Annual Report
July 1, 2016 – June 30, 2017
2017 Fiscal Year

Kids can... Think. Discover. Solve. Invent. change the world.
From the Director

I am delighted to share another annual report from the CEEO as we cross into our third decade. We spent some time celebrating this year (page 12) and then dug into reviewing and revitalizing our strategic plan. For us, looking at our mission, vision, and goals was a reflective process where faculty, staff, and students shared how they are deeply motivated by our mission and how personally meaningful the projects and activities at the Center are to them. In the end, we created a roadmap for our goals as well as a refined mission statement to better reflect our passion for bringing engineering to more students, the importance of research, and our commitment to bridging research and practice: “To create the problem solvers of tomorrow by empowering all students, kindergarten through college, with innovative, research-based engineering experiences.”

You can see evidence of the work we are doing toward our mission throughout this report. To build the experiences for the next generation of problem solvers we talk about in our mission, we first and foremost need research that helps us to understand student and teacher learning in engineering, how learning environments and technologies interact with learning, and how role models and support resources can be used to tackle the learning environment. In this report, you can learn about the expansive efforts of Kristen Wendell’s Engineering Learning Systems Lab (page 17) in studying student and teacher learning in new ways, from creating new tools and resources for the classroom, to researching new contexts for engineering in community-based problems. You’ll read about Making Engineering Playful in Schools, the project taking place in Billund, Denmark, that is building knowledge about how to design makerspace environments, what materials are needed in these spaces, and the interaction between narrative, story and creation (page 13). In addition, we had nine graduate students defend their theses which contributed knowledge in diverse areas, from how kids learn from failure to understanding the design of programming environments for the Internet of Things (page 11).

We use the word experiences in our mission statement to encompass the technologies we design as well as outreach programs we create. All of these experiences draw on the outcomes generated by our research projects as well as leverage current knowledge in the fields of engineering and education. You can learn about about how Internet of Things technologies are being explored (page 11), the continued success of Ethan Danahy’s InterLACE/Visual Classrooms work (page 14), the dissemination of Novel Engineering (page 13), and the now 16-year-old STOMP program that engages 60 undergraduates annually in reaching 30 local classrooms (page 15). You’ll also see the impact of our work in the number of students, teachers, and web visitors from around the world (page 7). We also reached more teachers through the 2017 LEGO Education Symposium (page 11) and more undergraduate students through our Winternship program (page 12).

During our strategic planning process, many people mentioned how valuable the CEEO’s commitment to innovation and exploration is to our faculty, staff, and students. We know the interdisciplinary nature of the CEEO; the freedom to try new ideas, and our “out of the box” thinking has contributed to many CEEO research and outreach projects. As the CEEO has grown we’ve had to be more purposeful to ensure that amongst all the data collection, analysis, workshops, and tool testing we still have space to create and explore. To that end, we’ve established the CEEO Innovation Fund which awards small grants to CEEO faculty, staff, and graduate students to explore a new area of research, try a new outreach idea, or prototype a tool. We highlight this past year’s innovation projects to give you a peek at some of the ideas that are in the pipeline (page 14).

The CEEO continues to house a talented and passionate group of individuals, at every level, dedicated to changing the world through K-College engineering education work. I feel incredibly fortunate to work with them every day on our shared mission of helping to tackle the problems of tomorrow – from clean air to renewable energy to personalized learning – by creating the next generation of problem solvers. I hope you enjoy this latest update which, as always, is only a small snapshot of all the work happening here. 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

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Tufts Center for Engineering Education and Outreach
Annual Report FY 2017
Who We Are and What We Do

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 People and Organization

Advisory Board Members
Thabiti Brown
Head of School, Codman Academy
Mey Campbell
Chief of Innovation & Strategy, Codman Academy
Jeanne Diefenderfer
Trustee, Tufts University
Per Haugwitz
Senior Ventures Manager, LEGO Foundation
Holly James
Board Member, James S. McDonnell Foundation
Steve Karol
Managing Partner & Founder, Watermill Group
Ralph Linsalata

Director
Merrieth Piante-Naremore

Faculty
Ethan Daniel Research Assistant Professor, CEOE and Computer Science
Kristen Wendell McConnell Family Professor in Education Assistant Professor, Multidisciplinary Studies
Bill Church Lecturer

Faculty Steering Committee
Laurie Gaskins Baise Department Chair and Professor of Civil and Environmental Engineering
Adjunct Professor of Earth and Ocean Sciences
Barbara Bruscia Professor of Education
Dean of Academic Affairs for Arts & Sciences
David Hammer Professor of Education & Physics
Department Chair of Education Director of STEM Education Program
Chris Rogers Department Chair and Professor of Mechanical Engineering Adjunct Professor of Education
Chris Swan Faculty Associate, Jonathan M. Tisch College of Associate Professor of Civil and Environmental Engineering Civil & Enviro
Adjunct Associate Professor of Education

CEEO Fellows
Marina Bers Professor, Eliot-Pearson Department of Child Study and Human Development Adjunct Professor of Computer Science Director of DevTech Research Group
Brian Gravel Associate Professor of Developmental Psychology Assistant Dean for University Education
Daniel Hannan Professor of the Practice in Human Factors Engineering
Rich Lerner Professor, Eliot-Pearson Department of Child Study and Human Development
Megan Mueller Elizabeth Arnold Stevens Junior Professor Associate Director of the Tufts Institute for Human-Machine Interactive Research Assistant Professor of Clinical Sciences and Continuing Studies
Jesse Lander Engineering Education Program

