

The CEID at 10

Celebrating a decade of innovation,
collaboration and education



When the Center for Engineering Innovation and Design (CEID) officially launched in 2012 — 10 years ago! — it opened a whole new world of innovation for the Yale community. Countless SEAS majors began their engineering journey at the CEID. Perhaps they were invited by a friend or were curious about what they saw through the massive windows that line Prospect Street. Maybe they stopped in for one of the many workshops held at the CEID — hands-on explorations into everything from Arduinos to molecular gastronomy to motion graphics to ham radios and working with concrete.

With the CEID, Yale had for the first time a primary, centralized hub where people could generate ideas and produce prototypes. It quickly became a place where plans made their way from the whiteboard to the real world. Better ways to perform surgeries, make music, preserve art, and

countless other innovations had their genesis at the CEID in the last 10 years.

The CEID acts as both an educational resource as well as a focal point for design and engineering on campus. Designed as a space to foster collaboration, its 8,700-square-foot John Klingenstein '50 Design Lab combines an open studio, lecture hall, wet lab, and meeting rooms. The studio is equipped with 3D printers, hand tools, electronics workstations, and a variety of materials for members to use. Typically, members have 24/7 access to the studio space, as well as to a state-of-the-art machine shop, wood shop, and wet lab during regular staffed hours. The CEID was one of former SEAS Dean Kyle Vanderlick's strategic priorities in 2010 when she led efforts to create and support the center's design, construction, and operations.

“My friends and colleagues from the CEID have gone on to earn Ph.D.s from top institutions and start businesses; and they are some of the first people I reach out to when I have questions or need advice,” said Glen Meyerowitz ’14, now the director of engineering for biodesign at UCLA Health. “It was a privilege to have access to a world-class facility filled with curious and enterprising students, staff, faculty, and community members.”

Students have used the CEID as a base for launching what would become million-dollar startup companies. Faculty have used it to bolster game-changing research. But the CEID has also wended its way into the nooks and crannies of everyday life, as students use the same space and resources to make presents for families or sculptures to mount on their mortarboards at graduation.

“I always felt welcomed by the CEID, and in turn I felt a sense of duty to make the CEID as welcoming as possible to anyone who entered,” Antonio Medina, ’19, a former CEID design fellow. “From theater majors to architects, surgeons to football coaches, everyone on campus knew that the CEID was the go-to spot to turn their ideas into reality.”

In its first 10 years, the CEID has made engineering, innovation, and technology more accessible to everyone. Guest lectures, tech talks, social events, undergraduate clubs, and hackathons have brought together folks from Yale and well beyond campus. To celebrate a decade of innovating and collaborating, we highlight 10 great things about the CEID:

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Where Engineering Meets Medicine

Since its beginning, the CEID has closely aligned itself with the Yale School of Medicine through numerous collaborations. The most recent example is the new Master of Science in Personalized Medicine & Applied Engineering (see story on page 6). One of its most fruitful collaborations is the course Medical Device Design (MENG/BENG 404). There, student teams work with “clients” from Yale Medicine to come up with an innovation to improve healthcare in some way. Results have included a balancing device that measures the recovery progress of head injury patients, a device to better transport donated organs, and a virtual reality platform to examine kidney biopsies. Some of these projects outlasted the course, with the clients and students continuing to iterate and improve on them. Others have become their own start-ups (more on that soon).



Glen Meyerowitz

Director of Engineering for Biodesign at UCLA Health

The CEID was established while I was a student at Yale, and its presence radically changed the course of my time at Yale. My first two years on campus were “pre-CEID” and the final two years were “post-CEID.” The CEID had a very positive impact on me, serving as a nexus of innovation and collaboration, bringing together disparate groups of students, faculty, campus institutions, and more in ways that was difficult to do before. From working on class projects to student groups, I probably spent more time in the CEID than any other place on campus after it opened. The doors that were opened for me have propelled my personal and professional growth since then.





