding of the world.”

Jennifer Thomas
Tufts University, 2015
B.S. in Mechanical Engineering
Pursuing M.S. in Mechanical Engineering

Jennifer Scinto
Tufts University, 2015
B.S. in Mechanical Engineering

Sam Woolf
Tufts University, 2013
B.S., Mechanical Engineering and Mathematics

Highlights at a Glance
The LEGO Learning Symposium was held on the 6th and 7th of June 2016 at Tufts University. Teachers, administrators, and other educational partners from sixteen different countries came together over the two day event to explore how K-12 learning happens in science, engineering, mathematics, literacy, and other disciplines using LEGO technologies.

The Symposium kicked off with a keynote presentation from Mitchel Resnick (Designer of Scratch software and Director of the Lifelong Kindergarten group at the MIT Media Lab) and was packed full of teacher talks, hands-on workshops, panel discussions with teachers and students, and lots of networking amongst participants. At the event, seven exceptional teachers (from Australia, Hong Kong, Korea, Costa Rica, and Russia) were recognized as part of the first-ever international LEGO Education Teacher Award.

**Billund Builds Music**

From October 19th to 24th, a group of researchers, students, and partners from the CEEO went to Denmark to participate in Billund Builds Music, an intervention funded by the LEGO Foundation and the Capital of Children. Involving ten local schools, over four thousand students of all ages spent time during their school day exploring sound, building their own instruments out of found materials, then composing and performing pieces of music. Leading up to the week, pilot workshops with students were conducted in Boston as well as professional development with a group of ten teachers from Denmark who participated in the program.

While in Denmark, researchers spent their time videotaping and following the progress of specific classes to develop case studies while CEEO students and partners went around to classes to run workshops on various concepts in music, the science of sound, and the engineering design process. Classrooms from all over the Billund Kommune were able to post pictures and videos of their work and view the work of their peers on a website developed by the CEEO which can be found at www.BillundBuilds.dk. The week presented a number of challenges to the team, but a sentiment shared by most teachers was their surprise at how much learning happens when students were left to explore and build on their own.

**Kristen Wendell Returns to Tufts University**

In January of 2016, CEEO alum Kristen Wendell returned to Tufts as a new assistant professor in the Department of Mechanical Engineering. Kristen earned her Ph.D. in Science Education from Tufts in 2011. Kristen came to Tufts from the University of Massachusetts, Boston’s Center of Science and Mathematics in Context (COSMIC), where she was principal investigator on two NSF-funded projects: one on the use of community-based engineering to prepare novice urban elementary school teachers in science and engineering and the other on supporting urban students’ engineering discourse. In May, Kristen was a recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE), the U.S. government’s highest award for scientists and engineers in the early stages of their independent research careers.

2016 Tufts STEM Education Conference

On June 7–8, 2016, Tufts University hosted a STEM Education Conference for more than 140 registrants from sixteen countries. Tufts is home to a diverse and vibrant collection of educational research and outreach projects in science, technology, engineering, and mathematics. The conference provided an opportunity for Tufts professors and researchers to share their work with a wider audience of educators. The STEM conference overlapped with the LEGO Learning Symposium, allowing both groups of attendees to benefit by interacting.

The STEM conference was organized around four talks by Tufts professors and a large number of workshops. The morning talks, by David Hammer and Marina Bers, focused on ways of deepening understanding in STEM education: how to really listen to student thinking and how to engage young children in programming. The afternoon talks, by Natasha Wright and David Kaplan, offered intriguing glimpses into their engineering research on desalination systems and silk, respectively. The workshops covered a wide array of topics as well, from LEGO and STEM to ScratchJr to Community-Based Engineering to Teaching Infectious Diseases. The excitement and exchanges of ideas carried beyond the formal presentations; the participants made excellent use of the time built into the conference for discussion and networking.