Undergraduate Students and Hourly Workers
Haleem Alshamali Intern
Eric Albright Mathematics Education
Emra Cakirov Interdisciplinary Studies
Lucy Fell Intern
John Fernandez Intern
Georgii Fedorov Civil Engineering
Taylor Feuchting Intern
Joy Bajwa Mathematics Education
Katie Finck Intern
Terra Finck Intern
Umarial Fatma Intern
Elizabeth Binghams
Sarah Duncan Intern
Donald Callahan Intern
Christopher Camacho Intern
Bianca Capretta
Camille Carlholt
Donna Chen
Jahnel Cheung
Kristina Cho
Chandler Cline
Benjamin Collman
Haas Collins

Student Interns
Emma Cakirov
Ben Cristol
Colin Cielo
Lucy Fell
John Fernandez
Georgii Fedorov
Taylor Feuchting
Joy Bajwa
Katie Finck
Terra Finck
Umarial Fatma
Elizabeth Binghams
Sarah Duncan
Donald Callahan
Christopher Camacho
Bianca Capretta
Camille Carlholt
Donna Chen
Jahnel Cheung
Kristina Cho
Chandler Cline
Benjamin Collman
Haas Collins

CEEO Collaborators
Barbara Bruscia
Assistant Professor of Engineering
Adam Carberry
Associate Professor in Engineering
Gary Garber
Physics Teacher, Boston, MA
Morgan Hynes
Assistant Professor of Engineering
William Messner
Assistant Professor of Mechanical Engineering
James Muller
Assistant Professor of Computer Science
Victoria May
Executive Director, Institute for School Partnership
Joshua Feitelberger
Teaching Assistant Professor
Kris McBurney
Teaching Assistant Professor
Robin Stok
Mathematics Teacher
Transcript

Tufts Center for Engineering Education and Outreach

Annual Report FY 2017
Who We Are And What We Do

CEEo’s Impact at a Glance

- 857 Teachers
- 747 Classrooms
- 13,422 Students

Cumulative Impact by STOMP, Novel Engineering, and InterLACE since 2001

7 countries visited by CEEO faculty, staff, and students in FY2017
5 countries represented by visitors hosted by the CEEO this year

Who We Are And What We Do

Project and Program Overview: FY 2017 Milestones

New Grants
- IoT and National Instruments, National Instruments
- STOMP Support, Tides Foundation
- Novel Engineering: Advancing Implementation and Understanding of Teacher Practice, James S. McDonnell Family Foundation
- NovelEngineeringChallenges.org, United Engineering Foundation
- Connections in the Making, National Science Foundation

New Gifts
- National Instruments Gift, National Instruments
- LEGO Education Outreach Gift 2017, LEGO Education
- PTC IoT Preliminary Investigation, PTC

Closed Grants
- Integrating Engineering and Literacy (Novel Engineering), National Science Foundation
- Development of a New Class in the Science and Engineering of Music, Tufts University

Top 10 Countries Following CEEO on Social Media

- Canada
- US
- UK
- India
- Australia
- Turkey
- Spain
- Japan
- Egypt
- Indonesia

35 Workshops at the CEEO in FY 2017

Co-Ed Robotics Session 1
July 11-15, 2016
Grades 3-8

Girls Design and Engineering Week
July 18-22, 2016
Grades 4-7

Engineering, Earthquakes, and More! Week 1
July 18-22, 2016
Grades 5-8

2016 Summer LEGO Engineering Institute for Educators:
Beginner EV3
July 18-22, 2016

2016 Summer LEGO Engineering Institute for Educators:
Intermediate EV3
July 25-29, 2016

Co-Ed Robotics Session 3
July 25-29, 2016
Grades 3-8

Co-Ed Robotics Session 2
August 1-5, 2016
Grades 3-8

Engineering, Earthquakes, and More! Week 2
August 1-5, 2016
Grades 5-8

Robotic Artbots
August 8-10, 2016
Grades 1-2

Fun with Engineering & Robots! Morning Session
August 15-17, 2016
Grades 1-2

Fun with Engineering & Robots! Afternoon Session
August 15-17, 2016
Grades 1-2

Discover Engineering After School
October 5 – December 14, 2016
Grades 1-3

Engineering Around the World After School
October 6 – December 8, 2016
Grades 3-6

The Art of Engineering
October 8, 2016
Grades K-2

Rube Goldberg Machines
October 15, 2016
Grades 6-8

Engineering a Day Pack
October 22, 2016
Grades K-2

STEAM Series Saturdays
November 5-19, 2016
Grades K-2

Superheroes Saturdays
November 5-19, 2016
Grades K-2

E-TEAM Fall/Winter Session
November 14-December 12, 2016
Grades K-2

Toy Testing for EN1 Simple Robots
December 5 & 12, 2016
Ages 4-8

The Wonderful World of Goo!
April 8, 2017
Grades 3-5

Going on a Safari!
April 15, 2017
Grades K-2nd

April Vacation: Discover Engineering
February 11-15, 2017
Grades 3rd - 5th

E-TEAM Spring Session
February 13 – April 10, 2017
Grades K-2

February Break Workshop: Game Design
February 21-24, 2017
Grades 3-5

Come Meet the LEGOland Discovery Center Boston Master Model Builder
March 11, 2017
Grades 3-6