Completed in 1504, Michelangelo's David was remarkably well-constructed. But it's been more than 500 years, and time takes a toll on everything. Hairline cracks have been showing up in David's ankles. In the course Materials Science of Art, these tiny cracks served as a window into the artistic process and how a work changes over time. It also gave students a chance to engineer solutions to keep David from keeling over.

In other artistic pursuits, students have explored the chemical make-up of paints, and why certain photos will fade. A student group worked with Yale's Center for Collaborative Arts and Media (CCAM) to create an automated rotating sign that announces the organization's presence to all passersby on York Street. Courses on the artistry of light and spaces have also taken place here. And in a less structured role, the CEID has also been a go-to space for individual artists to come and hash out their own work.

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The CEID and the Arts

The Yale lacrosse team won its first national championship since 1883 the same year it first started using the Lightboard, a device created at the CEID to help goalies hone their reaction times. A coincidence? Perhaps we're biased, but we're pretty sure there's a connection. The device has 15 circular lights, each a different color that the user hits upon flashing as fast as he or she can. It's a deceptively simple idea that improves players' reflexes and provides coaches with a heap of useful data. It was just one of the many CEID-based projects designed to boost athletics.

The Bulldog RepBox ensures that users are performing their push-ups, squats, sit-ups, and other exercises properly. As the flagship item in the Projects2Products (P2P) program, you might soon be seeing it in a lot of gyms. P2P is an undergraduate student innovation program that provides hands-on experience in all angles of entrepreneurship — product design, manufacturing, and marketing — to turn student projects into commercial products.

Other sporty innovations include a mat fitted with sensors to help tennis players improve the accuracy of their serves, and a weight training device known as the Velociraptor that measures the speed of the user's movements.

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3 Engineering a Better Athlete

4 Where Entrepreneurship Begins

Khushi Baby, a company that uses technology to improve community healthcare, was started as a student project at the CEID by Ruchit Nagar '16. It's now a global company with 50 employees that has screened more than 18 million people in Rajasthan, India's largest state. The company has developed a platform that stores medical histories, sends messages to beneficiaries, and provides health officials with critical data. Together, it ensures offline, informed, and accountable screening, referral, and follow-up care.

The CEID also spawned the start-up Arix, a company founded by Dianna Liu '18 and two recent SEAS grads Petter Wehlin '17 and Bryan Duerfeldt '17 that uses robotics to inspect pipes for corrosion — a much easier and safer way than conventional methods.

Wellinks, founded by Ellen Su '13 and Levi DeLuke '14 also came out of the CEID. The startup focused on a smart strap for scoliosis braces aimed at giving its users, especially children, a greater sense of independence.



Antonio Medina

Current student, Stanford University's Design Impact Program

I owe so many of the incredible experiences I had at Yale directly to my involvement with the CEID. In the span of one year, I got to write a paper with the United Nations, design and teach my own technical workshops, present at a musical invention competition, host a conference with instructors from makerspaces around the world, develop a product with a manufacturer in China, and give a tour to the president of a foreign nation, all while helping mentor students, work on my own side-projects, and apply to grad school.






Kayla Matheus

The first CEID design fellow, and now a Ph.D. student in the lab of Yale Computer Science Prof. Brian Scassellati

I remember it feeling very unique at the time, how interdisciplinary the center was. [Being a dual art and engineering major], it felt like there was this turning point where I was in these totally separate worlds and here was a place and a vision that was trying to pull people of different mindsets from different departments together. It was funded through SEAS, but anyone on campus could come and make things. That was absolutely amazing to me at the time and it still is. And I think in the last ten years, coming back now, it's shown that there are a lot more students that are thinking in this interdisciplinary way and are coming together.



