Annual Report
July 1, 2012 - June 30, 2013
2013 Fiscal Year

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

I always knew the CCEO was a busy place but when I moved into the Director’s Office, which has a clear view of our entryway, I was reminded of how many people work at the Center. During the academic year, there is a near constant stream of undergraduate students coming in and out to work on projects, transcribe video or prepare for teaching a STOMP classroom; graduate students move between classes, meetings, and long hours of data analysis or coding; operations staff work at answering phones, greeting visitors, booking travel, checking budgets, and hiring new student workers; other staff members and post doctoral associates are running between projects, school visits, teacher professional developments and workshops for students; and faculty members rush between meetings, classes, work with students, grant writing and more. In FY 2013 we had 134 students, staff and faculty contributing to the significant accomplishments within engineering research, education research, and outreach.

In engineering, we worked on the development of a wireless LEGO-based robotics option for younger students, touch tables, just-in-time tutorials for engineering design challenges using LabVIEW, and the new LEGO robotics platform (EV3). InterLACE is making wonderful progress on their web-based tool as well as on the collection of data on its impact on learning in science classrooms. On the educational research side, Integrating Engineering and Literacy continued to add new teachers and worked on submitting three journal publications on the research findings. We also added a new research project looking at the impact of robotics on the social skills of children with Autism Spectrum Disorders. Within outreach, we saw STOMP continue to grow and the second cohort of Master’s of Arts in Teaching Engineering come through.

The new organizational structure of the CCEO has allowed us some time and bandwidth to think about returning current CCEO projects as well as some new goals for FY 2014 that will advance our work. STOMP, which has been enormously successful to date, will look to refine its classroom model and the way that we collect data about it’s impact. We also will be looking to expand the reach of the CCEO through participation with other STEM organizations, and by creating materials and courses to give more teachers access to our work. We’re also getting excited about MakerSpaces and how we can influence the technology and the research in that area. Finally, we’re making new efforts to take the research methodology we use in K-12 to college classrooms to carefully study how college engineering students engage in engineering design.

The CCEO’s many faces have changed over the year. We had six students graduate with master’s degrees – four in Mechanical Engineering, one in Computer Science, and one in Science Education. In January 2013 Dr. R. Benjamin Shapiro, the new McDonnell Family Professor of Engineering Education arrived at Tufts. Ben joined the Department of Computer Science as an Assistant Professor and will also spend time at the CCEO. All our new activity has necessitated new support and Lynne Ramsey, a long time temporary employee, became a full-time office assistant to support Magee Giarrosso. Next year, we will also be adding two teachers, on leave from teaching, to our staff to help with upcoming outreach initiatives. Chris Rogers will be on sabbatical for the 2013/2014 academic year making visits to Switzerland, Australia, Japan and more – all fodder for next year’s annual report.

We’re excited about welcoming a new cohort of graduate students in Education, Computer Science, and Mechanical Engineering and kicking off some new projects and ideas that are brewing for the coming year.

Sincerely,

Merredith Portsmore
CCEO Associate Director
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Thank You to our Donors ............................. 30
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.

**KIDS CAN...**
CEEO People and Organization: Fiscal Year 2013

Advisory Board Members

Ray Almgren
Vice President of Development & Academic Relations, National Instruments

Barbara Brizuela
Associate Professor & Chair in Education, Tufts University

Masao Ishihara
President, Learning Systems

Steve Karol
Managing Partner & Founder, Watermill Group

Jens Maibom
LEGO Foundation

John McDonnell
Former Chairman & CEO of McDonnell Douglas Corporation

Ioannis Miaoulis
President & Director of Boston Museum of Science

Stacey Morse
Tufts Engineering Alum

Bill Wulf
Professor of Computer Science, University of Virginia

Faculty & Teacher Partners

Linda Beardsley
Professor of Education, Tufts

Marina Bers
Associate Professor of Child Development, Tufts

Barbara Bratzel
8th Grade Physics Teacher, Boston

Roula Choueiri
Assistant Professor, Tufts School of Medicine

Gary Garber
Physics Teacher, Boston University Academy

Brian Gravel
Lecturer in Education & Director of Elementary Education, Tufts

Daniel Hannon
Professor of the Practice in Human Factors Engineering, Tufts

William Messner
Department Chair and Professor of Mechanical Engineering, Tufts

Paul Lehrman
Lecturer of Music, Tufts

Chris Swan
Professor of Civil Engineering, Tufts

Rob Torok
Mathematics Teacher, Tasmania

Kristen Bethke Wendell
Assistant Professor of Education, UMass Boston

Michelle Wilkerson-Jerde
Assistant Professor of Education, Tufts
## CEEO’s Impact at a Glance

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>CEEO students that have or are currently pursuing degrees in the Tufts STEM Education program.</td>
</tr>
<tr>
<td>192</td>
<td>Countries with at least one visitor to CEEO websites in 2011.</td>
</tr>
<tr>
<td>5,200</td>
<td>Educators who have participated in LEGO Engineering Conferences and Symposia since they began in 2004.</td>
</tr>
<tr>
<td>8,300</td>
<td>K-12 students in the Boston area impacted by STOMP since its inception in 2001.</td>
</tr>
<tr>
<td>317,513</td>
<td>Visits to CEEO websites from July 1, 2012 - June 30, 2013.</td>
</tr>
</tbody>
</table>

### How Popular are our Websites in the World?

Top 10 viewed Countries:
- United States
- Canada
- Brazil
- Australia
- United Kingdom
- France
- Spain
- Germany
- China
- Russia

Total Visitors: 317,500

July 2012 - June 2013

#### Who are our top hitters?

- **Tufts**
  - Total Visits: 35,400

- **LEGO®engineering**
  - Total Visits: 266,600
Project and Program Overview: FY 2013 Milestones

New Grants
- Creation of Interactive Content to Support More Discussion-Based Instruction in Engineering, Tufts Innovates
- Bringing LEGO Engineering to AB Combs School, LEGO Education and LEGO Education North America
- Changing the Classroom: Building Student-led Learning, National Collegiate Inventors and Innovators Alliance (NCIIA)

New Gifts
- **BotLab**: CEEO and the Mechanical Engineering Department at Tufts support a space on campus for students to have the opportunity to build, program, hack and play with different engineering platforms. The money was given from the Tufts SOE Dean’s Office to help support materials for the BotLab.
- **Sharing Website for Teaching Engineering**: The McDonnell Foundation is funding the development and support of a sharing website for the teaching of engineering. This money will be used to pay for a full time web developer.
- **Simple Robotics Course**: The Dean's Office gave money to Prof. Danahy to support his Freshman Robotics course through funding TAs and materials.