Explore Engineering!
April 22, 2017
Grades 3-5

Computational Thinking After School
May 23 – June 15, 2017
Grades 3rd - 5th

Co-Ed Robotics: Session 1
June 19-23, 2017
Grades 3-8
Highlights at a Glance

Graduating and New Students in FY 2017

2016–2017 CEEO Graduates

Chelsea Andrews
PhD in Education
Dissertation: Elementary Students’ Engagement in Failure-Prone Engineering Design Tasks
Currently: Postdoctoral Scholar at Tufts CEEO in Medford, MA

Whitney Crooks
PhD in Mechanical Engineering
Dissertation: Soft Robotic Manipulators Inspired by the Fin Ray Effect
Currently: Staff at Tufts CEEO in Medford, MA

Amber Kendall
PhD in Education
Dissertation: Design and Analysis of an IoT Usage Tracking and Equipment Management System Within a University Makerspace
Currently: Coordinator of STEM Partnership Development at North Carolina State University in Raleigh, NC

Brian O’Connell
PhD in Mechanical Engineering
Dissertation: Design and Analysis of an IoT Usage Tracking and Equipment Management System Within a University Makerspace
Currently: Assistant Teaching Professor in the First Year Engineering Program, Northeastern University in Boston, MA

Susan Bitetti
MS in Mechanical Engineering
Thesis: The Development and Implementation of a Tool for Encouraging the Practice of Student-Driven Documentation in Engineering Design
Currently: Staff at Tufts CEEO in Medford, MA

Andrew Braren
MS in Human Factors Engineering
Thesis: Making the Maker Network: Designing and Developing a Web-Based Community Platform for Student Project Documentation
Currently: Web consulting in Boston, MA

Mahsa Hayeri
MA in Education
Research: SiMSAM Project

Jennifer Scinto
MS in Mechanical Engineering
Currently: Acoustical Consultant at SoundSense in New York, NY

Jennifer Thomas
MS in Mechanical Engineering
Currently: Web Developer for viagogo in London, England

New Graduate Students

Kerrianne Marino
Pursuing MS in Human Factors Engineering
BA in Applied Physics
St. Anselm College, 2016

Checking in with CEEO Alumni

Mike Mogenson
MS in Mechanical Engineering

Mike Mogenson graduated from Tufts in 2012, where he developed engineering education tools in LabView software. That experience launched him on a cross-disciplinary trajectory, with a strong emphasis on software development. In the next five years, he worked as an electro-mechanical engineer for the Wyss Institute at Harvard University, developing products as diverse as high-quality electronic drum-pads and powered exo-suits, and as a software engineer at LeafLabs developing firmware for a smartphone. Now Mike is the lead firmware engineer at Root Robotics, a company that got its start from a project he had worked on at Wyss.

Root is a robot designed to teach computer science and computational thinking, logic, and sequencing to kids of all ages. It is designed to be highly interactive as well as to provide a seamless transition from basic ‘block’ programming to more advanced text-based programming in Python. Mike is motivated by a strong sense that what he learned at the CEEO is something that all kids should have access to. For him, this project embodies a familiar overlap between engineering and education; his ambition is to be able to “point to something on a shelf and say ‘I made that’ and hear someone say, ‘I didn’t know I liked computer programming until I used [Root] and I liked it a lot.”

Mike wears many hats as a software engineer who has to talk with mechanical engineers, electrical engineers, and educators; he attributes much of that flexibility to his time at the CEEO, saying “the CEEO was a good place for that. There were not a lot of hard, defined roles. It was like, I need to do a thing, so I’ll learn how to do it.” He hopes to utilize those skills to “create things that improve people’s lives”, starting with Root and moving forward.

CEEO Masters Student Alumni – Where Are They Now?

Jessica Noble
MS, Mechanical Engineering, 2013
Software Engineer at Wayfair, Boston, MA

Leonardo Madariaga
MS, Human Factors Engineering, 2015
Ph.D. Student, Pontificia Universidad Católica de Chile, Valparaiso, Chile
Adjunct Lecturer, Universidad Técnica Federico Santa María, Santiago, Chile

Tim Hellickson
MS, Mechanical Engineering, 2016
Opto-Mechanical Design Engineer, Massachusetts Institute of Technology (MIT), Cambridge, MA
Highlights of FY 2017

Internet of Things (IoT)

As the Internet and low cost hardware become more ubiquitous, it becomes easier to connect more devices to it. This has led to the emergence of the Internet of Things (IoT), a network of continually connected devices with embedded software that can communicate data to each other or the Internet. These devices, like the Nest thermostat, can sense their surroundings, collect data, and actuate on the environment.

The rapid growth in IoT has resulted in a gap in engineering education. In order to teach and lower the barrier of entry to IoT, CEEO master’s student Jenn Thomas designed, developed, and tested a new learning platform: a website with a drag and drop user interface that communicates with a raspberry Pi and PTC’s web-based IoT platform called ThingWorx. This enables users to easily code an IoT project with no prior experience and create projects like a smart coaster that senses a cold beverage and sends a text message if the coaster is occupied.

CEEO also partnered with National Instruments to create an educational toolkit to easily connect hardware to the cloud. One of the projects reads a light sensor in Professor Chris Rogers’ office to see if he is there. If he is there, a user at the CEEO can press a button to initiate a Skype call request and Chris may accept or deny the request using buttons.