Exhibits, curators, and scientists at some of the most prestigious museums in the U.S. have all benefited from the work of the CEID. Sometimes it's a matter of custom-making a machine to generate multi-colored lights for an exhibit at the Yale University Art Gallery. Or it could be to help preserve priceless and centuries-old artifacts from ancient Egypt. In that case, a student team devised a way to dampen vibrations that could potentially damage ancient wooden coffins in the Egyptian Art collection at The Metropolitan Museum of Art in New York.

Another group of students worked with officials at both the Smithsonian Institute in Washington, D.C. and Yale's own Peabody Museum of Natural History on a contactless microscope. It's now being tested for use in museums. Patrons operate the device, named the Hover, to get a more detailed look at some of the museums' artifacts.

Officials at the Yale Center for British Art have also worked with the CEID on projects ranging from better ways to clean paintings to setting up new exhibits.

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5 Assisting the World's Greatest Museums

6

CHIME: Collaborating in a Crisis

In the spring of 2020, the CEID doubled as the hub for the urgently formed Coalition for Health Innovation in Medical Emergencies (CHIME), a collaboration of engineers, physicians, nurses, and many others, to provide healthcare professionals with the tools they needed to combat COVID as it was first hitting the U.S. The team first identified the most crucial problems facing healthcare workers and the best ways to address them. This included a new technology to test non-certified face masks, alleviating a critical shortage of masks in hospitals.

Progress was quickly made on several other projects, including a device to measure the reliability of non-certified respirators, and efforts to allow ventilators to treat more than one patient at a time. A partnership with researchers at the School of Engineering & Applied Science and the School of Medicine resulted in a research journal paper on bench-top testing of masks and respirators allowing the work at Yale to be replicated around the world.

The CEID, which has been described by Yale SEAS Dean Jeffrey Brock as the “portal to the world for innovation at Yale,” has hosted several international guests and events. This includes the International Symposium on Academic Makerspaces (ISAM), which convened at Yale in 2019. The event was co-hosted by Olin College and attended by 350 maker educators, equipment manufacturers, and other enthusiasts from 156 universities from 14 countries. For three days, they talked shop, traded notes, and heard from leaders in the growing multi-disciplinary field.

The CEID also hosted a partnership between SEAS, the School of Architecture, and the Whitney and Betty MacMillan Center for International and Area Studies at Yale—all of whom worked with Afghan entrepreneur Roya Mahboob on designing the Dreamer Institute, a school to be attended by both boys and girls in Kabul.

Students taking the course Environmental Technology and the Developing World traveled to Nicaragua to collect data and run experiments designed to solve real-world problems related to water purification and air quality.

Most recently, the CEID hosted a weeklong workshop for Israeli high school students, where they learned the many aspects of turning student projects into commercial products.

7 From Prospect Street to the Rest of the World



Lauren Chapey

Manager, New Markets Advisors

There were so many interesting projects and experiments going on, and I found a lot of inspiration from my peers and their work.

While the CEID is obviously an engineering-centric space, the most important skills I developed there were non-technical, like collaboration, communication, and public speaking. Even the most sophisticated engineering project loses its value if you can't show it to the world.

All the hands-on courses and extracurriculars I participated in at the CEID taught me not only how to build interesting things but also how to explain them to my peers and to the broader world. I continue to use these skills in my everyday life today, fostering community wherever I go.

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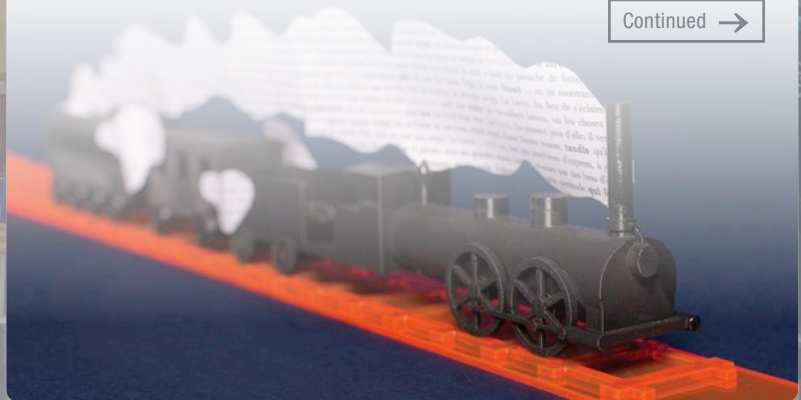
Collaborations You Probably Hadn't Considered