LEGOengineering.com/symposium2016

TuftsSTEMEdConference.org

www.BillundBuilds.dk
Annual Report FY 2016

Tufts Center for Engineering Education and Outreach

13

Highlights at a Glance

Visiting Faculty at the CEEO

Barbara Bratzel
Barbara Bratzel worked at the CEEO from July 2015 to August 2016 as an educator in residence during a one-year leave of absence from her job as a science teacher at Shady Hill School in Cambridge, MA. Barbara worked on outreach, professional development for teachers, and curriculum development.

Clare Gartland
Dr. Clare Gartland, Senior Lecturer in the Department of Education at the University of Suffolk in Suffolk, England, visited the CEEO in November 2015. Clare came to Tufts CEEO to learn more about our STOMP program.

Irma Mgeladze
Swiss high school teacher Irma Mgeladze, a physics and math teacher in Köniz, Switzerland, came to Tufts CEEO during her sabbatical in March of 2016. Irma teaches a robotics course for tenth graders and came to the CEEO to learn about new educational projects involving robots.

Sung Ho Yoon
Professor Sung Ho Yoon is visiting from the Mechanical Engineering Department of Kumoh National Institute of Technology (KIT), Korea, from January 2016-January 2017 and is interested in both K-12 and college-level engineering education reform.

FLOWGO Toolkit
Principal Investigators Erica Kemmerling and Meredith Portsmore – the development of a tool to help K-12 students learn fluid mechanics.

RFID installed in front of the CEEO Maker Studio

Novel Engineering Update

During the past year, Novel Engineering has focused on dissemination. In addition to holding workshops, we have developed a package of Novel Engineering dissemination materials and are developing a network of partners that will also be able to hold Novel Engineering professional development. Partners include New York Hall of Science, Purdue University, Washington University in St. Louis, Harpeth Hall School (a girls’ school in Tennessee), and North Carolina State University. The dissemination package includes a website, book units, a teacher guide, and materials for dissemination partners. We are also writing a Novel Engineering book and hope to have a draft by the end of September. In the next year, we will support dissemination partners and submit the Novel Engineering book to publishers as well as support local schools that are participating in Novel Engineering.

novenengineering.org

Research Faculty at the CEEO

As September 2015 started, the Center for Engineering Education and Outreach (CEE) was able to appoint the first CEEO faculty members in conjunction with an overall restructuring. As Chris Rogers and David Hammer moved from Co-Directors to become Co-Chairs of the CEEO Steering Committee, Ethan Danahy and Meredith Portsmore became the first Research Assistant Faculty with primary appointments at the CEEO. Since 2010, Dr. Ethan Danahy had been a Research Assistant Professor within the Department of Computer Science at Tufts, working closely with the CEEO throughout that time. Now, his primary appointment will be at the CEEO, keeping a secondary appointment in Computer Science.

Dr. Ethan Danahy
Research Assistant Professor, CEEO and CS

Dr. Meredith Portsmore
Research Assistant Professor, CEEO

InterLACE Update

The InterLACE (Interactive Learning and Collaboration Environment) project completed another successful year. Visual Classrooms, the start-up created by Eric Coopey and Leslie Schneider to commercialize the InterLACE platform, saw continued adoption in classrooms at both high-school and university levels, and several new features were added to support teachers in the administration, coordination, and organization of their activities, classes, and classroom data. Two computer science students (Hamid Mansoor and Ryan Dougherty) completed their master’s projects around implementing new features and interactive elements associated with the new InterLACE Interface 2.0 (the continued research and development on the collaborative learning environment happening here at the CEEO). In spring 2016, the “Design Team Teachers” group was relaunched, with teachers meeting periodically and experimenting with the use of InterLACE, Visual Classrooms, and collaborative projects in their classrooms as they explored and reflected on peer-to-peer learning techniques with their students.

visualclassrooms.com

InterLACE Design Team Teachers from NH and MA meeting at the CEEO, Spring 2016

InterLACE Design Team Teachers from NH and MA meeting at the CEEO, Spring 2016
Online K-12 Engineering Education (OKEE)

While the CEEO has been inspiring students and educators with hands-on tools and progressive pedagogical approaches for the past twenty years, the reach of that work was often limited by finances, location, and personnel. In fall 2015, we undertook a new initiative to provide access to CEEO-based engineering teaching to any teacher, anywhere in the world. The Online K-12 Engineering Education (OKEE) program is a set of four graduate-level courses, offered 100 percent online over eighteen months, that provides K-12 educators a chance to develop their content knowledge and the teaching practice in engineering.

