Design and Engineering Workshops
Annual Report
2014-2015
Executive Summary

Design and Engineering Workshops (DEW) comprise one important part of the CEEO’s outreach efforts. Each of our workshops is designed around open-ended engineering challenges that allow students to demonstrate their knowledge and creativity. This year, we hosted over XX workshops and reached almost XXX students and XX teachers.

Our workshops help our research and tool development efforts, and they enable us to engage a wide variety of students in the engineering design process. We also host teacher workshops allowing us to leverage our ideas and think about how we disseminate our work.

This year, we held workshops in our new space at 200 Boston Avenue. The larger space enabled us to accommodate more students and more workshops. We also used Jumbo’s Maker Studio, the CEEO’s new makerspace, to host “Mini-Makers,” a workshop that used technologies such as the 3D printer and the laser cutter. The proximity of the maker studio has allowed us and our students to access a greater variety of resources. We also continued to expand the technology we use. This year, we incorporated materials such as LittleBits and the LEGO StoryStarter kit.

Finally, we over the past year, we increased our publicity efforts. We redesigned the CEEO Outreach website, published a case study on one of our after-school workshops, and created unique laser-cut badges for each of our workshop offerings.
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DEW Team

Elissa Milto- Director of Outreach

Elissa began working with the CEEO in 1999 while she was a classroom teacher at a local school. The following year she entered Tufts as a graduate student at the Center, taking classes in engineering and education, and received a M.Ed in 2002. Elissa has been working as CEEO staff since graduation. Elissa is particularly interested in bringing engineering to elementary students and does this through her work at the CEEO and her children's classrooms.

Daniel Wise- CEEO Educator in Residence

Dan is an Educator in Residence at the CEEO. He comes to us from San Diego, California, where he taught 10th Grade Humanities at High Tech High- a project-based charter school. He previously taught grades 6-9 in public schools in New York City and was the Program Director at Urban Action Academy- a small public high school in Brooklyn. His work with students has been featured in Phi Delta Kappan, on the New York Times website, and in the Harvard Graduate School of Education's Center for Student Work.

Lynne Ramsey- Office Assistant

Lynne received a Bachelor's Degree in Psychology from Dickinson College. She went on to earn a Master's Degree from University of Nevada, Reno, in Experimental Psychology. There, she worked on Project Washoe, a research study conducted by Drs. Allen and Beatrix Gardner during which they cross-fostered chimpanzees and taught them American Sign Language. Lynne began working at the CEEO in the summer of 2010.
Aaron William Johnson- Post-Doctoral Research Associate

Aaron received his Ph.D. in Aeronautics and Astronautics from the Massachusetts Institute of Technology in 2014. His research focused on human-automation interaction in complex aerospace vehicles. Specifically, he investigated how operators changed their visual attention across control mode transitions and the effect this had on flying performance, mental workload, and situation awareness. Aaron also obtained a master's degree from MIT in 2010 and a bachelor's degree from the University of Michigan in 2008, both in aerospace engineering. At MIT, Aaron served as project coordinator for the MIT+K12 project, and also created numerous educational videos about STEM topics. Aaron is also interested in communicating ideas about STEM to broad audiences: he has worked as a freelance writer and has presented his sports analytics research at the MIT Sloan Sports Analytics Conference and on ESPN2's "Numbers Never Lie."

Barbara Bratzel- Partner Educator

Barbara is a science teacher at the Shady Hill School, a preK-8 independent school in Cambridge, Massachusetts. In addition, she is a consulting teacher at the CEEO. Her most recent book, STEM by Design, is a collection of classroom activities using the LEGO EV3.

Richard Danahy- Partner Educator

Richard has been teaching high school physics for the past 23 years. He currently works at the Sant Bani School in New Hampshire. He studied Nuclear Engineering at the Lowell Technical Institute.
Matthew Mueller- Graduate Student in Mechanical Engineering

Matt just graduated from Tufts University School of Engineering with a B.S. in Mechanical Engineering and a minor in Engineering Education, and he will stay at Tufts working towards a PhD in Mechanical Engineering. He has been involved in the CEEO since my freshman year with an intro LEGO robotics course and STOMP, and continued working on various projects throughout his four years. In his free time he bikes when it's warm, snowboards when it's cold, and loves making and listening to music in any weather.

Jessica Swenson- Graduate Student in Mechanical Engineering

Jessica found her love of engineering education through running a summer program for girls through the Society of Women Engineers at Northwestern. A proud Minnesotan, she likes baking, synchronized skating, and the outdoors.