If you thought a 132-year-old French literary classic would be out of place in a tech-heavy hub of innovation, think again. Working with assistant professor of French Morgane Cadieu and her students, the CEID staff 3D-printed the train at the center of Emile Zola's 1890 novel "La Bête Humaine" ("The Beast Within") based entirely on descriptions from the book. Once the train found its way to Cadieu's classroom, it became the focal point of discussions on language, metaphor, and the nuances of translation.

Fictional trains are one thing, but can you 3D-print a neuron? Absolutely. With help from the CEID, Dr. Gordon Shepherd, professor of neurobiology became the first person in the world to do so. The 3D-printed neuron is approximately 1,000 times bigger than the actual neuron in the hippocampus. When holding the printed neuron, researchers said they could notice details of the flexible dendrites that they hadn't noticed from looking at models on the computer.

The makerspace has also contributed to Yale's vaunted tradition in the dramatic arts, thanks to the senior project of mechanical engineering major Sydney Garick '18. Working in the CEID, she built a giant LED panel – essentially, a floor with programmable lights – to be used in the Yale production of the musical "Fun Home."

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Air, Bones, and Other Faculty Research

However esoteric the subject, the CEID can help. That includes monkey bones. Dr. Robert Wyman, professor of molecular, cellular and developmental biology, took advantage of the CEID's resources to replicate the bones of extant specimens of the cercopithecoid primates, which include baboons and macaques. The 3D-printed replicas were used for comparisons to fossils and to study the degree of variations between the bones.

The CEID is also helping you breathe better air. Students in ENAS 118 worked with Drew Gentner, associate professor of chemical & environmental engineering and the environment on sensors for a study on the air quality of Baltimore. The devices measure particles and volatile compounds in the air in micrometers. Some were designed for portability, so that the study's subjects could carry them around all day.

When Dr. David Frumberg in Yale Orthopedics needed to fix an abnormal connection between two bones in a patient's leg, he knew X-rays and CT scans wouldn't give enough information for the tricky case. He went to the CEID to make a 3D-printed model of the joints. Having the model allowed him to see things he couldn't before. The operation was a success.



Jan Kolmas

**Software Developer —
Flight Control, Wingcopter**

My favorite part about the CEID was the atmosphere — everyone there shared a passion for building things and was excited to tell about it. Plus, no matter when I passed by, there was always someone I knew.

I learned a lot of hands-on skills with mechanical design, prototyping, machining, as well as electronics. I also developed a love for whiteboards.

10

Years of Teaching Engineering in All Its Forms

Perhaps more than anything, the CIED is a place to lean. In its 10 years, the CEID has been a hub for forward-thinking, collaborative courses. In Engineering Innovation and Design, taught by Larry Wilen, a Yale senior research scientist and design mentor in the Center for Engineering & Design, and SEAS Deputy Dean and James S. Tyler Director of the CEID Vincent Wilczynski, students learn to work in teams across multiple engineering disciplines to develop a project for a guest client.

In Musical Acoustics & Instrument Design, students design and build entirely new musical instruments. Taught by Larry Wilen and Konrad Kaczmarek, a composer and lecturer in the Department of Music, the course has produced instruments that draw inspiration from everything from wine glasses and Ben Franklin to Tuvan throat singers.

In Making It, taught by Joe Zinter, assistant director at the CEID, students take on the many facets of product design and development while simultaneously working to conceive and develop a marketable product and business.

The projects that come out of these often take on lives that go well beyond the courses themselves, in the form of products or extended multidisciplinary collaborations. 