Designed and developed during the 2014 academic year, we looked at the challenge of reaching a wider audience of teachers and identified key design requirements of the program. From talking to the teachers we met at conferences and events, we knew it needed to be 100 percent online to reach teachers who would never be able to make it to the Tufts campus. Busy professional teachers with families let us know OKEE needed to be asynchronous to allow educators with shift demands of their job and life. From our own years of workshops, research projects, and working with pre-service teachers at Tufts, we knew that helping teachers become great engineering teachers was more than learning engineering practices and ideas, it was also essential they develop teaching practices to support hands-on engineering projects and understand research and theory related to students’ learning through design. We were also passionate that our online program would be as interactive, hands-on, and dynamic as our in-person workshops and classes, a far cry from generic online offerings with taped lectures and multiple choice quizzes.

To that end, we created a four-course sequence (sixteen credit hours) that alternates between content and pedagogy courses.

We welcomed our first small cohort of six students in Fall 2015. This group is from across the country and around world -- from Marblehead, MA, to a military base in Japan. They have engaged in hands-on design challenges, in-depth readings of engineering education research, and analyzed lots of video of students engaged in design. We have loved getting to know our students who are true mavericks, working to implement engineering education in innovative ways in a variety of settings, from private school STEM programs to traditional classrooms. Feedback has been very positive about our courses and this amazing group of educators have also helped to shape the improvements and revisions for the OKEE program. For Fall 2016, we had 15 students join us for the program and an additional 15 students try a single course. Cohort 2 has students from as close as Malden, MA, and as far as Qatar. Across both cohorts, we’re continuing to build a community of dedicated educators who are committed to working toward bringing engineering to students in the most dynamic and innovative ways.

We’re currently working on improving the overall messaging and advertising for OKEE with the help of Limelight Marketing as we work toward recruiting Cohort 3 for Fall 2017. The biggest takeaway for us is that hands-on online engineering education adds value to teachers’ toolbox and that it enables us to get to know and bring into the CEEO some amazing and dedicated educators.

Meet the First OKEE Students

Becky McDowell has a long career in education, teaching various elementary and middle school classes, as well as developing STEM curriculum for the NGSS standards as a product developer for an education company. She currently teaches K-S STEM using LEGO in the pilot year of her school’s program.

Carl Guinn started his career in the armed forces, serving on active duty for the U.S. Navy and Army, before becoming an elementary school teacher. For the last six years he’s taught fifth grade on a military base in Japan to the children of military and civilian personnel stationed there.

Silvia Scott is a multi-media expert who has been teaching technology to K-S students for many years, and is now the Tech Integration Specialist at her school. She teaches such diverse subjects and technologies as digital citizenship, coding, iMovie, and MakeyMakey.

Sarah Matheny is the first teacher of a new innovation lab at an independent school. She works with students from pre-K up through fifth grade, teaching them engineering skills such as design thinking. Her hands-on lessons have students using everything from LEGO to 3D-printers.

Beth Sommers has spent the last ten years teaching jobs pre-K through eighth grade. Her current role is as the Curriculum Integration/Extended Learning Coordinator at her school, where she focuses on teaching STEM education and Reading/Math Enrichment, as well as organizing exciting enrichment opportunities for her students and colleagues.

Ned Dawes was a consulting civil engineer for twenty-five years before changing careers to education nine years ago. He now teaches technology and engineering to seventh and eighth graders, as well as running the after-school Bridge Building club.