Closed Grants
- Service Learning Grant, NSF
- SET Camps Support Services, WFD Corporations
- Summer of Innovation Pilot, NASA

Workshops and Symposia in FY2013

<table>
<thead>
<tr>
<th>Event</th>
<th>Dates</th>
<th>Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Elementary Robotics AM</td>
<td>July 10-12, 2012</td>
<td>Grades 1-2</td>
</tr>
<tr>
<td>Early Elementary Robotics PM</td>
<td>July 10-12, 2012</td>
<td>Grades 1-2</td>
</tr>
<tr>
<td>Co-Ed Robotics</td>
<td>July 16-20, 2012</td>
<td>Grades 3-8</td>
</tr>
<tr>
<td>Co-Ed Robotics</td>
<td>July 23-27, 2012</td>
<td>Grades 3-8</td>
</tr>
<tr>
<td>2012 Summer LEGO Engineering Institute for Educators</td>
<td>July 30-August 3, 2012</td>
<td></td>
</tr>
<tr>
<td>W-STOMP Summer Camp for Girls</td>
<td>August 6-10, 2012</td>
<td>Grades 3-6</td>
</tr>
<tr>
<td>Meet, Greet, &amp; Build w/ an Astronaut</td>
<td>August 15, 2012</td>
<td>Grades 5-8 &amp; Grades 9-12</td>
</tr>
<tr>
<td>PaperBots</td>
<td>October 27, 2012</td>
<td>Grades 5-6</td>
</tr>
<tr>
<td>ES93 Prototypes</td>
<td>December 3, 2012</td>
<td>Ages 4-8</td>
</tr>
<tr>
<td>ES93 Final Projects</td>
<td>December 10, 2012</td>
<td>Ages 4-8</td>
</tr>
<tr>
<td>Toy Testing for Japanese Guest Students</td>
<td>March 22, 2013</td>
<td>Ages 5-8</td>
</tr>
<tr>
<td>LEGOs in Space</td>
<td>March 30, 2013</td>
<td>Grades 4-6</td>
</tr>
<tr>
<td>W-STOMP Lilypad Workshop</td>
<td>March 30, 2013</td>
<td>Grades 3-7</td>
</tr>
<tr>
<td>Science and Engineering Workshop</td>
<td>April 16-19, 2013</td>
<td>Grades 4-6</td>
</tr>
</tbody>
</table>
Graduating Students of FY 2013

2013 CEEO Graduates

Steve Boardman, M.S. in Mechanical Engineering
Thesis: The Use of a Large Multi-Touch Surface for Classroom Education
Currently: Looking for a Mechanical Engineering position in Robotics/MedTech

Danielle Dowling, M.S. in Science Education
Thesis: Teacher Noticing and Classroom Communication Systems: How They Can Inform Each Other
Currently: Looking for a position in learning technologies

Eric Fournier, M.S. in Mechanical Engineering
Thesis: Injectable Silk Foams for the Treatment of Cervical Insufficiency
Currently: Mechanical Engineer at MX Orthopedics

Jessica Noble, M.S. in Mechanical Engineering
Thesis: Building a LEGO-Based robotics platform for a 3rd grade classroom
Currently: Software Associate at Wayfair, LLC.

Brian O’Connell, M.S. in Mechanical Engineering
Thesis: The Development of the PaperBots Robotics Kit for Inexpensive Robotics Education Activities for Elementary Students
Currently: Pursuing a PhD in Engineering Education at Tufts University

Rafi Yagudin, M.S. in Computer Science
Thesis: SmartPost: An Authoring Tool for Online Education Communities
Currently: Software Developer and Researcher at Tufts University CEEO

New Graduate Students at CEEO

Chelsea Andrews, pursuing PhD in Engineering Education, Expeditionary Learning Project
B.S., Ocean Engineering, Texas A&M University, Texas
M.S. Civil and Environmental Engineering, MIT, Massachusetts

William Church, pursuing Master’s in Mechanical Engineering, LabVIEW Education Project
B.S., Physics, Binghamton University, New York
MAT, Curriculum and Instruction, Cornell University, New York

Whitney Crooks pursuing Master’s in Mechanical Engineering, IGERT Project
B.S., Mechanical Engineering, Washington University, Missouri

Saad Farooq, pursuing PhD in Computer Science, InterLACE Project
B.S., Electrical Engineering, NED University of Engineering & Technology, Pakistan
M.S., IT, Carnegie Mellon University, Australia

Timothy Hellickson, pursuing Master’s in Mechanical Engineering, Service Learning
B.S. Mechanical Engineering, University of Idaho, Idaho

Chris Smith, pursuing Master’s in Mechanical Engineering, Baxter Programmer
B.S. Mechanical Engineering, Tufts University, Massachusetts
Checking in with our CEEO Alumni

Adam Carberry, CEEO Alumni from Tufts University MSTE PhD Program

Adam Carberry served as the CEEO’s STOMP program manager and initiated some of the first college-level engineering education research on service learning at Tufts. After graduating with his doctorate from Tufts MSTE program in 2010, he headed west to take a post-doctoral position at Arizona State University where he went on to become an Assistant Professor in the Department of Engineering and Computing Systems in the College of Technology and Innovation. We caught up with Adam to hear about his latest research in teaching.