LEGO Education Symposium 2017

In May, Ethan Danahy and Elissa Milto traveled to Billund, Denmark, to attend the LEGO Education Symposium 2017. The Symposium, co-hosted by LEGO Education and Tufts CEEO, is an annual event that brings together top LEGO educators from across the world to recognize the innovative work they are doing in their classrooms and to allow them to share what they are doing with each other. This year’s attendees included teachers from Denmark, Poland, Russia, China, Australia, Kazakhstan, and the United States. Teachers applied to be part of the Symposium and were chosen from a pool of applicants based on the work they were doing in the classroom.

The first two days of the Symposium were a mix of educator presentations, workshops, socializing, and a visit to the International School of Billund. Ethan gave the keynote speech at the awards dinner and led several discussions throughout the Symposium. Elissa led two Novel Engineering introductory workshops on the second day. One of their favorite moments during the Symposium was an informal open house and cocktail hour where LEGO Teacher Award Winners each had a table with information that highlighted student work. During the third day of the Symposium, awardees toured the LEGO factory, visited LEGO Idea House (the private LEGO museum), and explored LEGOLand. Through all the events of the Symposium, attendees (including staff from LEGO and Tufts) were able to forge new connections and reflect on how to excite children to learn and innovate with LEGO. Next year’s LEGO Education Symposium will move back to Tufts in June 2018.

2017 Winternships

During the break between the fall 2016 semester and the start of the spring 2017 semester, the CEEO at Tufts University hosted its first ever “Winternship,” an opportunity for students staying local over winter break to spend the first two weeks of January working on CEEO-related technology development initiatives. A total of fourteen undergraduates from Tufts University, Wellesley College, UMass Amherst, and Stonehill College participated, starting the Winternship with an orientation learning about LEGO Robotics and Laser Cutting, and then transitioning to working on several research projects, each sponsored by a different Tufts University grad student, staff member, or professor in connection with ongoing research and development initiatives at the university.

Wintern Projects:
- Documentation Station
- Skill Training Robot for Children
- Online Clock for MakerGames Project
- Web-Based Integrated Development Environment for Python for the EV3
- IoT Robotic Controlled by Phone
- Internet Controlled LEDs
- EV3 Quickstart Program
- Interactive LEGO Robots

This was no ordinary celebration of course; in CEEO fashion, we had robots, research, competitions, and fun giveaways. Between three and five o’clock, guests picked up their laser-cut name tags and made their way through the different exhibits. There were hands-on activities that displayed our research and our outreach efforts. Guests could help solve an engineering problem from two different books from our Novel Engineering research, contribute to a LEGO robotics haunted house by building a spooky robot, draw something and have it laser cut on a CEEO keychain, make a musical instrument to bring home, and, borrowed from one of our STOMP activities, build a catapult to launch a LEGO minifigure across our office.

After guests spent time at the CEEO, they headed down the street to Breed Hall for our reception. At the reception, we had selfies with our big red robot, Baxter, a build-your-own LEGO maze, a community-based engineering challenge using cardboard and other tools, and a cookie-decorating robot! Guests went around to the different hands-on stations while enjoying refreshments.

2017 Winterns

- Interactive LEGO Robots
- EV3 Quickstart Program
- Internet Controlled LEDs
- IoT Robotic Controlled by Phone
- Web-Based Integrated Development Environment for Python for the EV3
- Online Clock for MakerGames Project
- Skill Training Robot for Children
- Documentation Station

This year, CEEO was excited to celebrate our 20th anniversary on October 23, 2016! The CEEO was established in 1996 and was one of the first pioneers to start thinking about engineering education.

We had two hundred guests attend this event. They were a mixture of Tufts staff, faculty, and deans, CEEO Advisory Board members, Engineering Advisory Board members, CEEO alumni, parents and children from the community, CEEO industry partners, CEEO teacher partners, and families and friends of the CEEO!

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Making Engineering Playful in Schools

Making Engineering Playful in Schools is a research partnership with the International School of Billund (ISB) and the LEGO Foundation. Over the past year, the CEEO initiated a second iteration of the “Researcher Residency” model in partnership with ISB and the LEGO Foundation. The goals of this partnership are to support ISB in bringing playful making and engineering into the curriculum, and to grow the role of the school’s Creator Space—a multimodal, multidisciplinary, and multitechnology making space—in the already burgeoning creative, playful culture at ISB. Tufts researchers Amanda Strawhacker (Ph.D. student in Child Studies and Human Development), Matt Mueller (Ph.D. student in Mechanical Engineering), and David Alsdorf (Research Assistant in Education) were all in residence at ISB at various times during the year. They worked closely with Kindergarten, P3, and P4 students and teachers to foster a culture of playful making and engineering. This included introducing curricular activities, developing tutorials for different tools (e.g., the laser cutter), and designing and constructing an age-appropriate making space for early childhood programs. The findings of this research focus on three central strands: (1) principles for the design of physical space and selection of equipment to foster playful making in schools, (2) the importance of tool and material supports for teachers and students, and (3) the role of story and narrative construction as frameworks for curricula on playful making. As such, the research and development team spent a lot of time and energy wrapping up the initiatives from the previous five years: writing papers summarizing findings, packaging up technologies, supporting existing users, and concluding work with the InterLACE Design Team Teachers (a group of teachers from across New England who have been supporting the investigations into technology-supported collaborative learning experiences within middle and high school classrooms). This year also saw continued success of Visual Classrooms, the spin-off company from the Tufts CEEO that has been enhancing and supporting the use of the platform in a wide variety of school subjects, and classes. Visual Classrooms has seen over 200K posts by about 10,000 different student accounts into the software platform throughout its lifetime.