OKEE Final Projects, from left to right, a snack alarm, a device to detect laundry falling behind the machine, and part of a robotic fish feeder

okee.tufts.edu
Featured Initiatives in FY 2016

Makers at Tufts

The CEEO is committed to supporting making at Tufts. During the past year, several exciting events and collaborations have shown how strong that commitment is, both on campus and abroad.

**Tufts Maker Network**
Since 2014, the CEEO has been investigating and supporting a distributed group of makerspaces across Tufts’ campus. This work – a collaboration between the CEEO and departments of Mechanical Engineering, Human Factors, and Occupational Therapy – has resulted in a growing interdisciplinary network of student makers who share on-campus resources, spaces, and expertise. Collaborating makerspaces include Jumbo’s Maker Studio at CLIC (Collaborative Learning and Innovation Complex) and 200 Boston Avenue, the Bray Lab, and the Tufts Crafts Center. Students and clubs participating in the network have hosted weekly workshops and activities, including a popular Tufts-wide “Weekend of Making” in January 2015.

**Jumbo’s Maker Studio**
During the past year, Jumbo’s Maker Studio has made a big impact on the Tufts campus. Jumbo’s Maker Studio at 200 Boston Avenue has thrived as the CEEO’s local makerspace, and another branch has opened at Tufts’ new Collaborative Learning and Innovation Complex (CLIC) at 574 Boston Avenue. The new Maker Studio @ CLIC has a lot of traffic, due to weekly maker community events like take-apart nights, waffle nights, and switch-and-solder workshops. The CLIC facilities include 3D printing, soldering, sewing, and more (laser cutting is still available at 200 Boston Avenue). Tufts students, staff, and faculty all tinker together at both locations.

The Bray Lab is a new space designated specifically for Mechanical Engineering students to explore making and rapid prototyping. The Shop space in Bray is organized to maximize safety and scaffold making explorations with the powerful tools housed in this shop, including CNC (computer numerical control) routers, vertical band saws, and lathes. Researchers who run the space offer regular trainings to Engineering School students on safe handling and construction with the tools. Bray also offers a Design Lab for ideation and prototyping, and an Instrumentation Lab for testing and data collection, and a Mechatronics Lab for creating with technology and robotics.

**Making on Tufts Campus**
Several courses at Tufts have incorporated making into their class explorations, with students building prototypes at Jumbo’s Maker Studio to strengthen their learning. In the Occupational Therapy department, the course Physical Dysfunction and Pediatrics invited students to design solutions for unique and disabled populations. Offerings from Mechanical Engineering included three making-heavy courses this year. Freshman entering the Engineering School took an introductory Simple Robotics class, where they augmented their robotic constructions with 3D-printed and laser-cut elements. Interdisciplinary courses allowed students to explore building musical instruments (Instruments and Experiments, out of the Mechanical Engineering, Physics, and Music Departments), and to practice designing toys and games for young children (Tech Tools for Learning, a course in the Education and Child Development departments). Finally, a CEEO researcher taught an experimental course called Creativity, Fabrication, and Problem Solving, designed to expose interested students from any background and major to the opportunities available in Jumbo’s Maker Studio.

In the upcoming semester, a new Mechanical Engineering course, How to Make Almost Anything, will be taught by a visiting maker from Artisan’s Asylum, a community fabrication center in Somerville.

**International Making**
Members of the CEEO are collaborating with teachers and students at the International School of Bilund (ISB) as they launch their new Creator Space. Researchers stayed in Denmark as Researchers, Makers, and Artists in Residence, and explored robotics, woodworking, architecture, and tangible storytelling with ISB students from PreK-8th grade. This research is funded by LEGO Foundation.

A CEEO Masters student spent several weeks in Christchurch, New Zealand, launching a documentation area for the LEGO Imagination Station. The educational maker space is happy to have a way for children to post and share their own work to the Imagination Station community of followers.

A CEEO doctoral student provided outreach and professional development to Queensland schools in Australia. Educators curious about new STEM curriculum policies in their region were excited to explore pedagogy, along with PaperBots and LEGO WeDo 2.0, in these educational workshops.