Adam is currently working on two NSF funded research projects looking at ideas in undergraduate engineering education – one on Product Archaeology and one on “Just in Time” teaching. The Product Archaeology work challenges students in an engineering design course to dissect a product and depict its evolution. Adam says, “The goal is to really get students away from designing for themselves and think about how a product was designed and for whom.” His “Just in Time” project looks at instructional techniques that can give an educator formative feedback about what students are understanding in a given class. One technique he is working on is “Muddiest Point Reflection”, which asks students to reflect on what was the most confusing part of a class. Adam uses new online tools to collect students’ reflections on his Materials Science classes to determine what concepts he should recover in the next class in a new way. According to Adam, “Typically students identify concepts that are hard to visualize so I’ll make new slides, use YouTube videos that colleagues have made or identify other simulations to present the material they identify as challenging again, but in a different way.”

There are a number of other projects and grants that Adam is working on, including a collaboration with fellow CEEO Alumni at other institutions. He is currently working with Morgan Hynes (Purdue) and Kristen Wendell (UMass Boston) on a project that assesses and categorizes the design processes of different engineering learners.

In all his work, Adam is committed to changing engineering education, “I want to help completely transform the way people view engineering education as well as what we focus on. The ideas of beliefs, self-efficacy, and motivation -- if we look at these factors and assess how they impact students learning in engineering, we are going to force programs to change the way they teach to the benefit of students.”

As he continues to experience success at ASU, Adam reflected on his time at Tufts, “The CEEO really prepared all of us to be successful in academia because of the opportunities the CEEO afforded us. Grant writing, teaching courses, managing your time.” He also still plays Ultimate Frisbee regularly.

New Faculty Positions for CEEO Alumni

Chris Wright received an Assistant Professor position at the University of Tennessee, Knoxville College of Education, Health, and Human Sciences in the Department of Theory and Practice in Teacher Education.

Morgan Hynes received an Assistant Professor position in Engineering Education at Purdue University’s School of Engineering Education.
Highlights of FY 2013

In FY 2013 we had some exciting new developments at the CEEO: three very strong students took on the Master’s of Art in Teaching, CEEO graduate students Bill Church and Jessica Noble made great strides in their research, LEGO launched EV3 with CEEO’s development advice, our grant focusing on children on the Autism Spectrum launched, PETE grants helped Tufts students get excited to teach engineering, and W-STOMP continued to engage with 4th and 5th grade girls.

Master’s of Art in Teaching (MAT)

The Master’s of Art in Teaching (MAT) Engineering program graduated its first teachers in May 2011. Both teachers are now teaching engineering in high schools. Steve Cogger is at Reading Memorial High School, and Tim Norton is at Stoughton High School. We are very proud to call them alumni of the MAT in Engineering program as they are both establishing themselves as leaders in engineering education in the state.

The program matriculated three very strong students for the 2012-13 school year. Jennifer Bunting, a former middle school technology teacher in Waltham, brings a wealth of teaching experience she shares with fellow students Jeremy Shaw and Heather Lambert as they begin teaching for the first time. Heather and Jeremy are both engineers planning a career change to pursue teaching. Heather, a former NASA aeronautics engineer, brings deep engineering knowledge and experience as well as a passion for introducing girls to engineering. Jeremy’s work as a nuclear power engineer along with his youthful energy have served him well as he makes his mark on a developing pre-engineering program as a full-time intern at Somerville High School.

We continue to develop new partnerships with local schools and teachers to strengthen the programmatic opportunities as well as the employment opportunities for our graduates. Our partnership with Somerville High School has proven fruitful, as we have worked with them in creating a new pre-engineering program, which Jeremy spearheaded with another one of their teachers. Undergraduate Ethan Peritz, pursing a future with Teach for America, worked on developing a four-year curriculum for Somerville that approaches engineering through service-learning.
Highlights at a Glance

Highlights of FY 2013

Wireless WeDo

CEEEO Graduate Student, Jessica Noble, completed her masters thesis early in the 2013 fiscal year, developing a prototype for an iPad wirelessly controlling LEGO WeDo motors. The final product allowed students to program motors and sensors on the iPad and then send the information wirelessly down to an intelligent box that would then control the motors. The box also had four buttons that allowed students to turn the motors on and off without any programming. Jessica now is a software developer at Wayfair, LLC.

New EV3 LEGO Mindstorms Product

LEGO announced a new LEGO Mindstorms product, EV3, in January which was officially made available in Fall 2013. The CEEEO has been involved with the development since its inception. While there are a number of cool hardware improvements (including faster construction and much more computing power), we are most excited about the changes in the software. The software now contains a Digital Content Area, where students can watch instructional videos or take pictures and write about their inventions. With this new feature, the software can actively support the student, linking to help when needed and allowing the students to share their ideas, inventions, and code. Another exciting addition is the graphical programming component in the Experiment portion of the software. Here, students can see a live plot of sensor values and then program their robot to do different things depending on where in the plot the sensor value is. We are looking forward to bringing the EV3 into our classes at Tufts and beyond with teachers around the world.