Novel Engineering Update

This winter, CEEO received two Novel Engineering follow-up grants. Both look at increasing awareness and dissemination of Novel Engineering. The first, funded by the United Engineering Foundation, will support work on Novel Engineering Challenges, a series of three online challenges. The goal is to broaden interest and participation in engineering by providing a new entry point to engineering through literacy and human-centered problems. This initiative is a hybrid between the content and approach of Novel Engineering and the online sharing platform of Dr. E’s Challenges. Each challenge tasks participants with reading a book, identifying a problem the characters face, designing and building a solution, and then sharing that solution. Solutions are shared on the website and then the community will be invited to comment and vote on the solutions to build excitement and feedback for the students’ work. The second grant, funded by the James S. McDonnell Family Foundation, focuses on dissemination though a bundled approach that includes a one-day, in-person workshop that is followed by participation in a year-long, online graduate level course based on the TEEP model. For the upcoming year, there will be two cohorts of teachers, from St. Louis and Boston. In preparation, we have trained a group of educators in St. Louis who will act as Novel Engineering facilitators, certified to run Novel Engineering workshops, and we will soon certify another cohort. This past summer, we developed the online course to support the class and the first group of Novel Engineering facilitators. Excitement from the education community for Novel Engineering continues to grow and the first group of Novel Engineering facilitators is using the online course to support the class and the first group of Novel Engineering facilitators. Encouraging to the education community for Novel Engineering continues to grow and we hope that Novel Engineering Challenges and our refined dissemination approach will help to support the teachers who are interested in including Novel Engineering in their classrooms.

CCEE Innovation Fund

This was the second year awarding CCEE Innovation Fund grants. These grants give an opportunity to CCEE faculty, staff, and graduate students to apply for internal research money to allow them to explore research projects that may not be able to be funded elsewhere. All four of this year’s proposals, described below, were funded.

Designing an Early Childhood Makerspace (Amanda Strawhacker and Miki Vizner) – This grant funded the creation of a developmentally appropriate Early Childhood Makerspace for children ages four to eight years. The mission of this space is to serve as an active maker space for children and a testing site for Tufts researchers.

1234Cast (Sam Woolf) – This grant funded the development and testing of 1234Cast, an online weather forecasting portal that caters to young children by displaying developmentally appropriate methods, using pictures and animations rather than text and graphs. Learn more at 1234Cast.com.

MakerGames (Matt Mueller and David Alsdorf) – MakerGames is a board game designed to leverage the power of make believe play and to spark thoughtful conversations about engineering concepts as students engage in open-ended design challenges. Play online at www.MakerGames.education.

Developing Social Awareness for Adolescents with Autism through Making Human-Centered Robots (Dan Hannon and Elissa Milto) – This study used robotics as a way to engage children with Autism Spectrum Disorder (ASD) in social interactions through design problems that required students to build solutions that meet the needs of someone other than themselves.
Featured Initiatives in FY 2017

Student Teacher Outreach Mentorship Program (STOMP)

The Student Teacher Outreach Mentorship Program (STOMP) has spent the past 16 years advancing engineering curriculum in classrooms in the greater Boston area. The CEEO created STOMP in 2001 with a mission to build partnerships between educators and university students. STOMP has lived up to its mission by making invaluable connections with local schools and communities, and has furthered engineering education at all levels from K-12.

Partners in Engineering Design

When Tufts University students become STOMP fellows, not only do they become role models for the students in the classrooms they visit, they also reinforce their own knowledge by teaching engineering concepts on a weekly basis. Their host teachers also benefit from the student:teacher ratio in their classrooms, they also reinforce their own knowledge by teaching engineering concepts on a weekly basis. Their host teachers also benefit from the student:teacher ratio in their classrooms, and with smart, talented, and diverse role models.

STOMP Keeps Growing and Growing

The CEEO has carefully fostered STOMP’s growth over the past 16 years. STOMP has grown from five fellows teaching 50 students in 2001 to 58 fellows supporting 43 classrooms and over 800 students in Arlington, Boston, Cambridge, Everett, Malden, Medford, Somerville, and Winchester.

Women in particular have been drawn to STOMP in increasing numbers. Currently, 60 percent of STOMP fellows are female engineering students. STOMP has been able to pair more female engineering role models with more classrooms than ever before, thus allowing young girls the opportunity to imagine themselves as engineers. In fact, the percentage of women involved in the STOMP program is greater than the percentage of female students in the entire School of Engineering.

Promoting Diversity in Our Corner of the University

This past year, STOMP management made a concerted effort to increase diversity within its fellowship program. During the 2016-2017 academic year, STOMP set clear goals to create a more inclusive environment, to create spaces for racial minorities, and to more closely match fellows to the demographics of the schools in which STOMP teaches. Research indicates that students of color or will perform better when they are taught by teachers in whom they can see themselves. This is meaningful for STOMP because at roughly half of STOMP schools, more than 50 percent of the population being taught are students of color. Through focused recruitment efforts, STOMP has been able to shift its demographics towards a racially diverse fellowship. In the fall of 2016, 52 percent of STOMP fellows were white and 45.5 percent were students of color. The numbers increased in favor of diversity again in the spring 2017 semester, when 48.3 percent of STOMP fellows were white and 51.7 percent were students of color. STOMP remains committed to providing local classrooms with both the educational and social resources they need to thrive and learn, and with smart, talented, and diverse role models.

For Latino STEM Alliance, having a female engineering student representing the underrepresented STEM demographics impacted our young female students. Seeing a woman like themselves as a successful college student gave them confidence to believe in themselves as students. This same opportunity is available to them if they work hard.

