



School of Engineering Innovation & Entrepreneurial Thinking Program

Program Summary for 2017-18

Innovation & Entrepreneurial Thinking

Motivated by our involvement in KEEN (Kern Engineering Entrepreneurship Network), the School of Engineering is enhancing student learning opportunities offered in the area of engineering innovation and entrepreneurial thinking.

Entrepreneurial thinking, in this sense, is very broadly defined and is not limited to the Silicon Valley notion of teaching students to create start-ups. Instead, our interest is in developing a mindset that enables students to harness raw technical innovation by knowing how to apply technology to solve real problems for real people, and to do it in a way that is financially and logistically sustainable. As such, the tenets of this entrepreneurial mindset are applicable to any new engineering venture, be it a start-up, a development effort in a larger company, or even a not-for-profit social enterprise.

The program capitalizes on a framework for student outcomes focused on instilling an ***“entrepreneurial mindset, coupled with engineering thought and action, expressed through collaboration and communication, and founded on character.”**** The entrepreneurial mindset itself combines a ***Curiosity*** about our world, the ability to make ***Connections*** from many sources of information to gain insight, and the savvy to identify and capitalize on opportunities to ***Create Value***.

Our involvement in this effort began in 2009 and has been supported through grants from the Kern Family Foundation and collaborating industrial partners. As part of this program, we collaborate with more than 30 other universities in the KEEN network to share best practices and collectively advance the techniques for teaching the entrepreneurial mindset. Other KEEN universities include Bucknell University, Villanova University, Gonzaga University, St. Louis University, Baylor University, Worcester Polytechnic Institute, and the Georgia Institute of Technology

Program Opportunities

Since 2009, our involvement in this program has led to the development of a variety of new programs, courses, extra-curricular activities, and joint projects with KEEN partners. It has also led to increased collaboration between the School of Engineering and other Santa Clara University entities such as the Leavey School of Business and the Law School.

Examples of program activities include:

- **Curricular Programs:** In the Design Thinking Core Curriculum Pathway, students connect diverse topics to the holistic elements of design. The new Minor in Technical Innovation and Entrepreneurial Thinking highlights the role of value creation in the engineering process.
- **Courses:** Elective courses include the program’s flagship Smart Product Design course, courses in a new BioInnovation track, and nearly 20 new 1-unit courses on topics such as Opportunity Recognition, Creativity, and Business Fundamentals. Standard engineering courses are being enhanced to link topics to solving real-world problems, creating measureable economic and social value, and informing engineering decision-making with deep customer understanding and insight on how engineering enterprises function.
- **Co-/Extra-curricular Activities:** Each quarter we offer an exciting lineup of activities such as industry seminars and tours, entrepreneurial design challenges, lunch with an entrepreneur events, movie nights, and an industry mentoring reception.
- **Faculty Development:** New seminars, online courses, workshops and curriculum development exercises exist for faculty to learn more about how to develop the entrepreneurial mindset in students.
- **KEEN collaborations:** Collaborative “real world engineering enterprise” projects engage students in projects that have real, long-term customers and which result in functional, fielded, supported engineering products/systems.

School of Engineering

Innovation & Entrepreneurial Thinking Program

EDVenture Lab

The EDVenture Lab Initiative

A 2015 grant from the Kern Family Foundation allows the School of Engineering to expand its Innovation and Entrepreneurial Thinking program with the creation of the EDVenture Lab. The vision of this Lab is:

- To serve as a physical nexus for interactions between Engineering and a) university partners from business, law, and the arts, and b) industry partners engaged in entrepreneurial partnerships,
- To host/incubate real world engineering enterprise projects focused on providing real products and services to real customers (to include commercial startups, corporate intrapreneurial initiatives, and social enterprise projects),
- To host activities that are part of our KEEN (and associated) program(s), such as entrepreneurial thinking courses, extra-/co-curricular activities, etc.