Merredith Portmore- Director of the Center for Engineering Education and Outreach

Merredith earned both a B.S. in Mechanical Engineering and B.A. in English from Tufts University in 1998. Merredith has also received her M.A. in Education from Tufts University in 1999. She completed her PhD in Engineering Education in 2010. She currently resides in Chelmsford, MA with her husband Dan and sons Austin and Connor.

Brian O’Connell- Graduate Student in Mechanical Engineering

Brian received his B.S. in Mechanical Engineering at the University of Massachusetts at Amherst. During his tenure there, he was a trumpet player and section leader in the UMass Minuteman Marching Band. As a member of UMass Amherst's chapter of the National Honorary Service Fraternity of Kappa Kappa Psi, he served in elected offices at both the local and district level. After 5 years of designing periscopes and optronic masts
for US and foreign navies, he found that industry no longer appealed to him as it once had. This led to
some examination of his life and the discovery of how much education still interested him. This
realization led him to Tufts University as a graduate student in Mechanical Engineering. He has
completed his MS and is continuing with Tufts as a PhD focusing on makerspaces as interactive learning
environments
Mission

Our design and engineering workshops are intended to engage students and teachers in creative engineering activities. To attract as wide an audience as possible, including populations that might not otherwise be interested in engineering, we have a variety of themes and materials.

Our workshops for students allow us to engage young people and excite them about engineering. Each workshop consists of open-ended design challenges and ends with an exhibition for families and guests.

Many of these workshops are revenue-generating, with each workshop allocating some room for scholarships. Other workshops are explicitly designed so that we can test new products and ideas. For example, we held a workshop to see how students with high-functioning autism-spectrum disorders respond to robotics. We also, in collaboration with LEGO, hosted a workshop to test ideas for their new StoryStarter product. All of our workshops with students inform our approach to engineering education, including how we reach out to groups that are traditionally underrepresented in STEM fields.

We also offer workshops for teachers. Like our workshops for students, these allow us to reach a wide audience, test new ideas, generate revenue, and disseminate best practices. Workshops this year included trainings with the LEGO EV3, and Novel Engineering - based on our Integrating Engineering and Literacy grant.
Professional Development

LEGO Engineering Institute

Tufts University's CEEO Summer LEGO Engineering Institute gives teachers the background they need to make effective use of LEGO robotics in their classrooms. Through hands-on, open-ended design projects, participants will learn engineering concepts, LEGO hardware & software, and related pedagogy. Throughout, we will focus on effective classroom implementation: how to share these concepts with students in an approachable and creative way.

In the Beginning EV3 Workshop, participants will learn the basics of LEGO programming, building, and data logging, including the use of motors, sensors, and gears. Classroom management will also be discussed—running multi-day open-ended projects, appealing to both girls and boys, grouping students effectively, organizing and storing materials. Sample project: attach a gyro sensor and markers to a simple car and program it to draw spirograph designs.

In the Intermediate EV3 Workshops, participants will build on their previous experience, learning more advanced programming, building, and data-logging techniques. Programming topics include multiple switches, variables, data wires, mathematical operations, and arrays. Building topics include different types of gears and mechanisms such as four-bar linkages and reciprocating legs. Sample project: design a robotic puppy that uses proportional control to heel.

Work with Linden STEAM Academy

Beginning this January, the CEEO began a partnership with the Linden STEAM Academy in Malden. The Linden STEAM Academy is an innovation school for grades K-8. We wanted to work with Principal Richard Bransfield and the teachers at Linden because they have been working to incorporate STEAM (science, technology, engineering, arts and math) through project-based learning since they became an innovation school is 2012. We feel that the school’s mission is closely aligned with the CEEO’s own mission and its core principles.

The plan for January 2015-June 2015 was to support teachers as they implement Novel Engineering in their classrooms. We are doing this through monthly professional development workshops and by spending one full day each week at the school to visit classrooms and talk to teachers. The professional development workshops are designed to introduce the teachers to the Novel Engineering approach by showing videos of students engaged in Novel Engineering, sharing what other teachers have done in their classrooms and helping them plan for implementation in their own classrooms. Each teacher is approaching Novel Engineering and engineering in a way that works best for their classrooms and with comfort level. We are working closely with the teachers in hopes that they will be able to offer us insight into what we should include in a Novel Engineering package as the grant is ending and we are turning our attention from research to dissemination. Our hope is to continue the partnership during the 2015-2016 school year because we've been very excited by what we've seen so far.
The first professional development session was held at the end of January. This was a brief introduction to Novel Engineering. The teachers read *Peter’s Chair* by Ezra Jack Keats and then found and solved problems related to this text. We spent some time talking about the Novel Engineering approach and books that have been used at other schools. We assumed that the teachers would wait until the next workshop before trying Novel Engineering, but several of the teachers decided to try it in their classroom.