Sarah Abramson, Program Manager, Latino STEM Alliance, Tobin K-8 School, Roxbury

Consistency in the Classroom

All teachers know that the key to successful classroom management is consistent rituals and routines. STOMP was able to support this by scheduling the same fellows in the same classrooms for both semesters. In previous years, STOMP fellows had switched schedules and classes often. The feedback from the new and improved schedule was overwhelmingly positive from students, teachers, and fellows. Consistent weekly routines for the students meant the same faces on the same days each week, and more opportunities for fellows and teachers to create curriculum that spanned across the whole year. STOMP fellows benefitted because they were able to get a valuable taste of what it is like to teach the same students over the course of a year and watch them learn, grow, and change, and get excited about engineering. Students knew what to expect on a weekly basis, and were able to bond with their fellows.

My students were at the computer lab close to the time when our STOMP fellows were to arrive. They ensured that we left a note on the classroom door and assigned a lookout so that we didn’t miss our fellows. They really looked forward to working with them every week.

Fourth Grade Teacher, Healey Elementary School, Somerville

Curriculum is catered specifically to each unique classroom and developed as a team between teachers and fellows. Past projects and challenges have included superheroes, Pokémon, and year-long units like a mission to Mars that culminated in a semester-long colonization effort and a unit that focused on important female scientists through the study of different kinds of energy, culminating in the creation of amusement parks and creative promotional videos. Teachers noted improvements in problem-solving and collaboration outside of STOMP, and perfect attendance on STOMP days.

To check out all the exciting developments in STOMP, such as example curricula, photos from classrooms, and how to get involved, visit our website.

stompprogram.org
Engineering Learning Systems (ELS) Lab

For visitors to the CCEO in 2017, there was a new stop on the CCEO tour: the Engineering Learning Systems Lab. The lab is headquarters for the research group of Dr. Kristen Wendell, McDonnell Family Assistant Professor in Engineering Education. Given her interdisciplinary role across the Departments of Mechanical Engineering and Education at Tufts, Dr. Wendell knew that her research group would flourish in the interdisciplinary culture of the CCEO. The projects underway at the lab focus on the interactions between learners, teachers, tools, and tasks within engineering learning environments.

Featured Initiatives in FY 2017

Digital Design Notebooks

In collaboration with Dr. Ethan Danahy, the ELS Lab is developing and studying a tablet-based documentation platform that allows students to easily capture their design ideas and test results in the moment. Currently an iOS app in beta testing at local schools, it is comprised of a set of templates, or “cards,” for different aspects of an engineering design process, including “Ideas,” “Test,” and “Feature” cards. The digital cards are open-ended enough to be used in any design challenge, yet they provide enough structure to help elementary students meet the language demands of collaborative engineering design and engage in more informed decision-making during design projects.

Mechanical Engineering Learning Dynamics

The Engineering Learning Systems Lab also studies engineering learning by college students. Doctoral student Jessica Swenson’s dissertation will report findings from her ethnographic study of mechanical engineering students’ interactions while doing and perceptions of homework. This work sheds light on a learning system that many of us have experienced – problem set sessions – but that educational researchers have seldom examined.

Design Failure and Learning

In April 2017, ELS lab member Chelsea Andrews defended her dissertation on “failure-prone” engineering design tasks. She studied how elementary students evaluate failed tests and decide on changes to their design constructions, how their reasoning evolves as they repeatedly encounter physical failure, and how students and facilitators construct norms that help students expect and manage repetitive failure.

Design for Civic Engagement

Spurred by Dr. Wendell’s involvement in the Faculty Fellows program at Tufts’ Tisch College of Civic Life, a new strand of work in the lab explores approaches to and effects of framing mechanical engineering design as an act of civic engagement. For the senior capstone design course taught by Dr. Wendell, post-doctoral researcher Fay Shaw is developing modules and projects that emphasize human-centered design and engineers’ social responsibilities.
Press and Publications in FY 2017

CEEO in the News

Community for Advancing Discovery Research in Education Summer Newsletter (July 28, 2016) – Engineering for Every K-12 Student

Tufts University Office of Sustainability Blog (August 10, 2016) – Eco-Ambassador Grant Launches Reusable Cups Initiative, Diverts Significant Waste

Mass.com Live (August 22, 2016) – 3 Western Massachusetts teachers win White House award for excellence in science, math teaching

Presidential Awards for Excellence (August 22, 2016) – John Heffernan, Tufts alumnus and part-time lecturer

White House (August 22, 2016) – President Obama Honors Outstanding Mathematics and Science Teachers

Mass Department of Education (August 23, 2016) Four Massachusetts Teachers Honored with Presidential Award for Excellence in Mathematics and Science Teaching

Boston Herald (August 24, 2016) – 4 Massachusetts teachers win presidential award

Daily Hampshire Gazette (August 24, 2016) – Local teachers get presidential awards

The CES Newsroom (August 24, 2016) – 3 Western Massachusetts teachers win White House award for excellence in science, math teaching

WWLP (August 24, 2016) – Springfield & Williamsburg teachers honored with Presidential Award

UMass Amherst News & Media Relations (August 29, 2016) – Obama Cites Three Education Alumni for Excellence in Mathematics and Science Teaching

LinkEngineering (September 9, 2016) – LinkEngineering: Implementing PreK-12 Engineering

Daily Hampshire Gazette (September 19, 2016) – Williamsburg teacher earns national math and science award