The name “EDVenture” blends 3 critical components of the SCU vision of the entrepreneurial mindset:

- **E = Engineering:** Reinforcing our commitment to deep science and engineering knowledge;
- **D = Design:** Exploiting the body of knowledge known as Design Thinking, this program element infuses conventional engineering processes with holistic systems thinking, deep customer empathy, creativity, and knowledge from the liberal arts;
- **Venture = Enterprise Activities:** Acknowledging that any engineering innovation must ultimately be produced/served in a logistically and financially sustainable manner, this program element integrates enterprise processes that are part of any initiative intended to create value, including entrepreneurial start-ups, corporate intrapreneurship initiatives, and social enterprises.

With the EDVenture Lab, we’ve found a fun name (implying an “educational adventure”) for a new initiative that resonates at SCU on many levels. First, it demands all of the KEEN skills and behaviors that we are incorporating within our undergraduate engineering programs. Second, it calls out the primary elements of a scholarly model of innovation and the entrepreneurial mindset: technical feasibility, economic viability, and customer desirability. Third, it represents the three physical “neighborhoods” that constitute

SCU’s new Innovation Landscape (and campus re-architecting) initiative: the STEM (engineering and sciences) area, the Arts neighborhood, and the “Professional” area (Business and Law schools).

EDVenture Lab Activities

The defining activity of the EDVenture Lab is the cultivation of student teams in the creation of real-world, entrepreneurial, engineering enterprises. These enterprises include new commercial and social ventures, teams that provide real market-driven products and services, Minimum Viable Product (MVP) creation activities, and teams that conduct prototype-based customer discovery with industry partners. These opportunities transform an engineering education by grounding the development process in the context of creating value for real customers, implementing a functional business model, and achieving competitive performance.

To date, the Lab has hosted 10+ enterprises involving more than 60 students, several new student ventures, and a half dozen external partners. Examples of EDVenture enterprises include:

- **OnePointOne: Aeroponic Agriculture:** This student-led startup is pioneering a new agricultural market with a functional prototype, a business plan with extensive market research, and new venture capital investment. 
- **TETEA: Assisting Students in Tanzania:** This student-created social enterprise provides SMS/web data services to help students in Tanzania study system for national exams and access educational data. 
- **SE3D: BioPrinting to the Classroom:** Via an SBIR partnership, students developed an MVP incubator to complement the SE3D’s line of products. Interns also developed the first version of the company’s bioprinter, built the first 15 units, and transitioned manufacturing to a contract manufacturer. 
- **FASS: Indoor Inspection Drones:** Students developed an MVP indoor inspection drone for a FASS, a local utility services company, which is now commercializing the design. 

Additional enterprises have included providing remote prototype fabrication and fulfillment services for Intel product designers, developing deep learning sensor analytics for an SBIR-funded company, creating a new concussion-tracking system for athletes, and exploring new personal training services through the use of optical tracking and virtual reality technology.



Through the SCU robotics program, out of which the EDventure real-world projects program grew, students continue to create and operate ongoing real-world enterprises involving robotic and automation technology. This work includes providing contract satellite control services for NASA, providing underwater mapping and inspection services for the U.S. Geological Service and academic scientists, developing an MVP autopilot system for an automated boat system being developed by corporate partner Deep Ocean Engineering, and creating a new indoor drone product MVP using a custom Intel computing platform. The unique real-world nature of this program has resulted in recognition by the National Academy of Engineering and by IEEE.



The EDventure KEEN-Wide UAV Initiative

One particularly interesting real-world EDventure initiative is the creation of new student-run enterprises involving the provision of Unmanned Aerial Vehicle (UAV) services. These services include aerial mapping, roof inspection, photography and filmmaking, and vegetation health monitoring. This is a particularly fascinating area given the rapid advancement of UAV technology, the formation of new UAV markets, etc. This focus also exposes students to a range of real-world issues such as legal and regulatory constraints, ethical implications, and professional practice.



An interdisciplinary student team ranging from freshman to doctoral students learns to prepare a group of UAVs for flight.