High School Physics Teacher Getting Masters in Mechanical Engineering

Bill Church came to CEEEO with 13 years of teaching high school physics in Littleton NH. His goal is to develop a high school/college curriculum that allows students to explore the world of science and engineering through open-ended design projects. These projects are combined with a number of "just-in-time" tutorials that students can use to learn how to program or build simple circuits. The overall goal is to have a curriculum that contains a number of these very structured tutorials, coupled with a smaller number of highly constrained design problems that lead to a single open-ended design problem at the end. Students can enter the curriculum at a number of different levels, depending on their previous experiences and knowledge.
Tufts Collaborates Grant Focuses on Students with Autism Spectrum Disorder

As part of a Tufts Collaborates grant, the CEEO teamed up with Tufts Medical Center to study the effects that robotic design has on the social skills of students with Autism Spectrum Disorders. This past year, the CEEO held a LEGO Robotics Club exclusively for children with Autism Spectrum Disorder between the ages of 7-14. The LEGO Robotics Club was designed to welcome children into a space designed to promote socialization, communication, and of course, robotic building skills. Once a week for 90 minutes, participants would join the LEGO Club and be presented with a challenge. Tasks ranged from building a car that drove itself to a robotic mini golf course to interactive scenes from their favorite movies. Children were given a lot of creative license but were most importantly required to work in pairs or teams to complete this project. Communication was key to a successful project. A second group of children was enrolled in a non-LEGO social skills group to practice social skills such as introductions to others, taking turns, and compromising in tough situations. At the end of the 16-week club, children between the ages 9 to 11 showed the greatest improvements in communicating and socializing with both peers and instructors. Data analysis of videos taken during both the LEGO club and the social skills group are currently being analyzed.

Operations Hires More Staff as CEEO Continues to Grow

As CEEO continues to grow, we were desperately in need of more administrative support. In FY 2013 we were able to hire Lynne Ramsey, who had been a part time temporary employee since summer 2010, as a full time Office Assistant. Lynne received a B.A. in Psychology from Dickinson College. She went on to earn a M.A. from University of Nevada, Reno, in Experimental Psychology. There, she worked on Project Washoe, a research study conducted by Doctors Allen and Beatrix Gardner during which they cross-fostered chimpanzees and taught them American Sign Language. Lynne’s role at the CEEO is to provide support to CEEO staff and students. She assists the Administrative Assistant with purchasing, reimbursements, accounting, and other general office work. We are very excited to have Lynne as a full time staff member part of the CEEO operations team!
Highlights at a Glance

Highlights of FY 2013

Preparing Engineers to Educate Grant Updates

The Preparing Engineers To Educate (PETE) grant from the NSF has included an undergraduate internship experience dubbed the PETErnship for the past two years. Undergraduate engineering students have participated in the program where they work on engineering education projects. The projects range from developing educational technologies for the classroom to creating classroom activities that integrate engineering and literacy.

During the 2011-12 school year there were eight PETErns. Of those eight, four returned and were joined by seven newcomers to form a 2012-13 cohort of 11. Three of the groups (7 students) focused on curriculum development projects. Two groups developed mini Integrating Engineering and Literacy (IEL) activities as precursors to larger IEL projects.

The wind-up toy images to the left come from one group’s reverse engineering activity where students dissect wind-up toys very similar to how Hugo Cabret disassembles toys to construct his automaton in the movie “Hugo”. The activity introduces students to the idea of figuring out how things work through reverse engineering. The students are asked to carefully take apart a wind-up toy documenting and drawing all the parts and pieces. They are then asked to label the pieces with names that make sense to them and include a brief functional description of each part.

R. Benjamin Shapiro Selected for McDonnell Family Professorship in Engineering Education

During Spring 2012, the search for the McDonnell Family Professorship in Engineering Education concluded with the selection and acceptance of R. Benjamin (Ben) Shapiro for the position. Ben joined the Department of Computer Science in January 2013 and works closely with the CEEO. Ben started his academic career at University of California, San Diego, studying computer science and cognitive science. He went on to complete a Ph.D. in Learning Sciences at Northwestern. Most recently, he was a postdoctoral fellow in the Games+Learning+Society group at the Wisconsin Institute for Discovery at the University of Wisconsin, Madison. Ben’s research focuses on playful and constructivist learning environments. More on Ben’s work can be found at http://benshapi.ro/.

W-STOMP Engages 5th - 7th Grade Girls in Engineering

W-STOMP, funded by Verizon, focused on leveraging STOMP’s high percentage of female undergraduate students to engage 5th and 7th grade girls in engineering through traditional STOMP in their classroom. These girls were also invited to a special summer program that extended their experience. The first year, we had 8 participating classrooms and 18 girls participate in the summer extension. This showcased a new way to combine formal and informal education. We have been able to sustain many of the W-STOMP initiatives through traditional STOMP and with financial support of our other CEEO camps and workshops. A majority of our W-STOMP girls returned for another week long program during the summer of 2013, which is a strong indicator of how this ongoing model is working. This year’s program culminated with designing solutions for real dogs – like how to help graduate student Chelsea Andrews’ dog Elphaba keep bugs out of her food.
InterLACE: Interactive Learning and Collaboration Environment Grant

Project Development in FY 2013

Overview of InterLACE
The four-year InterLACE (Interactive Learning and Collaboration Environment) project, funded by the National Science Foundation (NSF) under grant #1119321, started in fall 2011 and over the last two years has seen significant developments in the creation of an online web-based sharing platform, and implementation within classrooms. The project also includes continuing educational research investigations into the impact of more open-ended, inquiry-based, computer-supported collaborative learning in high-school physics.

InterLACE Use
In addition to the high school physics classrooms being targeted under the NSF research, the InterLACE platform has been leveraged in a variety of other scenarios, from use in the PI’s own university classrooms (Ethan Danahy’s first-year robotics course, Dan Hannon’s human factors engineering, and Morgan Hynes’ graduate-level education seminar), to use in CEEO brainstorming sessions, to tracking progress throughout group-based development projects. Since launching the platform in January of 2012, the first year and a half of use has seen some impressive statistics, despite still being a system closed to the general public.

InterLACE Usage: January 2012 to June 2013

<table>
<thead>
<tr>
<th>Lessons</th>
<th>Class Sessions</th>
<th>Participants</th>
<th>Posts</th>
<th>Uploaded Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>386</td>
<td>771</td>
<td>1,390</td>
<td>30,284</td>
<td>8,322</td>
</tr>
</tbody>
</table>

InterLACE Interface Design
Throughout this same time period, the interface itself has developed significantly, leveraging the feedback from our initial Design Team Teachers to better address their classroom style, structure, and activities. For more information about these changes visit the site at int.erlandace.com and see a demonstration of many features at http://www.youtube.com/watch?v=CaANnbp9ZD4.