Shoe to help characters escape from a pit of bones from *House of the Scorpion*, by Nancy Farmer.

Teachers from several grades recreated their learning experience and did Peter’s Chair in their own classrooms. Lauren Walsh, a 7th grade English Language Arts teacher, felt that she had a strong enough understanding of Novel Engineering that she could incorporate engineering into her literary groups in four of her classes. The structure of her reading groups remained the same, but students were tasked with finding and solving engineering problems in the books they were reading. We had several conversations with Ms. Walsh to help her define the project and to think about how to include engineering in her classroom.

Each class included five or six reading groups consisting of three to four students. Ms. Walsh gave each group a list of books from which to choose. Students read the books independently, but met with their book groups several times a week to discuss the books, augmenting their usual discussion foci to include those about problems the characters encountered in the text. Students were given a planning sheet that helped them keep track of problems and brainstorm possible solutions. After completing the books, the students moved to the building phase of the unit.

They were given five class periods to plan, build, and present their design solutions. Materials included the typical array of Novel Engineering found materials. We visited several of Ms. Walsh’s class sections as they were building and noticed how thoughtful the students were being about the materials they had
chosen and about how their design solutions would fit within the books given the setting and design constraints that the students had identified in the texts.

This was the first time we’d seen Novel Engineering implemented with students in the same class reading such a large variety of books. We weren’t sure what it would look like and if students would be able to navigate the complexities of integrating engineering and literacy since whole-class discussions would not be present in the classroom. The book group structure that the students had been using all year already focused on discussion and using evidence to support literacy claims worked well and the students did a wonder job. Students used their literacy skills to cite evidence from the books to support chosen design features.

As students built, they tested their designs, making changes based on the results. Each group had share-out, or design review, mid-way through their building time so groups had another source of feedback besides physical tests. Upon completion of their designs, students presented their final solutions and their justifications of why their solution would help solve the characters’ problems.

While students were discussing the books and then building, Principal Bransfield and Susan Terban, the literacy coach, were so impressed with the interdisciplinary work the students were doing that Principal Bransfield invited Malden school administrators, members of the school board and Gary Christenson, the mayor of Malden, to a presentation where students could share their engineering design experiences.

A week after completion of the projects, the students were standing in front of the mayor and other invited guests in the school’s auditorium. Due to time, each group was not able to present their project, but many of the groups were able to talk about what they had built and the rationale for their designs.
At the end of presentations, one student said that when Ms. Walsh first told his class about the project, he thought it was a bad idea and would not work, but he really enjoyed himself and learned a lot. Several of the students said that doing the Novel Engineering unit made them read and think of the book in a different way.

Upon reflecting on the unit and her students’ work, Ms. Walsh said that her students were very engaged and that the engineering brought a new facet to the book groups. She felt that they gained a deep understanding of the books they were reading which was evident through their conversations and writing. We were excited to hear that she will be including Novel Engineering in her classes next year.

This is just one account of what has been happening at the Linden Steam Academy. We’ll continue to spend every Wednesday there until the end of the school year to support teachers and better understand what we need to include as part of the Novel Engineering dissemination package. We have been working with other teachers and classrooms at the Linden STEAM Academy and excited for more teachers to use Novel Engineering in their classrooms.

Safe space to help a character with emotional issues from Flipped, by Wendelin Van Draanen.
2014-2015

Highlights:

- Our new space at 200 Boston Avenue allowed us to add more students to each workshop and to have more workshops over the summer. We also had easy access to Jumbo's Maker Studio, a makerspace next to our workshop room.
- We continued to run workshops to support research projects such as Novel Engineering and Robot Companions and CEEO initiatives such as Billund Builds Music.
- We experimented with new tools such as Little Bits, 3D printers, a laser cutter, and LEGO StoryStarter.
- We collaborated with the Tufts School of Veterinary Medicine on a Saturday workshop based on animal needs.
Publicity

We put together a 24 page glossy book featuring photos from our workshops.

Design and Engineering Workshops
Tufts University
Center for Engineering Education and Outreach

We re-designed the CEEO Outreach Website:

CEEEO WORKSHOPS

Our goal is to provide educators and students with resource and unique opportunities to learn engineering and related STEM concepts. In our local area, we offer a variety of programs for teachers and kids to support STEM education. Our fun and educational workshops provide hands-on learning opportunities that help students and teachers more confidently approach problems in the classroom. We work closely with engineers and educational researchers to ensure that our programs are informed by the latest research and offer innovative, interesting content. We work to develop a long-term relationship with participants in our programs to provide continued opportunities and support.