SCU is leading a group of half a dozen KEEN universities, to include institutions such as St. Louis University and Baylor University, to create these enterprises by navigating federal UAV requirements, developing flight policies consistent with the risk and safety requirements for each campus, and creating effective flight training and operations protocols.

The EDventure Innovation Sandbox

The Innovation Sandbox Program is a new EDventure Lab initiative in which students are able to observe the operation of business partners, identify opportunities to create value, and pitch new engineering development initiatives for potential funding and implementation. Current industry partners for this program include Avaya Stadium, home to the San Jose Earthquakes soccer team, and Aver Winery, a local family winery.



EDventure Lab Partnerships

The new EDventure Lab is located in Guadalupe Hall immediately next to the expanded Maker Lab and the Frugal Innovation Hub. Through partnerships with the Center for Innovation and Entrepreneurship (CIE), the Entrepreneur's Law Clinic (ELC) and High Tech Law Institute (HTLI), the Miller Center for Social Entrepreneurship, the Markkula Center for Applied Ethics, and the Sponsored Projects Office (SPO), the Lab offers a quarterly series of talks/workshops and mentoring sessions on the business, legal and ethical challenges relating to new engineering ventures. It also helps to integrate non-engineering students into EDventure Lab activities in order to provide broad interdisciplinary expertise for new ventures.

EDventure Lab activities are complemented by our Maker Lab programs, creating a powerful resource for conducting educational activities and performing joint projects with industry, community, and K-12 partners.

School of Engineering

Innovation & Entrepreneurial Thinking Program

Student Engagement Program and Co-/Extra-curricular Activities

Program Objective

The purpose of this program is to enhance our engineering program with co-/extra-curricular activities that complement classroom learning, foster professional skills, provide leadership opportunities, and instill entrepreneurial thinking. The program leverages many established programs and is supported by the University and the School of Engineering, private donors, industry partners, and the School's KEEN grant.

Quarterly Industry-Affiliated Events

Each quarter, we conduct a series of activities involving industry partners in the local area. Each of these activities routinely draws 25-50 students and faculty. These activities include:

- **Technical Innovation Seminar:** This features a technical presentation of a company's new technology and how they are attempting to use it to create value through new products and services.
- **Lunch with an Entrepreneur:** We host two of these Lunches each quarter, featuring an entrepreneur who share's his/her story on starting a new venture. These informal and interactive lunches often address lessons learned, professional motivations, pros/cons of new ventures, and discussions of "things I wish I knew."



A CEO from a local startup shares lessons learned during a Lunch with an Entrepreneur event.

- **Entrepreneurial Thinking Challenge:** These activities challenge students to showcase their entrepreneurial skills in various ways, often with grand prizes of \$1,000-\$2,500. A typical challenge involves conceptualizing a new product-service for an industry partner that results from applying their core technology to a new market. In addition, one challenge each year is a Maker

Challenge in which teams conceive, design, and make several dozen units of a product which are then sold in the campus bookstore.



Three undergraduate students win \$500 in a design challenge involving the design of a new NASA space mission patch.

- **Mentoring program:** Quarterly mentoring receptions are held with students and local industry engineers in order to foster informal networking. These events occasionally include "speed mentoring" or "mentor bingo" activities to help break the ice and stimulate conversation. Informal mentoring during the year is encouraged based on connections made at each reception.



More than 75 students and industry engineers participate in a quarterly mentoring dinner.

- **Movie Nights:** Movie nights (and sometimes lunches) are held, featuring documentaries such as Design and Thinking, Make: The Movie, Something Ventured, and Generation StartUp.

Education Outreach & Community Service

Outreach to the K-12 educational community and educational service supporting after school programs for underserved students are both supported through a new Makerpreneurship program.