**RFID Tag System**
Through the Tufts Maker Network, Tufts students have access to all the specialized materials and equipment they need to turn their ideas into reality. With so many new tools to explore, students quickly run into challenges, or want to ask for advice. Engineers at the CEEO are working to create an automated system for tracking this kind of maker activity, and providing just-in-time help when students get stuck. JumboTap terminals in each space allow makers to start and stop individual sessions with each machine station. A handy “Help” button alerts the knowledgeable volunteer makers, researchers, or faculty members who run each space to step by and help that student get started. The JumboTap terminal also lets students document and share their work. “Snap” buttons on the terminal take a picture of the awesome new creation, and post it directly on the Tufts Maker Network website, where students can show off the result of their hard work.

The development and use of the JumboTap RFID terminals are the focus of a doctoral dissertation in Mechanical Engineering, with a focus on Engineering Education. The terminals were developed as part of a CEEO Innovation Fund grant.
Press and Publications in FY 2016

White House (February 18, 2016) – President Obama Honors Early Career Scientists
Kansas City infoZine (February 19, 2016) – President Barack Obama Honors Early Career Scientists
YouTube/ Curtin University (February 25, 2016) – Learning through LEGO
YouTube/ Curtin University (February 25, 2016) – Teaching and Learning at Curtin is Fun...Seriously!
Tufts Now (March 2, 2016) – People Notes
El Punt Avui (March 7, 2016) – Going Native with Neil Stokes
International Technology and Engineering Educators Association (March 10, 2016) – STEM Connections, March 2016
Boston Business Journal (March 15, 2016) – With Playtime and Toy Scissors, LEGO Education Opens Back Bay HQ
Boston City TV (March 15, 2016) – LEGO Education Boston Headquarters Ribbon Cutting
Boston herald.com (March 16, 2016) – LEGO Education unveils new HQ in Back Bay
Globe.com (March 16, 2016) – LEGO Education HQ Now Officially in Boston
7 News.com (March 16, 2016) – LEGO to Celebrate its Opening Day in Boston
InnovateLI (March 20, 2016) – You Know the Mother of Invention. Here’s the Son
EurekAlert! (March 23, 2016) – Tufts Faculty Earn National Awards for Exceptional Potential in Science and Engineering
TuftsNow (March 23, 2016) – Tufts Faculty Earn National Awards for Exceptional Potential in Science and Engineering
The Tufts Daily (March 31, 2016) – Maker Network Connects Maker Organizations on Campus, Increases Accessibility of Makerspaces
Tufts News & Events, Graduate School of Arts & Sciences, School of Engineering (April 25, 2016) – Soft Robot Challenge
El Mundo (April 28, 2016) – Ability-Based Education (La educación basada en las habilidades)
White House (May 5, 2016) – Honoring Federally Funded Scientists and Engineers at the Forefront of Research and Discovery
National Science Foundation (www.medium.com) (May 6, 2016) – “Teacher-Scholars” Honored
National Science Foundation (May 17, 2016) – Investigating STEM Literacies in Makerspaces
National Science Foundation (May 17, 2016) – Student Thinking in Novel Engineering
Tufts Innovates (May 23, 2016) – Tufts Announcements/Tufts Innovates
Education 2.1 (Spring 2016) – Careers in STEM Interview with Brian O’Connell
EurekAlert! (June 1, 2016) – Tufts engineer earns NSF Career Award to study multidimensional data science
Wicked Local Malden (June 3, 2016) – Student Projects Combine Science and Art
Campus Technology (June 6, 2016) – Tufts U to Host LEGO Learning Symposium
Digital Journal (June 6, 2016) – LEGO Learning Symposium Explores New STEAM Teaching Methods for K-12 Education
LEGO Education (June 6, 2016) – LEGO Learning Symposium Explores New STEAM Teaching Methods for K-12 Education
THE Journal (June 6, 2016) – Tufts U to Host Lego Learning Symposium for K-12 Educators
LEGO Education (June 25, 2016) – LEGO Education Elementary News June 2016 Newsletter