On-Going Research
Additionally, we have been carrying out a variety of design experiments examining the use of the platform. One study is focused on documenting teachers’ use of InterLACE to understand and support student thinking. A second study uses InterLACE content and social network analysis to evaluate the use of InterLACE for formative assessment of student learning and participation. The third investigates the use of InterLACE to support student collaboration and interactivity. All of these efforts have utilized semi-automated analysis of InterLACE posts to provide both teachers and researchers with data visualizations and formative assessment tools for identifying patterns of activity that correspond to meaningful learning and knowledge construction.
InterLACE: Interactive Learning and Collaboration Environment Grant

Meet the InterLACE Graduate Students

Graduate Students
Three graduate students have provided major support for the project over the last two years.

Danielle Dowling is a master's candidate who started in the Tufts University Math, Science, Technology, and Engineering (MSTE) Education Program in fall of 2011. After nearly 20 years as a journalist, Danielle decided to return to school to earn a second bachelor's degree in physics, which she received in the spring of 2011 from Hunter College in New York City.

After working nine years as a professional software engineer and Web developer, Eric Coopey joined Tufts in fall of 2011 to pursue a Ph.D. in Computer Science. His background spans a wide range of industries: from global corporations to world-class universities. He received a B.S. in Management Science and Information Systems from Pennsylvania State University in 2002 and M.S. in Computer Science from Case Western Reserve University in 2010.

Saad Farooq is pursuing a Ph.D. in Computer Science at Tufts University, starting in Fall 2012, after completing a bachelor's degree in Electrical Engineering from NED University in Pakistan and a Masters Degree in IT from Carnegie Mellon University (at their Australia campus).

User Feedback
Here are some quotes from our teacher and student users

I found InterLACE useful to just dump all the data into the workspace so we could focus more on the lab. When you go home, then you can reflect on the work and then make the lab notebook. It's a two-stage process. Pictures are really useful.

I like InterLACE because it can be used as an archive, so you can go back and look up stuff.

With InterLACE it's a lot easier to get a word in during class because the teachers only get to call on one person. Also, you get a second try without that awkward moment where the teacher is prodding you, putting you on the spot.

I learned the most when we talked about things after posting in InterLACE and made sure we were all on the same page. We are all right on our own but sometimes it's important to hear the teacher weigh in.

It's really helpful if there's a concept I don't understand, my friend has already translated it in terms I probably can understand. For homework, I post my best idea and then revise it based on what I learn from others.
We decided to feature STOMP in this year’s annual report as our oldest CEEO program that is currently figuring out how to take its next steps forward.

When the Student Teacher Outreach Mentorship Program (STOMP) started in 2001, engineering education was just starting to gain traction in K-12 education on a local and national scale. During the first year of STOMP we sent just five engineering students into three classrooms. They were supporting teachers using LEGO RCX and the CEEO’s ROBOLAB software. Fast forward twelve years later and this past year (FY 2013). STOMP had 48 Tufts students (called STOMP Fellows or STOMPers) serving 22 classrooms in Medford, Somerville, Boston, Winchester, and Cambridge, impacting 480 students in 1st through 8th grade. LEGO, in the form of WeDO and NXT kits, is still one of the technologies that STOMPers take into the classroom but we also see STOMP fellows supporting literacy-based engineering work (from our Integrating Engineering and Literacy project), Service Learning experiences (where students identify problems in their school and design solutions), and trying out new technologies and curricula from other research projects at Tufts. The STOMP program has come a long way in twelve years and along the way we’ve had nearly 300 STOMP fellows and 140 teachers team up to serve over 3500 area students.

STOMP has always had a lens toward improving and innovating the STOMP model. What started as a just matching willing undergrads with teacher requests has evolved to include weekly talks, seminars, and group work that supports STOMPers developing understandings of learning, teaching, and the inner workings of schools.
One of the hallmarks of STOMP that has emerged over the years is that we see STOMP impacting all 3 stakeholders. It provides a chance for K-12 students to design and innovate, it provides teachers with a way to try engineering, and it provides STOMP fellows with a service-learning experience that strengthens their engineering technical and professional skills.

This 3-way partnership is one of the things that both the CEEO and STOMPers value. However, it has proven challenging in terms of sustainability and metrics for success. Do we measure students’ interest in engineering? Their achievement in school? Or do we look at how STOMP helps increase teachers’ comfort with teaching engineering? Or do we focus on assessing STOMPers perceived benefit from participating in STOMP? To date, in an effort to keep STOMP costs low and a general lack of consensus over which group we should focus on for evaluation, we have not engaged in substantive measures for evaluating the impact or effectiveness of STOMP. Since it’s inception, STOMP has been funded by gifts and a few corporate foundation grants with limited requirements for metrics of success. However, as we engage Tufts faculty in funding STOMP positions through federal grants and look to engage new donors in giving to STOMP, we need to take a hard look at how we can better measure and report on the impact of STOMP. To that end we will be forming a STOMP Advisory Board that will look at issues of sustainability and evaluation as well as programmatic issues with STOMP. This group will convene in 2014 and be comprised of former STOMP members, faculty in engineering and education, and those who have helped sustain STOMP through their donations.

STOMP has been one of the CEEO’s most successful and innovative outreach programs. It’s 12 year history is a result of the hard work of numerous faculty, staff, graduate students and most of all our dedicated group of undergraduates. We’re hoping with the establishment of the STOMP Advisory Board we can see STOMP continue, grow, and improve over the next 10 years.