The central elements of this program are our new Mobile Maker Lab, associated hands-on STEM and makerpreneurship curricular activities that are being



The Mobile Maker Lab is the primary facility for our education outreach and community service program.

developed with local educators, and a range of support services that are being implemented through the use of our main School of Engineering Maker Lab. These elements combine to provide the following services:

- An in-school and after school program visitation capability in which the Mobile Maker Lab can be used to conduct a range of hands-on maker-oriented STEM activities.
- A remote consultation and fabrication capability in which local students can upload 3D printer, laser cutter, and vinyl cutter designs. This can be used to obtain interactive feedback from university students via internet videoconferencing and to also support part fabrication.
- Teacher training, curriculum sharing, and machine support services for local educators interested in incorporating maker capabilities into their programs.



Local teachers tour the Mobile Maker Lab as part of a teacher training program.

Educational outreach blends these services to serve the needs of local teachers. Outreach can range from a single field trip-style visit to an integrated partnership that includes multiple visits, remote consultation and fabrication services, curricular collaboration, and teaching/maintenance support. Existing curricular

modules meet a range of national teaching standards and Project Lead The Way objectives. Key partners in this program include the SCU School of Education (teachers in training are helping to develop curricular modules) and the non-profit Ignite program (which has a network of more than 1,000 local STEM teachers interested in opportunities such as this).

From a community service perspective, this program includes similar use of the Mobile Maker Lab and remote fabrication capabilities in order to assist local after school programs for underserved communities. These programs focus on the development of an entrepreneurial mindset, and the addition of maker-style prototyping will allow these programs to complement exercises in opportunity recognition and concept design with intentional prototyping that improves feasibility assessment, customer engagement, and the articulation of value. During the 2016-17 academic year, we plan to institutionalize SCU student involvement in this program as part of the University's established Experiential Learning for Social Justice (ELSJ) program, a core curriculum activity required of every student in the University. This ELSJ option will be in the form of a new course, Makerpreneurship, and will involve teaching and mentoring the underserved middle and high school students that are part of these programs. Expected partners for this program include D-Farm in East Palo Alto and City Year in San Jose

Student Club Leadership

Student-led clubs are a powerful way to develop leadership skills and to allow students to define activities and contributions based on their own interests. Through the University's and School of Engineering's student clubs program, two specific clubs are active in activities relevant to our program:

- Santa Clara Innovation and Design Club (SCID): During the past year, SCID organized their own speaker series featuring prominent product designers and design engineers from the local area. SCID also organized and conducted their 2nd annual Designathon, a full day hackathon-style competition involving more than 70 participants, complete with a keynote speaker, industry judges, meals, and several thousand dollars of prizes. Teams were challenged to identify and propose a

solution to problems in the broad area of “travel.” SCID students will be volunteering in the previously described community service program involving after school entrepreneurial thinking programs for underserved youth.

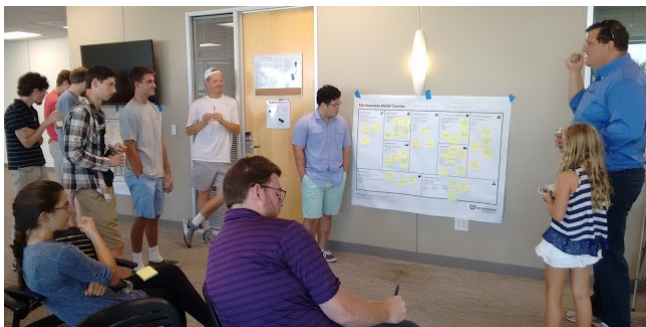


More than 70 students and industry mentors participated in SCID's annual Designathon.

- **Maker Club:** Students in the Maker Club conduct their own maker-oriented projects and also volunteer as student supervisors in the Maker Lab. These students will be volunteering in the previously described Makerpreneurship education outreach and community service program.

Summer Professional Development Series

Each summer, we conduct a series of weekly lunchtime talks focusing on a range of professional development topics.



Students pitch a business model concept for an entrepreneurial initiative as part of a summer professional development exercise.

These topics include subjects such as professional networking, business and legal challenges/issues in engineering enterprises, the nature of engineering jobs in small and large companies, the entrepreneurial ecosystem of the Silicon Valley, and the similarities and differences between conventional entrepreneurship, corporate intrapreneurship, and social entrepreneurship.