Tufts University School of Engineering Research & News (October 7, 2016) – Alumnus Heffernan receives national teaching award

Tufts Now (October 17, 2016) – Creative Spaces to Learn

Tufts News & Notes, Department of Occupational Therapy (Fall 2016) – Jumbo’s Workshop: New Maker Studio Builds Creations and Collaborations AND Boomer Goes to School, OT and STOMP Collaborate on Doggy Designs

School Library Journal (December 2, 2016) – Engineering, Inspired by Kid Lit


CBS Boston (February 20, 2017) – Eye On Education: Boston Schools Use LEGO To Teach Engineering

Start Engineering (February 23, 2017) – Engineering as a Stealth Language Art, Part 2

Press and Publications in FY 2017

NSTA Reports (February 2017) – Engineering Literary Solutions

Steppingstone Foundation Blog (March 6, 2017) – Experiencing Campus Life

Tufts School of Engineering Research & News (March 8, 2017) – Early Engineering Education

Community Advocate (April 9, 2017) – Tufts University Cummings School outreach program challenges kids to build STEM skills

The Tufts Daily (April 7, 2017) – Tufts buys Prysm boards to offer increased class technological integration


Tufts Now (May 25, 2017) – Working Toward Independence

Tufts University Art Gallery (May 31, 2017) – The Tufts University Art Gallery Faculty Connection

Woburn Public Media Center, Education Access Channel (June 19, 2017) – Build a Better World at Woburn Public Library - Summer Reading Program 2017
Publications and Presentations by CEEO Authors

Journal Articles and Book Chapters


Conference Papers, Posters, Publications, and Workshops


Panels and Presentations


Portsmore, M. (2017). Teaching Content in STEM. Invited Panel Participant, ITEEA Annual Conference. Dallas, TX.


## FY 2017 Financials: Overview of Revenue and Expenses

Fiscal Year 2017 brought in a few new government grants with the arrival of Kristen Wendell’s research in engineering education, housed in the Department of Mechanical Engineering. Her projects all run through the CEEO as you can see by the increase of revenue from government grant installments. We participated in a few fundraising efforts with Tufts Development to reach out to alumni which increased our gifts total. The Tufts University funding category is now at $0 since we did not apply for any Tufts Innovates or Collaborates grants in FY 2017. Expenses in FY 2017 had a shift in administrative costs as the project manager for Novel Engineering transferred her salary to more administrative-based costs as we closed out the Novel Engineering NSF grant in early FY 2017.

### Revenue

<table>
<thead>
<tr>
<th>Source</th>
<th>FY 2017</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royalties</td>
<td>$5,466</td>
<td>$4,493</td>
</tr>
<tr>
<td>Fees</td>
<td>$195,262</td>
<td>$137,666</td>
</tr>
<tr>
<td>Private Grants</td>
<td>$313,192</td>
<td>$303,590</td>
</tr>
<tr>
<td>Government Grants</td>
<td>$1,301,073</td>
<td>$98,256</td>
</tr>
<tr>
<td>Tufts SOE Dean's Office</td>
<td>$198,167</td>
<td>$197,584</td>
</tr>
<tr>
<td>ICR Return</td>
<td>$30,632</td>
<td>$29,633</td>
</tr>
<tr>
<td>Tufts University Funding</td>
<td>$23,199</td>
<td>$39,917</td>
</tr>
<tr>
<td>Gifts</td>
<td>$230,554</td>
<td>$104,692</td>
</tr>
<tr>
<td>Tuition</td>
<td>$91,200</td>
<td>$28,900</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td><strong>$2,388,745</strong></td>
<td><strong>$975,359</strong></td>
</tr>
</tbody>
</table>

**In-Kind Support**

<table>
<thead>
<tr>
<th>Source</th>
<th>FY 2017</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEGO</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>National Instruments</td>
<td>$20,000</td>
<td>$9,000</td>
</tr>
<tr>
<td><strong>Total Revenue + In-Kind</strong></td>
<td><strong>$2,448,745</strong></td>
<td><strong>$1,024,359</strong></td>
</tr>
</tbody>
</table>

### Expenses

<table>
<thead>
<tr>
<th>Category</th>
<th>FY 2017</th>
<th>FY 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td>$261,431</td>
<td>$267,064</td>
</tr>
<tr>
<td>Administrative</td>
<td>$214,256</td>
<td>$122,334</td>
</tr>
<tr>
<td>Project Staff</td>
<td>$134,006</td>
<td>$245,253</td>
</tr>
<tr>
<td>Postdocs</td>
<td>$20,358</td>
<td>$156,044</td>
</tr>
<tr>
<td>Students + tuition/fees</td>
<td>$660,135</td>
<td>$564,524</td>
</tr>
<tr>
<td>Teacher Stipends + Consulting</td>
<td>$151,442</td>
<td>$136,875</td>
</tr>
<tr>
<td>Total Benefits for Staff, Faculty, + Students</td>
<td>$171,102</td>
<td>$182,067</td>
</tr>
<tr>
<td>Materials + other</td>
<td>$123,160</td>
<td>$220,064</td>
</tr>
<tr>
<td>Travel</td>
<td>$26,440</td>
<td>$61,523</td>
</tr>
<tr>
<td>Domestic</td>
<td>$24,864</td>
<td>$88,591</td>
</tr>
<tr>
<td>International</td>
<td>$310,657</td>
<td>$441,108</td>
</tr>
<tr>
<td><strong>F&amp;A</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td><strong>$2,097,851</strong></td>
<td><strong>$2,486,447</strong></td>
</tr>
</tbody>
</table>

The graphs below represent the revenue brought into the CEEO during FY 2017, broken down by funding source; FY 2017 expenses broken down by funding sources; and the overall FY 2017 expenses breakdown.
Financial Statements

Balance Overview
As we wrap up the fiscal year 2017, the “Snapshot of Balances” charts show the ending balance of our accounts at the end of FY2016 and FY2017. We are still mostly funded by government grants starting FY 2018.