Press and Publications in FY 2016

CxEEO in the News

Billund Online (July 29, 2015) – It Swings in Boston: Travel Letter from Teacher Group in Boston
Sloan Science & Film (July 30, 2015) – Building Blocks: Lego and Engineering
Caja Popcorn email blast (August 16, 2015) – Tins in Time for Labor Day
think1 (September 4, 2015) – Daniela Torres: KIBO
Huffington Post (September 8, 2015) – Democratizing the Maker Movement
Start Engineering (September 23, 2015) – How to Protect Your Students from Job-Eating Robots
Tufts Now (October 2015) – People Notes October 2015: Kristen Wendell
Tufts Now (October 2015) – People Notes October 2015: Meredith Portland
Tufts Now (October 2015) – People Notes October 2015: Brian Gravel
Tufts Now (October 2015) – People Notes October 2015: Chris Rogers
billundonline (October 16, 2015) – Music Occupies Billund Community
massive.com (October 20, 2015) – LEGO Education North America Relocating to Boston’s Back Bay
Colby Magazine (December 2015) – Margaret Aiken Strengthens Connections Between Museum and Community
www.100kin10.org (December 15, 2015) – 100K in 10
The Hechinger Report (December 16, 2015) – Wire Those Sensors! Save that Turtle!
Slate.com (December 16, 2015) – A Novel Way to Teach Kids About Engineering
Mastertech Blog (December 18, 2015) – Novel Engineering Project Teaches Kids About Engineering by Using Fiction Books @TuftsCxEEO
Tufts Now (January 11, 2016) – How Pets Help People
Other Machine Co Blog (January 12, 2016) – LEGO and Super Soakers: How a Tufts University Professor is Changing Education
Tufts University School of Engineering, Research and News (January 13, 2016) – Rogers Interviewed by CNC Machine Company
Big Deal Media (January 14, 2016) – Put STEAM into STEM
You Tube (January 21, 2016) – Billund Builds Music
think1.tv (January 26, 2016) – Elissa Mito: Novel Engineering
The Tufts Daily (February 9, 2016) – Fletcher School Hosts Third Annual Innovation Week
The Tufts Daily (February 9, 2016) – 150 Students Attend Tufts Maker Network’s ‘Weekend of Making’
Empresarial UMH Science Park (February 16, 2016) – An Autistic Child Improves his Quality of Life Thanks to the Interaction with the Social Robot from Aisoy Robotics
100Kin10 Press Release (February 16, 2016) – 100Kin10 Announces New Partners
www.aisoy.com (February 16, 2016) – A Child with Autism Improves his Quality of Life Interacting with the Robot Aisoy 1
PR*Urgent.com (February 17, 2016) – PledgeCents, Inc. Named as Partner in 100Kin10, National Network to Grow STEM Teacher Force
National Science Foundation (February 18, 2016) – President Obama Honors Early Career Scientists with Top White House Award
Publications and Presentations by CEEO Authors

Journal Articles and Book Chapters

Conference Papers, Posters, Publications, and Workshops


Panels and Presentations
FY 2016 Financials: Overview of Revenue and Expenses

Fiscal Year 2016 brought in a few new projects and we saw a few leave as well. One of our faculty members took a job at another university, bringing a number of government grants with him at the end of FY 2015. As shown on the table below, the government grant installments has decreased due to the grants reported on in FY 2015 no longer being part of our funding in FY 2016. We launched our OKEE Certificate Program in FY 2016, so we now receive tuition money. Due to some transition in the Tufts Budget Center, we did not receive any ICR return in FY 2015, so it was received in FY 2016.