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Checking in with our STOMP Alum

Elsa Head (E09, G11, G12) – Elsa Head spent 3 years as an undergraduate in STOMP before going on to spend 2 years as the STOMP manager while getting her Master’s in Engineering Education at Tufts. She went on to get her MAT in Middle School Mathematics and is currently teaching at the Vassal Lane Upper School in Cambridge. Thinking about her time at STOMP, Elsa said “STOMP was a huge part of me figuring out what I wanted to do life. Through STOMP and the CEEO I learned that I love teaching, thinking about learning, and figuring out how my students are thinking.”
Press and Publications FY 2013

CEEO in the News

The CEEO was recognized both internally and externally to Tufts during FY 2013. The list below identifies areas where the CEEO was in the news.

Tufts Alumni (July 15, 2012) -- Prof. Danahy in Beijing, China for Tufts Alumni Event

Tufts Jumble (July 24, 2012) -- Engineering Land Movie

iCreate to Educate (July 24, 2012) -- SAM Animation and LEGO bring Engineering to Life

PRNewswire (July 30, 2012) -- NASA Brings Wonder of Space Station to Boston

NASA.gov (August 1, 2012) -- NASA astronaut Mike Foreman will be at the CEEO

Wickedlocal/Somerville (August 14, 2012) -- Somerville Kids Learn Engineering with LEGO

Insidemedford.com (August 14, 2012) -- Astronaut Visits Tufts, Works with Young Students

Somerville.patch.com (August 15, 2012) -- NASA Astronaut to Discuss LEGO in Space at Tufts

Tufts Daily (September 12, 2012) -- Professor Ethan Danahy is interviewed on his course ‘Simple Robotics’

Tufts Tisch College Newsletter (September 24, 2012) -- Re-engineering Engineering Education

Albawada.com (October 16, 2012) -- Professor Ethan Danahy gives a lecture in Jordan

Business Insider (October 29, 2012) -- Changing How We Think About Education

Tufts Jumble (November 14, 2012) -- CEEO Haunted House

Conservatory Lab: Scholars in Action (December, 2012) -- First Grade Engineers Help Three Little Pigs

Communications of the ACM (December 20, 2012) -- Education as Engineering: The Benefits of Combining Education with Engineering

Tufts Jumble (December 21, 2012) -- The Robot that Played the Violin


BostInno (January 7, 2013) -- 13 Accounts to Follow for All Things Entrepreneurship at Tufts

EurekAlert and Tufts Now (January 10, 2013) -- Lack of Guidelines Create Ethical Dilemmas in Social Network-Based Research

St. Louis Business Journal (January 11, 2013) -- McDonnell Foundation gifts $3 million to Tufts University

University of Wisconsin-Madison News (January 11, 2013) -- Scholars Call for New Ethical Guidelines to Direct Research on Social Networking

TechCrunch and AOL (January 13, 2013) -- The Playsurface Brings a Lot More to the Touchscreen Table Than Just Touch Video

Rascal Micro Blog (January 15, 2013) -- The First Rascal Hackathon at Tufts University

Computing Education Blog (January 17, 2013) -- First Endowed Chair CS Ed Professor, Ben Shapiro at Tufts
CEEO in the News

Tufts SOE Engineering E-News (February, 2013) -- Computer Science

Tufts SOE Engineering E-News (February, 2013) -- Center for Engineering Education and Outreach

Tufts SOE Engineering E-News (February, 2013) -- Lack of Guidelines Create Ethical Dilemmas in Social Network-Based Research

Tufts Daily (February 4, 2013) -- McDonnell Professor Selected

Tufts Daily (February 12, 2013) -- Massive Open Online Courses Pioneer in Education Technology

Sparkfun.com (February 26, 2013) -- SparkFun at Make a MakerSpace, hosted by Artisan’s Asylum, Part 2

Tufts Daily (February 28, 2013) -- Babak Moaven Receives NSF Grant and Uses CEEO Resources for Engineering Research

Gulf Times and The Peninsula (March, 2013) -- Ethan Danahy's Visit to ICT in Education

Kaleej Times (March 10, 2013) -- GESS Records Another Growth Year

Wired (March 13, 2013) -- GeekDad Discussion at Dinner: Stop the Spinning!

Tufts Tisch College Newsletter (March 19, 2013) -- Tufts Earns Place on National Community Service Honor Roll

EdWeek.org (March 28, 2013) -- Engineering Builds Steam in K-12 Education, STOMP

LEGO Education UK (April 1, 2013) -- Robotics Students Take on Dr. E’s Challenges

ConnectedLearning.tv (April 2, 2013) -- Ethan Danahy, Ben Shapiro & Brian O’Connell Sit on Virtual Panel for “Choice Based Assessments”

Tufts Now (April 9, 2013) -- Students Vs. Robots

Tufts Tisch College Newsletter (April 9, 2013) -- STOMPing Problems in Engineering Education

Rethink Robotics (April 25, 2013) -- Baxter and Chris Smith photo


Smithsonian Magazine (May 1, 2013) -- Chris Rogers Discuss LEGO Robotics and Engineering Education

Tufts Tisch College Newsletter (May 2, 2013) -- Presidential Awards: Ethan Peritz

LEGO Education UK (May 4, 2013) -- What’s New in the World of LEGO Education

IEEE Spectrum (May 6, 2013) -- Rethink Robotics Opens Up Baxter Robot For Researchers

Kickstarter: BrickPi (May 18, 2013) -- BrickPi in Boston and Baxter

Education Week (May 21, 2013) -- Engineering Building a Foundation in K-12 Curricula

QUEST: Exploring the Science of Sustainability (June 19, 2013) -- Gamers Going Green: New Video Game Turns Players Into Biofuel Farmers
Publications and Presentations by CEEO Authors in FY 2013


Danahy, E. (2012). Creativity in Retail: Preparing the Workforce for Innovation in Industry. Presentation at Retail Lab, Mexico City, Mexico.


Danahy, E. (2013). Flipping the University Engineering Classroom. Presentation at the Polytechnic Summit 2013, Boston, MA.

Publications and Presentations by CEEO Authors in FY 2013


Danahy, E. (2013). Integrating LEGO Robotics into School Classrooms. Presentation at GESS 2013, Dubai, UAE.