Total Commitments
The “Total Commitments” chart reflects how much money is contracted to us in FY 2018, FY 2019, and FY 2020 according to our yearly budgeted amount from government grants and private grants awarded to the CEEO.
### Grant Applications Submitted in FY 2017

<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>Connections in the Making</td>
<td>NSF - ITEST</td>
<td>Funded</td>
<td>3</td>
<td>$1,115,676</td>
</tr>
<tr>
<td>Novel Engineering: Advancing Implementation and Understanding of Teacher Practice</td>
<td>James S. McDonnell Family Foundation</td>
<td>Funded</td>
<td>1</td>
<td>$134,277</td>
</tr>
<tr>
<td>NovelEngineeringChallenges.org</td>
<td>United Engineering Foundation</td>
<td>Funded</td>
<td>1</td>
<td>$88,138</td>
</tr>
<tr>
<td>IoT and National Instruments</td>
<td>National Instruments</td>
<td>Funded</td>
<td>1</td>
<td>$50,063</td>
</tr>
<tr>
<td>STOMP Support</td>
<td>Tides Foundation</td>
<td>Funded</td>
<td>2</td>
<td>$35,000</td>
</tr>
<tr>
<td>PTC IoT Preliminary Investigation</td>
<td>PTC</td>
<td>Funded</td>
<td>1</td>
<td>$19,569</td>
</tr>
<tr>
<td>Role Models in Engineering Education</td>
<td>NSF-TEST</td>
<td>Pending</td>
<td>3</td>
<td>$599,789</td>
</tr>
<tr>
<td>Developing Teaching Noticing in Engineering in an Online Professional Development Program</td>
<td>NSF</td>
<td>Pending</td>
<td>3</td>
<td>$564,443</td>
</tr>
<tr>
<td>Designing Biometrics Robots</td>
<td>NSF - STEM+C</td>
<td>Pending</td>
<td>3</td>
<td>$319,175</td>
</tr>
<tr>
<td>Collaborative Research: Animal Investigators: Constructing Tools for Data-Driven Science</td>
<td>NSF - STEM+C</td>
<td>Pending</td>
<td>3</td>
<td>$236,271</td>
</tr>
<tr>
<td>A New Paradigm for Skill Development: An Integrated Platform to Facilitate Peer-Led Skill Training for High School Students to Teach and Learn Mobile App Development and Problem Solving</td>
<td>NSF - SBIR Phase I</td>
<td>Pending</td>
<td>1</td>
<td>$74,958</td>
</tr>
<tr>
<td>A Study of College Students Epistemological Development</td>
<td>NSF</td>
<td>Declined</td>
<td>3</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>Declined</td>
<td>1</td>
<td>$639,887</td>
</tr>
<tr>
<td>LENS: Linked Engineering Notebook System</td>
<td>NSF - Cyberlearning</td>
<td>Declined</td>
<td>3</td>
<td>$549,070</td>
</tr>
<tr>
<td>Animal Based Science and Engineering Education</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$123,990</td>
</tr>
</tbody>
</table>

### Grant Applications Submitted in FY 2017

<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>CAREER: Probabilistic Nonlinear Structural Identification for Health Monitoring of Civil Structures</td>
<td>Babak Moaveni, Associate Professor, Department of Civil and Environmental Engineering</td>
<td></td>
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<tr>
<td>CAREER: Mechanisms of Ion Transport in Ionomer-Free Electrodes</td>
<td>Iryna Zenyuk, Assistant Professor, Department of Mechanical Engineering</td>
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<td></td>
</tr>
<tr>
<td>CAREER: The Mechanics and Control of Cell Dispersal</td>
<td>Jeffrey Guasto, Assistant Professor, Department of Mechanical Engineering</td>
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</tr>
<tr>
<td>CAREER: Self-Assembly of Zwitterionic Amphiphilic Copolymers for Membranes with Sharp, Tunable Pore Size</td>
<td>Ayse Asatekin, Assistant Professor, Department of Chemical and Biological Engineering</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
We would like to thank the following donors for their generous contributions to the CEEOE between July 1, 2016 and June 30, 2017.

**Corporate and Foundation Donations**
- Idea Couture
- LEGO Education
- Sun, Moon & Stars Foundation, Inc.
- Move the World Foundation
- James S. McDonnell Family Foundation
- National Instruments
- PTC
- Leila Shakkour, Michael Thorne, and the LLL Foundation
- Fund of Tides Foundation

**Alumni and Friends Donations**
- Ethan E. Danahy
- Jeannie H. Diefenderfer
- Molly J. Douglas
- Eric P. Fournier
- Hannah A. Garfield
- David Hammer
- Lauren Hammer
- William A. Hsu
- Brian C. Lim
- Michael J. Mogenson
- Jill M. Pappas
- Thomas L. Pappas
- Danielle A. Pike
- Merredith D. Portsmore
- Jessica M. Scolnic
- Magee Shalhoub
- Susan B. Tse

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