<table>
<thead>
<tr>
<th>Revenue</th>
<th>FY 2016</th>
<th>FY 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fees</td>
<td>$137,666</td>
<td>$84,829</td>
</tr>
<tr>
<td>Private Grants</td>
<td>$303,590</td>
<td>$113,980</td>
</tr>
<tr>
<td>Government Grants</td>
<td>$98,256</td>
<td>$1,401,261</td>
</tr>
<tr>
<td>Tufts SOE Dean's Office</td>
<td>$197,584</td>
<td>$193,199</td>
</tr>
<tr>
<td>ICR Return</td>
<td>$29,633</td>
<td>$-</td>
</tr>
<tr>
<td>Tufts University Funding</td>
<td>$30,628</td>
<td>$3,974</td>
</tr>
<tr>
<td>Endowment</td>
<td>$39,917</td>
<td>$47,033</td>
</tr>
<tr>
<td>Gifts</td>
<td>$104,692</td>
<td>$201,850</td>
</tr>
<tr>
<td>Tuition</td>
<td>$28,900</td>
<td>$-</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td>$975,359</td>
<td>$2,046,126</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In-Kind Support</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>LEGO</td>
<td>$40,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>National Instruments</td>
<td>$9,000</td>
<td>$20,000</td>
</tr>
<tr>
<td><strong>Total Revenue + In-Kind</strong></td>
<td>$1,024,359</td>
<td>$2,096,126</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenses</th>
<th>FY 2016</th>
<th>FY 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>$267,064</td>
<td>$258,474</td>
</tr>
<tr>
<td>Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative</td>
<td>$122,334</td>
<td>$155,786</td>
</tr>
<tr>
<td>Project Staff</td>
<td>$245,253</td>
<td>$272,458</td>
</tr>
<tr>
<td>Post Docs</td>
<td>$156,044</td>
<td>$56,952</td>
</tr>
<tr>
<td>Students + tuition/fees</td>
<td>$564,524</td>
<td>$489,438</td>
</tr>
<tr>
<td>Teacher Stipends + Consulting</td>
<td>$136,875</td>
<td>$204,431</td>
</tr>
<tr>
<td>Total Benefits for Staff, Faculty, + Students</td>
<td>$183,067</td>
<td>$179,131</td>
</tr>
<tr>
<td>Materials + other</td>
<td>$220,064</td>
<td>$186,413</td>
</tr>
<tr>
<td>Travel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Domestic</td>
<td>$61,523</td>
<td>$91,369</td>
</tr>
<tr>
<td>International</td>
<td>$88,591</td>
<td>$50,062</td>
</tr>
<tr>
<td>Subcontracts</td>
<td>$-</td>
<td>$6,225</td>
</tr>
<tr>
<td>F&amp;A</td>
<td>$441,108</td>
<td>$495,477</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td>$2,486,447</td>
<td>$2,488,216</td>
</tr>
</tbody>
</table>

The graphs below represent the revenue brought into the CEEO during FY 2016 broken down by funding source; FY 2016 expenses broken down by funding sources; and the overall FY 2016 expenses breakdown.
Balance Overview and Total Commitments

As we wrap up the FY 2016, the chart “Snapshot of Balances as of June 30, 2015” shows the ending balance of our accounts. We are still mostly funded by government grants starting FY 2016. The “Total Commitments” chart reflects how much money is contracted to us in FY 2017 and FY 2018 according to our yearly budgeted amount from government grants and private grants awarded to the CEED.
### Grant Applications Submitted in FY 2016