**FY 2013 Financials: Overview of Revenue and Expenses**

**Statement of Activities**

FY 2013 brought in more growth for CEEO. We received new support from LEGO, NSF, USAID, Autism Speaks and 2 internal grants from Tufts University. Our personnel expenses increased with the addition of more graduate students to the CEEO and we also hired an new office assistant, Lynne Ramsey, as a full time staff member which is reflected in the increase of administrative staff expenses.

<table>
<thead>
<tr>
<th>Revenue</th>
<th>FY2013</th>
<th>FY2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Royalties</td>
<td>$40,632</td>
<td>$14,858</td>
</tr>
<tr>
<td>Fees</td>
<td>$55,451</td>
<td>$66,440</td>
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<tr>
<td>Private Grants</td>
<td>$169,829</td>
<td>$158,166</td>
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<tr>
<td>Government Grants</td>
<td>$1,275,935</td>
<td>$1,382,317</td>
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<td>Tufts SOE Dean’s Office</td>
<td>$143,199</td>
<td>$133,717</td>
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<tr>
<td>Tufts University Funding</td>
<td>$43,919</td>
<td>$56,329</td>
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<tr>
<td>Endowment</td>
<td>$20,924</td>
<td>$21,053</td>
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<tr>
<td>Gifts</td>
<td>$408,736</td>
<td>$716,593</td>
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</table>

**Total Revenues**

$2,138,209 $2,549,473

<table>
<thead>
<tr>
<th>InKind Support</th>
<th>FY2013</th>
<th>FY2012</th>
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</thead>
<tbody>
<tr>
<td>LEGO</td>
<td>$25,000</td>
<td>$50,000</td>
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<tr>
<td>NI</td>
<td>$10,000</td>
<td>$10,000</td>
</tr>
</tbody>
</table>

**Total Revenue + InKind**

$2,173,209 $2,609,473

<table>
<thead>
<tr>
<th>Expenses</th>
<th>FY2013</th>
<th>FY2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty</td>
<td>$251,085</td>
<td>$243,029</td>
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<tr>
<td>Staff</td>
<td></td>
<td></td>
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<tr>
<td>Administrative</td>
<td>$177,315</td>
<td>$110,331</td>
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<tr>
<td>Project Staff</td>
<td>$103,051</td>
<td>$118,455</td>
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<td>PostDocs</td>
<td>$75,125</td>
<td>$63,616</td>
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<td>Students</td>
<td>$547,405</td>
<td>$383,704</td>
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<tr>
<td>Teacher Stipends and Consulting</td>
<td>$149,314</td>
<td>$126,183</td>
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<td>Materials</td>
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<td>$91,902</td>
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<tr>
<td>Travel</td>
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<td></td>
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<tr>
<td>Domestic</td>
<td>$38,512</td>
<td>$41,666</td>
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<tr>
<td>International</td>
<td>$6,338</td>
<td>$9,145</td>
</tr>
<tr>
<td>F&amp;A</td>
<td>$384,597</td>
<td>$316,479</td>
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</tbody>
</table>

**Total Expenses**

$1,834,846 $1,504,510
FY 2013 Financials: Overview of Revenue and Expenses

Statement of Activities

Graphs representing: the revenue brought into the CEEO during FY 2013 broken out by funding source; FY 2013 expenses broken down by funding sources; and overall FY 2013 expenses breakdown.

**FY 2013 Revenue**
Total Revenue: $4,969,451

**FY 2013 Expenses Breakdown by Funding Source**

**Overall FY 2013 Expenses**
FY 2013 Balance Overview and Total Commitments for FY 2014-FY 2016

As we wrap up FY 2013, the chart ‘Snapshot of Balance as of June 30, 2012’ shows the ending balance of our accounts. We are still mostly funded by government grants starting FY 2014. Total commitments reflects how much money is contracted to us in 2014-2016 according to our yearly budgeted amount from government grants, private grants, and gifts awarded to the CEEO.
## Grants Applications Submitted in FY 2013

<table>
<thead>
<tr>
<th>Grant Name</th>
<th>Source</th>
<th>Status</th>
<th>Project Years</th>
<th>Total Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEGO Learning Labs</td>
<td>LEGO</td>
<td>Funded</td>
<td>3</td>
<td>$600,000</td>
</tr>
<tr>
<td>Prepare and Inspire: Designing an Integrated and Sustainable STEM Education Model for Indonesia</td>
<td>USAID</td>
<td>Funded</td>
<td>3</td>
<td>$200,974</td>
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<tr>
<td>BioSourcing: A Crowdsourcing Approach to Increase Public Understanding in Computational Biosciences</td>
<td>NSF</td>
<td>Funded</td>
<td>3</td>
<td>$160,467</td>
</tr>
<tr>
<td>Building Collaborative Problem Solving Social Skills with Educational Technologies</td>
<td>Autism Speaks</td>
<td>Funded</td>
<td>2</td>
<td>$115,904</td>
</tr>
<tr>
<td>SBIR Phase I: Interactive Multi-Touch Collaborative Table for Classrooms</td>
<td>NSF</td>
<td>Funded</td>
<td>1</td>
<td>$49,969</td>
</tr>
<tr>
<td>LEGO Engineering in NC</td>
<td>LEGO</td>
<td>Funded</td>
<td>3</td>
<td>$48,969</td>
</tr>
<tr>
<td>LEGO Robotics: Catalyzing Social Communication in Children with Autism</td>
<td>Tufts University</td>
<td>Funded</td>
<td>1</td>
<td>$47,329</td>
</tr>
<tr>
<td>Creation of Interactive Content to Support More Discussion Based Instruction in Engineering</td>
<td>Tufts University</td>
<td>Funded</td>
<td>1</td>
<td>$9,138</td>
</tr>
<tr>
<td>DIP: A Real Time Visualization and Assessment Environment to improve teaching and learning</td>
<td>NSF Cyberlearning</td>
<td>Declined</td>
<td>4</td>
<td>$1,241,082</td>
</tr>
<tr>
<td>NRI-Small: Robust Control of Highly Deformable Robots</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$555,917</td>
</tr>
<tr>
<td>Collaborative Research: Design Epistemologies - How Students Select, Organize, and Use Knowledge in their Design Thinking</td>
<td>NSF</td>
<td>Declined</td>
<td>3</td>
<td>$499,070</td>
</tr>
<tr>
<td>StudentThinking.org</td>
<td>NSF</td>
<td>Declined</td>
<td>2</td>
<td>$449,837</td>
</tr>
<tr>
<td>Inner Visions: A New Interactive Radiology Curriculum for Medical Students</td>
<td>Tufts University</td>
<td>Declined</td>
<td>1</td>
<td>$49,703</td>
</tr>
<tr>
<td>A Collaborative Scientific Inquiry Approach to Interactive Bioscience Curricula</td>
<td>NSF ITEST</td>
<td>Pending</td>
<td>3</td>
<td>$1,199,078</td>
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<tr>
<td>A Video Game for Community Engagement to Improve Local Sustainability Decision-Making</td>
<td>NSF</td>
<td>Pending</td>
<td>2</td>
<td>$875,046</td>
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<tr>
<td>Broadening Participation in Computing with a Programmable Music Instrument Construction Kit</td>
<td>NSF</td>
<td>Pending</td>
<td>3</td>
<td>$496,088</td>
</tr>
</tbody>
</table>
Grants Applications Submitted in FY 2013