UPCOMING WORKSHOPS
We are pleased to announce Summer 2015 workshops for students and teachers. To see specific information, click here.

COMMUNITY OFFICE HOURS
The Tufts CEEO is pleased to announce that once a month, we will host community office hours. This is a time to get answers to specific questions you may have or to learn more about what the CEEO does.

January 8, February 5, March 5, April 2, May 7, and June 4 from 4-6

Anyone who is interested is welcome to:

- Learn about the CEEO’s projects
- Partake in events that can be used for excitement in the classroom
We wrote and published a case study on one of our design and engineering workshops

and we created unique laser-cut badges for each of our workshops
Workshops from the Past School Year (September 2014- August 2015)

Each workshop consisted of approximately 20 students and was staffed by at least one professional teacher and two undergraduate assistants.

Workshops Run by the DEW Team:

Telling Stories with LEGO

As part of our ongoing research on the new LEGO StoryStarter kit, we held a small workshop for students in grades 1-5. Students helped us test a new LEGO kit designed for constructing and telling stories. Participants learned about what makes a story a fable, and then brought a fable to life using the LEGO StoryStarter kit and the LEGO StoryVisualizer iPad app. At the end of the morning, all participants had a chance to share the story they create with the group.

Engineering for Animals

Engineering for Animals was inspired by our collaboration with Tufts Veterinary School. Middle school students worked on two engineering challenges that were related to medical issues that the Tufts Veterinary School has encountered: creating splints for broken bones and providing help for dogs that have paralyzed back legs.

Novel Engineering: Solving Real Problems for Characters in Literature

In this workshop students will gain hands-on experience with the engineering design process. Over the four sessions, we will use well-known children's' literature as a foundation for a number of engineering design challenges. As a group, we will read short stories or excerpts and identify problems the characters face. Then, students will take on these characters as “clients” and build working solutions to their problems. Students will have the opportunity to build with recycled materials, LEGO, simple electronics, and littleBits. Students will have opportunities to test the functionality of their constructions and improve them through redesign. Participation is limited to the first 22 students.
Engineering with LEGO

During this session, students design, build, and program robots using the engineering design process. Several open-ended challenges will be posed to the students throughout. They will use standard LEGO bricks, programmable LEGO bricks (including the LEGO EV3), and other materials. The session will start with activities focusing on stability in design and move to other topics such as gearing, weight distribution, and momentum as the students incorporate programming, sensors, and motors into their designs.

Novel Engineering After School Workshop

In this engineering design workshop, attendees participated in a Novel Engineering activity based on the book *Weslandia* by Paul Fleischman. Over the two 1.5 hour sessions, participants identified problems that characters faced and determined the criteria important to consider in their design. They then built working solutions for the characters using a combination of LEGO’s Simple Machines kit and LEGO’s Story Starter kit. They had opportunities to test their designs, gather feedback from their peers, improve their designs, and present these functional solutions to the entire group.

Introductory LEGO Robotics- EV3

This workshop was for students in grades 3-8 who had **no experience with the LEGO EV3 robotics platform**. Students were presented with a series of design challenges that required them to build, program, and cycle through the engineering design process.

Co-Ed Robotics

This session helped students design, build, and program using the engineering design process. Several open-ended challenges were posed to the students throughout the week. They used standard LEGO bricks, programmable LEGO bricks, and other materials to complete these design challenges. The week started with activities focusing on stability in design and moved to other topics, such as, gearing, weight distribution, and momentum, as the students incorporated programming and motors into their designs.
**Girls Design and Engineering Workshop**

The week consisted of open-ended mini-challenges using different materials and new technologies culminating in a larger user-centered design project. Students explored the topics of simple electronics, human factors, 3D printing, programming, robotics, and user-centered design. The focus was engineering, but special attention was paid to the client and scoping problems to better address problems in design solutions. Projects were shown off to family and friends in the afternoon on the concluding day of the program.

**Musical Instruments**

In this week, students learned the basic science behind sound while working to design, build, and ultimately perform on a musical instrument of their own invention. Once they were familiar with concepts such as pitch and tone, the students discovered what causes the changes through experiments and demonstrations. The kids then went through the engineering design process to brainstorm, plan, and build instruments out of a variety of materials such as PVC pipe, glass bottles, LEGO and stretched string before practicing a little and putting on a concert at the end of the week.

**Helper ‘Bots**

Engineers help people in all aspects of their lives. In this workshop, we learned (through books, YouTube and more) about robots that help people and design and build our own helping robotic devices. We used the LEGO WeDO platform to build and program our robots.

**Play that Song**

In this workshop, students used found and craft materials to learn about sound. Participants designed and played their own musical instruments. (This session does NOT use LEGO Robotics).