<table>
<thead>
<tr>
<th>Grant Name</th>
<th>Sponsor</th>
<th>Status</th>
<th>Project Years</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEGO Education Sponsored Research Agreement</td>
<td>LEGO Education</td>
<td>Awarded</td>
<td>3</td>
<td>$450,000</td>
</tr>
<tr>
<td>Maker Studios in Schools: Bringing Creativity and Play to the Classroom (ISB)</td>
<td>LEGO Education</td>
<td>Awarded</td>
<td>2</td>
<td>$399,981</td>
</tr>
<tr>
<td>CAREER: Urban Elementary Teacher</td>
<td>NSF</td>
<td>Awarded</td>
<td>2</td>
<td>$154,072</td>
</tr>
<tr>
<td>4-D Curriculum Visualization Tool Design – Design Specification Development</td>
<td>100Kin10</td>
<td>Awarded</td>
<td>1</td>
<td>$31,622</td>
</tr>
<tr>
<td>Development of a New Class in the Science and Engineering Classroom</td>
<td>Tufts University</td>
<td>Awarded</td>
<td>1</td>
<td>$29,035</td>
</tr>
<tr>
<td>A Study of College Students Epistemological Development</td>
<td>NSF</td>
<td>Pending</td>
<td>5</td>
<td>$1,978,049</td>
</tr>
<tr>
<td>US Ignite: Collaborative Research: Focus Area 2: Virtual Transport Services for Real-Time Social Camera Applications</td>
<td>NSF</td>
<td>Pending</td>
<td>1</td>
<td>$639,887</td>
</tr>
<tr>
<td>Collaborative Research: Strategies: STOMP as a Program Model for Developing Understanding of Engineering Design and STEM Careers in Youth</td>
<td>NSF</td>
<td>Pending</td>
<td>3</td>
<td>$469,719</td>
</tr>
<tr>
<td>EAGER: MAKER: Investigating Culturally Contextualized Making with the Navajo Nation</td>
<td>NSF</td>
<td>Pending</td>
<td>1</td>
<td>$111,652</td>
</tr>
<tr>
<td>Examining Science and Engineering Practices in Out-of-School Workshops</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$897,109</td>
</tr>
<tr>
<td>Animal-Based Science and Engineering Education</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$599,788</td>
</tr>
</tbody>
</table>

### Grant Applications Submitted in FY 2016 (continued)

<table>
<thead>
<tr>
<th>Grant Name</th>
<th>Sponsor</th>
<th>Status</th>
<th>Project Years</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>RET Site at Tufts University for Understanding Infrastructure in Civil and Environmental Engineering</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$596,185</td>
</tr>
<tr>
<td>EAGER: MAKER: Making to Learn: Self-Directed Learning and Assessment NSF App for Makers</td>
<td>NSF</td>
<td>Declined</td>
<td>2</td>
<td>$150,001</td>
</tr>
<tr>
<td>Assistive Technology Innovations</td>
<td>Tufts University</td>
<td>Declined</td>
<td>1</td>
<td>$36,348</td>
</tr>
</tbody>
</table>

### Breakdown of Applied to Funding Sources

- Total: $6,558,448
- Pending: $1,199,357
- Declined: $2,779,813
- Funded: $2,579,278

### CEEO Supported Grants

**CAREER: Probabilistic Nonlinear Structural Identification for Health Monitoring of Civil Structures**

- Babak Moaveni, Associate Professor, Department of Civil and Environmental Engineering

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**Financial Statements**

**Grant Applications Submitted in FY 2016**

**Grant Applications Submitted in FY 2016 (continued)**

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**Breakdown of Applied to Funding Sources**

**Grants Applied to in FY 2016**

Total: $6,558,448

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**CEEO Supported Grants**

**CAREER: Probabilistic Nonlinear Structural Identification for Health Monitoring of Civil Structures**

- Babak Moaveni, Associate Professor, Department of Civil and Environmental Engineering
Thank You to Our Donors
We would like to thank the following donors for their generous contributions to the CEEO between July 1, 2015 and June 30, 2016.

Corporate and Foundation Donations
Capital of Children Company
Fundació Sant Joan de Déu
James S. McDonnell Family Foundation
LEGO Education
LEGO Foundation
National Instruments
Leila Shakkour, Michael Thorne, and the LLL Foundation
Fund of Tides Foundation
PTC, Inc.
Move the World Foundation

Alumni and Friends Donations
Ethan E. Danahy, Ph.D.
David M. & Ellen Scolnic
Mr. Philip C. Strassburger
Thomas L. and Jill M. Pappas

And to our anonymous donors as well!
CEE0 has recently launched a new blog to keep you up to date on the latest happenings. Email ceeo@tufts.edu to receive the blog posts as an email newsletter.