Breakdown of Applied to Funding Source

- NSF: 56%
- Tufts University: 19%
- LEGO: 13%
- Autism Speaks: 6%
- USAID: 6%

Grants Applied to in FY2013
Total: $6,598,571

- Funded: $2,570,212
- Declined: $1,232,750
- Pending for FY 2014: $2,795,609
Goals for 2012

CEEO Challenges and Goals for FY 2014
Expanding Our Reach and Pushing Boundaries

As this report highlights, there are numerous projects going on at the CEEO, all of which have goals, research outcomes, and technology prototypes that will develop over the next year. This section focuses on selected CEEO-wide initiatives that will be emphasized in the upcoming year. Featured initiatives center on two main thrusts – expanding our reach to increase the impact of our work and continuing to push the boundaries to reimagine technology and research.

Expanding Our Reach

Our efforts to expand our reach are focused on making sure our work impacts the national conversation on K-12 engineering education, providing more ways for educators to access CEEO-based preparation for teaching engineering and working to improve access to a wider range of teachers and students to our programs.

The National K-12 Conversation: At the K-12 level, the Next Generation Science Standards, which include engineering learning goals for K-12 students, are being adopted by many states in the United States. As the Next Generation Science Standards came to fruition, the CEEO and its work was notably absent from the discussion that led to the formulation of the standards. In an effort to be part of the conversation going forward, we are taking steps to be more involved in groups that are thinking about policy and standards like the American Society for Engineering Education’s (ASEE) K-12 division, the Triangle Coalition, and STEM groups within Massachusetts. Being part of these groups will give us an opportunity to share the outcomes of our research and to champion the particular kind of engineering education that centers on responsive teaching and attention to student thinking that we see as essential for K-12 students and teachers.

Engineering Education for Educators: As particular states and schools move forward with incorporating engineering into K-12 instruction, motivated by Next Generation Science Standards, we want the CEEO research and tools to be accessible to them in their planning and implementation. To this end, we will spend a good portion of next year working on two outreach initiatives. The first is a book comprised of case studies of K-12 students engaged in engineering that could be used in teacher professional development on engineering and the second is an exploration of how CEEO could offer workshops toward certification in teaching engineering.

Participation of Underrepresented Groups in Engineering Education: The CEEO has always been interested in thinking about how we engage underrepresented groups in engineering education. However, our efforts this far have been opportunistic rather than strategic. This year we will be working to form a strategic plan on how we can better include different populations in our work. We have taken initial steps toward this in our outreach work by working to outline a scholarship process and beginning to formalize recruitment strategies for scholarship spots.

Pushing Boundaries

With our unique expertise from faculty in Mechanical Engineering, Human Factors Engineering, Science Education, Computer Science and Engineering Education, the CEEO will spend time in FY 2014 thinking about how we can innovate with college-level engineering education research and Makerspaces.

College-Level Engineering Education Research: The CEEO has had a few college-level research projects but it has not been a focus of our work. This next year we will work to take our approach to K-12 research into the college classroom. Our K-12 work is characterized by the careful study of student thinking through analysis of video of students engaged in engineering design tasks. This approach to research is not currently widely used in the college-level engineering education research community. In the coming year, we are looking to study students at Tufts within Mechanical Engineering that are engaged in design projects at the freshmen, sophomore, and senior level. Formally extending our research to the college-level will not only expand the people impacted by our work but help us form a more cohesive understanding of how engineering practices develop over time.

MakerSpaces for Education: MakerSpace is a popular new word, describing spaces where people can engage in programming and/or building technologies. The CEEO is excited to think about Makerspaces – how they can be used by K-12 students and how they can have a place in schools and universities. Questions framing the technology work include: How do we get young children to use 3-D printers? How do we arrange the space and technologies so that students can explore different projects? How do we create learning materials that support students learning to use technologies, like LEGO or Arduino robots? Research will also begin to explore questions related to how learning happens in the space, how learners approach open-ended projects, and how we can direct the learning by the technologies and resources available in the space.
Thank You to our Donors
We would like to thank the following donors for their generous contributions to the CEEO between July 1, 2012 - June 30, 2013

Corporation and Foundation Donations

Colegato Foundation
James S. McDonnell Family Foundation
LEGO Education
Sarah Hartman
SparkFun Electronics
Sims Family Foundation

Personal Donations

David and Ellen Scolnic
Holly James
Chris and Cathy Rogers